XVII Congress of the International Society of Craniofacial Surgery (ISCFs)

ABSTRACTS BOOK

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ABSTRACTS
1
THE EFFICIENCY OF ANTERIOR AND POSTERIOR DISTRACTION OSTEOSTGENESIS FOR CRANIOSYNOSTOSIS REPAIR
Presenter: Amanda A. Gosman, M.D. 251 (6 Min)
Authors: Amanda A. Gosman, Michael G. Brandel, Cecilia L. Dalle Ore, Chris M. Reid, Samuel Lance, Hal Meltzer
Institution: University of California, San Diego

Abstract
Introduction: Cranial vault remodeling (CVR) with distraction osteogenesis (DO) may be completed with an anterior or posterior approach, unilaterally or bilaterally. We sought to determine 1) the relative efficiency of different approaches in expanding intracranial volume (ICV) and 2) the impact of adjusting for ICV growth on measured DO efficiency.

Methods: Craniosynostosis patients were treated with open CVR and internal DO. Pre/postoperative CT scans were used to quantify ICV change. DO efficiency is reported using our previously described Metric, calculated from the division of percent ICV change by total distraction length. Nonparametric statistical tests and multivariable linear regression were used to compare the Metric between different approaches and distraction laterality. An ICV growth curve was used to adjust for normal growth.

Results: 21 patients underwent CVR with DO; 12 unicoronal, 5 bicoronal, 3 multisutural, and 1 lambdoid. Results are reported in medians. Distraction efficiency was 1.12%/mm for anterior unilateral (n=12, age=8.93 mo.), 0.26%/mm for posterior unilateral (n=1, age=13.74 mo.), 0.40%/mm for anterior bilateral (n=3, age=15.10 mo.), 3.41%/mm for posterior bilateral DO (n=5, age=6.74 mo.). Mann-Whitney U Tests showed posterior bilateral DO was more efficient than anterior unilateral DO (p=0.05), which was more efficient than anterior bilateral DO (p=0.02). On regression analysis controlling for age, posterior bilateral DO was more efficient than other types of DO (p<0.01). An adjusted metric was calculated for patients who received anterior unilateral distraction, which was 0.38%/mm. This was significantly different than the unadjusted metric (p=0.0001).

Conclusions: Posterior distraction is more efficient for ICV expansion than anterior distraction, which may have implications for the choice of approach for craniosynostosis repair. Additionally, adjusting the efficiency metric for expected ICV growth significantly impacts.

2
IMPROVEMENT OF SLEEP APNEA AFTER FRONTOFACIAL MONOBLOC IN 108 FACIOCRANIOSYNOSTOSES
Presenter: Eric Arnaud M.D.
Authors: Eric Arnaud, S. Haber, G. Paternoster, S. James, B. Fauroux, Ph. Meyer
Institution: Hospital Necker Craniofacial Unit

Abstract:
Long-term effectiveness of Frontofacial Monobloc Advancement (FFMBA) on sleep apnea was analyzed.

Methods: This is a monocentric prospective cohort study on 108 kids with FCS treated by FFMBA with 4 internal distractors and with a 5 months consolidation time. The primary outcome was achieving a normal Apnea Hypopnea Index (AHI) (less than 5/hour) on polysomnography (PSG) without additional surgery. Age at operation was 47.7 ± 36.6 months. Mean follow-up was 56.5 ± 48.6 months.

Results: 69 children (63.9%) achieved at least 50% improvement in AHI. Among them 39 (36.1%) normalized their AHI without additional surgery in 28.3 ± 28.3 months while 16 others (14.8%) did so after additional surgery (ENT). 10 patients (9.3%) eventually relapsed in 22.0 ± 14.0 months. Previous turbinectomy and tonsillectomy were associated with a better response rate, a faster response, a longer period before relapse, and less need for additional surgery (p<0.05). FGFR2 mutation, and previous posterior or lateral decompression or Rénier H technique were all associated with less relapse, while previous fronto-orbital or facial advancement were associated with more relapse. Higher AHI at baseline was associated with secondary facial advancement (21 children, 19.4%). Age at operation was not significantly associated with treatment response and relapse. However, young age was associated with previous tracheotomy, higher AHI at baseline, Pfeiffer syndrome, use of transfacial Kirschner wires with external traction, and absence of previous turbinectomy and tonsillectomy, corresponding to greater severity.

Conclusion: FFMBA is an effective procedure to correct or minimize OSA in FCS. Turbinectomy, tonsillectomy and cranial vault expansion are indicated before FFMBA. Previous FOA or Lefort 3 before FFMBA are associated with earlier relapse.
Abstracts

3
A SOFT TISSUE PREDICTION MODEL TO EVALUATE OUTCOME OF FRONTOFACIAL DISTRACTION SURGERY IN SYNDROMIC CRANIOSYNOSTOSIS
Presenter: Freida Angullia M.D.
Authors: Freida Angullia, W R Fright, R Richards, A D Linney, S Schievano, D J Dunaway
Institution: Great Ormond Street Hospital for Children
ARANZ Medical Ltd, Cavendish Implants Ltd, UCL Ear Institute, UCL Institute of Child Health, Great Ormond Street Hospital for Children

Introduction: Distraction of the monobloc segment in syndromic craniosynostoses does not directly correlate with the overlying soft tissue response. This study aims to present monobloc facial distraction outcome of bone and skin as relative movements in 3-dimensions and predict soft tissue outcome.

Method: 21 monobloc procedures for Crouzon-Pfeiffer syndrome were retrospectively analysed. Bone and skin surfaces of pre- and post-operative 3D CT scans were landmarked. Unoperated regions were registered and aligned. Change vectors at each landmark were computed for the bone and skin across 7 facial regions. The cohort was grouped according to standardised craniometric measurements. An interpolation function was applied to the surfaces between landmarks to produce a predicted post-operative skin surface per group. Differences between predicted and actual skin outcome is reported as RMS values (root-mean-squared; like standard-deviation).

Results: Mean distraction vectors (mm) for skin, and monobloc segment, by region were 10.8, 14.7-ocular; 15.1, 14.9-brow; 15.1, 15.2-forehead; 15.3, 15-nasal; 11.7, 13.5 zygomatic; 14.6, 14 maxillary; 8.4, 5.5-mandibular. Skin:bone ratios were 0.7:1-ocular; 1.1-brow; 1.1-forehead; 1.1-nasal; 0.9:1-zygomatic; 1:1-maxillary; 1:1:mandibular. RMS values (mm) were 2.5-ocular; 1.5(cenral), 3.5(lateral) brow-forehead; 2.8-nasal; 3.0-maxillary; 3.2-zygomatic; 3.2-mandibular.

Discussion and Conclusion: The predictive model ‘overcorrected’ the midface and ‘under-rotated’ mandibular regions. Midline shape was better predicted than lateral regions. Exorbitism correction was under-predicted. Accuracy of prediction of globes and lateral face are affected by ‘unconstrained’ areas of the globes and unoperated skull. Reducing heterogeneity of the cohort by grouping improved prediction efficacy. This novel approach in predicting outcome for frontofacial distraction has clinical value but needs constraining to be useful for planning surgery.

4
THE WHITAKER CLASSIFICATION OF CRANIOSYNOSTOSIS OUTCOMES: AN ASSESSMENT OF INTER-RATER RELIABILITY FOR FRONTAL-ORBITAL SURGERY
Presenter: Ari Wes M.D.
Authors: Ari Wes, Sanjay Naran, James Sun, Scott Bartlett, Linton Whitaker, Jesse Taylor
Institution: Children’s Hospital of Philadelphia

Abstract: Introduction: The Whitaker classification is a simple and widely used system for describing aesthetic outcomes after craniosynostosis surgery. The purpose of this study is to evaluate its inter-rater reliability for patients who have undergone frontal-orbital surgery.

Methods: A retrospective review of patients with craniosynostosis who underwent surgical intervention at a tertiary referral center was conducted. Inclusion criteria were: single-suture craniosynostosis, surgical intervention before age two years, and photographs taken prior to revisions between 5 and 20 years of age. Twelve craniofacial surgeons independently reviewed the subject’s photographs and assigned Whitaker classifications. The Whitaker classification ranges from I (no revisions necessary) to IV (requiring revision that meets or exceeds the original surgery). Inter-rater reliability was assessed with Cohen’s kappa.

Results: Twenty nine subjects were included. Average ages at surgery and the time of photographs were 0.8 years, and 12.8 years, respectively. The κ value for all 12 raters was 0.1567 (p<0.0001), indicating ‘slight agreement’. Pairwise comparisons demonstrated κ values ranging from 0.0384 to 0.5492. The average rating for the set of 29 photos differed significantly across the 12 raters (p=0.0020) and ranged from 1.79±0.68 to 2.79±0.77. Finally, we found that patients who underwent subsequent cranioplasty and/or fronto-orbital advancement did not have significantly higher Whitaker ratings (subsequent procedures 2.45±0.55, no subsequent procedures 1.88±0.78, p=0.1087).

Conclusions: The Whitaker Classification exhibits low inter-rater reliability. It is incumbent upon craniofacial surgeons to create new evaluation tools with greater accuracy, to improve the quality of patient care and craniofacial outcomes research.
5 TELESCOPING WITH MULTIPLE REVOLUTION CRANIAL OSTEOTOMIES IN PATIENTS WITH SIMPLE CRANIOSYNOSTOSIS
Presenter: Diego Jose Caycedo M.D.
Authors: Diego Jose Caycedo, Marcela Cabal, Luis Fernando Santacruz
Institution: Universidad del Valle, Centro Medico Imbanaco, Cali – Colombia
Abstract:
Craniosynostosis is secondary to a premature closure of two or more cranial bone sutures, with a consequent growth and cerebral expansion alteration that occurs during first years of a child’s life. The cranial growth alteration occurs as parallel flattening to the compromised suture with compensatory bulging in a perpendicular vector. The surgical treatments that have been in use until now consist in suturectomies with simultaneous cranioplasties, with dynamic or multiple revolution osteotomies that allow secondary cranial deformation correction. In Cali, Colombia, in Centro Médico Imbanaco and in Fundación Infantil Club Noel, Universidad del Valle, 13 patients with simple Craniosynostosis were operated from January 2015 to December 2016, including 4 cases with plagiocephaly and 9 with scaphocephaly. The aim of the study is to describe and observe, how after realizing the suturectomy, and the telescoping with multiple revolution cranial osteotomies, the bone expansion with cranial form correction is maintained with the use of absorbable plates, being placed 180º from each level of every circumvolution of the spiral osteotomies.

6 SELF-STABILIZING S-OSTEOTOMY IN FOREHEAD REMODELLING FOR CRANIOSYNOSTOSIS
Presenter: David Johnson M.D.
Author: David Johnson, Greg Thomas, Steven Wall
Institution: Oxford Craniofacial Unit
Abstract:
Introduction: Fronto-orbital advancement and remodelling (FOAR) is a well-established technique. The frontal bone can be remodelled either by reshaping the existing forehead or replacing it. In Oxford we favour a one piece vertex melon-slice neoforehead, which provides good convexity, shape and symmetry. If vertex asymmetry exists we use a central self-stabilizing S-osteotomy developed in Oxford in 1997. This creates a neoforehead from 2 disparate areas of cranium. Following success we extended this technique to cases where good vertex symmetry exists, but the melon-slice radius is too great for the forehead. S-osteotomy allows central narrowing potentially preferable to lateral remodelling.
Methods: A retrospective review of all patients in Oxford who underwent an FOAR between 2006 and 2016.
Results: 277 patients underwent FOAR. 121 S-osteotomies were performed. The majority were for metopic or unicoronal synostosis, with follow-up from 5 months to 10 years. There were no central contour anomalies requiring revision and no central wires required removal.
Conclusion: The self-stabilising S-osteotomy provides flexibility in creating greater convexity and symmetry in FOAR. Midline complications have never been encountered.
7
LATE PRESENTATION OF SYRINX IN CROUZON PATIENTS AND THEIR CLINICAL SYMPTOMS
Presenter: Irene Mathijssen M.D.
Authors: Irene Mathijssen, Priya Doerga, Robbin de Goederen, Sarah Versnel, Koen Joosten, Marie-Lise van Veelen
Institution: Erasmus MC

Abstract:
Patients with Crouzon syndrome are known to have a high risk on intracranial hypertension and Chiari malformation with or without a syrinx. Recently, we were confronted with two Crouzon patients who were known to have an asymptomatic Chiari malformation and a syrinx, who developed symptoms years later. To analyse the frequency with which these neurological abnormalities occur, we reviewed all our Crouzon patients who were at least 8 years of age at the time of latest assessment, including a MRI.
28 patients were included of whom 5 (18%) had no tonsillar herniation, 6 (21%) had tonsillar herniation up to 5 mm, and 17 (61%) had a Chiari I malformation. Of the 17 patients, 5 had a syrinx which was first seen on an MRI at the ages between 8 and 17. All five were initially asymptomatic but in time two developed a hypertonic gait disturbance at the age of 17. These patients were treated with an atlanto-occipital decompression and duraplasty, after which the walking patterns improved almost completely, with recovery of the Chiari and syrinx.
In this presentation we will analyze all risk factors associated with occurrence of Chiari and syrinx, such as intracranial volume, ventricular volume and OSA, and present an algorithm for the management of Crouzon patients. Long-term follow-up of Crouzon patients beyond the age of 18 is thus vital.

8
10-YEAR OUTCOME OF PRE-ADOLESCENT LEFORT III DISTRACTION OSTEOREGENESIS IN SYNDROMIC CRANIOSYNOSTOSIS
Presenter: Pradip Shetye M.D. #158 (6 min)
Authors: Pradip Shetye, Travis L. Gibson, Barry H. Grayson, Joseph G. McCarth
Institution: NYU Langone Medical Center

Abstract:
Background: Le Fort III distraction osteogenesis may be indicated for treatment of syndromic craniosynostosis. Both surgical relapse and facial growth can adversely influence long-term phenotypic stability.

Method: Retrospective review identified 15 patients with syndromic craniosynostosis treated by Le Fort III distraction (TG, mean age 4.9 years). Lateral cephalograms at pre-surgery, immediate post-distraction, and 1-, 5-, and 10-years follow-up were superimposed. Post-surgical changes were assessed, and phenotype compared to an unaffected control (CG).

Results: Le Fort III distraction resulted in a mean midface advancement of 14.9mm at A-point and 10.2mm at orbitale, and reduced proptosis by 7.4mm. Phenotypic correction of midface position and proptosis occurred, with no significant differences between TG and CG. Overjet improved 12.7mm, with 4.4mm overcorrection compared to CG. Maxillomandibular relationship (ANB) improved 17.9° and mandibular plane was controlled. Retrognathia was seen in TG, with pogonion 9.7mm more retrusive than CG at age 5. No significant surgical relapse was detected. By 10-years post-distraction, phenotypic relapse of proptosis occurred by anterior globe displacement and remodeling of the orbital rim; 3.3mm proptosis correction remained. Maxillary growth in TG was deficient, with decreased downward dentoalveolar remodeling and no A-P growth. The mandible demonstrated ‘catch-up’ growth in TG, with no significant difference in pogonion position compared to CG at 10-year follow-up. This resulted in phenotypic relapse of overjet to pre-treatment values; while 7.5° of ANB improvement was maintained.

Conclusions: Le Fort III distraction resulted in correction of midface position, proptosis, occlusal and maxillomandibular relationships. Surgical stability was excellent, but long-term follow-up demonstrated phenotypic relapse through a combination of deficient midface growth, bony remodeling, and ‘catch-up’ growth of the mandible.
PEDIATRIC BLOOD MANAGEMENT TEAM IN CRANIOFACIAL SURGERY
Presenter: John Girotto M.D.
Authors: John Girotto, Brian Boville, Josh Kelley, John Polley, Robert Mann, Dominic Sanfilippo
Institution: Helen DeVos Childrens Hospital

Abstract: Pediatric Blood Management Team in Craniofacial Surgery

Introduction: Craniofacial procedures require preparation and care. Transfusions are often required. Independent use of erythropoietin or intraoperative tranexamic acid can reduce transfusion.

Objectives: To determine if a Pediatric Blood Management (PBM) Team can reduce transfusion requirements in children undergoing craniofacial surgery.

Methods: A protocol was developed which involved pre-operative optimization of hemoglobin, intraoperative use of tranexamic acid and CellSaver(TM) technology, and blood sparing operative techniques. Patients were preoperatively screened for altered coagulation including hypofibrinogenemia and von Willebrand's disease. Prospective data on patients was collected. Retrospective data on 20 consecutive patients who underwent craniofacial surgery prior were used as controls.

Results: Groups were similar in age and weight. Patients PBM post-intervention had a higher ASA classification. The rate of transfusion decreased to 65% post-intervention. Post-intervention, patients received a mean of 106 mL of intraoperative PRBC, while pre-intervention, patients received a mean of 224 mL. (p=0.024). Postoperative hemoglobin concentrations were also similar with 9.6 g/dL and the intervention arm 10.5 g/dL (p=0.64). Discharge hemoglobin concentrations also were similar with 9.6 g/dL and 10.6 g/dL in the control and PBM group, respectively (p=0.196). Furthermore, 3 patients were found to have von Willebrand's disease preoperatively and did not require transfusion.

Conclusion: We found that the institution of a Pediatric Blood Management Team significantly reduced the transfusion burden of patients, including complex patients with von Willebrand's disease. The use of a multimodal approach to hematologic management optimized patients for their procedures and helped minimize exposure to transfusion associated complications.

THE TRANSFUSION OUTCOME OF PRE-OPERATIVE ADMINISTRATION OF IRON IN INFANT CRANIOSYNOSTOSIS SURGERY
Presenter: Chelsea Durocher, MD. Lisa Luxford, MD
Author: Chelsea Duroche M.D., Lisa Luxford, Benita Lee, Nadia Naraine, Tara Der, John Phillips
Institution: The Hospital for Sick Children

Abstract: Cranial vault reshaping for craniosynostosis usually occurs between 6-12 months of age. This is a procedure that requires a coronal scalp flap and the removal of the anterior cranial vault plus or minus the supraorbital rim. Due to the size and age of these patients and extent of the procedure many of these patients require a blood transfusion intra-operatively. While giving blood can be life saving in certain procedures there has been shown to be an independent association of allogenic blood transfusion with longer hospital stays and therefore higher costs. Greater transfusion volumes have also been shown to increase the complication rate, such as infections and morbidity of the patient stay.

The Ontario Nurse Transfusion Coordinators (ONTraC) Program is a Provincial Patient Blood Management (PBM) or Blood Conservation Program (BCP) that attempts to enhance transfusion practice by promoting alternatives such as iron supplements to donor or allogeneic blood transfusion in surgical patients, improving patient care and well-being in a cost-effective manner.

Method: As of 2013 the ONTraC program was instituted for cranial-facial patients at the Hospital for Sick Children, which entailed the education of the patients' parents with respect to Hemoglobin and the administration of oral Iron. The infants are started on 0.25ml Fer-in-sol and 0.25ml Tri VI sol (contains Vit C which is needed to help the iron get absorbed) daily. The parents are then called in 4-5 days and questioned on how the baby is tolerating the iron with respect to stomach upset. The iron dose is increased to 0.5ml if the child is doing ok, after 3-4 days it is increased again until we get to the maximum dose of 6mg /kg. It can take 5-6 weeks to get to maximum dose.

Prior to 2013 routine pre-op iron therapy was not instituted. Fifty-four patients undergoing cranial vault reshaping were identified as taken part in the Iron Administration Program between 2013-15.
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RECTUS MUSCLE CYCLOROTATION AND STRABISMUS: IMPACT OF ORBITAL ANATOMY IN SYNDROMIC CRANIOSYNOSTOSIS  
Presenter: Linda Dagi, MD  
Author: Linda Dagi, MD, Sarah Mackinnon, MSc, OC(C), David Zurakowski, PhD, Sanjay Prabhu, MBBS  
Institution: Boston Children’s Hospital  

Abstract:  
Purpose: V-pattern strabismus observed with syndromic craniosynostosis has been attributed, in part, to excyclorotation of the extraocular muscles. We compared severity of strabismus with degree of excyclorotation and orbital apical anatomy that might result in excyclorotation in syndromic craniosynostosis.  
Methods: 43 patients with Apert, Crouzon, or Pfeiffer syndromes referred to Boston Children’s Hospital Department of Ophthalmology were identified. 28 met inclusion criteria for retrospective study: (1) sensorimotor measurements in cardinal gazes, (2) quantified fundus torsion, and (3) orbital CT imaging sufficient to measure rectus muscle cyclorotation in coronal and quasicoronal planes both posteriorly (near orbital apex) and anteriorly (near muscle pulleys). Patients were placed in one of four V-pattern severity groups. The most severe group demonstrated inability to elevate abducted eye above midline with characteristic “seesaw” pattern. Rectus muscle excyclorotation was measured by neuroradiologist blinded to group placement. Primary outcome was correlation of severity of V-pattern strabismus with degree of excyclorotation. Secondary outcome was correlation of strabismus severity with craniosynostosis diagnosis and orbital morphology.  
Results: Increasing severity of V pattern correlated with greater excyclorotation in anterior coronal (p=0.009), anterior quasicoronal (p=0.021), posterior coronal (p=0.014), and posterior quasicoronal (p=0.040) planes for moderate-to-severe V pattern. Even greater excyclorotation was associated with most severe seesaw strabismus in anterior quasicoronal (p=0.004) and posterior quasicoronal (p=0.001) views. Highly significant association was found between Apert syndrome orbital morphology and severity of V pattern (p=0.004).  
Conclusions: Severity of V pattern is associated with magnitude of excyclorotation. Most severe V pattern and seesaw strabismus noted with Apert syndrome and may result from its distinctive o
MORPHOLOGIC SEVERITY OF CRANIOSYNOSTOSIS: IMPLICATIONS FOR SPEECH AND NEURODEVELOPMENT

Presenter: Kamlesh B. Patel M.D.
Authors: Damini Tandon, Gary B. Skolnick, Lynn M. Grames, Mary M. Cradock, Matthew D. Smyth, Kamlesh B. Patel
Institution: Division of Plastic and Reconstructive Surgery, Department of Surgery, Washington University School of Medicine

Abstract:
Single-suture craniosynostosis (SSC) may result in neurodevelopmental deficits. We examine the correlation between morphologic severity and incidence of speech or psychological needs.

In the 62 SSC patients (33 sagittal, 17 metopic, and 12 unicoronal), morphologic severity was determined via preoperative CT. Severity metrics for sagittal, metopic, and unicoronal synostosis were cephalic index (CI), interfrontal angle (IFA), and anterior cranial fossa area ratio (ACFR) respectively. Speech and psychological outcomes were assessed at age ≥ 4.5 years. Speech or psychological concern was defined as recommendation for therapy or monitoring; speech score summed performance in 7 areas. 38 had open repair and 24 had endoscopic. Mean assessment age was 5.8 ± 1.0 years. 34% had speech concerns, 44% had psychological concerns; 44% had neither.

In sagittal cohort, CI of those with speech concerns (0.62 ± 0.03) and without (0.61 ± 0.04) were statistically equivalent (p = 0.84), as were CI of those with psychological concerns (0.62 ± 0.05) and without (0.62 ± 0.03) (p = 0.060). In metopic cohort, IFA of those with speech concerns (120 ± 18) and without (125 ± 10) were equivalent (p = 0.43), as were IFA of those with psychological concerns (120 ± 17) and without (123 ± 11) (p = 0.66). In unicoronal cohort, ACFR of those with speech concerns (0.72 ± 0.06) and without (0.62 ± 0.09) were equivalent (p = 0.06), as were ACFR of those with psychological concerns (0.65 ± 0.11) and without (0.69 ± 0.05) (p = 0.45). Bivariate rank correlation with Holm-Bonferonni correction showed no significant association between morphologic severity and speech score (sagittal, & #961; = 0.087 (p = 0.63); metopic, & #961; = -0.327 (p = 0.20); unicoronal, & #961; = 0.702 (p = 0.01)). In addition, no significant difference was seen in rates of speech (p = 0.59) or psychological concerns (p = 0.29) between open and endoscopic groups.

A large portion of patients with SSC had speech or psychological concerns.

NEURODEVELOPMENTAL, COGNITIVE, SPEECH, LANGUAGE, AND PSYCHOSOCIAL OUTCOMES FOR CHILDREN WITH A MUTATION IN THE TCF12 GENE AND ASSOCIATED CRANIOSYNOSTOSIS: A RETROSPECTIVE STUDY

Presenter: Patrick Kennedy-Williams
Authors: Patrick Kennedy-Williams, Sarah Kilcoyne, Helen Care, Andrew Wilkie, David Johnson
Institution: Oxford University Hospitals NHS Foundation Trust

Introduction: Mutations in the TCF12 gene have recently been discovered as a cause of coronal craniosynostosis (CS) (Sharma et al., 2013; di Rocco et al., 2014). However, limited information regarding the phenotypic profile is available. Here we provide the first detailed study of the neurodevelopmental, speech, language, and psychosocial implications for patients with a TCF12 mutation and associated CS.

Methods: A clinical casenote audit was conducted at the Oxford Craniofacial Unit, UK. All patients (N=25) with an identified TCF12 mutation and CS (bicoronal CS=12, unicoronal CS=10, pansynostosis=3) were included. 92% had undergone transcranial surgery (mean surgery age=17 months).

Results: Standardised cognitive assessment scores (N=22) indicated slightly increased risk of cognitive delay, where 18% (N=4) of patients scored >2SD below the mean. 32% demonstrated neurodevelopmental difficulties (whereby 16% had a confirmed Autistic Spectrum Disorder (ASD); 20% with other attention-related difficulties). Special educational provision was required for 3/25 patients. Language results were available for (n=10/25) at three time points (T1, T2 and T3). Results indicated at T1 (0;9-1;6 years) 3/5 had language results >1SD from the mean. At T2 (3;1-4;3 years) 3/3 had appropriate language and 2/3 had disordered speech. At T3 (6;8-7;6 years) 2/2 had appropriate language and 1/2 had a speech disorder. There was evidence of behavioural and mental health difficulties throughout childhood, however not at an increased rate.

Discussion: Early data suggests an increased risk of cognitive, language, executive function (attention/concentration) difficulties, and ASD, expanding on that which is previously reported (Sharma et al., 2013). Where appropriate, results are discussed with reference to a matched comparison group of non-syndromic unicoronal CS patients, and non-craniofacial population norms. Implications for future research and a specific screening protocol are proposed.
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THE LIVERPOOL-YORK HEAD MODEL - A NOVEL SHAPE-BASED OUTCOMES TOOL FOR CRANIOFACIAL SURGEONS
Presenter: Christian Duncan, MD
Author: Christian Duncan, Mr Hang Dai Meng, Mr Will Smith PhD, Mr Nick Pears PhD
Institution: Alder Hey Childrens Hospital NHSFT

Abstract:
Introduction: We present the worlds first morphable model of the Caucasian head, and demonstrate proposals for its use to measure outcome following craniosynostosis surgery.

Method: The Liverpool-York Head Model (LYHM) was developed from the ‘Headspace Project’ - a public partnership data gathering exercise that collected 3d images of volunteers, with consent, using specific photographic protocols and compiled them into a database with metadata. 1000 3D images were compiled into directories according to demographics and other metadata and imported into Matlab. These were automatically aligned, and compiled to produce different age and sex appropriate models of head shape, comprising of a mean and modes of variation. 3D clinical images of craniosynostosis patients were compared with the most appropriate model.

Results: 25 scaphocephaly patients aged over 3 years who were operated on consecutively using strip craniectomy and micro-barrel staving(SMB) or a modified Melbourne technique (MMT), with recorded standard outcome measures(cephalic index, blood loss and complications).

Comparison with the 0-16 age group LYHM showed that the mean of the mahalanobis distance (a statistical measure of complex shapes) changed from 3 standard deviations(SD) from normal pre-op in both groups to 1 SD post-op in the SMB groups and 2 SD in the MMT group.

Analysis of overlay comparisons between clinical 3D images and LYHM provided comprehensive information about head morphology pre and post op.

Conclusion: We have developed a morphable model of the human head that can generate comprehensive aesthetic outcomes using 3dMD photos of craniosynostosis patients including empirical statements about normalization.

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FRONTO-FACIAL FEATURES OF UNILATERAL LAMBDOID CRANIOSYNOSTOSIS: A MULTI-CENTER ASSESSMENT
Presenter: Joseph E Losee, MD
Author: Jonathan Y Lee, Sanjay Naran, Jesse A Taylor, Jesse A Goldstein, Scott P Bartlett, Joseph E Losee
Institution: University of Pittsburgh Medical Center

Abstract:
Background: Unilateral lambdoid craniosynostosis is differentiated from deformational plagiocephaly primarily by assessing the cranium from the posterior and bird’s-eye view. Findings typically include posterior displacement of the ipsilateral ear, ipsilateral posterior flattening with mastoid bulge, and contralateral frontal bossing. Diagnosis based off facial morphology may be an easier approach because the face is less obstructed by hair, head-coverings, and can easily be assessed when supine. Fronto-facial characteristics of unilateral lambdoid craniosynostosis are not well described in the literature.

Methods: A retrospective cohort review of all patients with isolated, unilateral lambdoid craniosynostosis from the Children’s Hospital of Pittsburgh and the Children’s Hospital of Philadelphia was performed. Preoperative frontal-view and profile photographs were reviewed for salient characteristics.

Results: Nineteen patients met inclusion criteria. Eleven patients had left lambdoid craniosynostosis, and eight had right. All patient were non-syndromic. Patients demonstrated contralateral parietal bossing and greater visibility of the ipsilateral ear. Contralateral frontal bossing was mild. The orbits were tall and turricephaly was present in varying severity. Facial scoliosis as a C-shaped deformity was also present in varying severity. The nasal root and chin pointed to the contralateral side.

Conclusions: The combination of greater visibility of the ipsilateral ear, contralateral parietal bossing, and C-shape, convex ipsilateral facial scoliosis are the hallmark fronto-facial features of unilateral lambdoid craniosynostosis. Although the ipsilateral ear is more posterior, the greater visibility may be attributed to lateral displacement from the mastoid bulge. Further evaluation of long-term postoperative results is needed to assess if facial morphology is corrected with posterior vault reconstruction.
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HYDROCEPHALUS IN FGFR BASED SYNDROMIC CRANIOSYNOSTOSIS - CORRELATING DISTINCT GENETIC MUTATIONS
Presenter: Steven Wall, MD
Author: Steven Wall M.D., O Manley, A Wilkie, D Jayamohan, D Johnson, S Magdum
Institution: Oxford Craniofacial Unit

Abstract:
We present the Oxford Craniofacial Unit experience with hydrocephalus in Syndromic Craniosynostosis associated with FGFR mutations. We identified 210 clinically syndromic patients of which FGFR mutation had been identified in 192 children. Hydrocephalus present in 12% as established by unequivocal clinical and radiological evidence or in equivocal cases by formal Intracranial Pressure monitoring.
39 Different FGFR mutations were identified and in the 24 patients with hydrocephalus all but 6 were associated with 4 mutations:-
FGFR3 A391E Crouzon with Acanthosis Negricans 43%
FGFR2C342R Severe Pfeiffer 83%
FGFR2 S354C Crouzon 100%
FGFR2 S252W Apert 33% vs FRFR2 P353R Apert 0% P=0.03
Fishers Exact Two tailed
The first three are in keeping with previous published literature but the Apert data is a novel finding which may contribute to the long term management by assisting in differentiating non-hydrocephalic ventricular dysmorphia from early hydrocephalus.
Likewise further mutation correlation with age of shunting may further may further establish risk in those cases not presenting with hydrocephalus in the neonatal period.

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ANTERIOR CRANIAL VAULT RECONSTRUCTION WITH DISTRACTION FOR PRIMARY AND SECONDARY CRANIOSYNOSTOSIS REPAIR
Presenter: Jason Miller, MD
Author: Jason Miller, MD, Stephan Barrientos, MD
Institution: University of Nebraska Medical Center

Abstract
Background: Traditional fronto-orbital advancement continues to be a useful tool for correction of craniosynostosis involving the coronal or metopic sutures. Recently distraction osteogenesis has become a popular tool to correct a variety of cranial deformities. Recent studies have mostly focused on posterior vault distraction due to its proven benefits of simplicity and obvious greater volume gain as compared to anterior vault distraction. Certain patients are not candidates for posterior distraction due to anterior deformity and need for expansion of the frontal skull. We have developed a technique that allows for both reshaping as well as distraction of the anterior cranial vault. We have found this technique useful for patients with severe anterior skull deformity either as a primary procedure or for older patients who have had previous cranial reconstruction.

Materials/Methods: This was a retrospective chart review that was performed between March 2012 and October 2016 at a single institution by a single plastic surgeon. Thirty nine (39) patients were included in this study. The indications for surgical intervention were signs of increased intracranial pressure in the setting of recurrent craniosynostosis, or severe anterior skull deformity in the setting of craniosynostosis. We reviewed patient characteristics, diagnosis, age at surgery, length of follow up, number of previous surgeries, complications, and number of subsequent surgeries.

Results: Average age of patient undergoing procedure was 5.2 years (range 6mo - 15yrs), 24 patients had 1 previous surgery, 3 had 2 previous surgeries, 1 had 3 previous surgeries and 11 had no previous surgeries. Follow up ranged from 6 months to 54 months. One patient had a complication requiring a return to the operating room for a broken activation.
19 MANAGING THE VARIATION IN DEFORMITY IN SAGITTAL SYNOSTOSIS USING CALVARIAL VAULT REMODELING
Presenter: David Johnson M.D.
Author: David Johnson M.D., Greg Thomas, Shailendra Magdum, Jay Jayamohan, Peter Richards, Steven Wall
Institution: Oxford Craniofacial Unit

Abstract:
Introduction: In the Oxford Craniofacial Unit (OCU) our aims of surgery for sagittal synostosis are to correct all aspects of the secondary deformity and to reduce the risk of developing raised ICP. Prior to 2007 we performed a strip craniectomy (SC) for children aged around 6 months, and a cranial vault remodelling procedure (CVR) for children aged 1 year old. Our outcome results showed CVR to be superior to SC and so after 2007, all children with sagittal synostosis underwent CVR.

Methods: A retrospective analysis of 3 separate studies looked at 1. The long term morphological outcomes in nonsyndromic sagittal craniosynostosis in patients undergoing SC and CVR. 2. The incidence of raised intracranial pressure in nonsyndromic sagittal synostosis following SC and CVR. 3. The aesthetic outcome of consecutive patients undergoing CVR.

Results: Study 1 included 224 consecutive patients with sagittal synostosis (62 had SC and 162 had CVR). Children who underwent CVR were significantly more likely to achieve a normal cephalic index than those undergoing SC. Study 2 included 217 consecutive patients with sagittal synostosis (89 had SC and 128 had CVR). 14.6% of the SC patients went on to develop raised ICP and need a calvarial expansion cf only 1.6% of patients who had CVR. Study 3 included 42 consecutive patients undergoing CVR. There was greater than 70% improvement in all secondary deformities associated with sagittal synostosis.

Conclusion: CVR is consistent and reliable and unlike SC can be customised to address all secondary features of sagittal synostosis. The subsequent development of raised intracranial pressure is 6 times less likely in children undergoing CVR making CVR a more powerful technique than SC.

20 CRANIOTOMY WITH INTACT PERIOSTEUM REDUCES BLOOD LOSS IN PI-PLASTY SURGERY FOR SAGITTAL SYNOSTOSIS
Presenter: Tobias Hallén M.D.
Author: Tobias Hallén M.D., Lars Kölby, Robert Olsson, Peter Tarnow, Giovanni Maltese
Institution: Dept of Neurosurgery, Sahlgrenska University Hospital, Gothenburg, Sweden

Abstract:
Background: Cranioplasty is often accompanied by a substantial, oozing bleeding from the bone surface and bone edges.

Objective: The objective was to measure if strict subgaleal dissection, without any periosteal release, during pi-plasty surgery for sagittal synostosis (SSS) reduces blood loss.

Method: Retrospective single-center cohort study. A group of 32 children that between 2010-2014 underwent pi-plasty surgery at Sahlgrenska University Hospital for SSS with traditional subgaleal dissection combined with incision and release of the periosteum adjacent to the osteotomy lines was compared to a group of 7 children that underwent pi-plasty with strict subgaleal dissection and osteotomy through the bone with the periosteum attached. Information about blood loss and body weight was extracted from medical records.

Results: The mean blood loss in the group of 7 children with strict subgaleal dissection was 102 ± 86 ml (mean ± SD), (10 ± 7 ml/kg) compared to 320 ± 119 ml (32 ± 12 ml/kg) in the control group with traditional periosteal release (p<0.001).

Conclusion: Intact periosteum at the osteotomy lines reduces blood loss in pi-plasty surgery for sagittal synostosis. The mechanism is likely preserved veins between the bone surface and periosteum.
21 NUMERICAL MODELLING TO ASSESS THE EFFECT OF SURGICAL PARAMETERS ON SPRING CRANIOPLASTY OUTCOMES

Presenter: Alessandro Borghi M.D.
Author: Alessandro Borghi M.D., Jan Bruse, Naiara Rodríguez Florez, Silvia Schievano, David Dunaway, Owase Jeelani
Institution: UCL GOS Institute of Child Health and Great Ormond Street Hospital

Abstract:
Each individual procedure in spring cranioplasty provides limited information for the planning of future cases since surgical parameters are chosen on an ad-hoc basis according to the severity of the disease. In this work, an average shape model of the scaphocephalic skull was created statistically and used to simulate spring insertion via finite element (FE) analysis. Surgical parameters were varied to assess the effect of spring positioning and combinations on final skull dimensions. CT images from 12 scaphocephaly patients (age = 3.6±1.2 months) treated with springs (3 devices: weak S10, medium S12 and strong S14) were selected: skull 3D surface meshes were reconstructed to create the population average skull model (template) by means of statistical shape modeling. Osteotomy width (LAT) and spring positioning (coronal to anterior spring distance A, anterior to posterior spring distance B) recorded in theatre from 26 consecutive procedures were averaged, and 8 surgical models were replicated using the template shape AND varying the values of A and B in the range mean±SD. For each model, 9 FE simulations of spring insertion were run, varying the combination of the 3 spring devices. The resulting skull shapes were compared with the pre-op template. The template pre-op craniofacial index (CI) was 70%. Surgical parameters were LAT = 20.8, A = 41.5±10.5 mm and B = 38.8±12.0 mm. With different A, B and spring device, post-implantation CI varied from 71.2% (S10-S10, anterior spring placed in mid-skull and posterior spring close to the back) to 74.2% (S14-S14, both springs in mid-skull position). Spring combination had the largest effect on post-op CI: change in spring location maintaining the same spring combination only caused a CI variation from 0.46% to 0.92%. In this work, we have quantified the effect of surgical parameters on an average model of scaphocephalic skull: the results show that the choice of spring combination has the highest impact on skull remodeling.

22 LONG-TERM OUTCOMES OF SPRING-ASSISTED CRANIOPLASTY FOR SAGITTAL CRANIOSYNOSTOSIS

Presenter: Daniel Couture M.D.
Author: Christopher Runyan, Daniel Couture, Christopher Michael, Runyan, Edreca Allison Thompson, Kyle Gabrick, Jungwon Genevieve Park, Lisa Renee David
Institution: Wake Forest

Abstract:
Spring-assisted cranioplasty (SAC) is an efficacious means for correcting scaphocephaly due to sagittal craniosynostosis. Long-term stability of correction and complication profiles have not been previously reported due to the more recent implementation of this technique. To investigate these factors we retrospectively examined our series of patients with sagittal craniosynostosis, treated with SAC. From 2000-2016 we treated 172 patients with SAC. Mean age at spring-placement surgery was 4.6 months, and those older than 6 months were generally not offered SAC. Molding helmet therapy was not performed as part of the treatment protocol. Mean age of followup was 5.0 years. Mean lengths of time for spring placement and removal operations were 45.7 and 26.8 minutes, respectively. No patients required a blood transfusion for either spring placement or removal operations. No deaths occurred. Nine patients required unplanned surgery for complications (5.2%), including spring malposition (6, 3.5%), and infection (2, 1.2%). One patient experienced incomplete correction of frontal bossing, requiring secondary calvarial vault remodeling (0.3%). Other long-term complications included a suture abscess (1, 0.3%), referral to neurology for headaches (2, 1.2%) or for seizures (1, 0.3%). Mean cephalic index (CI) prior to SAC was 71.0. This improved to 74.8 post-op (p<0.001). There were no significant differences between immediate post-op CI and those measured at post-operative years 1 (73.8), 6 (74.8) and 12 (73.9). In conclusion, correction of scaphocephaly using SAC is durable and has an excellent degree of associated morbidity and complication profile. SAC should be considered amongst the standard of care for treatment of sagittal craniosynostosis in infants less than 6 months of age.
Abstract:
Introduction: Numerous surgical techniques for correction of sagittal synostosis have been described. When reviewing outcomes for the endoscopic approaches, cephalic index is one measurement which is used commonly but fails to capture the often persistent temporal constraint. To address the temporal deformity, the endoscopic surgical technique was modified to include releasing cuts across the coronal sutures in the area of the temporal constraint. The purpose of this study is to evaluate the early benefit of releasing cuts across the coronal suture for the correction of the temporal constraint.

Methods: A retrospective chart review was performed of 33 consecutive patients who underwent releasing coronal cuts. Standardized post surgical images generated by Digital Surface Imaging Technology were examined. This cohort was compared with 33 consecutive patients who underwent the same endoscopic correction without the coronal cuts. Both groups were age matched and underwent the same post surgical banding protocol. Whitaker scoring system was used by an experienced craniofacial surgeon blinded to the surgical technique. Images were reviewed at exit from the cranial band and at 6 months post exit from band.

Results: 33 patients underwent endoscopic sagittal synostosis correction with releasing cuts across the coronal suture at average age of 3.2 months. Banding was initiated at average of 14 days post surgery and continued for an average of 14 weeks. Whitaker classification for this early post-op period documented improved temporal contour with less constraint in the 33 patients who underwent the additional coronal cuts in comparison to the cohort that did not.

Conclusions: During this early post-surgical period, greater and more rapid improvement in the temporal constraint was noted in the cohort who underwent the additional cuts across the coronal sutures during the correction of sagittal synostosis. Longer term follow up is needed as relapse is known to occur.

Abstract:
Objective: Sagittal strip craniectomy is widely used to normalize head shape in the treatment of sagittal craniosynostosis. The aim of this study was to determine the rate and location of head shape change after extended sagittal strip craniectomy and compare the head shape after treatment to normal subjects.

Methods: An IRB approved retrospective chart review was performed for patients treated with sagittal strip craniectomy and postoperative helmet therapy by a single orthotist. Cranial Index (CI) measurements and 3D surface scans were obtained before surgery and serially throughout treatment. CI was fitted using an exponential equation and the end point of CI was calculated at a change less than 0.01 CI/day. 3D images of sagittal patients were compared to age-matched controls.

Results: 25 patients (8 Female, 17 male) were included. The average age at surgery was 110±18 days. The average duration of postoperative helmet therapy was 341±93 days. The average postoperative time until stabilization of CI was 54±31 days. There was a significant increase in the CI from 72.0±3.7 preoperative to 81.2±4.0 postoperative. Composite 3D images were generated for subjects at the preoperative and end of helmet therapy time points. The regions of maximum change were in the vertical and transverse dimension of the posterior vault. When compared to age-matched normal subjects at the end of treatment, subjects treated with sagittal strip craniectomy had larger heads with greater dimensions in the posterior vault in the vertical and anteroposterior vectors. The transverse dimension was smaller in the parietal area compared to normal subjects.

Conclusions: Extended sagittal strip craniectomy and helmet therapy achieved normal CI and significantly improved head shape. 3D analysis showed small discrepancies in head size and shape when compared to age-matched normal controls.
25 LONGITUDINAL CORRELATES OF NEURODEVELOPMENT IN PATIENTS WITH UNICORONTAL OR METOPIC CRANIOSYNOSTOSIS

Presenter: Alexis L. Johns, PhD
Author: Alexis L. Johns, PhD, J. Gordon McComb, MD, Michaela Tsuha, BS, Artur Fahradyan, MD, Mark M. Urata, MD, DDS
Institution: Childrens Hospital Los Angeles

Abstract:

Purpose: There has been an ongoing debate on the neurodevelopment of patients with craniosynostosis (CS). To provide more data to our patient's families, all patients with CS complete serial evaluations. We examined intrinsic, extrinsic and surgical correlates of neurodevelopment for patients with unicoronal or metopic CS at baseline and 3 post-operative time points.

Method: From 10/2009-3/2016, 45 patients (58% male) with isolated unicoronal (n = 21) or metopic (n = 24) CS underwent surgery and were tested with baseline Bayley Scales of Infant and Toddler Development-Third Edition. Their mean age in months was 7.7 (SD = 2.1) at baseline, 8.6 (SD = 1.9) at surgery (6-14 months) and 15.1 (SD = 2.0) at 6-month postoperative testing (n = 45). Surgical time was 183-304 minutes (M = 244, SD = 30) and anesthesia length was 270-422 minutes (M = 348, SD = 34). Testing was completed 18-months postoperatively (n = 20) with a mean age of 26.6 (SD = 1.9) and at 3 years (n = 17) with a mean age of 36.9 (SD = 2.4). There were diverse ethnicities and socioeconomic status (SES). Testing was in English (42%), Spanish (29%), English/Spanish (18%) or a third language (11%).

Results: There were no significant relationships for surgery age, surgical time or anesthesia length. Significant (p < 0.05) 2-tailed Pearson correlations were seen for intrinsic and extrinsic variables. Females had consistently higher communication and gross motor skills. The unicoronal group had higher fine motor skills at age 3. SES was the strongest variable over time for cognitive, communication and fine motor skills. Related to SES, non-English speakers had areas of lower functioning.

Conclusions: There were moderate to strong associations with higher neurodevelopmental scores for higher SES, females and English-speakers. Within the sample's clinical range, there were no relationships for surgical variables, highlighting the need to account for intrinsic and extrinsic correlates in neurodevelopment.

26 A SINGLE INSTITUTION EXPERIENCE WITH ENDOSCOPIC SUTURECTOMY AND CRANIAL VAULT REMODELLING FOR TREATMENT OF SAGITTAL CRANIOSYNOSTOSIS

Presenter: Mark R. Proctor, M.D.
Author: John G. Meara, Mark R. Proctor, Kathryn V. Isaac
Institution: Boston Children's Hospital

Abstract:

Purpose: This study compares the perioperative morbidity, long-term head growth and aesthetic outcomes of endoscopic suturectomy (ES) and cranial vault remodelling (CVR) for the treatment of isolated sagittal craniosynostosis (CS).

Methods: For all patients with sagittal CS treated from 2004 - 2015, charts were retrospectively reviewed. Data were recorded for: operative details, head growth, re-operation rates and long-term aesthetic outcome using the Whitaker classification.

Results: A total of 211 patients with isolated sagittal craniosynostosis were treated with ES (n= 191) or CVR (n=20). Mean age of follow-up was 3.1 years (range 1 - 9) for the ES group and 3.9 years (range 2 - 6.75) for the CVR group. The ES group had a lower mean operative time (46 +/-9 vs. 207 +/- 42 minutes), length of stay (1.1 vs. 3.6 days), estimated blood loss (30 +/- 30 vs. 345 +/- 182cc) and blood transfusion rate (2% vs. 85%). Head growth was not significantly different between the treatment groups; mean pre-operative cranial index (CI) was equal at 0.69 in both groups and both normalized by 3 years of age (CI 0.75 for ES group, CI 0.73 for CVR group). In the ES group, 2 surgical site infections required re-operation. For the ES group, 97% (n=159/163) were Whitaker class I and 0.6% (n=1/163) class III. Three patients (1.8%) developed increased intracranial pressure with progressive sutural fusion and required re-expansion with a CVR for secondary expansion. Of the patients treated with CVR, 95% (n=19/20) were Whitaker class I and 5% (n=1/20) were class II.

Conclusion: ES is an effective treatment for isolated sagittal CS with comparable head growth, aesthetic outcomes and less perioperative morbidity relative to CVR. Secondary cranial vault expansion following ES is infrequently (<2%) required. Despite synostotic suture release with ES or CVR, patients may still develop increased intra-cranial pressure and require annual follow-up for assessment.
DEVELOPMENTAL OUTCOMES IN CHILDREN WITH SAGITTAL CRANIOSYNOSTOSIS AT 3 AND 5 YEARS OF AGE

Presenter: Helen Care M.D.
Author: Helen Care M.D. Jo Horton, Maria Knapp, Natasha Rooney, Louise Dalton, David Johnson
Institution: Oxford Craniofacial Unit, Oxford University Hospitals NHS Foundation Trust, Oxford UK

Abstract:
The nature of developmental outcomes for children with single suture craniosynostosis (SSC) remains contentious. Starr et al (2007) concluded that most children with SSC have neurodevelopmental test scores within the average range. However, several studies have also demonstrated a higher risk of learning difficulties and developmental delays in children with SSC (e.g. Starr et al 2007; Starr et al 2012; Speltz et al 2015). In 2015 a developmental screening protocol was introduced across the four supraregional craniofacial units (SCUs) in the UK. The current analysis focuses on data for children with single suture sagittal synostosis (SS) at the ages of 3 and 5 years.

Method: Parents of children with SS attending the SCUs completed two screening questionnaires: a developmental measure looking at 5 domains of general development, including motor skills and communication (Ages & Stages Questionnaire, ASQ-3, Squires & Bricker, 2009) and a behavioural measure looking at 6 domains, including hyperactivity and prosocial behaviours (Strengths & Difficulties Questionnaire, SDQ, Goodman 1997).

Results: The ASQ was completed for 91 and 23 patients at 3 and 5 years, respectively; SDQ was completed for 61 and 62. ASQ and SDQ scores were within the normal range for the majority of patients. Compared to the normative sample, patients in the current cohort had a higher rate of deficiency in 2 domains of the ASQ (21% vs 7.4% at 3 years, 35% vs 5.4% at 5 years.) The mean total SDQ score was higher for the current cohort than the population norms (9.3 vs 7.3 at 3 years, 12 vs 8.6 at 5 years).

Conclusions: The majority of children with SS fell within the developmentally average range at both 3 and 5 years of age. However, there were important differences between SS and normative populations on both developmental and behavioural measures. Hypotheses regarding the differences are discussed, and directions for future research outlined.

INITIAL EXPERIENCE OF A MODIFIED MELBOURNE TECHNIQUE FOR SCAPHOCEPHALY CORRECTION AT GREAT ORMOND STREET

Presenter: Julia Sharma M.D.
Author: Greg James, Julia Sharma M.D, Alessandro Borghi, Juling Ong, David J Dunaway, Nu Owase Jeelani, Justine L O Hara, Greg James
Institution: Great Ormond Street Hospital

Abstract:
After reports from Melbourne of their new technique of correcting scaphocephaly, we introduced it in our institution. We use this technique for children > 1 year of age, as we utilize spring-assisted cranioplasty in infants. We modified it in 2 ways: 1) 2 stage approach, starting surgery in supine position for anterior remodeling, temporarily closing, then turning the child prone for completion; 2) remodel the forehead using our standard, non-bandeau fronto-orbital technique. We report our initial results. 8 consecutive patients were identified between July 2015 and August 2016. All had non-syndromic sagittal synostosis. 7 were boys and mean age at surgery was 2.3 y (range 1.3-3.6). The mean weight was 14 kg (range 10-17.2). All patients had significant scaphocephaly with the typical features of frontal bossing, parietal narrowing, occipital bulleting, and an anteriorly displaced vertex. Operating time ranged from 3.5 to 7 hours (mean 6.1 hours). All eight patients received a blood transfusion receiving a mean transfusion volume of 31 mL/kg of packed red blood cells/kg per patient (range 13-83 mL/kg). Average length of hospital stay was 4.9 days (range 4-6). All patients had significant subjective improvement in head shape as demonstrated by clinical photographs and feedback from families. Post-operative cranial index was calculated on 5 patients (3 post-op CT, 2 post-op 3D optical scan). Mean cranial index increased from 0.64 to 0.75 after surgery. Pre- and post-operative calvarial volumes could be calculated in 5 patients. All patients had an increased calvarial volume following surgery. The mean calvarial volume increased from 1481 cm to 1671 cm. This represents an average increase in volume of 14%. There were 3 minor complications: 1 wound leak, 1 wire protrusion and 1 chest infection. There were no major complications. We agree that the Melbourne technique is safe and effective for the treatment of severe scaphocephaly in sagittal synostosis.
LONG-TERM RESULTS IN ISOLATED METOPIC SYNOSTOSIS - A 22-YEAR REVIEW OF 245 TREATED PATIENTS

Presenter: Hamidreza Natghian M.D.
Author: Hamidreza Natghian M.D., Marie Song, Jay Jayamoha, David Johnson, Shailendra Magdum, Steven Wall
Institution: Oxford Craniofacial Unit

Abstract:

Background: Metopic synostosis causing trigonocephaly is treated by fronto-orbital advancement and remodelling to correct the deformity, cerebral distortion and treat intracranial hypertension in a small number of cases. This study aimed to evaluate complications, revisions and long-term outcomes of patients with isolated metopic synostosis.

Methods: A retrospective chart review was performed on consecutive metopic craniosynostosis patients treated between February 1995 and February 2017 at the Oxford Craniofacial Unit. Patient demographics, operative details and postoperative data were collected.

Results: From 1995 to 2017, 245 patients with isolated metopic synostosis were seen. 202 patients underwent fronto-orbital advancement and remodelling. 50 (25%) female; 152 (75%) male. Mean age at surgery was 16.8 months (range 7-60 months). Mean weight preoperatively was 12kg. All patients received blood transfusion. Mean postoperative stay was 6 days. Average follow-up time was 96 months. There were 8 (4%) major complications. 7 (3.5 %) patients required secondary calvarial expansion for late raised intracranial pressure. 31 (15%) had other subsequent procedures including wire removal (8%) and forehead shape contouring (4%) with alloplastic onlay. There was evidence of raised intracranial pressure prior to surgery in 2 cases (at age of 16 and 22 months) determined by ICPM.

Conclusion: Metopic synostosis is the second most frequent type of craniosynostosis (1:5,200). Treatment of the skull malformation consists of a fronto-orbital advancement and remodelling, restoring both internal and external skull configuration. Following surgical intervention a 3.5% risk of late raised intracranial pressure was identified requiring secondary calvarial expansion, necessitating prolonged follow up in all cases. Temporal hollowing and forehead contour defects were not uncommon resulting in a need for onlay recontouring in selected cases.

SURGICAL OUTCOMES IN TRIGONOCEPHALY CORRECTION USING SPRING ASSISTED THERAPY

Presenter: Juan Martin Chavanne M.D.
Author: Juan Martin Chavanne M.D., Alfredo Houssa
Institution: WCF Bs.As. Craniofacial Center

Abstract:

Background: Spring assisted therapy (SAT) has become an alternative method of treatment for many craniosynostosis. The method is used today with the purpose of reducing operative time, morbidity and overall costs of surgery. The experience regarding its application in surgical treatment of metopic synostosis is still limited.

Purpose: The authors retrospectively analysed a group of 12 patients with metopic synostosis who underwent bilateral FOR with spring assisted therapies with a five-year follow-up period.

Materials and Methods: Between February 2011 and December 2016, a total of 12 patients with metopic synostosis were operated in our centre using SAT. Eight patients were female and 4 male. Seven patients were under 7 months of age and the remaining 5 patients were over 6 months of age. Surgical technique performed in all cases included metopic suturectomy followed by bilateral 8 mm fronto-orbital-sphenoidal craniectomy plus implantable spring’s devices laterally at fronto-temporal osteotomy of 1.17, 1.28, and 1.35 mm custom-made preoperatively following the Swedish technique. Milling of glabelar midline was performed in order to induce passive widening of the interorbital distance. The average number of spring placed in each patient was: 2,4. Average age at spring placement was 6.2 months, and the average age at spring removal was 8.4 months. The same author and a pediatric neurosurgeon at a single institution operated all of the patients on. Cranio-metric indices and CT scans were used to quantify the correction and control areas of bone regeneration.

Results: Surgical outcome in all patients were satisfactory from a positive cranio-metric balance after 5 year of treatment of the initial procedure. Acceptable remodeling at the entire supraorbital and forehead surface was observed in the majority of the patients immediately at the end of the operation. Distance between the orbits improved the hypotelorism condition when this was present.
Abstracts

31
3D CT ANALYSIS OF LATE DEFORMITY AFTER FRONTO-ORBITAL REMODELLING FOR METOPIC SYNOSTOSIS
Presenter: Silvia Schievano M.D.
Author: Naiara Rodriguez-Florez, Arantzazu Florez Tapia,
Silvia Schievano, NU Owase Jeelani,
David J Dunaway, Richard Hayward
Institution: UCL GOS Institute of Child Health and Great Ormond Street Hospital for Children

Abstract:
Introduction: Late deformity is a well-recognized problem following fronto-orbital remodeling (FOR) for trigonocephaly in metopic synostosis. Although its cause remains unclear, it has been suggested that aberrant re-attachment of temporalis muscle might be a contributory factor. We hypothesised that if this was so, the loss of its osteogenic stimulus would with age lead not only to deformity but also thinning of the underlying bone.

Method: Bone and soft tissues were separately segmented and reconstructed in 3D from CT head scans of metopic patients (n=8; age=1.5-18 years) who had previously undergone FOR (operated at 16±2 months) and from age-matched controls (n=8). Bone and soft tissue thickness were computed and visualised in 3D. Average bone thickness and bone thickness of the particularly indented area above the lateral part of the supra orbital ridge were calculated for each patient. 3D maps of temporal soft tissue thickness were used as a proxy for temporalis muscle morphology.

Results: Average skull thickness increased with age in controls (logarithmic fit R²=0.69) and metopic patients (R²=0.71). In metopic patients, the indented area had a thickness of 96% of the average skull thickness immediately after FOR, but decreased linearly to 76% 16 years after surgery (R²=0.64); no such trend was found in controls. 3D soft tissue thickness maps revealed that in post-FOR patients, the temporalis muscle extends upwards only as far as the indented area.

Conclusions: These results demonstrate how, in post-FOR metopic patients, bone thickness in the area of maximum deformity gradually decreases after surgery. In addition, limited upward extension of soft tissues in the temporal fossa further enhances the deformity. These findings strengthen the hypothesis that aberrant re-attachment of the temporalis muscle makes a material contribution to late deformity following FOR for metopic synostosis.

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THE CORRECTION OF ORBITAL HYPOTELORISM
Presenter: S Anthony Wolfe M.D.
Author: S Anthony Wolfe M.D.
Institution: Division of Plastic Surgery Miami Children’s Health System

Abstract:
Paul Tessier treated hundreds of patients with orbital hypertelorism, but among his records there are no cases of hypotelorism. 6 cases have been performed, through a transcranial approach. There have been no complications with bleeding, dural breach, diplopia or patient dissatisfaction. The indications have been entirely aesthetic. The procedure is much easier than hypertelorism correction, since noting need be done for the nose.
THE METOPIC SYNOSTOSIS CORRECTION WITH DISTRACTION

Presenter: Damian Palafox, M.D.
Author: Damian Palafox, M.D., Pablo Arrieta-Joffe, Fernando Molina

The metopic suture has a very important role in the development of the frontal bone, it is the main responsible for the shape of the forehead. Its early closure produces a triangular bone prominence and flattening of the lateral regions. It is also a cause of hypotelorism. Trigonocephaly is traditionally treated with osteotomies in the skull, reshaping the frontal bone and increasing the orbital distance. This procedure is extensive, with blood loss frequently requiring transfusion and miniplates and screws to fix bone segments. In order to minimize procedures and morbidity, trigonocephaly can be corrected resecting the pathological bone suture and using springs to produce new bone. The spring-based calvarial remodeling is an alternative for complex advanced craniofacial surgery procedures in non syndromic craniosynostosis. When compared to other alternatives, spring-based surgery is less invasive, with diminished blood loss and less traumatic and morbid for the patients. We herein present our experience with the procedure in our institution. Charts were evaluated in a retrospective manner. Demographic (age, gender, type of craniosynostosis) and surgical (such as operative time, complications, hospital stay) data were collected. We also performed an analysis on follow up (duration, aesthetic analysis). We present a clinical series of 8 patients, 3 male, 5 female, with trigonocephaly, with a range of age of 3-6 months. A preoperative 3D CT Scan confirmed the total closure of the suture. Surgical correction was performed between 6 and 8 months old. Through a bicoronal incision and exposure of the frontal bone, the metopic suture is resected extending the procedure until the middle portion of the sagittal suture. A residual bone gap wide of 1.5 cm diameter is left. Then we insert 3 to 5 springs, omega shaped, with medium diameter, along the open suture. With a fine chisel we produce a “green stick” fracture between the orbits and we insert one last spring very near to this area. In order to avoid that wires move far apart from the cranial surface and produce pressure on the skin, the aforementioned are fixed to the skull with absorbable sutures, adapting them to the cranial curvature. Drains are placed and the incision is closed. Springs begin acting immediately, further separating the bone gap edges. Its strength and capacity to separate bone segments are concluded between 4 and 6 weeks later. By this time, radiological controls show an early area of bone regeneration. The springs are left in the skull for 5-6 months. At this time, x-ray controls show the presence of healthy cortical bone. By then, we decide to remove the devices. With this surgical technique, frontal bone deformity is corrected very satisfactorily. At the lateral frontal region flattening is also corrected, producing a better final configuration of the entire skull. The distance between the orbits increases with hypotelorism correction. In this clinical series we have not observed any complications such as bone infection, hematoma, intracranial dead space, intracranial hypertension, seizures or other neurological problems. Our longest clinical follow-up is four years. Spring-based calvarial remodeling, represents the first line treatment for non syndromic craniosynostosis patients. Its main disadvantage is that a second surgical procedure is needed for springs removal.

It is a less invasive procedure compared to other craniofacial procedures with good functional and aesthetic results.
QUANTITATIVE OUTCOMES OF ENDOSCOPIC STRIP CRANIECTOMY FOR METOPIC CRANIOSYNOSTOSIS WITH SEVERE TRIGONOCEPHALY

Presenter: Suresh N. Magge M.D.
Author: Orgest Lajthia, Chima O. Oluigbo, John S. Myseros, Robert F. Keating, Gary F. Rogers, Suresh N. Magge
Institution: Childrens National Health System

Abstract:

Objective: The goal of this study was to present quantitative results of early treatment of infants with severe trigonocephaly who had metopic craniosynostosis using endoscopic strip craniectomy with postoperative helmet therapy, with over 2 year follow-up.

Methods: This was an IRB-approved, retrospective study to examine the results of consecutive patients with metopic craniosynostosis who had undergone minimally invasive endoscopic strip craniectomy followed by helmet therapy. Preoperative and follow-up clinical parameters were collected from patient charts. The severity of trigonocephaly was assessed by measuring the interfrontal divergence angle (IFA) on preoperative CT 3D reconstructions as well as 2D pictures both pre- and postoperatively.

Results: There were 7 patients (4 male, 3 female), mean age at surgery 2.76 months (range 1.8 to 4.1 months), with mean follow-up of 2.02 years. Mean operative time was 91.4 minutes and mean EBL was 57.1 ml. Mean length of stay was 1.14 days. Trigonocephaly was significantly improved from a preoperative IFA of 118.8 degrees to 135.4 degrees in follow-up (p<0.01). The mean IFA in follow-up was within normal limits. Head circumference percentile was not significantly changed in follow-up. There was a statistically significant improvement in the inner-to-outer canthal distance ratio (p<0.01) in follow-up, showing an improvement in hypotelorism. There were no dural tears, CSF leaks, infections, or other significant morbidities, and there were no serious complications related to the use of helmet therapy. All patients achieved excellent aesthetic results judged by photograph comparisons.

Conclusions: This study showed quantitative improvement in patients treated with endoscopic strip craniectomy for severe trigonocephaly due to metopic craniosynostosis, at over 2 year follow-up. Endoscopic strip craniectomy for metopic craniosynostosis is a safe and effective treatment associated with excellent results.

EARLY SURGICAL CORRECTION OF TRIGONOCEPHALY WITH MINIMALLY INVASIVE METOPIC AND LATERAL FRONTO-ORBITAL OSTECTOMIES: THE ADDITION OF BILATERAL BLEPHAROPLASTY INCISIONS ALLOWS A COMPLETE RELEASE AND ADVANCEMENT OF THE FRONTO-ORBITAL BAR

Presenter: Silvio Podda M.D.
Author: Silvio Podda M.D., Francesco Gargano
Institution: St. Josephs Childrens Hospital

Abstract:

We retrospectively reviewed patient’s charts and anesthesia records of 10 consecutive infants who underwent early surgical correction of trigonocephaly with minimally invasive metopic and lateral fronto-orbital ostectomies with the addition of bilateral blepharoplasty incisions, which allow the release and advancement of the fronto-orbital bar, between January 2012 and December 2015. Follow-up evaluations were performed until December 2015. Outcomes included (a) head shape, (b) blood loss during surgery, (c) duration of hospitalization, (d) duration of operation, (e) ICU admission, and (f) reoperation with craniofacial reconstruction procedures.

Methods and Results: 10 Infants ranging from 1 to 5 months of age, presented for early surgical correction of trigonocephaly. The correction was performed with a minimally invasive cranial approach that allowed the ostectomy of the metopic suture down to the nasofrontal junction and the lateral fronto-orbital ostectomies. The addition of bilateral blepharoplasty incisions allowed the release and the advancement of the fronto-orbital bar with gentle digital pressure. Mean surgical time was 135 minutes (range: 100 to 180 minutes). Median estimated blood loss was 96,85 cc (range from 30 to 200 cc). Median intraoperative blood transfusion was 87,5 cc. 4 infants were admitted to the ICU. Factors associated with ICU admission were blood transfusion and respiratory complications. 4 infants were discharged on postoperative day 1 (range: 1 to 4 days). None of the infants underwent subsequent fronto-orbital advancement. No complications were recorded.

Conclusions: Benefits of an early endoscopically assisted approach to treat craniosynostosis include: reduction in intraoperative blood loss, decrease hospitalization time and hospital cost, shorter operative times and decreased risk of anesthesia-related complications. We believe that, in the treatment of an early diagnosed trigonocephaly, a minimally invasive cranial approach.
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SAGITTAL CRANIECTOMY WITH BIPARIETAL  
MORCELLATION: OUTCOME ANALYSIS OF AGE AT  
SURGERY AND EXTENDED  
Presenter: Brooke French, MD  
Techniques  
Author: Brooke French, MD, C. Corbett Wilkinson, MD, Brent O’Neill, MD, David Khechoyan, MD, Ken Winston, MD, Aaron Kian, MD  
Institution: University of Colorado School of Medicine Division of Plastic and Reconstructive Surgery  
Abstract:  
Objective: Lack of consensus on type and timing of surgery for sagittal craniosynostosis, prompted evaluation of outcomes of sagittal craniectomy with biparietal morcellation (SCBM) with regards to age at surgery and differences in technique. Main question is whether outcomes are acceptable with SCBM in the younger versus older child, with or without variation in extended techniques.  
Design: Retrospective non-randomized. Demographic and clinical characteristics compared between two age-at-surgery groups, <6 mo and >/=6 mo, using Fisher's exact tests and two-sample t-tests. Association between age at surgery and change in CI by linear model. Hypothesis tests were two-sided with significance set 0.05.  
Setting: University of Colorado School of Medicine, Children’s Hospital Colorado  
Patients: Between 2/2013-8/2016, 70 participants with both pre and post-operative 3D images and underwent SCBM. Interventions: SCBM with or without forehead remodeling was undertaken fo correction of sagittal craniosynostosis. 3D images with 3dMD camera system morphometrically analyzed. Main Outcome Measures: Change in CI, Whitaker scores  
Results: Average change in CI for <6 mo at surgery was 8% and 4% for those >/= 6 mo. Younger patients tended to undergo standard operation. >/+6 months, more commonly extended morcellation anterior to coronal sutures and had forehead remodeling.  
Conclusions: SCBM leads to increase in CI, although the effect is less in older subjects. Improvement in CI in the older group may partly be due to more extensive surgery. 79% Whitaker score of 1 overall. Longer follow up needed. Consideration of alternative/more extensive surgeries or orthotic molding helmets for the older child.
OUTCOMES OF EARLY EXTENDED MIDLINE STRIP CRANIECTOMY FOR SAGITTAL SYNOSTOSIS

Presenter: Parks CJ M.D.
Author: Ellenbogen JR, England JL, Turnock C, Parks CJ M.D.
Institution: Alder Hey Childrens NHS Foundation Trust

Abstract:
Aims: Passive correction of sagittal synostosis utilising open extended midline strip craniectomy with bilateral micro-barrel staving (OEMC) is performed before 20 weeks of age in our unit. Our aim was to identify the effectiveness and morbidity associated with this technique.

Methods: Non-syndromic patients who underwent OEMC for single suture sagittal synostosis over a three year period (2014-2016) were identified from a prospectively collected database. Data collection included demographics, operative age, operative time, head shape measurements, blood loss, transfusion volumes and surgical infection.

Results: 45 patients were identified in total (12 Female, 33 Male). The median age at operation was 131 (range 99 - 171) days. The median operative time was 117 (range 89 -171) minutes. 25 (56%) patients underwent a blood transfusion, the median red blood cell volume given was 130 (range 40-250) mls. The median pre-op cranial index (CI) was 67 (range 61-83) %. The first post-op CI, taken a median of 56 (range 12-107) days post-op , was 79 (range 73-90)%. This is a median change of 11 (range 0-22) percentage points. 10 patients had follow-up measurements performed after more than 1 year of follow-up (median 433, range 406-583), these patients had a median change in CI of 8 (range 4-12) percentage points. There were no complications in this group of patients and no patients required re-operation.

Conclusion: Early OEMC for correction of sagittal synostosis is a safe and effective technique, associated with minimal morbidity, producing sustained excellent head shape morphology on short to medium term follow-up.

MULTIPLE SUTURE SYNOSTOSIS ASSOCIATED WITH CONGENITAL MYOTONIC DYSTROPHY: A CASE REPORT

Presenter: Ikkei Tamada M.D.
Author: Ikkei Tamada M.D, Hiroshi Yoshihashi, Satoshi Ihara
Institution: Department of Plastic and Reconstructive Surgery, Tokyo Metropolitan Childrens Medical Center

Abstract:
Background: Myotonic dystrophy (DM), an autosomal dominant genetic disorder characterized by myotonia and progressive muscle weakness, can occur in a congenital form typically associated with severe clinical symptoms. The number of case reports of DM associated with craniosynostosis is rather small, and eligible surgical procedures are unknown.

Case Report: A 3-month-old girl was referred to our hospital with ventriculomegaly, right diaphragm elevation, and ventricular septal defect. Computed tomography revealed multiple suture synostosis with a diffuse, beaten copper appearance. The ventriculomegaly was not regarded as clinically critical; hence posterior cranial vault distraction was carried out when the patient was 5m 16d old. The surgery and the postoperative course in the intensive care unit and general ward were uneventful. However, after completing the entire 25 mm of posterior distraction, the distracted bone gradually started moving upward. We were finally able to achieve intracranial volume expansion but the postoperative cranial shape was suboptimal. DM had been suspected soon after birth and was genetically confirmed when the patient was 2 years old.

Discussion: We regard gross motor retardation to be one of the major factors influencing retention failure. The present patient was unable to tilt her head during consolidation period, thereby possibly placing continued mechanical stress on the distraction device. Although few patients present DM associated with craniosynostosis, surgeons need to be vigilant when carrying out posterior vault distraction in patients with severely retarded gross motor development as in the present case.
Abstracts

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DIPYRIDAMOLE-LOADED 3D-PRINTED BIOACTIVE CERAMIC SCAFFOLDS PROMOTE BONE REGENERATION AND PRESERVE CRANIAL SUTURE PATENCY IN A SKELETALLY-IMMATURE RABBIT CALVARIAL DEFECT MODEL  
Presenter: Lukasz Witek, MD  (3 min)  
Authors: Jonathan M. Bekisz, BA, Roberto L. Flores, MD, Lukasz Witek, MSci, PhD, Christopher D. Lopez, BA, Andrea Torroni, MD, Paulo G. Coelho, DDS, PhD  
Institution: New York University School of Medicine  
Abstract:  
Background: This study tests the efficacy of 3D-printed bioactive ceramic scaffolds (3DPBC) loaded with dipyridamole (DIPY) in promoting cranial bone generation while preserving growing suture patency in a skeletally-immature rabbit model.  
Methods: In 5-week-old New Zealand White rabbits (n=10), full-thickness, critical-sized calvarial defects (11-mm) were created 2 mm posterior to the coronal suture. 3DPBC scaffolds composed of 100% beta-tricalcium phosphate (β-TCP) were implanted bilaterally in 7 animals. All were designed with a porous inferior surface and walls and immersed in a 1000 µm concentration DIPY solution prior to implantation, a one log increase from the standard therapeutic concentration of 100 µm. Solid cap 3DPBC scaffolds (Closed) were placed on right-sided defects and porous cap 3DPBC scaffolds (Open) were placed on the left. 3 rabbits served as negative controls. Animals were euthanized 8-weeks post-operatively. Samples were analyzed using micro-computed tomography with 3D reconstruction. For statistical analysis, significance was set at an alpha of 0.05.  
Results: The mean volume of space occupied by bone was significantly higher (>80%) in the Closed group compared to controls (27.9%±6.5% vs. 15.3%±8.3%; p=0.02). A non-significant increase in bone formation (>25%) was observed in the Open group (Mean=19.3%±5.2%) compared to controls. Paired analysis revealed a significant increase in bone volume occupancy (>40%) in the Closed group compared to the Open group (p<0.01). Patency of the coronal sutures was assessed and confirmed in all DIPY samples.  
Conclusions: DIPY-loaded 3DPBC scaffolds effectively regenerate bone in critical-sized calvarial defects in a skeletally-immature model. The optimal design of such scaffolds may entail a solid scalp-facing surface and porous structures opposing the osteomized bone margins and dura. Additionally, cranial suture preservation suggests that dipyridamole may be safe for use in the pediatric skeleton.

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SURGERY OF AURICULOTEMPORAL NEUROFIBROMATOSIS IN YOUNG PATIENTS  
Presenter: Mckay Mckinnon M.D.  
Author: Mckay Mckinnon M.D., Nguyen Hong Ha, MD, Nguyen Tuan, MD  
Institution: LurieChildrens Hospital, Presence St. Joseph Hospital  
Abstract:  
Purpose: It is common that the child who presents with neurofibromatosis of the auriculotemporal nerve is: (1) advised to do nothing until the end of puberty; (2) has a partial surgery with rapid tumor recurrence; or (3) has a radical resection with loss of facial nerve function. This study aims to systematically present the principles and rationale for early, radical surgery along with the technical maneuvers to avoid mutilation and facial nerve paralysis in the child and young adult with tumor of the auriculotemporal nerve.  
Method: A retrospective analysis of 18 consecutive patients under age 22 who underwent radical surgery for NF1 of the auriculotemporal nerve was performed. Patients with pre-existing facial nerve paralysis were excluded from study. Pre and post-op photos, videos and examinations greater than 6 months after surgery were studied.  
Results: All patients were seen at 6 or more months post-operatively. Two patients had prolonged (>2 months) facial palsy following surgery which recovered to normal facial nerve function. All surgeries were done by the same surgeon using an alternating current nerve stimulator. Three patients to date have required repeat surgery for recurrent tumor. Most patients required ancillary facelifting and some type of otoplasty procedure in addition to tumor resection. No intrinsic tumor of the facial nerve was demonstrated, although tumor mass produced an apparent pseudo-palsy in several pre-operative patients.  
Conclusions: Most NF1 tumors in the parotid and temporal regions are due to tumor of the auriculotemporal nerve. After facial nerve dissection, the entire auriculotemporal nerve within two centimeters of the trigeminal ganglion can be resected. Surgery in the pre-pubescent age should be encouraged to avoid progressive destruction of facial form and function. Avoidance of facial nerve injury should be a standard result, even though repeat operations for tumor may be necessary.
NON-SYNDROMIC COMPLEX CRANIOSYNOSTOSIS IN FINLAND 1987-2010
Presenter: Pia Vuola M.D.
Author: Pia Vuola M.D., Arja Heliovaara, Annukka Ritvanen, Virve Koljonen, Junnu Leikola
Institution: Helsinki University Hospital, Craniofacial Centre, Finland

Abstract:
Introduction and Aims: In non-syndromic complex craniosynostosis the multisutural fusion is not associated with a known craniofacial syndrome. The aim of this study was to investigate special features of nonsyndromic multisutural craniosynostosis in Finland 1987-2010. This study is a part of nationwide, population-based study.

Material and Methods: Births and selective terminations of pregnancy with craniosynostosis between 1987-2010 were collected from the nationwide registers: the Register of Congenital Malformations, the Medical Birth Register, the Hospital Care Register (hospital discharges and outpatient registers of all hospitals in Finland) and from the Cause of Death Statistics. The register data for all cases, including medical records and autopsy records in stillbirths and infant deaths, were reviewed by a craniofacial surgeon and a clinical geneticist to confirm and give an accurate diagnosis. 901 craniosynostosis cases were confirmed, 81% (727) of them being single suture synostoses, 10% (92) had craniosynostosis syndrome, 6% (57) were multisutural non-syndromic, 3% (25) have not yet achieved accurate diagnosis.

Preliminary Results: Of 57 multisutural non-syndromic cases two were stillbirths and two had terminations of pregnancy. The most common synostosis was bilateral lambdoid synostosis combined with sagittal synostosis (BLLS), occurring in 21 cases (37%). 25 cases (44%) had multiple associated anomalies, three of those with chromosomal abnormality. 11 patients died before their first birthday. 39 cases (68%) were operated.

Conclusion: In the future this unique confirmed data will be used to study the risk factors, inheritance and treatment of this heterogenic but interesting category of craniosynostosis.
A TWENTY-YEAR RETROSPECTIVE ON LONG-TERM CRANIOSYNOSTOSIS OUTCOMES AT THE UNIVERSITY OF MICHIGAN

Presenter: Fan Liang, M.D.
Author: Fan Liang, M.D., Fan Liang, Peter Beck, Meike Stoldts, Eboni Saywer, Christian Vercler, Steven Buchman
Institution: University of Michigan

Abstract:
Objective: Previously reported long-term results for total vault remodeling in craniosynostosis have demonstrated significant rates of relapse. 40% of patients required further soft or bony correction, 5% required repeat craniotomy and reshaping of the fronto-orbital region, and up to 50% developed bitemporal constriction. At the University of Michigan, we hypothesized that substantial overcorrection, judicious use of split calvarial bone grafts, and primary temporal augmentation with temporalis turnover flaps would result in significantly lower rates of re-operation.

Methods: A retrospective review of all cranial vault remodeling procedures at the University of Michigan from 1996-2017 was conducted. Only patients with at least five years of follow-up were included. We documented all cases requiring secondary reconstruction as well as augmentation of the temporal region. Both acute and long-term complications were noted, including infection, wound dehiscence, large contour irregularities, and hardware exposure.

Results: Of the 241 patients that fulfilled inclusion criteria (avg. follow-up: 9.2 years), 61 (25%) had metopic, 113 (47%) had sagittal, 7 (3%) had lambdoid, 58 (24%) had coronal, and 2 (1%) had multisuture craniosynostosis. 26 (11%) of the patients were syndromic. None required repeat craniotomy. 20 (8.3%) required bone grafting for small cranial defects. 9 (3.7%) required fat grafting and soft tissue augmentation. 8 (3.3%) required removal of prominent hardware and 5 (2.1%) had I&D for infection, 29 (12%) had mild bitemporal constrictions.

Conclusions: Craniosynostosis management with substantial over-correction, split bone grafts, and primary temporal augmentation results in long term fidelity of surgical results. Only 12% required bone or soft tissue augmentation, compared to historic rates of 40%, and only 12% demonstrated mild temporal hollowing, compared to historic rates of 50%. The rates were even lower after excluding the syndromic patients.

SYSTEMATIC CLASSIFICATION OF THE COMPLICATION PANORAMA IN 1023 CONSECUTIVE CRANIOFACIAL OPERATIONS
Authors: Bhatti-Söfteland Madiha, M.D., Paganini Anna, R.N., MSc, Kölbby David, BSc, Hansson Emma, M.D., PhD., Maltese Giovanni, M.D., PhD., Tarnow Peter, M.D., PhD., Kölbby Lars, M.D., PhD.
Institution: University of Gothenburg, The Sahlgrenska Academy, Department of Plastic Surgery, Sahlgrenska University Hospital, Gothenburg, Sweden.
Key words: craniosynostosis, craniofacial syndromes, complications, craniofacial surgery

Abstract
Background: Craniofacial surgery comprises a wide range of diagnoses, a plethora of surgical procedures and a spectrum of complications. The aim of the present study was to systematically review the peri- and postoperative complications in a large, consecutive series of patients undergoing craniofacial surgery.

Methods: All operations between 2006 and 2015 were reviewed. Each procedure was classified into one of eight groups and all complications were noted and classified into one of six types according to the newly proposed Leeds (L) classification: (0) perioperative occurrences; (1) inpatient complications; (2) outpatient complications not requiring re-admission (3) outpatient complications requiring re-admission (4) unexpected long-term deficit; (5) mortality. We then compared our results using the standard Clavien-Dindo (C-D) grade.

Results: A total of 1023 procedures were identified in 641 patients. Complications were found in 178 procedures, 14.8% and 7.8 % with L and C-D, respectively. No mortality was found. The majority of complications were perioperative. The highest complication rate was found in the midface corrections, 55.6 %. Cranial vault remodelling led to twice as many complications as did craniotomies with springs. Within the group of patients that had undergone a cranial vault remodelling, syndromic patients more often had a complication than non-syndromic patients.

Conclusion: By using established and well-defined instruments, the complication rates can be honestly recorded and compared. The recently proposed Leeds classification was more sensitive than Clavien-Dindo.
ARRHINIA, CONCEPTS AND TREATMENT
Presenter: Rolando Prada, M.D.
Author: Rolando Prada
Institution: Hospital Infantil Universitario de San José

Abstract:
Because arrhinea is a rare anomaly, the concepts and treatment of this condition is not well determined. Our management depends on the anatomical alteration and the age at which the patient arrives to the clinic. The two most important conditions to consider are nasal reconstruction and correction of orthognathic alteration produced by the maxillary hypoplasia. If the patients arrive at an early age, they begin with a nasal reconstruction, continue with the maxillary advancement by Distraction Osteogenesis and culminate with a second and final nasal reconstruction. If the patients arrive in the adolescence or adulthood, the Distraction Osteogenesis is performed and then a definitive nasal reconstruction is done. Concepts and classifications are clarified and cases of Arrinea, Hemiarrinea and related pathology are presented. Six arrhineas, four hemiarrhineas and two related cases. We never perform reconstruction of the nasal cavity because it is a non-physiological procedure with poor results.

VARIANT OF FRONTOORBITAL ADVANCEMENT BEFORE HYPERTELORISM CORRECTION
Presenter: J. Britto M.D.
Author: Eric Arnaud, D. Benderbous, J. Britto, G. Paternoster, S. James, E. Vergnaud, M. Zerah
Institution: Hospital Necker craniofacial unit

Abstract:
Boxshift osteotomy is commonly used around 4 years of age to correct an hypertelorism when the occlusion is normal. In case of an associated craniosynostosis, Marchac has recommended the initial correction of craniosynostosis before one year of age, and secondarily the boxshift.

Patients and methods: Five children with frontocranionasal dysplasia (a rare condition linked to chromosome X which combines a bicoronal dysostosis and an increase distance between the bony orbits.) were treated in a two stage strategy. All children underwent a fronto orbital advancement before one year of age. In order to prepare the boxshift, a modified cut of the osteotomy is designed at the time of the FOA. In both lateral upper part of the bandeau, a slight triangular shape was integrated , corresponding to the mirror design in the inferior lateral part of the forehead. This modification was carried out with resorbable fixation.

Results: In all patients there was no defect in reossification in the triangular part, allowing for a simpler procedure at the time of boxshift medialization. When the boxshift has been carried out, the Marchac technique of conservation of lateral spurs allow the avoidance of the supraorbital bar , making the procedure simpler.

Conclusion: This variation emphasizes the two stage strategy of treatment in cranio-fronto-nasal dysplasia, :
1) modified FOA before age 1
2) Boxshift osteotomy around 4 years of age (when occlusion is normal)
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DIGITAL MEDICINE IN THE CORRECTION OF HYPERTELORISM
Presenter: Zheyuan Yu M.D.
Author: Zheyuan Yu M.D, Min Wei, Jie Yuan, Liang Xu, Xiongzheng Mu
Institution: Dept. of PRS, Shanghai Ninth People Hospital

Abstract:
Correction of hypertelorism is one of the most typical surgeries in craniofacial surgery. With the development of digital medical techniques, is there any new progress made in this operation? What's the role of digital medicine played in this typical surgery?
During the past seven years, the authors have used a series digital techniques to improve the operation of box-shifting in 40 hypertelorism cases. A virtual surgery based on the spiral CT data has already been a routine work in all the cases. The width of the removal rhinofrontal bone block and the rotation and movement of orbital boxes are quantified before surgery and fully discussed. To apply the digital design accurately, several navigation methods have been tried including cutting splint, Brainlab navigation system and our own augmented reality system. According to the one-year follow-up CT image comparison, the error between our design and follow-up is less than 1.5mm.
Unfortunately, even the bone reconstruction is so close to our pre-surgical design, the appearance outcome is yet not satisfied. As a matter of fact, the key points of hypertelorism correction might be rhinoplasty, median canthoplasty, frontal reshaping, accurate osteotomy and ocular position adjustment. Current digital techniques can provide us powerful tools to reshape the bone structure into normal position. But it's still far away from regaining the normal appearance of hypertelorism. Further investigations are needed to all the craniofacial surgeons.

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PARTICULATE BONE GRAFT FOR RECONSTRUCTION OF THE NASAL DORSUM AFTER ORBITAL BOX OSTEOTOMIES
Presenter: Anna Carlson, MD
Author: Anna Carlson, MD, Andre Marshall, MD, Jeffrey Marcus, MD
Institution: Duke University Hospital Division of Plastic Surgery

Abstract:
Introduction: Orbital hypertelorism is defined as increased interorbital distance and may result from frontonasal dysplasia, midline facial clefting, or encephalocele. Surgical treatment consists of orbital box osteotomies. Reconstruction of the nasal dorsum after medial mobilization of the orbits is often required, and is classically described using bone grafts from the frontal bone. Herein, we report a novel technique for nasal dorsum reconstruction using particulate bone graft and fascia, which creates a pliable, precisely moldable, autologous alternative to frontal bone grafts.

Methods: An 11-year-old male underwent box osteotomies for correction of orbital hypertelorism resultant from an encephalocele. After mobilization of the orbits medially, particulate bone graft was harvested from the endocranial surface of the frontal bone flap using a low speed craniotome. The graft was prepared with a mixture of 5cc of patient's blood and surflack powder. The prepared graft material was placed into a tubularized piece of deep temporal fascia, creating a pliable composite graft construct. The construct was secured to the nasal dorsum using vicryl suture. After redraping of the midfacial skin envelope, the graft was molded according to desired nasal dorsum aesthetics.

Results: Postoperatively, a nasal splint remained in place for 5 days. Clinical exam and postoperative imaging showed appropriate positioning of the graft with stable contour. In the intermediate-term postoperative period, the graft has continued to display excellent retention of contour, volume, and position.

Conclusion: A construct of particulate bone graft with tubularized temporal fascia represents a novel technique for reconstruction of the nasal dorsum. This technique offers a highly pliable, moldable, and readily available alternative to cortical grafts harvested from the frontal bone, and has shown excellent postoperative results.
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A 22-YEAR REVIEW OF THE USE OF STAINLESS WIRES IN CRANIOSYNOSTOSIS SURGERY - A SINGLE CENTRE STUDY
Presenter: Hamidreza Natghian M.D.
Author: Hamidreza Natghian M.D., Marie Song, Steven Wall, David Johnson
Institution: Oxford Craniofacial Unit
Abstract:
Background: Controversy exists as to the ideal form of bone fixation in craniosynostosis surgery with the use of resorbable plates predominating in most units. However the use of stainless steel wires have been the preferred fixation method at the Oxford Craniofacial Unit (OCU) since its establishment. Wires have the advantage of being malleable, inexpensive and quick and easy to use.

Methods: A retrospective review of all patients who underwent craniosynostosis surgery at the OCU between February 1995 and February 2017 was undertaken. Patients were followed up for an average of 141 months (11.7 years).

Results: A total number of 1,226 craniosynostosis procedures were performed. A minimum of 16,160 wires were inserted. No complications were identified resulting from transdural migration of wires. 156 wires were removed in 92 patients during 113 general anaesthetic day care procedures. This was due to discomfort on palpation in the majority of cases. The average time from primary surgery to removal of wires was 37 months (3.1 years). The most common site for wire removal was in the supraorbital and lateral forehead region and occurred most frequently in children who had undergone FOAR.

Conclusion: The use of wires in craniofacial surgery is safe. 1% of all wires that were inserted had to be removed. Children undergoing primary craniosynostosis surgery have a 9% chance of needing a subsequent day care procedure to have a wire removed. Taking into account the cost of this additional surgical procedure, the primary use of wires in craniosynostosis surgery is still significantly cheaper than the use of resorbable plates.

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IMPROVED PERIOPERATIVE OUTCOMES ASSOCIATED WITH CRANIOFACIAL TEAM ANESTHESIOLOGIST
Presenter: Albert K. Oh, M.D.
Author: Albert K. Oh, Srijaya K. Reddy, Sophie R. Pestieau, Erin M. Rada, Robert F. Keating, Gary F. Rogers
Institution: Children's National Health System
Abstract:
Background: There is limited data regarding the effects of an anesthesia team-based approach for complex pediatric surgery on patient management and outcomes. The aim of this study was to determine if intraoperative management by a craniofacial (CF) team anesthesiologist would impact perioperative outcomes for children undergoing CF surgery.

Methods: Sixty-two children with craniosynostosis undergoing major CF reconstructive surgery between July 2013 and December 2015 were identified. Fifty-four patients were managed by a CF team anesthesiologist, while 8 patients were managed by anesthesiologists not on the CF team. Demographic data was analyzed and a multitude of continuous and categorical perioperative variables were assessed. Normality of all continuous outcomes was determined and means were compared using a student's t-test. Categorical outcomes were compared using a Fisher's exact test.

Results: A total of 6 CF team anesthesiologists and 6 non-CF team anesthesiologists were involved in providing care to all patients. There were no significant demographic differences between the two groups. Subanalysis by craniofacial neurosurgeon and plastic surgeon also yielded no significant differences in outcomes. Children taken care of by a CF team anesthesiologist had significantly lower calculated blood loss, reduced RBC transfusion volume, fewer intraoperative blood donor exposures, less crystalloid volume administration, higher rate of extubation at the end of the case, fewer postoperative complications, and decreased length of ICU and hospital length of stay than patients who were managed by non-CF team anesthesiologists.

Conclusion: Intraoperative management by a CF team anesthesiologist was associated with improved outcomes in children undergoing CF reconstructive surgery. These findings suggest that patients may benefit from a subspecialty team-based approach to management of these high-risk cases.
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52 MINIMIZING ALLOGENIC BLOOD TRANSFUSIONS IN CHILDREN UNDERGOING PRIMARY CRANIAL VAULT REMODELING FOR CRANIOSYNOSTOSIS: AKRON CHILDREN’S HOSPITAL PROTOCOL
Presenter: Bin Song M.D.
Author: Bin Song M.D., Ananth Murthy, Niyant Patel
Institution: Akron Children’s Hospital

Abstract:
Background: Cranial vault remodeling for craniosynostosis in pediatric patients is traditionally associated with high rates of allogenic blood transfusion. The purpose of this study was to investigate the impact of our current protocol on allogenic blood transfusion rates in this population.

Methods: A retrospective study was conducted of all children who underwent primary cranial vault remodeling for craniosynostosis from 2009 to 2016. Our blood conservation protocol was instituted in 2013, and included the following main components; pre-op: the administration of recombinant erythropoietin and iron supplementation, intra-op: the use of an intraoperative continuous autologous transfusion system, hemovigilance, and post-op: lowering the transfusion trigger to a hemoglobin of < 6.5 g/dl.

Results: A total of 106 children were identified. 48 children were since the institution of the protocol, and 58 children consisted of the control group. The two groups were comparable in age and weight at time of surgery. The operative times in the control group were shorter than those in the protocol group (196 vs 306 minutes, p<0.01). In the protocol group there was an increase in the preoperative hemoglobin level (12.0 g/dL vs 13.4 g/dL p<0.01). The protocol group had a lower incidence of intraoperative (25% vs 97%, p<0.01) and postoperative allogenic blood transfusion rate than in the control group (6% vs 25%, p<0.01). Additionally, the overall allogenic blood transfusion rate was lower in the protocol group (31% vs 97%, p<0.01). Furthermore, exposure to more than one donor was less likely in the protocol group (0.0% vs 24.1 %, p<0.01, ARR = 24.1%). There were no adverse events in the protocol group. Also, no children required re-admission or transfusion after discharge.

Conclusions: The implementation of this blood conservation protocol is safe and effective, which may be considered to reduce perioperative transfusion rates in primary cranial vault remodeling surgery.

53 RISK FACTORS FOR DELAYED REFERRAL TO A CRANIOFACIAL SPECIALIST FOR TREATMENT OF CRANIOSYNOSTOSIS
Presenter: Brad Gandolfi, MD
Author: Anna Carlson, MD, Brad Gandolfi, MD, Danielle Sobol, MD, Alfredo Farjat, PhD, Alexander Allori, MD, MPH, Jeffrey Marcus, MD, Anna R Carlson, MD
Institution: Duke University Hospital Division of Plastic Surgery

Abstract:
Objective: To assess the impact of age at referral on treatment options in craniosynostosis, and to identify risk factors for referral delays in this population.

Methods: A retrospective review was performed of patients with an abnormal head shape diagnosis treated at a major academic medical center between 1/1/2004 and 1/1/2014. Newly diagnosed craniosynostosis patients were isolated and referral patterns were examined. A multivariate logistic regression model was used to identify risk factors associated with the range of ages at initial referral.

Results: 477 patients were evaluated at our institution, 197 of whom were subsequently diagnosed with craniosynostosis. The median age at initial appointment was 5.6 months (mean 8.2 months). Only 28% of children were referred within three months of birth. Patients referred within three months of birth were less likely to have had pre-appointment imaging than those patients referred slightly later (OR 2.53, CI 1.07-5.98, p=0.035). Several variables were associated with referral after 12 months of age including multiple suture involvement (OR 4.21, CI 1.06-16.68, p=0.041), minority race (OR 4.96, CI 1.91-12.9, p=<0.0001), and referral by a non-pediatrician (OR 6.9, CI 1.73-27.49, p=0.006).

Conclusions: The obtainment of imaging before specialist referral for abnormal head shape delays evaluation and potentially increases radiation exposure and limits treatment options in patients with craniosynostosis. Additionally, children from minority groups, children referred from someone other than a pediatrician’s office, and those with multiple suture craniosynostosis are at increased risk of delayed referral. Further studies into the cause of these delays are warranted.
Abstracts

54 SQUAMOSAL CRANIOSYNSOSTOSIS: EXPECTED PHENOTYPE AND MANAGEMENT
Presenter: Alexander Y. Lin, MD, FACS
Author: Alexander Y. Lin, MD, FACS, Kashyap Tadisina
Institution: Saint Louis University School of Medicine

Abstract:
Background: Squamosal craniosynostosis is seldomly reported in the craniofacial literature. Given that this is an uncommon diagnosis, phenotype and management remain unclear. The authors present a case series and review the literature to define the phenotype and management of these patients.

Methods: We retrospectively reviewed seven patients from our institution and systematically reviewed all published cases of squamosal craniosynostosis. Demographics, medical history, imaging, clinical presentation, subsequent workup, and treatment were examined and analyzed.

Results: A comprehensive review of the literature yielded a total of 31 cases (including our new series) of squamosal craniosynostosis. Average age of presentation was 25.3 months, 52% of patients female, 74% of cases with bilateral squamosal involvement, 44% syndromic, 39% isolated squamosal (vs 61% multisutural). Overall, 56% of cases were handled surgically, while 44% were managed conservatively. 33% of surgical cases required multiple operations. One patient with isolated bilateral squamosal craniosynostosis developed elevated intracranial pressure, requiring cranial vault remodeling.

Conclusions: Squamosal craniosynostosis frequently presents in a delayed fashion with non-syndromic, bilateral involvement. In isolated bilateral squamosal cases, the associated phenotype is: frontal prominence, occipital flattening, scaphocephalic tendency (low-end normocephalic cranial index), and superior parietal cornering. Evaluation of clinical signs and CT imaging guides management, as evidence of increased intracranial pressure may indicate need for cranial vault remodeling. Although previous literature suggests that non-syndromic cases are nonsurgical, the majority of cases reviewed required surgical intervention, including our case of isolated bilateral squamosal craniosynostosis. We recommend vigilant management in patients with squamosal craniosynostosis, even those with isolated squamosal involvement.

55 SIN? SALVAGE? OR FINAL SOLUTION? ALLOPLASTIC RECONSTRUCTION IN HEMIFACIAL MICROsomia (HFM)
Presenter: John Polley, M.D.
Author: John Polley, M.D., John Girotto, MD, Spiros Lazaros, MD, Neophytos Demetriades, DDS MD, Joseph Taylor, MD, Nicholas Adams, MD
Institution: Helen DeVos Childrens Hospital, Grand Rapids, Michigan USA

Abstract:
Introduction: Skeletal reconstruction in severe grades of HFM continues to be challenging. Traditional techniques of autografts and osseous distraction for reconstruction of the glenoid fossa, condyle and ramus often fall short of expectations and can create new problems. This Intercontinental study analyzes the role of alloplastic skeletal rehabilitation in severe HFM.

Methods: 9 consecutive skeletally mature HFM patients with failed traditional reconstructions were successfully treated with virtually planned alloplastic reconstructions (10 joints) and simultaneous orthognathic surgery. The glenoid fossa, condyle, and ramus on the affected sides were reconstructed with custom designed titanium implants. All patients achieved occlusal stabilization, normalization of posterior facial height and sagittal mandibular projection, and maintenance or improved interincisal opening. There were no major complications or repeat surgeries. Follow-up ranges 6-50 months.

Discussion: Theoretically autogenous reconstructions in HFM are preferred. In reality, however, traditional reconstructions are often unsuccessful at achieving ideal face proportions and often create secondary problems including ankylosis. The central problem is that traditional techniques in severe grades of HFM cannot supply adequate 3-dimensional bone and do not create a stable fossa to assure a secure centric relation (CR).
Alloplastic reconstruction allows for precise vertical reconstruction of the ramus and condyle, and sagittal repositioning of the mandibular body. The glenoid fossa component is firmly anchored to the skull base assuring a stable CR on the reconstructed side. The longevity of these exact alloplasts for TMJ reconstruction exceeds 25 years.

Conclusion: With the consistent functional and aesthetic success obtained in this series of difficult HFM patient's with alloplastic reconstruction, the question becomes: Is this still a Sin, Salvage technique, or should this become our.
A COMPARATIVE ANALYSIS OF LONG-TERM OUTCOMES FOR TREATMENT OF ISOLATED UNILATERAL CORONAL SYNOSTOSIS WITH ENDOSCOPIC SUTURECTOMY OR FRONTO-ORBITAL ADVANCEMENT

Presenter: Kathryn V. Isaac M.D.
Author: Kathryn V. Isaac M.D., Sarah MacKinnon, John G. Meara, Mark R. Proctor, Linda R. Dagi
Institution: Boston Childrens Hospital

Abstract:
Purpose: This study compares the outcomes of patients with isolated unilateral coronal synostosis (UCS) treated with endoscopic suturectomy (ES) or front-orbital advancement (FOA). Perioperative morbidity, long-term aesthetic and ophthalmologic outcomes were examined.

Methods: For all patients with UCS treated from 2004 - 2015, charts were retrospectively reviewed. Data were recorded for: operative details, re-operations, long-term aesthetic result using the Whitaker classification, presence of strabismus and need for surgical correction.

Results: Ninety-five patients with isolated UCS were treated with ES (n= 60) or FOA (n=35). The average age of follow-up was 3.6 years (range, 1 to 9 years) for the ES group and 5.1 years (range, 1 to 11 years) for the FOA group. The ES group had a lower mean operative time (42 +/- 12 vs. 215+/- 50 minutes), length of stay (1.1 vs. 4.0 days), estimated blood loss (26+/- 10 vs. 275+/-118cc) and blood transfusion rate (0% vs. 89%). In the ES group, there were 2 dural tears repaired primarily. In the FOA group, 1 wound infection required debridement. For the ES treatment group, 88% (n=50/57) were Whitaker class I and 5% (3/57) were class II. In the FOA group, 41% (14/34) were class I and 44% (15/34) were class II. The need for revision of bony irregularities (Whitaker class III) was similar in both ES and FOA groups (n=2/57 vs. n=3/34). The need for a secondary cranial vault procedure (Whitaker class IV) was also similar in both ES and FOA groups (n=2/57 vs. n=2/34). In the ES group, 34% (n=14/41) had or require strabismus surgery. In contrast, 65% of patients in the FOA group (n=19/29) had clinically significant strabismus requiring surgical correction.

Conclusion: For the treatment of isolated unilateral craniosynostosis, ES is associated with lower perioperative morbidity and comparable long-term aesthetic outcomes. Patients treated with ES are half as likely to require strabismus surgery compared to those treated with FOA.

NON-SYNDROMIC UNICORONAL SYNOSTOSIS: DOES THE FACE UNTWIST?

Presenter: Jonathan A. Burge, M.D.
Author: Mark J. Edmondson, Sebastian M. A. Brooke, Jonathan A. Burge, M.D.
Institution: The Royal Childrens Hospital, Melbourne

Abstract:
Background: Unicoronal synostosis creates facial asymmetry characterized by torsion of the midface to the contralateral side. Whether the facial tort corrects spontaneously following bifrontal orbital advancement (BFOA) remains a subject of debate. We present our preliminary results aimed to evaluate the degree of spontaneous correction of facial torsion after BFOA of non-syndromic unicoronal synostosis (NSUCS).

Methods: Ethics approved retrospective review of pre- and post-operative AP photographs of all NSUCS patients treated by BFOA from 1994 to 2016. Facial torsion was measured by angulation of the nasal tip from the mid-sagittal plane (a perpendicular line through the glabella). Serial measurements were performed throughout the post-operative period of follow-up. Images were classified as perceptible or not perceptible for qualitative review.

Results: 62 Patients with NSUCS were eligible for inclusion in the study. Median age at BFOA was 11 months and follow-up of 36 months. 261 AP photographs were reviewed. Median nasal tip angulation was 5.8 degrees (range 1.6-10.9) at first review with 1.5 degrees (range -3.7-6.9) correction at final follow-up (p<0.0001, 95% CI: 1.11-2.134). Persistent perceptible facial torsion was present at final review in all patients.

Discussion: The aim of this study was to evaluate the degree to which facial torsion spontaneously corrects in NSUCS. A median correction of facial torsion by 1.5 degrees was found, but this did not lead to perceptible improvement in facial torsion. Qualitative evaluation demonstrated that pre-operative perceptible facial torsion was present in both short- and long-term post-operative photographs. Although severity of perceptible asymmetry was not quantified, subjective degree of perceptible facial torsion pre-operatively is unchanged in long-term follow up. We have demonstrated no clear evidence for the spontaneous correction of facial asymmetry in NSUCS in our study.
NON-INVASIVE ICP MEASUREMENT IN CRANIOFACIAL DISORDERS
Presenter: T Forcht Dagi
Author: T Forcht Dagi, Linda Dagi, Javier Fandino, Robert Keating, Joe Sam Robinson, Arminas Ragauskas
Institution: Queens University Belfast and Vittamed Neurosciences Corp

Abstract:
This paper discusses the feasibility of using a non-invasive intracranial pressure monitoring devices in patients with craniofacial anomalies. Elevated intracranial pressure is not uncommon in these patients and may affect management decisions pre- and post-operatively. Most methods for the quantitative measurement of ICP are invasive and not without risk. We introduce a non-invasive method that uses the ophthalmic artery as an ICP sensor. Uniquely in non-invasive approaches to the measurement of CP, it does not require individual patient calibration.

The ophthalmic artery comprises a proximal intracranial and a distal orbital segment. The segments are substantially alike both with respect to their anatomy and their physiology other than the fact that the proximal segment is subject to ICP and the distal is not. As a result, vascular dynamics differ between the two segments. The differences can be studied by Doppler ultrasound and displayed as a waveform. The stepwise application of calibrated pressure to the orbit matches the distal waveform to the proximal. The ICP is derived directly from the amount of pressure required to achieve this match.

A semi-automated instrument incorporating a Doppler ultrasound, computerized control systems, proprietary algorithms, and orbital pressure delivery system has been introduced [Vittamed 205, Vittamed Neurosciences, Boston]. Safety has been demonstrated in over 350 adults and 20 children. Over 100 matched data sets comparing invasive to non-invasive measurements have been analyzed. Mean systematic error was low at 0.12 mm Hg [confidence level of 0.98] as was the standard deviation of the paired reading at 2.18 mm Hg, [confidence level of 0.98], indicating a high level of precision. There have been no adverse effects.

While variations in orbital and skull base anatomy may limit the application of this system, its performance and convenience support additional study in the population of patients with craniofacial anomalies.

A VOLUMETRIC AND CRANIOMETRIC ANALYSIS OF CRANIAL BASE IN UNICORONAL CRANIOSYNOSTOSIS
Presenter: Hoppe Ian, M.D.
Author: Hoppe Ian, M.D., Daniel Mazzafarre, Ari Wes, Sanjay Naran, Scott Bartlett, Jesse Taylor
Institution: The Childrens Hospital of Philadelphia

Abstract:
Background
We hypothesized that patients with unicoronal craniosynostosis (UCS) have deviation of the vault, cranial base, and face resulting in significant differences in skull base morphology and segmental cranial vault volume relative to non-affected controls.

Methods: UCS patients were collected from our IRB-approved, prospective, craniofacial registry; controls were from a trauma registry. MimicsÂ® software was used to compare those with UCS to controls for a series of standardized craniometric angles and distances. A segmented volumetric analysis of anterior, middle, and posterior cranial fossae was performed, as well.

Results: The study included 18 patients with UCS and 19 controls. Nearly all angles measured between the synostosed side of UCS and control patients differed significantly (p<0.002). Overall cranial vault volume did not differ between UCS and controls (p= 0.250). Three volumetric ratios comparing the synostosed side to the contralateral were significantly less than controls: anterior (0.44±0.03 vs. 0.5±0.01, p<0.001), middle (0.45±0.02 vs. 0.5±0.02, p<0.001), posterior (0.46±0.02 vs. 0.5±0.02, p<0.001). The ratio of total middle volume to total cranial volume was larger in UCS patients vs. controls, but the posterior ratio was smaller: anterior (0.13±0.02 vs. 0.12±0.02, p=0.545), middle (0.5±0.05 vs. 0.42±0.04, p=0.001), posterior (0.37±0.05 vs. 0.45±0.03, p=0.001).

Conclusions: This study provides quantitative evidence of the degree of angulation and torsion of the cranial base in UCS and its profound effect on volumetric differences in the cranial vault, with significant restriction on the synostosed side and compensatory expansion on the non-synostosed side. Future work will focus on the effects of volumetric differences on cerebral architecture and postoperative volumetric changes.
FMRI REVEALS ALTERED BRAIN ACTIVATION IN SPATIAL WORKING MEMORY IN UNICORONAL SYNOSTOSIS

Presenter: Jenny F. Yang, MD
Author: Jenny F. Yang, MD, Eric D.K. Brooks, MD, Cheryl LaCadie, MS, Alex Sun, BS, Derek M. Steinbacher, MD, DMD, FACS, John A. Persing, MD
Institution: Yale Plastic and Reconstructive Surgery

Abstract:
Background: Unicoronal synostosis (UCS) is associated with a complex pattern of craniofacial deformities and distortion in the underlying brain. A critical question is whether the abnormally shaped brain can form the correct functional connections needed for higher-level processing. This study utilizes fMRI to examine brain activation patterns in UCS patients vs. controls during spatial working memory.

Methods: 10 children participated in the study: 5 with right-sided UCS and 5 controls. Controls were individually matched by age, sex, handedness, and race. Exclusion criteria include neurological conditions that may account for developmental delays (e.g. seizures, hydrocephalus, traumatic or intraoperative brain injury). The same fMRI scanner was used to record brain hemodynamics in all participants as they performed a spatially based working memory test. Data were analyzed using BioImageSuite software. Participants also underwent WISC-IV neurocognitive testing.

Results: UCS patients demonstrated significantly lower hemodynamic activity in Brodmann Areas 47 (p=0.03), 6 (p=0.03), and 7 (p=0.04), which are located in the prefrontal and superior parietal cortices. Patients also had decreased activity of the thalamus compared to controls, though this difference was not significant (p=0.06). UCS patients had lower accuracy of responses than controls, however paired t-test did not suggest a significant difference (p=0.11). WISC-IV revealed no significant differences in full scale IQ (p=0.08).

Conclusion: The current study demonstrates altered hemodynamic activation in spatial working memory in UCS patients. Significantly reduced activation was found in the prefrontal cortex, which has been shown to be crucial in working memory, as well as the superior parietal cortex, a region that plays a critical role in visuospatial processing. These findings suggest a basis for dysfunction in UCS.
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SPEECH AND LANGUAGE DEVELOPMENT IN CHILDREN WITH SYNDROMIC AND NON-SYNDROMIC UNICORONAL SYNOSTOSIS: A LONGITUDINAL RETROSPECTIVE REVIEW  
Presenter: Sarah Kilcoyne M.D  
Author: Sarah Kilcoyne M.D, Carrie Luscombe, Andrew Wilkie, Steven Wall, David Johnson  
Institution: Oxford Craniofacial Unit  

Abstract:  
Unicoronal synostosis has an estimated prevalence of 1:14,000-19,000 births (Lajeunie et al., 1995) and may be associated with syndromes (e.g. Muenke). However most cases are classified as non-syndromic (Eley et al., 2012). Limited research has examined language development in this population (Mathijssen et al., 2006; Chieffo, et al., 2011). This study investigated speech and language outcomes at three key developmental time points for children with non-syndromic and syndromic unicoronal synostosis.  

Method:  
A retrospective review of 150 language assessments conducted in children with unicoronal synostosis (born 1993-2014) presenting to the Oxford Craniofacial Unit was undertaken. Inclusion criteria were 1) radiologically-confirmed unicoronal synostosis; 2) genetic screening undertaken; 3) language evaluated via standardised assessment. Participants were assigned two groups: syndromic (clinical diagnosis of a syndrome and/or genetically positive for TCF12, TWIST1, FGFR3, EFNB1); or non-syndromic (syndrome excluded by genetic screening and clinical examination) - 133 assessments met the inclusion criteria. Language assessment results at three key time points (T1, T2 and T3) were analysed (T1 age range: 0;11-2;0); (T2 age range: 3;0-4;11); (T3 age range: 6;0-7;11).  

Results:  
Results indicated that at T1 (n=56) 20% of non-syndromic (n=7/35) and 33% of syndromic cases (n=7/21) had a speech and/or language delay. At T2 (n=50), corresponding figures were 21% of non-syndromic (n=7/33) and 64% of syndromic (n=11/17). At T3 (n=27) 25% of non-syndromic (n=2/8) and 68% of syndromic (n=13/19) had a speech and/or language delay, highlighting the need for long-term follow up of language development in all cases of syndromic and non-syndromic unicoronal synostosis.  

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3D PRINTING GUIDED SURGERY IN TREATMENT OF UNICORONAL CRANIOSYNOSTOSIS  
Presenter: Tarek Elbanoby M.D  
Author: Tarek Elbanoby M.D, Amr Mohammed Elbatawy, Gaber M. Aly, Usama A. Abdelfattah, Mohab A. Sharafuddin  
Institution: Al Azhar University, Cairo, Egypt  

Abstract:  
Introduction: Restoration of all abnormal features of unicoronal synostosis considers a challenge for craniofacial surgeons. The main purpose of this abstract is to evaluate the usage of 3D mirror image models in guiding of the Fronto-Orbital Advancement in Unicoronal synostosis.  

Methods: A retrospective analysis of 12 consecutive patients who underwent surgical correction of uni-coronal Synostosis at our institution between 2012 and 2017. Patients with syndromic craniosynostosis or associated craniofacial anomalies 3D printing were excluded from analysis. In all cases, the senior author used a 3D mirror image models for guiding unilateral Fronto-Orbital Advancement. Demographic, perioperative, and follow-up data were collected for comparison. Cranial and Orbital volumes with craniometric measurement were documented preoperative and postoperatively and compared with the non-synostotic side. The postsurgical appearance of the face was documented photographically and then evaluated and scored using the Whitaker scoring system.  

Results: The mean age of the patients at the time of the operation was 20 months (range 10-34 months). The mean follow-up duration was 36 months (range one to four years). No patients exhibited a relapse of uni-coronal plagiocephaly characteristics that required surgical correction. There were improvements in the orbital indices and volume to be near equal to the normal side.  

Conclusions: Our study demonstrates that patients who undergo uni coronal plagiocephaly correction with a 3D mirror image models for guiding unilateral Fronto-Orbital Advancement achieved satisfactory improvement. Our results suggest that the surgical technique used in the correction of unilateral coronal synostosis is strongly associated with near equal in both orbital volumes.  
Key Words: craniosynostosis, uni coronal, plagiocephaly, front plagiocephaly, 3D printing.
INTERNAL DISTRACTION OSTEONEOGENESIS WITH PIEZOSURGERY OBLIQUE OSTEOTOMY OF SUPRAORBITAL MARGIN OF FRONTAL BONE FOR THE TREATMENT OF UNILATERAL CORONAL SYNOSTOSIS

Presenter: Shen Weimin, M.D.
Author: Cui Jie, Shen Weimin M.D., Jianbing Chen, Ji Yi, Liangliang Kong
Institution: Department of Plastic Surgery, Children’s Hospital of Nanjing Medical University

Abstract:

Purpose: To assess the utility of internal distraction osteogenesis with Piezosurgery oblique osteotomy of supraorbital margin of frontal bone for the treatment of unilateral coronal synostosis and to study the outcome and complications of this procedure. Oblique osteotomy allows for entry into the cranial cavity, and along with parallel cut to the roof of the orbit, avoids the need to cut into the orbit which forms the frontal flap.

Methods: Oblique osteotomy was performed along the supraorbital rim to do a frontal suture of the glabella (ages of patients were less than one year old) or on the opposite side of the supraorbital rim (ages of patients were over one year old) after performing a suturectomy of the effected coronal suture. Two internal distraction devices were subsequently placed across the osteotomized, fused coronal suture. Finally, the cranium pieces were divided in the middle and placed in the middle of the frontal bone using biological glue. Five days after the operation, a 0.6-mm distraction was done twice daily. The distraction was removed 6 months after reaching 2-3cm.

Results: Internal distraction osteogenesis with supraorbital oblique osteotomy was performed in nine patients suffering from unilateral coronal synostosis. Eight patients had no postoperative infections around the shaft puncture wounds. One patient had infection in the rods around the distraction during the period of fixed, but was cured with antibiotic treatment. During a mean follow-up period of 12 months (5 months to 26 months), all patients were satisfied with the cosmetic and functional results. No complications, including fixed screw displacement, penetration of the cranium and dura mater or retraction of distraction devices, occurred. The devices were exposed in one patient, resulting in a postoperative scar. Despite these complications, the cranium was successfully expanded in all patients.

Conclusions: Use of this procedure avoids the need for frontol osteotomy.

INTRACRANIAL VOLUME MEASUREMENT: A SYSTEMATIC REVIEW OF GLOBALLY USED TECHNIQUES AND A DIRECT COMPARISON OF MANUAL, SEMI-AUTOMATIC AND FULLY AUTOMATIC TECHNIQUES

Presenter: Will Breakey, M.D.
Author: Will Breakey, P.G.M Knoops, A. Borghi, D.J Dunaway, S. Schievano
Institution: Great Ormond Street and UCL Institute of Child Health

Abstract:

Introduction: The ability to calculate intracranial volume (ICV) from 3-dimensional imaging is a useful tool in a craniofacial team’s armamentarium. ICV uses range from decision making to assessment. Various methods to calculate ICV exist including fully manual, semi-automatic and fully automatic techniques and they are used with varying frequency in craniofacial centres globally. This study aimed to systematically analyse and compare ICV calculations across the three methods and provide information to allow the reader to utilise these processes in practice.

Methods: 26 CT scans from Apert patients were used to compare ICV measurements calculated using the following techniques: fully manual segmentation with OsiriX (taken as the gold standard); semi-automatic segmentation using Simpleware Scan IP; and fully automatic segmentation using FSL neuroimaging software. In addition, to assess the effect that a reducing CT scan slice number had on ICV measurement, 13 scans were re-measured using half, quarter and an eighth of the slices of the full scan.

Results: The manual and semi-automatic techniques had intraclass correlation coefficients (ICC) of 0.997, and 0.993 respectively. ICV measurements using the semi- and fully automatic techniques showed high linear correlation with manual techniques (R²=0.993 and R²=0.995). The coefficient of determination for full scan versus half, quarter and eighth scan were R² = 0.98, 0.96, and 0.94 respectively.

Conclusions: Similar ICV results can be obtained using manual, semi-automatic or automatic techniques with decreasing amount of time required to perform each method. Command line code for the fully automatic method is provided.
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CHIARI MALFORMATION MANAGEMENT IN BILAMBDOID AND SAGITTAL SYNOSTOSIS

Presenter: Giovanna Paternoster, M.D.
Author: Giovanna Paternoster, Syril James, Dominique Renier, Federico di Rocco, Michel Zerah, Eric Arnaud
Institution: Hopital Necker CF Unit

Abstract:
In combined bilambdoid and sagittal synostosis (BLSS), the tonsillar herniation or Chiari malformation (CM) seems to be responsible for an increased re-operation rate.

Patients and Methods: This is a monocentric retrospective study including 31 non-syndromic patients with BLSS treated between 1972 and 2014. Four out of 31 patients were not operated because of absence of raised intracranial pressure (ICP), absence or asymptomatic CM. Twenty-seven cases required surgery: vault decompression (10) or posterior expansion (17) among them 7 with distraction, or a combination including foramen magnum release (FM) in 4/27.

The influence of CM and type of surgery were analyzed on outcome.

Results:
Eight (8/27) patients operated on did not present with CM, but 3 required a secondary vault remodelling for raised ICP. No further problem occurred in that subgroup. Nineteen (19/27) operated patients presented CM at initial diagnosis, among them associated with syringomyelia (SYR) in 1 and with central apneas (CA) in 3. After treatment CM improved in 1, remained stable in 13/19 patients, and worsened in 5 with development of SYR that appeared 4 years later. In the subgroup that underwent FM decompression (4/19), none required secondary surgery and all had an uneventful follow-up. In the subgroup of 15/19 patients submitted to a posterior expansion or vault decompression without FM release, 8 secondary or tertiary procedures were necessary. Globally, 8/27 patients (30%) were operated twice and 4 of them (15%) needed more than two procedures, some of them for aesthetic reasons.

Discussion: The management of CM in BLSS is essential to reduce the number of surgical procedures. Posterior distraction alone was not sufficient in our experience to prevent deterioration of CM secondarily. FM decompression should initially be discussed in combination of posterior distraction.

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SYNDROMIC CRANIOSYNOSTOSIS AND LATE APPEARING SYRINGOMYELIA

Presenter: Syril James, M.D.
Author: Syril James, Giovanna Paternoster, Stéphanie Puget, Michel Zerah, Eric Arnaud
Institution: Hospital Necker craniofacial unit

Abstract:
It has been reported that due to premature synostosis of the lambdoid suture more than 70% of patients with Crouzon syndrome concurrently suffer from chronic tonsillar herniation (Chiari Type I malformation) and subsequently (20%) associated syringomyelia. This occurrence has not been studied for other syndromic craniosynostosis.

Methods: A 15-year, from 2000 to 2015, single-center, retrospective outcome assessment of 151 children treated for syndromic craniosynostosis was conducted. Crouzon (88 patients, 52M/36F), Aperts (33 patients, 18M/15F) and Pfeiffer (30 patients, 16M/14F) were included. Assessment of tonsillar herniation and syringomyelia was obtained through Magnetic Resonance imaging (MRI) and polysomnographic studies which looked for central obstructive apneas.

Results:
Among the 151 children, 42 patients presented Chiari type I malformation (19 patients with Crouzon, 23 with Pfeiffer, none in Aperts). Among them, syringomyelia was present in 25 children with Crouzon or Pfeiffer but none in Aperts. The mean age of syringomyelia diagnosis was 5.5 years (range, 10 months to 16 years). Posterior fossa decompression procedure was undertaken in 21 patients. Posterior fossa decompression (associated with posterior distraction in 5) decreased the number of central and obstructive sleep apneas.

Conclusions: The etiology of Chiari seems multifactorial. The authors recommend that posterior fossa decompression should be considered the primary treatment for Chiari malformation to prevent late syringomyelia and central sleep apneas, in Crouzon and Pfeiffer. It can be associated with posterior vault expansion in the same time if intracranial pressure is present, but this study suggests that insufficient treatment of Chiari will lead to syringomyelia.
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AUTOMATED OBJECTIVE VISUAL OUTCOMES ANALYSIS
Presenter: Elizabeth Zellner, M.D.
Author: Darren Smith, John Phillips, David Khechoyan, Jessica Ching, Elizabeth Zellner
Institution: The Hospital for Sick Children

Abstract:
Introduction: The plastic surgery literature continues to evolve in breath, depth and sophistication as a basis for the practice of evidence-based medicine in our field. The evidence, however, upon which we as plastic surgeons strive to base our medicine, has an inherent and frequently lamented critical flaw: a scarcity of objective metrics with regard to aesthetic outcomes. In a field that strives to achieve excellence in form and function, aesthetic outcomes represent half the definition of success. This issue pervades reconstructive and aesthetic procedures alike. A possible approach to addressing this problem is presented here: a case-specific computer-generated incremental scale as the basis for automated objective visual outcomes analysis (AOVOA).

Methods: The proposed procedure was performed using metopic craniosynostosis as an example. A normative infant skull shape [ref] was used as the desired result, or normal on the scale. A 3D mesh representing a severe case of metopic craniosynostosis was used as the most pathological end of the scale. Both of these 3D meshes were loaded into the Maya software package (San Rafael, CA). A standardized mesh was then shrink-wrapped to fit the shape of the normative skull and the severely metopic skull. Nine copies of the normal skull’s shrink-wrap mesh were then created. A blend shape deformer was then created between these nine shrink-wrap meshes and the metopic skull’s shrink-wrap mesh, using the metopic skull’s shrink-wrap mesh as the target. Each of these nine meshes was then deformed between 10% and 90% of the way to the target shape. This process produced a total of eleven shrink-wrap meshes, a normal representing the normative skull, the metopic representing the most pathological end of the scale, and nine meshes representing objective steps, at 10% increments, between normal and abnormal.

Results: This process produced a standardized set of objective landmarks against which a patient’s skull could be

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SURGERY NAVIGATION IN TREATING CONGENITAL MIDFACIAL DYSPLASIA OF FACIAL CLEFT PATIENTS
Presenter: Jie Yuan, M.D.
Author: Jie Yuan, Min Wei, Dong Li, Liang Xu, Zheyuan Yu
Institution: Department of plastic and reconstructive surgery, Shanghai 9th people hospital

Abstract
Aim: To explore a new accurate way for the treatment of congenital midfacial dysplasia in facial cleft patients. Materials and Methods: 12 patients with nasal deformity and midfacial dysplasia were collected (Tessier No. 3-11 cleft), aged 15-20 years old. We applied expanded frontal flap for nasal reconstruction and assistant with surgery navigation for modified nasal-maxillary-hard palatine osteotomy to advance the peri-pyriform bone structure and correct the midfacial dysplasia. After 6 to 12 months post-operation follow-up, we analyzed the differences between preoperative design and postoperative result through CT data. Results: Patients were satisfied with surgery, and CT data showed that there was no significant difference between preoperative design and postoperative result (p>0.05). Conclusions: Using expanded frontal flap and assistant with surgery navigated peri-pyriform advancement, we could treat congenital nasal deformity and midfacial dysplasia more effectively, accurately and safely in craniofacial cleft patients.
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AN OUTCOME REVIEW OF 225 PATIENTS WITH METOPIC SYNOSTOSIS TREATED AT BIRMINGHAM CHILDREN’S HOSPITAL OVER 15 YEARS  
Presenter: Neil Opie, M.D.  
Author: Neil Opie, MS Dover, H Nishikawa, M Evans, N White, D Rodrigues, M Sharp  
Institution: Birmingham Children Hospital

Abstract:  
Introduction: Metopic synostosis is one of the more common single suture craniosynostoses; the incidence has been reported as between 1:700 and 1:15,000 live births.1,2 The aetiology is largely unknown, although an association is recognised with thyroid hormone replacement therapy, the use of the anti-epileptic medication valproate in pregnancy, and a number of chromosomal disorders (e.g. 3q,7p; 9p22-24; 11q23; 22q11.2).3,4,5,6

Reoperation rates for aesthetic reasons have been reported as up 28%.7 All the medical records of those cases treated over a 15-year period were reviewed using data collected from our own database and validated against operating theatre log books. 225 patients were identified. The majority of patients were managed with one operation: a ‘melon slice’ technique. Complications included death (0.4%), wound breakdown (5.3%), infection with loss of the bony construct (0.4%), and extradural collections requiring drainage (1.3%). Return to theatre occurred in 14 cases (6.2%). Only 2 patients required revision surgery for poor aesthetic outcome. These were treated by calvarial remodelling and bony augmentation of the forehead in one case, and onlay of hydroxyapatite cement and cranioplasty in the other. Both patients had a satisfactory outcome.

Metopic synostosis is the commonest indication for fronto-orbital advancement in our unit. The results are predictable, the complication rate is consistent at 6% per year, and the need for revision surgery is low (0.8 %). The single death is a reminder of the potential for catastrophe in craniofacial surgery.


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CORRECTION OF RESIDUAL FACIAL DEFORMITY IN SYNDROMIC CRANIOSYNOSTOSIS AFTER MIDFACIAL ADVANCEMENT  
Presenter: David Dunaway M.D.  
Author: David Dunaway M.D., Daljit Gill, Owase Jeelani, Jonathan Britto, Robert Evans, Timothy Lloyd  
Institution: Royal Children’s Hospital of Melbourne

Abstract:  
Introduction: Craniofacial dysostoses are characterized by midfacial retrusion, and are commonly treated by monobloc or Le Fort III advancement. These procedures advance the midface en bloc but do not address intrinsic bony and soft tissue anomalies. Producing an ideal result often requires secondary procedures.

Method: The soft and hard tissue changes of 30 patients with syndromic craniosynostosis undergoing frontofacial advancement (Monobloc, bipartition, Le Fort III and Le Fort III/II) were analyzed using pre and post op CT data. Pre and postoperative means were compared with a control group of 12 unaffected individuals. The treatment of 10 patients subsequently treated for residual deformity as adults was also documented. Conventional cephalometric and 3D geometric morphometric techniques were used to document and visualize changes in facial form.

Results: All patients achieved an improvement in facial form following midfacial advancement, but complete normalization was unattainable because of intrinsic abnormalities of midfacial shape. Frontofacial advancement corrects periorbital bony and soft tissue anatomy, but tends to leave the malar areas flat and under-advances the maxilla. Post surgical midfacial soft tissue decent is common and there is an increase in asymmetry following surgery. Secondary procedures to correct these problems were effective and included Le Fort I and bimaxillary osteotomies, zygomatic onlays, genioplasty, rhinoplasty, midface lift and fat transfer.

Conclusion: Correctly targeted fronto facial advancement corrects midfacial retrusion, but cannot correct intrinsic midfacial disproportion and commonly produces a facial form with malar flattening and maxillary retrusion combined with soft tissue descent and asymmetry. Secondary osteotomies and soft tissue procedures in early adulthood significantly improve outcome.
INTRODUCTION OF THE ALDER HEY SURGICAL SITE INFECTION BUNDLE; REDUCING POST-OPERATIVE CRANIOFACIAL INFECTION RATES

Presenter: Jane England, M.D.
Author: Jane England M.D., Jonathan R Ellenbogen, Dawn Hennigan, Benedetta Pettorini, Christopher Parks
Institution: Alder Hey Childrens NHS Foundation Trust

Abstract:

**Aims:** Surgical site infection occurs within 30 days of surgery and can be categorised into superficial incisional infection, deep incisional infection and organ/space infection. Surgical site infection causes significant morbidity for patients with extended lengths of inpatient stay and/or recurrent admissions/attendances, exposure to antibiotic side effects and the risks of further surgery, together with the additional health economics costs of these factors to the hospital. The aim of this paper is to introduce the concept of the Alder Hey Surgical Site Infection Bundle (SSIB), and the impact that this has had on our surgical site infection rates.

**Methods:** We introduced the SSIB for all patients undergoing procedures within the Alder Hey Craniofacial Department in 2015, with the aim of reducing our surgical site infection. This protocol involved pre-, peri- and post-operative care bundles. Each surgical time frame has its own bundle which must be completed. We prospectively collected data on surgical site infection prior to the introduction of the SSIB, and after the SSIB was introduced.

**Results:** In the year prior to the introduction of the SSIB the surgical site infection rate for all craniofacial procedures was 4.9%. After the introduction of the SSIB, the surgical site infection rate for all craniofacial procedures was 1%. This is a significant improvement in the craniofacial surgical site infection rate.

**Conclusions:** The SSIB has reduced the surgical site infection rate by 3.9%. The SSIB is well tolerated and adhered to by patients. It has therefore had a positive impact on reducing patient morbidity, and improved craniofacial surgical health economics. We would recommend the introduction of similar protocols in other craniofacial surgical units.

COMPARATIVE COST ANALYSIS OF TEMPORAL HOLLOWING CORRECTION FOLLOWING NEUROSURGICAL PROCEDURES

Presenter: Gabriel F. Santiago, M.D.
Author: Gabriel F. Santiago, M.D., Anthony Asemota, M.D., M.P.H., Shuting Zhong, M.D., Chad R. Gordon, D.O.
Institution: Johns Hopkins University Department of Plastic and Reconstructive Surgery

Abstract:

**Purpose:** Temporal hollowing deformity (THD) is a visible concavity in the temporal fossa often seen following neurosurgical/craniofacial procedures. No study to date has shown costs associated with THD correction surgery. The purpose here is to compare and contrast costs using various methods including: 1) liquid PMMA implants with screw fixation, 2) hand-bent titanium mesh implants, and 3) customized cranial implants (CCIs). Understanding the financial implications related to this common complication will increase awareness of the costs associated with THD.

**Methods:** This is a single-surgeon, single-institution retrospective review of twenty-three THD cases from between 2008 and 2015. Cost analysis variables include length of hospital stay, facility/professional fees, implant material fees, payer information, reimbursement rate, and net revenue.

**Results:** Of the 23 patients, ages ranged from 23-68 years (mean of 48.3 years; SD 11.6). In the cohort, 39.1% received PMMA CCIs (Pterional-PLUS), 17.4% received hand-bent titanium mesh implants, and 43.5% received hand-molded, liquid PMMA implants with screw fixation. Total charges ranged from $1,978.00-$126,478.00. Average total charges per patient with CCIs was $34,775.89 (SD±$22,205.09) versus $35,826.00 (SD±$23,509.93) for modified titanium mesh implants and $46,547.90 (SD±$81,061.70) for liquid PMMA implants with screws. Mean length of inpatient stay was 5.7 days (SD=8.1), and did not differ between implant types (p=0.387).

**Conclusion:** THD is a costly complication to correct, and severe forms require revision surgery for definitive correction. Surgeons should employ techniques capable of 1) minimizing risk of developing THD, 2) reduce morbidity of associated treatment for THD, and 3) improve overall patient outcomes and satisfaction.
INCIDENCE OF SECONDARY MIDFACE ADVANCEMENT AT THE TIME OF SKELETAL MATURITY IN PATIENTS WITH A HISTORY OF EARLY LE FORT III DISTRACTION OSTEONEogenesis

Presenter: Gerald J. Cho M.D.
Author: Gerald J. Cho M.D., Zachary M. Borab, Travis L. Gibson, Pradip R. Shetye, Barry H. Grayson, Roberto L. Flores, Joseph G. McCarthy
Institution: NYU Langone Medical Center

Abstract:
Background: The purpose of this study is to report on long-term clinical outcomes of patients with syndromic craniosynostosis who have undergone early primary Le Fort III distraction osteogenesis and who have been followed longitudinally through skeletal maturity.

Methods: Single institution, retrospective review of all patients with syndromic craniosynostosis who underwent Le Fort III distraction osteogenesis between the ages of 3 to 11 years. Inclusion criteria entailed having preoperative medical photographs and cephalometric studies at 6 months and 1, 5, and 10 years postoperatively after the primary Le Fort III distraction osteogenesis as well as cephalometric documentation 6 months and 1 year after the secondary midface advancement after skeletal maturity.

Results: 17 patients fulfilled inclusion criteria with a mean age of 5.7 years at the time of initial Le Fort III distraction. The mean advancement of Point A was 14.9mm anteriorly (x-axis) and 2.7 mm inferiorly (y-axis). Orbitale moved 10.5mm anteriorly (x-axis) and 2.2mm (y-axis). At 10 years postoperatively Point A moved 3.4 mm anteriorly (x-axis) and 4.7mm inferiorly (y-axis), while orbitale moved 0.4mm posteriorly (x-axis) and 3 mm inferiorly (y-axis). At the time skeletal maturity there was a return of occlusal disharmony from normal mandibular growth and a return of proptosis due to remodeling of orbitale inferiorly, and the lateral orbital rim posteriorly, while the globe continued to grow in the anterior vector. All but one study patient underwent or is scheduled to undergo a secondary midface advancement at the Le Fort III and Le Fort I level after skeletal maturity was attained.

Conclusion: The data demonstrates that patients who undergo early Le Fort III distraction osteogenesis will still most likely need a secondary midface advancement after skeletal maturity is reached. There is a small degree of anterior growth at the level of the maxilla and no anterior growth at orbitale over time.

CRANIOSYNOSTOSIS REPAIR: FACTORS EFFECTING COMPLICATIONS, READMISSION, AND REOPERATION

Presenter: Renata Maricevich, M.D.
Author: Kevin Jubbal, Nikhil Agrawal, Larry Hollier, Jr Renata Maricevich, M.D.
Institution: Loma Linda University

Abstract:
Background: The impact of specific patient comorbidities on outcomes in craniosynostosis surgical repair is not well defined. The aim of this retrospective review was to evaluate the short-term 30-day reoperation rate, unplanned readmission rate, and overall morbidity of craniosynostosis surgical repair using the 2012 through 2014 American College of Surgeons National Surgical Quality Improvement Program-Pediatrics (ACS NSQIP-Pediatric) database.

Methods: Overall morbidity included pneumonia, wound occurrence, shock/sepsis, venous thromboembolism, cardiac complication, renal and urinary complications, or nerve injury. We identified patients undergoing craniosynostosis repair by CPT code resulting in 2,037 cases. Univariate and multivariate analyses were performed to identify risk factors for reoperation, readmission, and morbidity.

Results: The reoperation rate was 2.4%, the overall morbidity rate was 2.8%, and readmission rate was 3.4%. Regression analysis identified age, high ASA classification, and history of either neurologic or pulmonary disorders as associated with unplanned 30-day readmission, and a history of neurologic disorders was associated with overall morbidity. The most common reason for readmission was wound complications (n = 15) followed by respiratory complications (n = 7). Gender, gastrointestinal comorbidities, blood disorders, cardiac risk factors, and prior operation within 30 days did not show significant association with any outcome.

Conclusion: Craniosynostosis surgical repair is associated with low complication and readmission rates. Careful patient selection and preoperative optimization of these factors should be sought to reduce detrimental outcomes.
ORTHODONTICS AND ORTHOGNATHIC SURGERY IN PATIENTS WITH SYNDROMIC CRANIOSYNOSTOSIS
Presenter: Mariana Sabás M.D.
Author: Mariana Sabás M.D., Emmanuela Nadal-Lopez M.D.
Institution: Sociedad Argentina de Ortodoncia. Buenos Aires. Argentina

Abstract:
In syndromic craniosynostosis, severe midface hypoplasia can be corrected with Le Fort III or monobloc advancement. When craniofacial growth has concluded, often-additional corrective orthognathic surgery is indicated. A combined orthodontic and orthognathic surgical treatment is necessary to correct midface hypoplasia, to achieve Class I occlusion and improve significantly the occlusal function and facial aesthetics. A comprehensive pre-surgical orthodontic treatment is mandatory to ensure a good outcome. This treatment must correct dental crowding, generate adequate inclination of incisors, dental midline must be in concordance with skeletal midline and a good correlation in arch dimensions, providing stable occlusal surfaces to ensure a good post-surgical relation. Three-dimensional (3D) planning has become a standard in planning of orthognathic surgery. The aim of this presentation is to present our experience in the orthodontic and orthognathic treatment of patients with craniosynostosis syndromes (Apert and Crouzon).

SKULL GROWTH IN UNOPERATED SYNDROMIX
Presenter: Will Breakey, M.D.
Author: Will Breakey, P.G.M Knoops, G. James, S. Schievano, D. Dunaway, Nu O Jeelani M.D.
Institution: Great Ormond Street and UCL Institute of Child Health

Abstract:
Objectives: We aimed to assess skull growth characteristics in the largest cohort of unoperated syndromic craniosynostotic children published to date. We have created growth curves for intracranial volume (ICV) & occipitofrontal circumference (OFC) & intend to optimise management by utilising this normative data

Methods: 3D CT reconstructions for Apert patients (7 days to 17 years), Crouzon patients (1 day to 17.5 years), Pfeiffer patients (1 day to 14.4 years), Saethre Chotzen patients (75 days to 12.7 years) & age matched control patients (6 days to 18 years) were collated. ICV & OFC were measured on the same CT scan. Growth curves were plotted for both ICV & OFC in all groups & logarithmic fits were assessed. Linear correlation was plotted for ICV against OFC in both groups.

Results: 851 Apert patients with 78 scans, 53 Crouzon patients with 80 scans, 15 Pfeiffer patients with 31 scans, 20 Saethre Chotzen patients with 27 scans & 68 control subjects with 78 scans were identified.

Good logarithmic fit was seen for ICV in all groups with R2 of 0.91 in Apert, 0.60 in Crouzon, 0.59 in Pfeiffer (0.68 in Crouzon-Pfeiffer), 0.83 in Saethre Chotzen & 0.86 in the control group.

Apert patients had larger mean ICV & 95% confidence interval than all other groups. All groups showed similar growth in OFC over time. Good logarithmic fit for OFC was seen with R2 of 0.81 in Apert, 0.72 in Crouzon, 0.68 in Pfeiffer (0.76 in Crouzon-Pfeiffer), 0.78 in Saethre Chotzen & 0.80 in the control group.

Strongly positive linear correlation was seen between OFC & ICV in all groups. R2 = 0.88 (Apert), 0.78 (Crouzon), 0.88 (Pfeiffer), 0.83 (Crouzon-Pfeiffer), 0.89 (Saethre Chotzen) & 0.92 (control)

Conclusions: This data represents the largest collection of unoperated syndromic craniosynostosis patient intracranial volume & occipitofrontal head circumference measurements. When the syndromic diagnosis is known the head circumference can be used as a clinical indicator.
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ANALYSIS OF SURGICAL CORRECTION OF CRANIOSYNOSTOSIS: FOA VS PVDO
Presenter: Xiongzheng Mu M.D.
Author: Xiongzheng Mu M.D., Yingzhi Wu, Junyin Yang
Institution: Huashan Hospital, Fudan University

Abstract:
Methods: We retrospected 287 patients from 2009-2016 in our craniofacial team. All patients were devided into three groups: non-syndromic single suture craniosynostosis (NSSSC), non-syndromic multiple-suture craniosynostosis (NSMSC) and syndromic craniosynostosis (SC). The surgical and clinical data were collected.

Results: The proportion of three groups is NSSSC 62%(178) which is more scaphacephaly in the list(110), NSMSC 15.3%(44), SC 22.6%(65). The two major surgical procedures had employed were fronto-orbital advancement (FOA) and total vault reshaping. Posterior vault distraction osteogenesis (PVDO) also employed in recent 3 years. Almost all patients underwent total vault reshaping, which including 65/9% of FOA (189). PVDO were underwent primarily with 2.44% (7), among those who had PVDO first, 4 cases need secondary FOA. The mean linear were advancements 16.3 mm for FOA and backward 20.1 mm for PVDO. The mean difference in volume change was 28.4 cm3 for FOA and 78.3 cm3 for PVDO.

Conclusion: In this retrospective study, we found that PVDO are more effective than FOA in enlarging the volume of cranial vault. The long term follow-up were needed to further evaluate the effectiveness of surgical procedures.

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PATTERNS OF INTRACRANIAL PRESSURE IN CHILDREN WITH CRANIOSYNOSTOSIS UTILIZING OPTICAL COHERENCE TOMOGRAPHY
Presenter: Jordan Swanson M.D.
Author: Jordan Swanson M.D., Wen Xu, Grant Liu, Philip Storm, Scott Bartlett, Jesse Taylor
Institution: University of Pennsylvania

Abstract:
Background: Better understanding the incidence and patterns of elevated intracranial pressure (ICP) in patients with craniosynostosis may facilitate more timely intervention to alter neurocognitive outcomes. Spectral-domain optical coherence tomography (OCT) of the retinal laminae can non-invasively diagnose elevated ICP, and has demonstrated high sensitivity and specificity among patients with craniosynostosis. This study sought to characterize patterns of elevated ICP among a large cohort of patients with craniosynostosis.

Methods: Infants and children with craniosynostosis were prospectively enrolled, and demographic, clinical, and radiographic characteristics collected. Quantitative retinal parameters were prospectively assessed in both eyes using spectral-domain OCT, typically with the use of sedation in the peri-operative setting. Based on retinal OCT thresholds associated with elevated ICP (&#8805; 15mmHg) derived in previous studies, subjects were assigned an OCT diagnosis of elevated or non-elevated ICP.

Results: 80 subjects (aged 0.2-18 years) with craniosynostosis were enrolled; among these 67 (84%) were nonsyndromic. OCT evaluation was performed at initial vault expansion in 56 (70%) patients. Among this subset, 27 (48%) of patients had evidence of elevated ICP, reflecting a 44% incidence in nonsyndromic patients and 83% incidence in syndromic patients. The median age at initial vault expansion was higher among those with elevated ICP (11.1 months) than those without (7.8 months; p=0.04.) Multi-suture synostosis was associated with higher frequency of elevated ICP (75%) versus single-suture synostosis (41%; p=0.049.)

Interpretation: These findings suggest a high incidence of elevated ICP at time of initial vault expansion, with greater risk among older children and those with multiple suture involvement.
THE LONG-TERM MORPHOMETRIC OUTCOMES IN PATIENTS WITH UNTREATED CRANIOSYNOSTOSIS

Presenter:   John Phillips M.D.
Author:    John Phillips M.D., Christopher Forrest, Elizabeth Zellner, David Khechoyan, Darren Smith
Institution:   The Hospital for Sick Children

Abstract:
Introduction: Patients with craniosynostosis have abnormal head shapes compared to normal infants. There is minimal information in the literature to indicate how the cranial deformity changes with time. The purpose of this study is to characterize temporal changes in cranial morphology in unrepaired craniosynostosis.

Methods: All patients identified with craniosynostosis at the Hospital for Sick Children between 2008 and 2017 who did not undergo surgery and had at least two 3dMD photographs were included in the study. 3D images were analyzed using Vectra software to calculate cranial volume, cranial index(CI) and height. Images were scaled for growth and compared to normative skulls. 2D measurements of area under the curve (AUC) were calculated for each patient's frontal profile. A 3D skull mesh created with a simplifying decimation algorithm was used to calculate a curvature analysis.

Results: 26 patients met inclusion criteria (mean age 25 months, SD 24 months; 9F,17M; 14 sagittal, 8 metopic, 2 unicoronal, 2 bicoronal). 18 patients presented under 12 months of age. Skull volume growth revealed no significant difference in study pts vs controls (p<0.01). CI was also stable, with consistent scores within specific types of craniosynostosis. The slope of change was not statistically different from 0 (slope<-0.002, Pr>|t|>0.15). Even with early presentation < 12 months, the slope of change in CI was still indistinguishable from 0. Regarding frontal morphology, there was no significant increase in AUC with time in patients with craniosynostosis. Using 3D mesh analysis, no worsening of the skull shape was noted for any of the patients with craniosynostosis.

Conclusion: Volume change is consistent with normal controls and CI remains stable over time. Anterior AUC and 3D curvature analyses also remain stable. This data set represents the largest morphometric analysis of unrepaired craniosynostosis. The skull deformity in craniosynostosis does not worsen over time.

ALLOPLASTIC CRANIOPLASTY WITH POROUS POLYETHYLENE IN CHILDREN: OUTCOMES AND CRANIAL GROWTH

Presenter:   Joseph E. Losee, MD
Author:     Liliana Camison, Lucas A. Dvoracek, Ilona Brueckmann M.D., Jesse A. Goldstein, Mandeep S. Tamber, Joseph E. Losee
Institution:  University of Pittsburgh Medical Center

Abstract:
Background: The reconstruction of large calvarial defects in children is difficult, especially when autologous techniques fail. Custom-made porous polyethylene (PPE) implants are an alternative, but concerns for safety and growth restriction limit their use in children. We aimed to study outcomes and cranial growth after large pediatric PPE cranioplasty.

Methods: PPE cranioplasties for large calvarial defects (>30%) were retrospectively studied. Evolution, complications, and long-term appearance were evaluated. A subset analysis was performed in patients with CT scans >4 years apart to assess cranial growth. Intracranial volume (ICV) and head circumference (HC) were calculated using 3DCT and compared to autologous cranioplasty patients and age/gender-matched normal controls.

Results: 14 PPE patients (age 7.2 years; 2.4-16.5) were included. Average defect size was 152cm2. All patients had previously failed a cranioplasty attempt; 53% had previous neurosurgical infections. At last follow-up, averaging 4.5 years (1-8.5), all patients had good cranial contour without complications. Subset analyses of 8 patients with longest follow-ups (avg. 7 years; 5.4-9) showed that HC increased following growth curves of normal age-matched controls in all cases. Despite HC increase, ICV decreased in 62.5% of patients. Equivalent autologous cranioplasty patients (n=8) showed the same pattern, with 75% showing ICV decrease. This discrepancy between HC and ICV was associated with calvarial thickening and chronic VP shunting. Linear regression showed no correlation between HC and ICV changes (R2:0.08).

Conclusion: PPE appears to be a safe alternative for large pediatric cranioplasty. Despite circumferential cranial growth, ICV might still decrease in some patients. However, autologous cranioplasty patients show the same pattern, suggesting that ICV changes might be related to brain injury sequelae and not type of reconstruction. HC is a poor predictor of brain growth after brain injury.
Abstracts

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ON THE MECHANICAL BEHAVIOUR OF PEEK AND HA CRANIAL IMPLANTS UNDER IMPACT LOADING
Presenter: Jayaratnam Jayamohan M.D.
Author: Jayaratnam Jayamohan M.D., D. Garcia-Gonzalez, A. Jérusalem, S.N. Sotiropoulos, A. Arias, B. Siviour, J. Cook, S.H. Yoon
Institution: Oxford Craniofacial Unit

Abstract:
When critical conditions are met, impact injuries can result in brain swelling which, when severe enough, can be treated by a decompressive craniectomy [1]. After diminution of the swelling, a prosthesis is often used to replace the missing skull flap [2]. The patient then needs to go back to active life, thus potentially submitting their head to future impact loadings, a risk additionally exacerbated by a predisposition for further falls and epileptic events.

The work presented herein deals with the mechanical behaviour of cranial implants under impact loading [2]. The study was carried out on polyether-ether-ketone (PEEK) and macroporous hydroxyapatite (HA) prosthesis. These are two of the most commonly used artificial implant materials in order to analyse the suitability of both implants, a finite element head model was developed from magnetic resonance imaging data comprising scalp, skull, cerebral falx, cerebrospinal fluid and brain tissues, with a cranial implant substituting part of the skull. The mechanical behaviours of the human tissues and both biomaterials are studied and their constitutive models are provided. A numerical comparison of the effectiveness of PEEK and HA in a) avoiding failure and b) preventing traumatic brain injury is presented.

The results show the importance of the mechanical properties and nature of the material employed, highlighting the need for a patient-specific material choice. We are able to show the significant differences in biomechanical properties of both of these implants, versus bone re-integration. We demonstrate the importance for implant and the underlying brain, and present a predictive model of brain injury.

Finally, a new methodology is proposed for the risk evaluation of implant failure in case of impact over a wide range of impact conditions.

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RECONSTRUCTION OF SECONDARY SKULL DEFECTS WITH SPLIT CALVARIAL BONE GRAFTS IN A HIGH RISK POPULATION
Presenter: Russell Frautschi M.D.
Author: Russell Frautschi M.D., Brianna Halasa, Grzegorz Kwiecien, Antonio Rampazzo, James E. Zins, Bahar Bassiri Gharb
Institution: Cleveland Clinic

Abstract:
Background: In 2017, autologous bone still represents the first choice for reconstruction of calvarial defects. However, unanswered questions remain on appropriate reconstructive method in patients with multiple risk factors and on the natural of the bone graft. We investigated the outcomes of skull reconstruction with split calvarial bone graft, SCBG, examining the natural history of the SCBG and outcomes in high-risk patients.

Methods: A retrospective chart review of patients who underwent cranioplasty with SCBG between 1982 and 2016 at the Cleveland Clinic was performed. Patient demographics, comorbidities, size and location of defect, outcomes, and risk factors including lack of dura apposition were recorded. Changes in graft thickness were analyzed using follow-up CT and MRI scans.

Results: Forty patients with an average age of 33.2 years, cranial defect size 68cm², 27.6 months follow-up were included. The majority of patients, 85%, had significant risk factors, 43% experienced prior infection, and 68% of patients underwent an average of 2.2 prior skull reconstruction procedures. After reconstruction, 27.5% experienced a major complication. 17.5% of patients experienced resorption, 71% only at the recipient site, with 10% requiring reoperation. Patients with >1 risk factors, OR=2.12; p=0.04, or a smoking history, OR=6; p=0.02, were more likely to experience a complication. The presence of avascularity increased resorption rate, p=0.002. The mean ratio of the graft to the bicortical donor bone thickness was 0.48+/-.017 , recipient site, and 0.57+/-.010, donor site, at an average radiographic follow-up of 11.9+/-.10.9 years.

Conclusions: The current study demonstrates a 72% first-attempt success rate in a high-risk population. This is much lower than what is reported for healthy young patients. Patients with comorbidities and smokers should be adequately counseled on complication risk. The grafts maintain thickness over time with no evidence of bone hypertrophy.
USE OF TITANIUM MESH FOR CRANIOPLASTY REPORT ON 100 CASES
Presenter: Anil Madaree, MD
Author: Anil Madaree, MD, T Pillay
Institution: Nelson R Mandela School of Medicine, University of Kwazulu Natal, Durban, South Africa

Abstract:
Introduction: Craniofacial surgeons are often presented with patients who have significant defects of the cranium. Several methods are available to correct these deformities. Autogenous options include split calvarium, rib, iliac and costal cartilage. Alloplastic material include titanium, vitallium, porous polyethylene, methyl methacrylate, bone cement, hydroxyapatite and other forms of calcium phosphate. Heterogenous cadaver bone graft and xenograft have been used. We would like to report on our experience in the use of preformed titanium mesh plates in the correction of significant calvarial defects.

Material and Methods: We have been using preformed titanium mesh as our method of choice for the elective treatment of significant calvarial defects. On reviewing the records in our craniofacial unit, we found 100 patients in which this method was employed. There were 85 male and 15 female. Age varied from 18 to 52 years. The cause of the defects were trauma (76), infection (15), tumour removal (7) and following neurosurgical procedures (2). The anatomical areas affected were frontal, fronto temporal, parietotemporal and occipital. All cases were treated in an elective manner. There were all delayed reconstructions which were undertaken once all the wounds were well healed and the patients neurological status were stabilized and controlled. The period from the onset of the calvarial defect to the time of the cranioplasty varied from 6 months to 8 years. The surgical approach was via previous incisions raising the flap in a subgaleal plane. Sharp dissection with a blade was used to elevate the flap from the underlined dura. The periosteum was incised and elevated at the margins of the defect. A preformed titanium mesh plate was then chosen to match the defect. This plate was cut and modified as needed to achieve the best possible results. Fixation of the plate was performed using self-tapping screws. Recently we have used acellular dermal.

SYNDROME OF THE TREPHINED: FUNCTIONAL IMPROVEMENT AFTER RECONSTRUCTION OF LARGE CRANIAL VAULT DEFECTS
Presenter: James P Bradley, MD
Author: James P Bradley, MD, Matthew Hagan, MD, Joe Tarr, PhD, Justine Lee, MD, PhD
Institution: Temple University

Abstract:
Background: Large decompressive craniectomies may be life-saving; however, they may result in ‘Syndrome of the Trephined’ (SofT) This post-recovery sequella characterized by speech slowing, gait disturbance, and impaired mentation is poorly understood. We attempted to quantify the functional disturbance in patients with large cranial vault defects and changes after cranial vault reconstruction using quantitative functional analysis.

Methods: Of patients with large cranial vault defects (n=143), SofT (n=40) was diagnosed after deterioration in neuro rehab (55%) or after abrupt neurologic change (45%). Cranial vault reconstructive techniques varied from split cranial bone to alloplastic implants (PEEK) to titanium implants. Timing, complications, reoperations were recorded. Functional analysis was compared preoperatively and postoperatively (6 months) after cranial vault reconstruction using both: 1) Cognistat Active Form and 2) The FIM instrument (Functional Independence Measure).

Results: 1) Defects size was associated with SofT diagnosis (<50cm2=0%, 51-75cm2=22%, 76-100cm2=63%, >100cm2=100%) but not severity. 2) Improvement in SofT was independent of type of reconstruction; but, autogenous=least complication, longer, more EBL; alloplastic=more infection/exposure. 3) Timing of SofT symptoms improvement: 82 hours (mean) after reconstruction. Cognisant assessment showed functional improvement (attention, language, memory, reasoning) in 85% of patients; preop score=38+9 and postop score=69+11. FIM also showed improvement: preop 38+7 (partial dependence) to postop 98+10 (almost complete independence); Cognitive 11+4 to 26+10; Motor 27+10 to 71+10. In 4 patients, implants removed (infection), SofT returned then resolved after second cranial reconstruction.

Conclusions: Syndrome of the Trephined occurs more frequently then previously described in patients with large cranial vault defects; Cranial vault reconstruction reliably leads to symptomatic improvement in patients.
LONG-TERM OUTCOMES OF DEMINERALIZED BONE MATRIX AND RESORBABLE MESH BILAMINATE CRANIOPLASTY IN LARGE PEDIATRIC CALVARIAL DEFECTS IN THE SETTING OF SCARRED DURA

Presenter: Jonathan Y Lee, M.D.
Author: Jonathan Y Lee, Lucas Dvoracek, Joseph E Losee, Jesse A Goldstein
Institution: University of Pittsburgh Medical Center

Abstract:
Introduction: Autologous reconstructive techniques can be used successfully to treat large calvarial defects in the setting of scarred dura. This option is limited in pediatric patients when the diploic space is underdeveloped to aid split-calvarial grafting. Demineralized bone matrix (DBM) is an alternative, known to be effective when reconstructing large defects using a resorbable mesh bilaminate technique in craniosynostosis cranioplasty. Here we review our experience with this technique in the setting of scarred dura in post-decompressive craniectomy defects.

Methods: Retrospective review was performed of patients at a level one pediatric trauma center receiving a DBM and resorbable mesh bilaminate cranioplasty for post-decompressive craniectomy defects. Seven patients (mean age 5 years) met inclusion criteria with mean follow up of 36.1 months. Computed tomography before the DBM cranioplasty and at least one year postoperative were compared. Bone volume and coverage of the defect were assessed.

Results: All patients had hemispheric craniectomy and duraplasty with associated hemi-dural scarring. DBM cranioplasty demonstrated unpredictable and overall poor ossification. Defect coverage and defect bone volume minimally increased by 0.9% and 1.4% respectively. All patients required major revision cranioplasty with mean time to revision of 30.3 months. Pre-contoured porous polyethylene was utilized in six of the revisions while autologous bone graft was used in the remaining patient. Mean follow up after revision was 5.4 months without additional morbidity.

Conclusion: Although using DBM with resorbable mesh bilaminate is appropriate in craniosynostosis cranioplasty, it should be avoided in the setting of scarred or infected dura. In large post-decompressive craniectomy defects, custom pre-contoured porous polyethylene implants may be preferable and require further study.

CEPHALOMETRIC PREDICTORS OF CLINICAL SEVERITY IN TREACHER COLLINS SYNDROME

Presenter: Roberto L. Flores, MD
Author: Natalie M. Plana, Elcin Esenlik, DDS, PhD, Natalie M. Plana, BA, Barry H. Grayson, DDS, Joseph G. McCarthy, MD, Roberto L. Flores, MD
Institution: Hansjorg Wyss Department of Plastic Surgery

Abstract:
Background: The aim of this study is to identify cephalometric measurements associated with clinical severity of Treacher Collins Syndrome (TCS).

Methods: Retrospective single-instruction review of patients with TCS was conducted. Available pre-operative cephalograms (n=30) were evaluated and cephalometric measurements were compared to age-specific normative data using ANOVA. These values were correlated to clinical severity using Spearman analysis. Clinical severity was defined as: severe (required tracheostomy), moderate (obstructive sleep apnea, oral cleft, or gastrostomy-tube), or mild (absence of listed co-morbidities). Measurements with a strong correlation (rs>0.60) were identified as predictors of clinical severity.

Results: Thirty-two cephalometric measures were found to be significantly different from normative data (p<0.01). These measurements were largely related to maxillary/mandibular projection, maxillary/mandibular plane angle, mandibular morphology, facial height, facial convexity and mandible/throat position. Eight of these 32 statistically significant measurements were found to be strongly correlated (rs>0.60) to clinical severity including: a retruded mandibular projection/position (SNPg rs=-0.644, hyoid-Me rs=-0.624); decreased facial height (PFH/AFH rs=0.602); decreased vertical ramus height (Co-Go rs=-0.660); posterior jaw rotation (SN-MP rs=0.616, FH-MP rs=0.612, SN-PP rs=0.694, SN-Symphysis rs=-0.648).

Conclusions: Specific cephalometric measurements of mandibular projection, facial height, ramus height and jaw rotation are statistically associated and strongly correlated with clinical severity in patients with Treacher Collins syndrome. These parameters should be incorporated into a comprehensive classification system to predict prognosis and guide management in these patients.
CRANIAL VAULT RECONSTRUCTION FOLLOWING DECOMPRESSIVE CRANIECTOMY; OPTIMIZING FUNCTIONAL AND AESTHETIC OUTCOMES USING A MULTIDISCIPLINARY APPROACH
Presenter: Micaela Uberti M.D.
Author: Micaela Uberti, Glass, GE, Blythe, J, Homes, SB, Barber, J
Institution: Royal London Hospital

Abstract:
Cranial vault reconstruction following emergent decompressive craniectomy is deemed a low-priority operation in many neurotrauma units. Consequently, it is left to the most inexperienced surgeons to perform with little thought given to the approach through the scalp, bio-integration, tissue healing, infection prevention and aesthetic result. Moreover, evidence exists in support of cranial vault reconstruction optimizing neurologic and functional recovery following major neurotrauma. Additionally, neurotrauma usually occurs as one facet of a major craniomaxillofacial soft tissue and bony injury and the nuances of bony access and soft tissue preservation, crucial to optimizing outcomes are frequently overlooked in the acute situation. As one of the largest Major Trauma Centres in Europe our institution not only performs 80% of all decompressive craniectomies in the UK but also performs the greatest number of secondary cranial vault reconstructions. Prompted by a desire to optimise our outcomes, we formed a collaborative group consisting of a Plastic, Maxillo-Facial and Neurotrauma surgeon in order to approach these cases with technical expertise drawn from all three disciplines. We have developed a bespoke, patient-centred approach, rather than the ‘one-size fits-all’ philosophy that appears to be currently prevalent. Our vision is that this service will be able to function as a test bed for developing novel implant technology, incorporating the latest advances in three-dimensional printing along with osseo-regenerative techniques. Here, we present our first years’ experience following the introduction of this approach, including our outcome data and we discuss the lessons learned, including the need to change neurosurgical thinking regarding access to the cranial vault.

PURPOSE: THE PURPOSE OF THIS STUDY WAS TO DETERMINE THE HOSPITAL COSTS ASSOCIATED WITH DIFFERENT TYPES OF CRANIOPLASTY
Presenter: Oleh Antonyshyn M.D.
Author: Oleh Antonyshyn M.D., Adam Binhammer, Paul Binhammer
Institution: Sunnybrook Health Sciences Centre

Abstract:
Purpose: The purpose of this study was to determine the hospital costs associated with different types of cranioplasty.

Method: The study population consisted of a consecutive series of all patients undergoing cranial vault reconstruction by one surgeon (OA) at Sunnybrook Health Sciences Centre Jan 2001 to Dec 2015. Data collected included OR time, patient ward and ICU stay, and complications including reoperations. Patients were excluded from analysis if undergoing primary trauma skull reconstruction, hydroxyapatite use, associated procedures (free flaps, tumor resection with frozen section) and absent data. Standardized costs of operating room time per minute for cranioplasty and ICU and ward stay were acquired from hospital administration and applied to all cases and complications. Case-specific costs were acquired from hospital administration for implants. A bivariant and mutivariant analysis was carried out.

Results: 96 cases were identified: 25 non-custom titanium mesh, 21 custom titanium mesh, 26 PMMA, 13 autogenous, and 11 PEEK cases. Autogenous reconstruction had significantly longer operative time (P<0.0001). A bivariate analysis of the data revealed a significant relationship between implant type and total costs (P<0.0001), as well as implant type and operation duration (P<0.0001). An age controlled multivariate analysis found the differences in average total costs to be significantly higher in PEEK ($27,379.81) and PMMA ($18,540.00), than autogenous ($14,290.72) and non-custom titanium ($14,625.66). Custom titanium implants ($17,535.65) did not have a significantly higher average total cost than either autogenous bone or non-custom titanium.

Conclusions: This study reviews four materials employed for cranioplasty. Autogenous bone had the longest duration of surgery but significantly lower costs than PEEK and PMMA.
A VOLUMETRIC ANALYSIS OF THE COSTOCHONDRAL
GRAFT IN HEMIFACIAL MICROsomia

Presenter: Scott Bartlett, M.D.

Abstract:
Background: Costochondral rib grafts (CCG) are used for reconstruction of the hypoplastic mandible in children with hemifacial microsomia (HFM). However, the predictability of CCG growth is questioned. The purpose of this study is to determine the evolution of the graft in the reconstructed mandible.

Methods: A retrospective chart review of all HFM patients who underwent rib grafting from January 1998 to February 2017 was performed. Patient demographics, operative data, and postoperative computed tomographic (CT) scans were reviewed. Volumetric data were calculated using Mimics software and compared using Wilcoxon matched-pairs signed-ranks test.

Results: A total of 22 patients out of 181 HFM patients underwent grafting with 10 patients (9 unilateral, 1 bilateral) having two post-graft CT scans before additional mandible surgery. Out of 4 Pruzansky-Kaban type 2b and 7 type 3 mandibles, 3 were reconstructed with a single graft and 8 with multiple grafts. No operative complications were reported. Average age at placement of CCG was 6.4±1.2 years. Average time between postoperative CT scans was 3.1±1.8 years. Interestingly, volume and bone density did not show significant change (p>0.05) between scans, while a volumetric linear regression positively correlated with a 375mm³ increase every year (p<0.0001). Length increased by 7.9±2.7mm (p=0.003) between scans. No difference existed between single versus multiple grafts for volume, density and length. One patient developed ankylosis. No regrafting was needed. 9 grafted mandibles underwent additional distraction osteogenesis (DO) at 3.2±1.7 years postoperatively.

Conclusion: CCG allows for reliable reconstruction of hypoplastic mandibles in HFM patients, showing an increase in length and stable volume and density of grafts. Additional DO is often needed at a later stage for correction of asymmetry. Future studies will compare rates of CCG growth to contralateral mandibular growth, and determine effects of subsequent.

FEASIBILITY OF MAGNETIC ACTIVATION OF A
MAXILLOFACIAL DISTRACTION OSTEOGENESIS, DESIGN
OF A NEW DEVICE

Presenter: Boisson Jean M.D.

Abstract:
Introduction: Distraction osteogenesis is a technique of bone lengthening which uses the bone’s natural healing process. Current devices for craniofacial distraction require a transmucosal or transcutaneous activator and are associated with numerous complications. The aim of this study was to evaluate the feasibility of a rodless magnetic activation device that could be used in craniofacial distraction.

Methods: The method is based on the torque applied between two unaligned permanent magnets. This torque depends on magnet size, shape, composition, magnetization and distance between the two magnets. Using a configuration close to that which would be applied in actual distraction osteogenesis (in terms of the distance between the two magnets), we performed an analytical study and evaluated the results.

Results: We observed good agreement between the model and the experimental results, finding that the transmitted force value is comparable to the force required in mandibular distraction. Thus, we proposed a design of a new distracting device consisting of a cylindrical permanent magnet diametrically magnetized and fixed to an endless screw along its main axis. Activation of the distraction motion is achieved through interaction of the first magnet with a second cylindrical magnet whose magnetization is orthogonal to its main axis and to the device’s endless screw.

Conclusion: This preliminary study demonstrates that magnetic activation for mandibular osteogenic distraction is feasible and that device size is not a constraint. We propose a prototypic device.
DISTRACTION OSTEONEGENESIS IN MICROVASCULAR FREE FIBULA FLAP FOR HEMIFACIAL MICROsomia PATIENTS

Presenter: Eric Santamaría, M.D.
Author: Eric Santamaría, M.D., Adriana Guerrero, Maria Soledad Rubio, Damian Palafox, Maria del Carmen Pamplona
Institution: Hospital Dr. Manuel Gea Gonzalez

Abstract:
Hemifacial microsomia constitutes a craniofacial abnormality that occurs secondary to an anomalous development in any of the derivatives of the 1 or 2 branchial arches. Mandibular hypoplasia Pruzansky 3 is the less frequent presentation but also the most severe one. Free osteocutaneous flaps are the gold standard treatment in these patients. Mandibular malformation recurrence posterior to microvascular free flap reconstruction is related directly to the dynamism of the child underdeveloped skeleton. Distraction osteogenesis is a useful strategy to promote bone elongation. Our objective is to describe our distraction technique and our experience in free fibula flap mandibular distraction in patients with hemifacial microsomia. We include 5 pediatric patients with hemifacial microsomia Prusansky 3. Each of them had a free fibular flap for mandibular reconstruction, all of them had a mandibular deformity recurrence due to abnormal growing pattern in the microsomia mandibular side. The severity of the malformation was determined with OMENS classification, the facial asymmetry was viewed in photography and the bone asymmetry was measured in CT and panoramic radiography. 6 mandibular distractions were performed in 5 patients. The average age in which distraction was performed was 10,5 years. In 3 patients the osteotomy was performed between the fibula flap and the native mandible, 3 cases were made on the fibula bone. The distraction vector was vertical in 3 cases, horizontal in 2 cases and bidireccional in 1. The distraction average length was 19,5mm in the mandibular body and 23,3mm in the angle. The intergonial plane normalized in 5 patients, the mandibular deviation neutralized in 4 patients and the symmetry of the mandibular angles improved in 5 patients. Osteogenesis distraction is a useful strategy to achieve facial symmetry in patients with mandibular microvascular reconstruction, with the advantage that it can be performed several times during the child growth.

MODIFIED SIMULTANEOUS BIMAXILLARY DISTRACTION OSTEONEGENESIS FOR CORRECTION OF FACIAL ASYMMETRY USING SEMI-BURIED MANDIBULAR DISTRACTORS.IN CHILDREN AND ADULTS, WITH LONG-TERM FOLLOW UP

Presenter: Ahmed Medra M.D.
Author: Ahmed Medra M.D.
Institution: Alexandria University,Faculty Of Dentistry

Abstract:
Introduction: Facial asymmetry secondary to mandibular hypoplasia is a common problem in the field of craniomaxillofacial surgery. Mandibular hypoplasia uni- or bilateral, may result from disturbed embryogenesis, or may represent an acquired deformity as a sequel of condylar fractures suffered at an early age of life with secondary ankylosis of temporomandibular joint. Mandibular distraction in adult patients with facial asymmetry secondary to hemicranio-facial microsomia and/ or unilateral ankylosis of the temporomandibular joint , who usually, has stable (compensated) dental occlusion produces good esthetic results, but also produces severe alterations in the occlusion requiring complex and prolonged orthodontic treatment to solve this problem.

Aim: To study the efficacy of modified simultaneous maxillary mandibular distraction for correction of facial asymmetry in patients ( children and adults) with compensated dental occlusion and a canted occlusal plane using semi-buried mandibular distractors.

Patients and methods:
Inclusions Criteria: Patients with facial asymmetry; having compensated dental occlusion and a canted occlusal plane, both children (no. 30), ( 9 years old and more) and adults (no.60).
Two groups; A- patients with hemifacial microsomia,(30 patients,14 children and 16 adults)
B- patients with history of temporomandibular joint trauma early in life; four categories:
1. Unilateral Ankylosis (un-released), 15 children and 10 adults.
2. Unilateral Ankylosis (released), 20 children and 18 adults
3. Unilateral post-traumatic condylar hypoplasia with accepted mouth opening, 6 children and 8 adults.
4. Patients with resection of ramus-condyle unit early in life (tumor; four adults).
SPEECH AND LANGUAGE CONCERNS IN CRANIOFACIAL MICROsomia

Presenter: Nicole Kurnik, MD
Author: Davinder Singh, MD, Nicole Kurnik, MD, Kelly Cordero, PHD, CCC-SLP
Institution: Department of Plastic Surgery, Phoenix Childrens Hospital, Barrow Cleft and Craniofacial Center

Abstract:
Objective: The purpose of this study is two-fold, firstly; to determine the incidence of unilateral hypodynamic palate and velopharyngeal insufficiency (VPI) in non-clefted patients with craniofacial microsomia (CFM). And secondly; to determine what percent of these patients have other diagnoses related to speech and language skills. We further determined what percentage of these patients required surgical intervention verses speech therapy alone, and stratified this based on specific diagnosis.

Methods: A retrospective chart review was preformed to identify all patients with craniofacial microsomia without cleft palate. Speech evaluations were reviewed to determine incidence of VPI, as well as other speech diagnoses such as articulation difficulties and expressive or receptive language disorder that required intervention with speech pathology. We then evaluated incidence of surgery as a final treatment option in these patients.

Results: 59 patients with a diagnosis of craniofacial microsomia were reviewed. Overall 45.7% (27/59) of patients with had a speech-language diagnosis that required speech therapy intervention. The incidence of VPI without cleft palate was 13.5% (8/59). All of these patients received speech therapy and 37.5% (3/8) went on to need surgical intervention for treatment of their VPI. 32% (19/59) of these patients had speech difficulty relating to articulation or speech delay due to auditory considerations.

Conclusion: Many patients with craniofacial microsomia have difficulty related to speech-language skills and some require surgical intervention for velopharyngeal insufficiency. Early diagnosis and speech therapy intervention in this patient population is imperative. Given these findings we would recommend all patients undergo a through speech evaluation when receiving a diagnosis of craniofacial microsomia. These findings are helpful in the counseling of families and management of CFM patients.

CRANIAL BASE MEASUREMENT IN HEMIFACIAL MICROsomia

Presenter: Xianxian Yang M.D.
Author: Xianxian Yang M.D, Xiaojun Chen, Yan Zhang, Gang Chai
Institution: Department of Plastic and Reconstructive Surgery, Shanghai Ninth Peoples Hospital

Abstract:
Introduction: Many researchers have studied the relationship between facial asymmetry and cranial base, while failed to reach a consensus. This study aims at verifying whether cranial base is involved in hemifacial microsomia(HFM) or not.

Methods: Forty-one HFM patients treated at plastic and reconstructive department of Shanghai Ninth People's Hospital from 2014.01 to 2016.10 were included and divided into three groups according to Pruzansky and OMENS classifications, separately. Twenty patients diagnosed as mandibular angle hypertrophy with no facial asymmetry were chosen as controls. Angular and linear measurements of the cranial base were made respectively.

Results: The angle between two planes exists differences in mild and severe groups. In moderate and severe groups, the middle and posterior cranial angles have statistical significance and CI-P, S-P lengths are obviously shorter in the affected side. Such landmarks as internal acoustic canal, carotid canal, hypoglossal canal can also be considered as references.

Conclusions: Cranial base is not spared in hemifacial microsomia. It may help verify the hypothesis of HFM pathogenesis and may offer new treatment thoughts and classification methods.
3D EVALUATION OF MAXILLA AND FACE AFTER 2 AND 3 SEGMENTS SURGICALLY ASSISTED MAXILLARY EXPANSION

Presenter: Max Domingues Pereira M.D.
Author: Max Domingues Pereira M.D., Gabriela Prado, Alexandre Koga, Fabiane Furtado
Institution: Universidade Federal de São Paulo - Escola Paulista de Medicina - UNIFESP- EPM

Abstract:

Introduction: The treatment of choice for adult transverse maxillary deficiency (TMD) ≥ 5mm is surgically assisted rapid maxillary expansion (SARME). The existing studies comparing maxillary osteotomies in 2 segments (2S) or 3 segments (3S) do not have a properly study design to conclude so many advantages of 3S osteotomy. None of these studies also used three-dimensional methodologies to address their variables and outcomes. The better comprehension of the outcomes of 2S and 3S osteotomies will contribute to elucidate which is the best operative technique.

Objective: Compare 2S and 3S SARME effectiveness concerning maxillary expansion symmetry and changes in nose width and topology of the paranasal area.

Methods: 32 adult patients with TMD ≥5mm were randomly assigned to groups 2S (n=16) and 3S (n=16). Maxillary symmetry was assessed through 3D superimposed imaging of computed tomography analyzed by Geomagic Qualify 2013 software. Assessments were carried out before SARME (PRE) and at expansion accomplishment (EA). Face images of each patient were captured by Vivid 9i (Konica Minolta - Japan) PRE and 6 months (6m) after EA and then superimposed using Geomagic Qualify 2013 software to analyze nasal and paranasal topographic changes. RESULTS: No statistically significant difference in mean values of maxillary asymmetry was found between groups (p≥0.05). The mean increase of nose width was greater (p=0.017) in group 2S (2.73mm) than in group 3S (1.92mm). No differences between SARME techniques were found concerning paranasal changes excepting for changes along X-axis (transversal) which were greater for 3S technique (p=0.014).

Conclusions: The maxillary expansion asymmetry and paranasal area increase is similar in 2S and 3S, except for transverse changes in the topology of paranasal areas that is greater in 3S technique. The increase in nose width is greater in 2S intervention.

CONFORMITY OF THE ACTUAL TO PLANNED RESULT IN ORTHOGNATHIC SURGERY

Presenter: Sarika Madari M.D.
Author: Sarika Madari M.D., Rajendra Sawh-Martinez, Derek Steinbacher
Institution: Yale University

Abstract:

Purpose: Virtual surgical planning (VSP) has dramatically improved the workflow process for orthognathic surgery. Qualitative evidence suggests improved surgical efficiency, and splint accuracy. However, the translation from the 3D plan to the actual result, has not been adequately examined quantitatively. The purpose of this study is to compare the planned to the actual 3-dimensional result, comparing placement precision of the maxillomandibular complex in space. We hypothesize the greatest conformity exists in the Anteroposterior Dimensions.

Methods: This was an HIC-approved retrospective study of patients who underwent Le Fort I maxillary advancement, bilateral sagittal split osteotomies, and genioplasty using VSP. The preoperative planned 3D file (.stl) was imported into Mimics (Materialise, Leuven, Belgium), for manipulation. Postoperative cone beam CT scans were converted, and imported into the same digital platform. Registration between the two-sets was performed using non-changed landmarks (including, mastoid, styloid, and the orbitozygomatic region). Overall bony position was then assessed, as were 3D linear and angular measurements (including: A point, B point, Pg, Me, ANS, SNA, SNB, and ANB). Multiple instances of each measure were taken, and inter-rater reliability measured. Differences were compared using t-tests, with p <0.05 being statistically significant.

Conclusion: This studied reveals, that despite 3D planning with splint accuracy, there were small deviations in actual bony positioning compared with the planned position. These were more apt to occur in the transverse and vertical planes, but some difference was noted sagittally in all cases. The differences may be due to intraoperative aesthetic judgements pertaining to the vertical position and midline. Additionally, pitch alteration could influence the relative sagittal placement.
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VINTAGE ORTHOGNATIC SURGERY: NO FERWELL FOR MAJOR OSTEOTOMIES
Presenter: Jacobo Felemovicius M.D.
Author: Jacobo Felemovicius M.D.
Institution: Hospital General Dr. Manuel Gea Gonzalez

Abstract:
For the past 20 years the author has been in charge of the Orthognatic clinic at Hospital General Dr. Manuel Gea Gonzalez in Mexico City. During this period the author has had the privilege to be nourished and influenced by the best of the golden years of Cranio Facial (CF) surgery as well as the maturation and consolidation of Distraction Osteogenesis (DOG). There is no argument to oppose that these techniques were game changers and still are an essential part of the armamentarium of the CF surgeon. That said, very often, and especially in syndromic patients treated following state of the art distraction osteogenesis (DOG) algorithms, We keep facing a considerable number of patients, with skeletal maturity, that after having endured several procedures (corticotomies and DOG, early osteotomies), still present with many of the skeletal stigmata of their original malformation. The following presentation intends to highlight the leading role of classic, very well panned and sometimes daring, orthognathic surgery, in successfully treating this group of patients. It also intends to raise the question of whether we should re think or re write current algorithms for the management of some Cranio Maxillo Facial (CMF) pathologies.

During the past 20 years we have operated on several patients meeting this criteria: 400 + CLP patients with maxillary hypoplasia (in a couple of cases even being able to perform osteotomies and classic advancements in free fibular osteocutaneous prefabricated flaps, previously indicated to replace the premaxilla), 20 patients with Hemi Facial Microsomia (with as much as 3 previous DOG procedures), 15 patients with severe Long Face Syndrome, 6 cases with sequelae of complicated severe facial trauma (with a crippled occlusion), 5 patients with Treacher Collins Syndrome (un successfully treated with the traditional algorithm).

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AN INTEGRATED SURGICAL PROTOCOL FOR ADULT PATIENTS WITH HEMIFACIAL MICROsomia: METHODS AND OUTCOME
Presenter: Lun-Jou Lo, M.D.
Author: Lun-Jou Lo, M.D., Kazuaki Yamaguchi, Daniel Lonic, Ellen WC Ko, Lun-Jou Lo
Institution: Chang Gung Memorial Hospital

Abstract:
Background: Hemifacial microsomia (HFM) features hypoplasia and asymmetry in skeletal as well as soft tissue, and correction of the deformity is difficult in terms of aesthetic outcome. The purpose of this study is to examine the validity of an integrated treatment protocol for correction of this facial deformity.

Patients and Methods: A retrospective study was performed on adult HFM patients who received two-jaw orthognathic surgery combined with facial contouring procedures in the first stage, and fat injection for the residual facial deficiency in the second stage. Inclusion criteria were patients treated by the same surgeon and follow-up at least 6 months. The demographic, perioperative, and follow-up data were collected. We defined a facial surface area discrepancy index (FDI) for objective assessment of the symmetry between the affected and non-affected side, and utilized visual analogue scale (VAS) for subjective evaluation of facial asymmetry before and after surgical treatment.

Results: A total of 14 patients were included. The mean age at orthognathic surgery was 21.7 years. Four patients were categorized as Pruzansky-Kaban type I, while the remaining 10 patients were type II (7 patients type IIa, 3 patients type IIb). Fat injection as a secondary procedure was performed in eleven cases (79%). The mean pre- and postoperative FDI was 87.6±6.3 and 95.4±5.2 with a significant advance for symmetry (p < 0.001). The pre- and postoperative VAS for asymmetry was 7.2±1.7 and 3.8±2.4 respectively, with a significant improvement (p = 0.002).

Conclusion: Our integrated approach using orthognathic surgery, facial contouring surgery and subsequent fat injection is satisfactory and obtain significant improvement of the facial deformity considering the complexity of HFM.
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TRACHEAL SLEEVE CARTILAGE -- VARIATIONS IN PRESENTATION AND CHALLENGES IN MANAGEMENT
Presenter: Scott Rickert
Author: Scott Rickert
Institution: New York University Langone Medical Center

Abstract:
Tracheal sleeve cartilage or continuous cartilage along the tracheal airway is an unusual presentation of a tracheal anomaly. It can be asymptomatic in presentation or profounding symptomatic and is very patient dependent. Tracheal sleeve cartilage is typically found in the craniofacial population, particular in syndromic craniosynostosis.

The craniofacial population in general has a strong association with have a wide range of anatomy of airway/vocal tract anomalies. While there is an incidental report of non-syndromic tracheal sleeve cartilage, 90+% of presenting patients are syndromic. Furthermore, there is evidence that tracheotomy at the time of identification of tracheal sleeve advantageous to survival (p=0.0067) and is not dependent on age.

At NYU Langone Medical Center, there are approximately 300 craniofacial patients seen yearly and in the past 5 years, 13 tracheal sleeve cartilage patients have been identified. 11/13 are noted to be syndromic craniosynostosis and 1 is not syndromic. Their age at first identification ranges from 5 months to 17 years. 6/13 have a tracheotomy in place for airway support. Each patient underwent endoscopic airway evaluation prior to identification of the tracheal sleeve cartilage. The tracheal airway is best described by one of three manifestations: adequate airway (for age of patient) without significant malacia, adequate airway (for age of patient) with significant malacia, and stenotic inadequate airway (for age of the patient) with or without malacia segment. Tracheotomies were in place for 1/5 adequate airway without malacia, 3/5 for adequate airway with malacia and 2/3 for stenotic airway.

These three manifestations require significantly different management of the airway. Description, examples, and management decisions will be described for each of the three categories of tracheal away in this unusual entity to help the audience understand the complex airway decisions involved in tracheal sleeve cartilage airways.

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A NEW TECHNIQUE FOR POSTERIOR DISTRACTION IN CRANIOSYNOSTOSIS: THE DOUBLE DOOR TECHNIQUE
Presenter: Yoshiaki Sakamoto M.D.
Author: Yoshiaki Sakamoto M.D., Tomoru Miwa, Kazunari Yoshida, Kazuo Kishi
Institution: Keio University School of Medicine

Abstract:
Background: Posterior cranial vault distraction osteogenesis is a common treatment for syndromal cases of brachycephaly and oxycephaly. Although posterior distraction can increase intracranial volume, the flattened head phenotype is difficult to correct. The authors examined a new posterior distraction technique termed double door distraction for improvement of the flattened head phenotype.

Method: From 2010 to 2013, 6 patients with flattened posterior craniums were operated on using the double door distraction technique. The calvarial segment was cut at the midline and divided into two pieces. Distractors were then fixed in parallel to join the calvarial pieces. The distraction was initiated at a rate of 1.0 mm/day and continued until proper cranial form was confirmed by radiography and appearance.

Results: The average surgery time was 2 h 47min and the amount of distraction ranged from 15 to 22 mm. An improved head shape and expanded cranial vault was achieved in all cases without any complications.

Conclusions: The double door distraction technique is a useful technique not only for calvarial expansion, but also for correction of the flattened posterior cranium phenotype.
102  ANALYSIS OF 20 CONSECUTIVE CASES OF POSTERIOR CRANIAL VAULT DISTRACTION
Presenter: Yuzo Komuro M.D.
Author: Yuzo Komuro M.D., Daiki Senda, Kazuaki Shimoji, Masakazu Miyajima, Hajime Arai
Institution: Department of Plastic Surgery Teikyo University

Abstract:
Background: We have reported that in cases of craniosynostosis with posterior flattening, using the technique of distraction osteogenesis was very effective when carrying out posterior cranial vault expansion. We present the outcome of 20 patients, who were treated with this method.

Methods: Twenty patients with craniosynostosis were treated through a posterior calvarial distraction osteogenesis from 2001. A biparietal craniectomy was performed at the widest portion of the calvarium and a transverse bioccipital craniectomy was made as low as possible blow the superior nuchal line. Barrel stave osteotomies were also performed on the inferior occipital segment and bone segments were greenstick fractured posteriorly to expand the suboccipital region. Occipital bone was fixed to these bone segments with absorbable plates bilaterally. In the case with chronic Chiari malformation, foramen magnum decompression is made. Finally two or three distractors were applied to the osteotomized sites. The distraction device used in this study does not employ a plate for fixation on the bone and only involves the insertion of a U-shaped plate into the osteotomized region.

Results: In all of the cases except 1 case died from postoperative respiratory dysfunction with no causal relationship to the surgery, we were able to perform bone extension of 25 mm or more and achieve sufficient skull expansion. Within 1 year after the surgery, in all of the cases, favorable osteogenesis was observed in the distraction gap. Subarachnoid spaces were expanded and occipital lobe and stricture of the cerebellum was improved. In three cases with Chiari malformation preoperatively, ascent of the cerebellar tonsil was noticed on MRI after expansion of occipital bone. The present method is extremely useful for skull formation in cases of craniosynostosis with posterior flattening.

103  EXPERIENCE OF POSTERIOR DISTRACTION IN 117 CASES: ANALYSIS OF THE RESULTS AND PROSPECTS FOR THE FUTURE OF THE METHOD
Presenter: Leonid Satanin M.D.
Author: Leonid Satanin M.D., Niina Salokorpi, Ivan Teterin, Alexander Ivanov, Vitaly Roginsky, Willy Serlo
Institution: Moscow Burdenko Neurosurgery Institute, Russia

Abstract:
Background: The primary method for cranioplasty is a one-stage operation with the fixation of the bone flaps with wires, titanium or resorbable plates, screws or tacks. However, sometimes the required expansion of intracranial volume is greater than can safely be achieved by one-stage repair. In these cases Posterior cranial vault distraction (PCVD) is an effective option. The use of modern technologies (virtual modeling and volumetric evaluations, individual templates) makes the results of the PCVD predictable. However, the question of the optimal extent of distraction remains open. The purpose of the study was to evaluate the results of PCVD in order to improve the planning of the distraction and predicting its results.

Material and methods: During 2009 and 2017, 117 patients were treated by PCVD at Oulu Craniofacial Center, Finland, and Moscow Neurosurgical Institute, Russia. In 86 cases, a thorough anthropometric analysis using geometric morphometry methods was performed, volumetric measurements were made, including intracranial CSF volumes (ICSCFV). The modeling of the occipital distraction was performed with the calculation of intracranial volume (ICV) dynamics using Endex software. In 15 cases, individual templates were used to mark the osteotomy lines.

Results: The median ICV before surgery was 1073,7 ml and the ICV after PCVD was 1345,9 ml. The increase of the intracranial volume was thus 255,7 ml (23.2%). The changes in ICSCFV was 72.7 ml, (68,5%; median). A linear relationship between the extent of distraction and the increase in the ICV was observed.

Conclusion: PCVD is a useful and potentially predictable method when one stage cranioplasty is not feasible. The data obtained will allow the development of a personalized approach in the planning of PCVD for each specific case.
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THE OXFORD EXPERIENCE OF POSTERIOR CRANIAL VAULT DISTRACTION; EVIDENCE FOR A REDUCED CONSOLIDATION PERIOD
Presenter: David Johnson M.D.
Author: David Johnson M.D., Greg Thomas, Shailendra Magdum, Jay Jayamohan, Jo Byren, Steven Wall
Institution: Oxford Craniofacial Unit

Abstract:
Introduction: Posterior vault distraction (PVD) is now an established technique to increase the intracranial volume and correct calvarial morphology in patients with severe turribrachycephaly. Our experience in Oxford suggests that PVD more accurately represents distraction of an osteotomy site to create a bone gap, followed by subsequent osteogenesis rather than true distraction osteogenesis. The Oxford experience, therefore, questions the need for a latency period and a consolidation period in PVD.

Methods: A retrospective review was performed of all patients who underwent PVD at the Oxford Craniofacial Unit between 2007 and 2016.

Results: 44 patients were identified. 38 cases were performed for brachycephaly and 6 for raised intracranial pressure (ICP). In the majority of cases 2 Arnaud style distractors were used. Active distraction to 20mm or over was achieved in > 90% of patients. Of these, all but one demonstrated a significant improvement in morphology, with resolution of the symptoms and signs of raised ICP in all proven to have it preoperatively. Wound infection and tissue necrosis were the commonest complications. 27 patients had a consolidation period of less than 30 days and 10 patients had a consolidation period less than 14 days without evidence of significant clinical or radiological relapse.

Conclusion: PVD is an effective procedure in the management of raised ICP and severe turribrachycephaly. The lack of callus formation in the calvarium precludes the need for a latency period. Our results suggest that a reduced consolidation period does not lead to significant relapse. By removing the distractors early after the period of distraction the complication rate associated with wound infection is significantly reduced. Our experience provides evidence that PVD is not true distraction osteogenesis but rather distraction followed by osteogenesis across the distraction gap. This osteogenesis is most likely driven by the dura.

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POSTERIOR VAULT DISTRACTION IN MULTI-SUTURE SYNOSTOSIS: MORPHOMETRIC ANALYSIS AND OUTCOMES
Presenter: Christopher R. Forrest, MD
Author: Christopher R. Forrest, MD, Jessica A. Ching, MD, April Clausen, P. Eng
Institution: The Hospital for Sick Children, Toronto

Abstract:
Introduction: Treatment of multi-suture craniosynostosis increasingly includes posterior vault distraction (PVD); however, its effect on turricephaly is not well quantified. The purpose of this study was to examine the effect of PVD on cranial height and occipital inclination and outcomes.

Method: With REB approval, a retrospective review of patients treated with PVD was performed. CT scout radiographs and lateral skull radiographs were assessed preoperatively, during distraction, and after fronto-orbital or monobloc advancements, where available. Measures of interest included: turricephaly index (TI=cranial length/height), vertical growth index (VGI=cranial base length/height), absolute vertical height (AVH=sella to vertex distance), and occipital inclination angle (OIA).

Results: Twenty-three patients were included for analysis (12 males, 11 females), age 4 months to 12.5 years (mean=27.7 months). Fifteen patients carried a syndromic diagnosis. Underlying synostoses included bicoronal (n=13), sag/unicoronal (n=1), mercedes (n=4), and pansynostosis (n=5). Preoperatively, patients exhibited a mean TI of 1.34 (range=1.02-1.53, SD=0.16), VGI of 0.41 (range=0.26-0.58, SD=0.08), AVH of 107.37mm (range=87.4-149.4, SD=15.38), and OIA of 44.54 degrees (range=12.5-67.2, SD=12.17). PVD (n=18) demonstrated association with increased TI (mean=1.53,p<0.001) and VGI (mean=0.44,p=0.001), while flattening the OIA (mean=37.5,p=0.004). Posterior vault osteotomies and distractor placement did not contribute to changes in TI or VGI. Additional frontal advancement procedures after PVD (n=15) yielded further increase in TI (mean=1.59,p=0.004) and VGI (mean=0.47,p=0.012). AVH did not change significantly once distraction was initiated. Complications occurred in 11/23 patients.

Conclusions: PVD increases calvarial length relative to AVH and flattens occipital inclination, effectively normalizing turricephalic proportions. These results are improved by further frontal advancement surgerie.
CHANGES IN INTRACRANIAL VOLUME WITH POSTERIOR VAULT DISTRACTION FRONTAL ORBITAL ADVANCEMENT

Presenter: Daiki Senda M.D.
Author: Daiki Senda M.D., Azusa Shimizu, Doruk Orgun, Takaoki Kimura, Kazuaki Shimoji, Masakazu Miyajima, Hajime Arai, Yuzo Komuro
Institution: Department of Plastic and Reconstructive surgery, Juntendo University

Abstract:
Posterior cranial vault distraction osteogenesis (PVDO) is thought to be more effective in increasing intracranial volume (ICV) compared with fronto-orbital advancement (FOA) or fronto-orbital remodeling (FOR). Therefore, PVDO is the first choice of treatment for patients with craniosynostosis at our institution. However, in patients with severe deformity craniosynostosis, PVDO is usually insufficient to expand the ICV and fail to improve visual impairment. In such cases FOA or FOR is performed after PVDO at our institution. In this study, we have investigated the changes in ICV of patients with craniosynostosis after treatment with these techniques.

Nine patients (5 male and 4 female) aged from 5 months to 6 years 8 months (mean 26.6 months) at the time of first operation (PVDO) were treated with PVDO followed by FOA or FOR at Juntendo University Hospital from 2011 to 2016. 2 of these cases were treated with FOA and the remaining 7 with FOR. Patient characteristics, length of distraction, and pre- and postoperative computed tomography findings were reviewed. ICV was measured using the workstation functions on three-dimensional computed tomography scans.

For PVDO, the distraction length was 18 to 38mm (mean 28 mm), the ICV change was 144 to 281 mL (mean 198.8 mL), and the enlargement ratio of ICV was 109% to 134% (mean 123%). The present quantitative analysis of ICV change after PVDO showed greater increases in ICV. Furthermore, ICV in our patients became close to physiologic levels and were maintained throughout the entire follow-up period.

As a conclusion, we think that PVDO might have played a greater part for the increase of ICV, and FOA or FOR for the improvement of the visual impairment in these patients. PVDO was more effective for increasing the ICV compared with FOA or FOR in the same patient. Therefore, for the treatment of similar cases we think that PVDO should be performed in advance before FOA or FOR in order to achieve more desirable future results.

FORCE MEASUREMENTS DURING POSTERIOR CALVARIAL VAULT OSTEODISTRACTION: A NOVEL MEASUREMENT METHOD

Presenter: J.Leikola M.D.
Author: Mikko Savolainen, Antti Ritvanen, Daniel Nowinski, Daniel Saiepour, Mervi Paulasto-Kröckel, J.Hukki, E.Tukiainen, J.Leikola M.D.
Institution: Department of Plastic Surgery, Helsinki University Hospital

Abstract:
Posterior calvarial vault osteodistraction (PCVO) has become increasingly popular in the correction of craniosynostosis. When compared to cranioplasty, PCVO offers a shorter, less invasive operation, greater intracranial volume advancement and a lower rate of relapse.

In general, distraction protocols are based primarily on clinical observations rather than systematic research. Faster distraction protocols may reduce complications. However, distraction protocols producing higher forces can increase complications. Thus, we need to understand these forces in order to improve distraction protocols and devices.

We developed a force measurement method that can be used on PCVO devices in routine clinical practice. Here, we present preliminary data about the forces developed during PCVO. We measured the forces in four bilateral coronal craniosynostosis patients during PCVO.

We observed a linear-like trend between the force increase and the distraction distance within distraction sessions. We also observed a step-wise force increase between distraction sessions and found that the distraction force relaxed rapidly shortly after the distraction session. The mean maximum pre-distraction force for one distracter was 20.4 N, while the mean maximum end-distraction force for one distracter was 57.6 N. Our data suggests that current treatment protocols might be re-evaluated favouring shorter distraction distances and more frequent distraction sessions.
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A CRANIOMETRIC ANALYSIS OF POSTERIOR VAULT DISTRACTION AND ITS EFFECTS ON FRONTAL CRANIAL MORPHOLOGY

Presenter: Scott Bartlett M.D.
Author: Netanja ter Maaten, Dan Mazzaferro, Ari Wes, Sanjay Naran, Scott Bartlett, Jesse Taylor
Institution: Children's Hospital of Philadelphia

Abstract:
Background: In addition to its volumetric benefits, posterior vault distraction osteogenesis (PVDO) is believed to improve frontal contour in syndromic turribrachycephalic infants. This study provides an objective craniometric analysis to determine how PVDO affects anterior cranial morphology.

Methods: We queried our prospective craniofacial registry for patients undergoing PVDO. Inclusion criteria included a complete medical record, perioperative data, and pre- and post-operative computed tomography (CT) scans -- one within 3 months before surgery and another 1 to 6 months after surgery. Volumetric and craniometric data were obtained using Mimics software and compared using paired t-test, Wilcoxon rank-sum, and multilevel mixed-effects linear regression.

Results: From 2009 to February 2017, 65 patients underwent PVDO, and 13 patients met inclusion criteria. Mean age at intervention was 3.4 years (range, 0.3 to 14.1), and six patients underwent PVDO before 1 year of age. Average length of distraction was 22.5±6.5 days and distraction distance averaged 25±6 mm. The average increase in total cranial volume in all patients was 249±159 cm³ (p<0.0001). Craniometric analysis demonstrated that after PVDO, supraorbital retrusion decreased by an average of 1 mm (p=0.001). Also, the frontal bossing angle decreased by an average of 2.92±2.16 degrees (p=0.0004) indicating improvement in frontal bossing. No changes were found in anterior cranial height or basofrontal angle (p>0.05).

Conclusion: PVDO improves frontal contour by decreasing supraorbital retrusion and reducing frontal bossing in syndromic patients with turribrachycephaly. When combined with its proven efficacy for cranial expansion, these frontal changes likely reinforce PVDO’s ability to allow for a delay in frontal surgery in this group.

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POSTERIOR VAULT DISTRACTION OSTEOGENESIS AND NEUROLOGICAL OUTCOMES IN SYNDROMIC CRANIOSYNOSTOSIS

Presenter: James Thomas Paliga M.D.
Author: James Thomas Paliga M.D. James Sun Childrens, Ari M. Wes, Sanjay Naran, Scott P Bartlett, Jesse A Taylor
Institution: Children’s Hospital of Philadelphia

Abstract:
Background: Patients with syndromic craniosynostosis have increased incidence of hydrocephalus and elevated intracranial pressure requiring shunt placement and cranial vault expansion. Variable effect of craniosynostosis on cranial volumes increases risk of Chiari malformation. Impact of posterior vault distraction osteogenesis (PVDO) on the development of Chiari malformation and necessity of shunt placement has not been previously described.

Methods: An IRB-approved retrospective chart review was performed on patients with syndromic craniosynostosis who underwent cranial vault surgery between 2004 and 2016. Endpoints included demographics, interventions, and presence of Chiari malformation on radiographic studies or hydrocephalus requiring shunt placement. Patients with incomplete data were excluded. Statistical comparison was performed using Mann Whitney U test and Fisher’s exact test.

Results: 52 patients with syndromic craniosynostosis underwent PVDO (mean age 3.0±3.6 yrs) and 25 underwent anterior or posterior vault expansion during the study period (mean age 2.3±2.6 yrs). There were no statistically significant differences between the groups with regards to age (p=0.590), pre-operative incidence of Chiari malformation (34.6% vs 12.0%, p=0.055, OR=3.88) or hydrocephalus requiring shunt placement (15.4% vs 12.0%, p=1.000, OR=1.33). Patients who underwent PVDO had a significantly decreased incidence of developing Chiari malformation post-operatively compared to conventional cranial vault expansion (1.9% vs 16.0%, p=0.036, OR=0.10). There was no statistical difference in the incidence of post-operative hydrocephalus requiring shunt placement (3.8% vs 4.0%, p=1.000, OR = 0.96).

Conclusion: Syndromic patients treated with posterior vault distraction osteogenesis have a decreased incidence of Chiari malformation compared to those treated with conventional vault expansion. In this series, there was no statistical difference in rates of shunting between the two groups.
A 2 CENTRE EXPERIENCE OF 100 CONSECUTIVE POSTERIOR VAULT DISTRACTIONS: PROCEDURES, OUTCOMES AND COMPLICATIONS

Presenter: Michael Stephen Dover M.D.
Author:    Michael Stephen Dover M.D., Davi Johnson,
           Steven Wall, Nicholas White, Martin Evans,
           Greg Thomas, Desiderio Rodrigues,
           Sheilendra Magdum, Guirish Solanki,
           Jay Jayamohan, Hiroshi Nishikawa
Institution: Birmingham Children’s Hospital, UK

Introduction: Posterior vault distraction (PVD) is now an established technique. It is particularly useful in the management of patients with syndromic craniosynostosis, turri-brachycephaly and raised intra cranial pressure (ICP). Following treatment, some patients have also shown improvement in the extent of their Chiari malformation and syrinx.

We present combined data of 100 consecutive cases from the Birmingham and Oxford craniofacial centres, UK with an emphasis on development of the procedure, outcomes and complications.

Methods: This was a retrospective review of 100 consecutive cases undertaken in the two centres between 2006 and 2016. 32 patients were treated for raised ICP and 68 for brachycephaly. There were no deaths in this series. Four different distractor designs were used. Up to four distractors were used per patient early in this series; two distractors only are used now. The male to female ratio was 3:2, with two thirds of the patients having a genetically proven syndrome. Mean distraction distance was 24mm, (range 14 - 32mm). The age range was 4 months to 19 years (median age 18 months). There was improvement in vault shape (99%), resolution where signs and symptoms of raised ICP existed (100%), and a reduction in the number and severity of complications from 80% (2006) to 20% (2016). With increasing experience there is a trend to reduce the consolidation period (range 1 - 240 days). Only 33 patients went on to have some form of anterior vault surgery.

Conclusion: PVD can be used to correct skull shape and raised ICP. Complications are reduced with experience. PVD may reduce the need for and number of further procedures.

NEONATAL AND INFANT MANDIBULAR DISTRACTION OSTEOGENESIS: CAN WE PREDICT THE OUTCOME

Presenter:  Artur Fahradryan, MD
Author:    Artur Fahradryan, MD,
           Brady Colin, MD, Michaela Tsuha, BS,
           Mark M. Urata, Jeffrey A. Hammoudeh
Institution: Childrens Hospital Los Angeles

Abstract:
Introduction: Mandibular distraction osteogenesis (MDO) has shown to be successful in treating the upper airway obstruction (UAO) caused by micrognathia in pediatric patients. The purpose of this study is to assess the success rate of MDO and possible predictors for failure.

Methods: The records of all neonates and infants who underwent MDO from 2008 to 2015 at a single tertiary hospital were retrospectively reviewed. Procedural failure was defined as patient mortality or need for tracheostomy post-operatively. Details of distraction, length of stay (LOS), major and minor complications were captured and elucidated. SPSS 19 (SPSS Inc., Chicago, IL) was utilized for predictive uni- and multi-variate analysis.

Results: Out of 82 patients that met the study criteria, 47 (57.3%) were males, 41 (50%) had sporadic Pierre Robin Sequence (PRS), 38 (46.3%) had syndromic PRS, and three (3.7%) had micrognathia, not otherwise specified. The average distraction length was 27.5 (15-30) mm, average age at operation was 63 (3-342) days, and average LOS 66 (21-108) days with a follow-up period of 3.8 (0.2-12) years. There were seven (8.5%) failures (5 tracheostomies, 2 mortalities) resulting in a 91.5% success rate. Success slightly improved in non-syndromic compared to syndromic patients, however, this was not statistically significant (93.9% vs. 87.9%, Ï?2, p=0.287.). Stepwise logistic regression analysis showed that after removing all other variables the predicted probability for failure for the presence of CNS abnormality was 96.5% (p=0.007, 95% C.I, 72%-99.7%) and for being pre-operatively intubated was 91% (p=0.041, 95% C.I, 52%-99%) Conclusion: This review confirms that MDO is an effective method of treating the UAO caused by micrognathia with a high success rate. In our sample, the presence of CNS abnormalities and pre-operative intubation had significant impact on the failure rate; however given the wide confidence interval this will need to be confirmed in a larger sample.
Abstracts

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AN ALGORITHM FOR AIRWAY MANAGEMENT IN PIERRE ROBIN SEQUENCE
Presenter: Chad A Purnell M.D.
Author: Chad A Purnell M.D., Katherine E Hicks, Kathleen R Billings, John M Carter, Bharat Bhushan, Arun K Gosain, Dana M Thompson, Jeffry C Rastatter
Institution: Lurie Children’s Hospital of Northwestern Feinberg School of Medicine

Abstract:
Introduction: Airway management in neonates with Pierre Robin sequence (PRS) can be challenging. An algorithm for management of neonates with PRS admitted to a neonatal intensive care unit utilizing data acquired from polysomnography (PSG) and formal airway evaluation was developed and is described.

Methods: A retrospective case series analyzing airway management in neonates with PRS admitted to the NICU at a tertiary care pediatric hospital was performed. The utility of our proposed algorithm for airway management incorporating more consistent use of PSG and airway assessment was assessed.

Results: A total of 31 neonates with PRS (12 Males, 19 Females) with a mean gestational age of 38.2 weeks were analyzed. Thirteen (41.9%) patients had a named syndrome, chromosomal abnormality, or global delay. Twenty (64.5%) patients had pre-intervention PSG, and severe obstructive sleep apnea with an apnea-hypopnea index (AHI) ≥10 events/hour was identified in 19 (95.0%). Mandibular distraction osteogenesis was performed on 18 (58.1%) patients, and improved the AHI on post-operative PSGs. Direct assessment of the upper and lower airway was performed in 19 patients, and 13 (68.4%) were found to have secondary airway pathology. Presence of a concomitant syndrome was significantly associated with need for tracheostomy.

Conclusion: Our algorithm differs from previous ones in that it relies on rigorous pre-and post-intervention PSG (including with a nasopharyngeal airway), as well as that it allows flexibility between treatment options given the whole-patient clinical scenario and endoscopic findings. Results from these studies may be integrated to stratify patients into those who are most likely to benefit from conservative interventions, surgical procedures, or a combination of the two.

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INCREASED PEDIATRIC WEIGHT GAIN FOLLOWING MANDIBULAR DISTRACTION OSTEOGENESIS
Presenter: Cyril S Gary M.D.
Author: Cyril S Gary M.D., Sharon Marczewski, Patricia M Vitagliano, Derek M Steinbacher
Institution: Yale School of Medicine

Abstract:
Introduction: Infants with microretrognathia suffer from upper airway obstruction, which leads to difficulties with both breathing and feeding. Mandibular distraction osteogenesis (MDO) represents one therapeutic option designed to maximally open the airway in such patients. MDO is expected to improve breathing, but should also positively impact feeding. We hypothesize that feeding and weight gain will improve dramatically following MDO.

Methods: This retrospective chart review quantitatively assessed feeding and weight gain for 22 microretrognathic infants before and after MDO. Demographic, diagnostic, perioperative, and distraction protocol data was collected, along with weights and growth percentiles at available time points. Each patient’s weight plotted over time was then compared to his or her closest percentile growth curve as reported by the World Health Organization. Linear regression analysis was then used to estimate both actual average daily weight gain (ADWG) for each infant and expected ADWG for each infant’s respective growth curve. The actual vs. expected weight gains, along with percentile changes, were compared in several intervals with a Wilcoxon matched-pairs signed rank test.

Results: We found a statistically significant decrease in weight gain from birth to time of MDO (expected ADWG = 26.1 g/day, actual ADWG = 16.5 g/day, p = .0010), and a statistically significant increase in weight gain from MDO to removal (expected ADWG = 18.7 g/day, actual ADWG = 22.8 g/day, p = .0194), MDO to 6 months post-operatively (expected ADWG = 16.5 g/day, actual ADWG = 20.9 g/day, p = .0051), and MDO to 12 months post-operatively (expected ADWG = 13.4 g/day, actual ADWG = 16.6 g/day, p = .0049). Percentile changes followed a similar trend.

Conclusion: MDO results in significant weight gain following operative intervention. MDO is an effective modality for both treatment of airway obstruction and and problems with weight gain in these microretrognathic infants.
EXTREME MICROGNATHIA IN SYNDROMIC PATIENTS: SEQUENTIAL MANDIBULAR DISTRACTION DURING GROWTH TO FINAL SKELETAL CORRECTION

Presenter: Andrew Heggie M.D.  
Author: Andrew Heggie M.D., Anthony Holmes  
Institution: Royal Children's Hospital of Melbourne

Abstract:  
The advent of gradual bone lengthening using distraction osteogenesis (DO) has enabled patients with severe maxillo-mandibular deformities to be treated throughout growth and development with the aspiration they will function relatively normally and achieve acceptable facial aesthetics. It is the purpose of this paper to describe 3 patients who underwent DO as infants followed by further episodes of distraction to progressively advance the mandible.

Two patients had bilateral facial clefting syndromes, one of whom also had a bilateral cleft lip and palate and duplication of the posterior maxilla. A third patient was later diagnosed with auriculo-condylar syndrome (aglossia, ankylosis of the TMJ's and absence of an oral airway). All patients had extreme micrognathia and were treated with external and subsequently internal distraction devices to effect both vertical and antero-posterior bone lengthening. This also enabled orthodontic treatment and provided a framework for definitive skeletal correction at the completion of growth. Associated procedures were also necessary to better enhance function and soft tissue contours.

Treatment of these patients highlighted the advantages of repeating DO at strategic intervals. This was necessary to compensate for the intrinsic lack of growth potential due to the abnormal anatomy. Additionally, the challenge of managing the developing dentition and achieving a functional occlusion also needs to be considered in planning the sequence of intervention. Using all techniques now available to treat these rare patients with marked congenital deformities from infancy to adulthood, there is optimism that good results are possible to assist them in finding a secure place in the community.

PATHOGENESIS OF CLEFT PALATE IN ROBIN SEQUENCE: OBSERVATIONS FROM PRENATAL MRI

Presenter: Cory M. Resnick, DMD, MD, FACS  
Author: Cory M. Resnick, DMD, MD, FACS  
Tessa D. Kooiman, BS, Carly E. Calabrese, MPH, Judy A. Estroff, MD, Maarten J. Koudstaal, DMD, MD, Bonnie L. Padwa, DMD, MD, FACS  
Institution: Boston Children's Hospital

Abstract:  
Objective: The etiology of the palatal cleft in Robin sequence (RS) is unknown. The purpose of this study was to assess tongue position on prenatal magnetic resonance imaging (MRI) to determine if this plays a role in the formation of cleft palate in patients with RS.

Design: This is a retrospective case-control study including fetuses with prenatal MRIs from 2002-2017. Inclusion criteria were: (1) prenatal MRI of adequate quality, (2) live-born, and (3) post-natal diagnosis of Robin sequence, cleft lip/palate and/or micrognathia. Case subjects were divided into groups: RS with cleft palate (œRobin), cleft lip/palate without micrognathia or RS (œCLP), and micrognathia without RS or orofacial cleft (œmicrognathia). Subjects with post-natal RS without a palatal cleft were excluded. A control group with normal facial morphology was gestational-age matched. The outcome variable was tongue position on MRI described as: within cleft, along floor-of-mouth, other, or not determined.

Results: 145 subjects with mean gestational age at MRI of 25.8±4.9 weeks were included: Robin, n=21 (15%), CLP, n=47 (32%), micrognathia, n=23 (16%), control, n=54 (37%). The tongue was visualized within the cleft in 76.2% for the Robin group and 4.3% of the CLP group. The tongue was found along the floor-of-mouth (normal) in 23.8% for the Robin group, 95.7% for the CLP group, and 100% for both micrognathia and control groups.

Conclusion: These findings suggest a causal relationship between in-utero tongue position and the development of a cleft palate in RS.
NEURAL RESPONSE TO LANGUAGE IN CRANIOSYNOSTOSIS: AN ELECTROPHYSIOLOGIC STUDY

Presenter: Alexander Sun M.D.
Author: Alexander Sun M.D., Max Rolison, Carolyn Chuang, Derek Steinbacher, John Persing, James McPartland
Institution: Yale School of Medicine

Abstract:
Background: There is growing evidence that nonsyndromic craniosynostosis [NSC] is associated with language and learning disabilities. Mismatch negativity [MMN] is an auditory event-related potential ERP component of the electroencephalogram that has been used to predict language acquisition in childhood. Infants with sagittal NSC [SSO] have previously demonstrated significantly attenuated MMN, but this has not been studied in metopic craniosynostosis [MSO].

Methods: Thirty-one NSC infants [16 SSO, 15 MSO] and 35 age-matched controls were enrolled. Severity of MSO trigonocephaly was determined by the endocranial bifrontal angle measured from CT reconstruction, and six subjects were sub-classified as severe. Subjects underwent an auditory non-native phoneme discrimination task and EEG was recorded in NetStation [EGI, Eugene, OR]. Analysis focused on the frontal and central clusters of electrodes. The MMN component was calculated as the largest negative amplitude in the difference wave between 80-300ms after the stimulus.

Results: Overall, the MSO group did not demonstrate significant attenuation of MMN preoperatively or postoperatively [p=0.119 and p=0.321, respectively]; however, among the severe MSO subgroup, left frontal MMN was significantly attenuated postoperatively [p=0.002]. This difference was no longer significant postoperatively when compared to controls [p=0.700].

Conclusion: This study demonstrates that infants with severe MSO have significantly attenuated MMN components, a finding that was previously identified in SSO infants. In both groups, these differences were no longer significant postoperatively. This altered MMN was not seen in infants with only moderate trigonocephaly. While neurocognitive impairments in metopic craniosynostosis have not yet been well-characterized by neuropsychological testing, this study provides electrophysiologic evidence of aberrations in language acquisition that may exist in MSO infants, which may guide disease management.

ELUCIDATION OF GENETIC DISORDERS IN UNCLASSIFIED RARE CRANIOFACIAL HYPEROSTOSES: TWO CASES OF SOMATIC MUTATION MOSAICISM

Presenter: Yoshitaka Kubota M.D.
Author: Yoshitaka Kubota M.D., Yoshihisa Yamaji, Yoshitaro Sasahara, Shinsuke Akita, Nobuyuki Mitsukawa
Institution: Chiba University

Abstract:
Introduction: The cause of rare craniofacial hyperostosis is still unclear, though somatic mutation might be a cause in some patients. However, little is known about the genetics of these cases. We report two adult patients with craniofacial hyperostosis with suspected somatic mutation mosaicism.

Cases
Case 1: A 20-year-old male showed sporadically occurring hyperostoses on the cranium, mandible and cervical spine. He had no skin lesions. Contouring surgery was performed, and microscopic analysis of resected bone showed normal lamellar bone. Sequencing of the AKT1 gene in resected hypertrophic bone showed a normal sequence.

Case 2: A 21-year-old male showed sporadically occurring craniofacial hyperostosis and soft tissue overgrowth of his face, as well as hemimegalencephaly and mild developmental retardation. Epidermal nevus was observed on his face. Contouring surgery was performed on his bone, skin, and soft tissue. A microscopic examination of the excised bone was normal, but sequencing of the PIK3CA gene in the epidermal nevus tissue revealed mutations.

Discussion: Mutations that occur during embryogenesis are called somatic mutations, and are a strong candidate for the cause of sporadically occurring asymmetrical overgrowth syndrome. The asymmetrical hyperostoses seen in our patients suggest the presence of somatic mutations. Case 1 showed a normal AKT1 sequence, though the symptoms were similar to those of Proteus syndrome. Case 1 therefore indicates the existence of somatic mutation in a yet unidentified gene, though the possibility of a false negative in detecting mutations in AKT1 remains.

Dysfunction of the PI3K-AKT pathway is a cause of many overgrowth disorders. In Case 2, we detected a mutation in PIK3CA in an epidermal nevus. Detecting gene mutation in nevus is reported to be easier than in bone, which is consistent with our findings here.

We hope that sharing this report helps to shed light on the nature of rare and unclassified overgrowth syndromes.
Identifying Several Novel Craniosynostosis Genes by Next Generation Sequencing

Presenter: Jacqueline A.C. Goos
Author: Jacqueline A.C. Goos
Sigrid M.A. Swagemakers, Ans M.W. van den Ouweland, Marieke F. van Dooren, Andrew O.M. Wilkie, Irene M.J. Mathijssen
Institution: Erasmus MC, University Medical Center

Abstract:
Introduction: Over 100 syndromes are described in which craniosynostosis may be found and to date more than 50 causative genes are known. These numbers are growing rapidly since the development of next generation sequencing (NGS). After a pilot study, we now have tested 330 DNA samples by NGS, identifying several novel causative genes that will be described here.

Methods: DNA samples were collected from families with craniofacial malformations and negative single-gene tests. Whole genome sequencing (WGS) was applied according to the protocol of Complete Genomics (Complete Genomics, a BGI company, Mountain View, CA, USA). The produced data were checked for mutations in known craniofacial genes. If mutations were not found, further analysis was performed to identify novel genetic causes, including filtering based on the expected inheritance pattern, coverage, and characteristics of the mutations and of the affected genes.

Results: In total, 115 families (330 DNA samples) were whole-genome sequenced. Mutations were identified in 26 families; in known craniosynostosis genes in 15 families, in genes rarely associated with craniosynostosis in 6 families and in novel craniosynostosis genes in 5 families. These novel causative genes included BCL11B, a transcription factor that is involved in craniofacial suture fusion and fingerprinting in mice, FUZ, a planar cell polarity effector protein that is involved in the formation of the frontal bone in mice, and TLK2 a kinase that is mutated in patients with behavioral problems and craniosynostosis.

Conclusion: By NGS, causative mutations have been identified in 26/115 families. More and more mutations are identified in genes only rarely associated with craniosynostosis, underlining the importance of NGS. An additional advantage of NGS is the possibility of identifying new disease loci, as shown here.

Vegf Does Not Improve Bmp-2-Mediated Bone Regeneration in Complicated Calvarial Defects in Rabbits

Presenter: Liliana Camison M.D.
Author: Liliana Camison M.D., Michael R. Bykowski, Jack Brooker, Phil Campbell, Gregory M. Cooper, Joseph E. Losee
Institution: University of Pittsburgh Medical Center

Abstract:
Background: Complex craniofacial wounds resulting in calvarial defects pose a reconstructive challenge. Bacterial contamination is common and often results in infection, limiting options for primary salvage and secondary reconstruction by inhibiting bone healing and inducing significant scarring. This project aimed to improve bone repair in these complicated calvarial defects through the delivery of low-dose BMP-2 and VEGF in a biologic matrix, using inkjet bio-printing.

Methods: 15 x 15mm calvarial defects were created in 14 adult NZW rabbits. The bone graft was inoculated with S. aureus and replaced in situ. After a 2-week period of infection, animals underwent debridement and a 10-day course of antibiotics. Six weeks later, the defect was exposed, debrided and treated with an acellular dermal matrix (ADM) construct bio-printed with either: a) BMP-2; b) VEGF; c) BMP-2+VEGF; or d) ADM alone/control. After reconstruction, rabbits underwent CT scans at days 0, 14, 28 and 42 for evaluation of bone regeneration. Histology was performed after euthanasia.

Results: Bone regeneration was significantly higher in the BMP-2 group (10.6%) than controls (0.5%) at day 14. By day 42, bone regeneration in the BMP-2 group (25.6%) was significantly higher than the VEGF only group (9.2%), and higher than in the control (13.1%) and BMP-2+VEGF (17.48%) groups. There was a trend for lower bone regeneration in the BMP-2+VEGF group compared to BMP-2 alone at all time points, although this did not reach significance.

Conclusions: Microdoses of bio-printed BMP-2 were able to increase bone regeneration 50% above no therapy in complicated, scarred calvarial defects at 6 weeks. However, VEGF did not improve bone healing, either alone or combined with BMP-2. Although the percentage of bone regeneration achieved is not sufficient to be considered a viable reconstruction, further research along this line is warranted. Longer time points might show improved outcomes.
ELEVATED RETINOID SIGNALING AS THE GENETIC BASIS FOR AN OAVS-LIKE PRESENTATION IN MICE

Presenter: Timothy C Cox, M.D.
Author: Timothy C Cox, M.D., Esra D Camci
Institution: University of Washington

Abstract:
Oculo-Auriculo-Vertebral Spectrum (OAVS) affects ~1:5,600 live births and is characterized by a variable array of features that includes microtia, maxillary and mandibular hypoplasia, pre-auricular or lateral facial tags, ear canal atresia with associated hearing deficits, and cervical vertebral anomalies. OAVS is also particularly noted for its frequent asymmetric presentation. Despite rare examples of familial inheritance, few genes have been definitively implicated. However, an increased risk has been associated with elevated Vitamin A exposure during pregnancy.

Here we report a unique mutant mouse line that presents almost all of the classic OAVS features, including the marked phenotypic variability and asymmetry. Using low-pass whole genome sequencing we identified a ~20kb inversion within the mapping interval that physically disrupted only a single gene. This gene encodes a zinc-finger transcription factor, the expression of which was decreased by >90% in mutant tissue. However, complementation experiments demonstrated that loss of this gene is not responsible for the classic OAVS features. Re-evaluation of the chromosomal anomaly revealed that a small evolutionarily conserved intronic sequence was also deleted with the inversion. This deletion removes a validated chromatin insulator element, suggesting it could be disrupting local gene expression. Consistent with this, we demonstrate that the expression levels of two genes immediately adjacent to the transcription factor-encoding gene, which themselves are not physically disrupted, are upregulated more than 8 fold in mutant branchial arch tissue. Notably, these two genes are paralogs that encode relatively uncharacterized retinol dehydrogenase enzymes. Our data point to elevated retinoic acid signaling as a likely mechanism in this OAVS mouse model, providing the first direct evidence that genetic mutations disrupting retinoid signaling could underlie OAVS in patients.

DIPYRIDAMOLE ENHANCES BONE REGENERATION IN 3D PRINTED BIOACTIVE CERAMIC SCAFFOLDS

Presenter: Christopher D Lopez, BA
Author: Christopher D Lopez, BA, Lukasz Witek, MSci, PhD, Jonathan M Bekis BA, J. Rodrigo Diaz-Siso, MD, Eduardo D. Rodriguez, MD DDS, Paulo G. Coelho, DDS PhD
Institution: Icahn School of Medicine at Mount Sinai

Abstract:
Purpose: Standard of care for critical-sized bony defects is autologous bone tissue transfer, but this has limitations (e.g., morbidity, cost) which have driven progress in tissue engineering as alternative treatments. We explored the regenerative capacity of customized, 3D printed bioactive ceramic scaffolds with dipyriramole (DIPY), an adenosine A2A receptor indirect agonist known to enhance bone formation, at the rabbit ramus.

Methods: Critical-sized bony defects were created at the inferior aspect of the right mandibular rami, adjacent to the angular process (n=15). Each defect was replaced by a 3DBC printed porous scaffold composed of β-tricalcium phosphate. Scaffolds were uncoated (control), collagen-coated (COLL), or collagen coated/immersed in 100μM dipyridamole (DIPY). At t=8 weeks, animals were euthanized/rami retrieved. Bone growth was assessed within scaffold pores, evaluated by microCT/advanced reconstruction software and histology, calculated in segments as a function of distance from proximal to distal scaffold insertion, and compared to non-operated ramus segments. One way ANOVA was performed to compare means and 95% confidence intervals (CI).

Results: On 3D analysis, least bone growth was in control group (52.95±3.68% bone occupancy of free space), while most was in DIPY group (68.92±7.42%), (p<0.01). This trend was also seen on histologic analysis (38.24±10.52% control & 65.04±4.44% DIPY, p<0.01). A linear mixed model was performed for bone growth as a function of distance from the most proximal (deepest) aspect scaffold insertion site to the most superficial (distal at the mandibular border) aspect, for which DIPY-treated scaffolds demonstrated the most bone growth at the thinnest/least vascularized region of ramus bone at the proximal defect. Histology depicted intramembranous-like healing with highly cellular/vascularized bone.

Conclusion: DIPY significantly increased scaffold regenerative ability, and all groups demonstrated bone gDipyridamole Enhances Bone Regeneration in 3D Printed Bioactive Ceramic Scaffolds.
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MODELLING BONE FORMATION AT THE CRANIAL SUTURES IN WILD TYPE MOUSE

Presenter: Mehran Moazen M.D.
Author: Arsalan, Joseph Libby, Christian Babbs, Erwin Pauws Michael J. Fagan, Mehran Moazen
Institution: University College London, UK

Abstract:

Introduction: It is generally accepted that during post-natal skull development, brain growth loads the calvarial sutures. This inductive tissue interaction may contribute to the bone formation at the sutures. However, our understanding of the level of strain at the sutures due to the growing brain is still limited. Computational models have huge potentials to quantify this loading. The aim of this study was to develop a validated computational model of mouse skull growth to (1) understand the level of mechanical strain during the development at the sutures and based on that (2) to predict the pattern of bone formation at the sutures.

Methods: A series of wild type (WT) mice, at postnatal day (P) 3 (n=1), 7 (n=5) and 10 (n=5), were scanned using micro-computed tomography (CT). Changes in cranial suture sizes from P3-10 were quantified and used to validate the computational models. A 3D model of a WT mouse skull at P3 was developed based on the finite element (FE) method. The model included the bones, sutures and brain and was used to predict bone formation at the suture from P3-10.

Results: Computational models could predict the overall pattern of bone formation at the sutures from P3-10. For example, the models predicted interfrontal suture fusion by P10 and gradual bone formation at the coronal sutures from the lateral to the medial side of the parietals that were similar to the ex-vivo analysis of the bone formation at the aforementioned sutures.

Discussion: To best of our knowledge this is the first study modelling bone formation at the calvarial suture using finite element method. The close match between the predicted shape from the FE models and ex-vivo data and the actual bone formation pattern builds confidence in the modelling approach. Further studies will test this approach in genetically modified mouse models with cranial suture pathology.

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CRANIOFACIAL AND LONG BONE ANOMALIES IN STAT3 MUTATIONS

Presenter: David Boutboul
Author: Roman Hossein Khonsari, David Boutboul, Nabil Kaci, Kimberley Ching, John Manis, Laurence Legeai-Mallet
Institution: Hôpital Universitaire Necker - Enfants Malades, Paris, France

Abstract:

Aim: Autosomal dominant hyper-IgE syndrome (AD-HIES), also known as Job syndrome, is an immune disorder favouring recurrent bacterial infections, including pneumonia and skin infections. AD-HIES is caused by mutations in the STAT3 gene, which is known to interact with many factors involved in craniofacial development. There is no precise craniofacial phenotype associated with AD-HIES even though patients are known by clinicians to have specific facial features. Here we intended to investigate the craniofacial phenotype of AD-HIES using both clinical and mouse data.

Material and methods: Clinical data from 8 patients with AD-HIES was collected including photogrammetry. 3D pictures were analysed using landmark-based geometric morphometrics and usual cephalometry. Mice with a haplo-insufficiency of the Stat3 gene were screened for long bone and craniofacial anomalies at P0, 3 weeks and 3 months of age using μCT and standard histology.

Results: Patients with STAT3 mutations had specific facial features that are not reproduced by the mouse model of AD-HIES. Mice with Stat3 haplo-insufficiency had delayed long bone and craniofacial skeleton mineralization that are compatible with the axial skeleton phenotypes reported in AD-HIES.

Conclusion: The combination of clinical and fundamental data contributed to the characterization of the craniofacial phenotype in a condition without previously reported craniofacial bone anomalies.
ALTERED BRAIN FUNCTIONAL CONNECTIVITY VARIES BY FORM OF CRANIOSYNOSTOSIS
Presenter: Alexander Sun M.D.
Author: Alexander Sun M.D., Jeffrey Eilbott, Carolyn Chuang, Derek Steinbacher, Kevin Pelphrey, John Persing
Institution: Yale School of Medicine

Abstract:
Purpose: Recent studies have begun to elucidate the long-term neuropsychiatric sequelae of nonsyndromic craniosynostosis [NSC]. This study uses functional MRI [fMRI] to determine if there is structure evidence of altered brain connectivity in NSC, and whether these aberrations vary by form of synostosis.
Methods. Twenty adolescent participants with surgically-treated NSC [10 sagittal [SSO], 5 right unilateral coronal [UCS], 5 metopic [MSO]] were individually matched to controls by age, gender, and handedness. Resting-state fMRI was acquired in a 3T Siemens TIM Trio scanner. Data was processed in SPM and analyzed with Biolmage Suite. Resulting group-level t-maps were cluster-corrected using nonparametric permutation tests with 5000 permutations.
Results: SSO demonstrated decreased whole-brain intrinsic connectivity compared to controls in the superior parietal lobules and the angular gyrus [p=0.071], which are areas associated with visuomotor integration and attention. UCS had decreased intrinsic connectivity throughout the prefrontal cortex [PFC, p=0.031], which is an area crucial in executive function and behavior. On seed-based analysis, UCS had increased connectivity between left Brodmann Area [BA] 40 and bilateral BA6, 8, 9 [p=0.050], and between left BA7 and the PFC [p=0.065] and anterior cingulate gyrus [p=0.077]. MSO demonstrated increased connectivity between the left BA7 seed and the right inferior frontal gyrus and right insula [p=0.090].
Conclusion: NSC is associated with altered brain connectivity that varies by type of synostosis. SSO had decreased connectivity in regions associated with visuomotor integration and attention, while UCS had decreased connectivity in an area crucial in executive function. Finally, MSO had aberrations in the right insula and inferior frontal gyrus. This study provides neurologic evidence of long-term sequelae of NSC that vary by suture type, which may underlie different phenotypes of neuropsychiatric impairment.

CONNECTIVE TISSUE GROWTH FACTOR CTGF/CCN2 IS ESSENTIAL FOR SECONDARY PALATOGENESIS
Presenter: Joe Tarr, PhD
Author: James P Bradley, MD, Joe Tarr, PhD: Steve Popoff, MD, PhD, Alex Lambi, MD PhD
Institution: Temple University

Abstract:
Background: Previous cleft palate studies used TGF-beta 3 KO or IRF-6 KO models but these are inconsistent; not a close to human cleft condition. Connective tissue growth factor (CTGF/CCN2) acts as a downstream mediator of TGF-B dependent mesenchymal stem cell proliferation in palatogenesis. We investigated a novel cleft (CTGF KO) model's anatomy, histology, and cellular function compared to the wild-type (WT).
Methods: MicroCT and histology compared anatomic changes at pre and postnatal time points. Next, pre-osteoblasts were isolated from CTGF KO mice and compared to WT for cellular organization, functioning, proliferation, and migration. Next, CTGF KO palatal explant cultures were compared to WT explants harvested from a time point prior to normal palate closure; qRT-PCR of E14.5 embryos for relevant markers were used to study superselected cleft border cells; rhCTGF was used to attempt rescue of clefting.
Results: CTGF KO mice had complete absence in midline convergence of mesenchymal tissue compared to WT which demonstrated closure by E17. Pre-osteoblasts from CTGF KO mice exhibited decreased ability to adhere to extracellular matrices, reduced spreading, altered cytoskeletal organization, and reduced levels of total and activated Rac1. Proliferation of CTGF KO cells was decreased and migration was abnormal. TGF-B1, TGF-BR1, TGF-BR2, BMPR2, FGFR2IIIc, IHH were significantly increased in the CTGF/CCN2 KO. WT explants were brought through cleft closure, while CTGF KO palates stayed viable and clefted; rhCTGF in organ culture demonstrated cleft rescue with proper dose (based on dose response).
Conclusions: Cellular functions, abnormal in CTGF KO cells, are necessary for proper formation of the secondary palate and these defects in the mesenchyme account for failure of the palatal shelves to form and fuse. Our explant model showed the possibility of cleft rescue. The mechanism(s) responsible for secondary cleft palate in CTGF KO mice is being elucidated.
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PEPTIDE AMPHIPHILE NANOFIBERS AMPLIFY EFFECTS OF BMP-2 ON CRANIOFACIAL BONE REPAIR
Presenter: Reena Bakshi M.D.
Author: Reena Bakshi M.D., Akishige Hokugo, Kameron Rezzadeh, Mark, McClendon, Samuel Stupp, Reza Jarrahy
Institution: Regenerative Bioengineering and Repair (REBAR) Laboratory, Division of the Plastic and Reconstructive Surgery, Department of Surgery, David Geffen School of Medicine at UCLA

Abstract:
Purpose: Bone morphogenic proteins (BMPs) have numerous applications in craniofacial surgery and play a central role in the development of regenerative therapies for bone reconstruction. Unfortunately, the broad application of BMPs are limited by its side effect profile and high cost. Peptide amphiphiles (PAs) are a novel biomaterial that self-assemble into nanofibers. These PA gels have demonstrated the ability to function as a controlled release carrier of BMP-2 and support bone regeneration. In this study, we examined the effect of PA gels on in vitro osteogenic differentiation of bone marrow stromal cells (BMSCs) and in vivo bone regeneration in alveolar defects.

Methods: BMSCs were cultured and treated either with control media or media with BMP-2 and PAs. Quantitative RT-PCR of genes specifically related to osteogenesis was used to assess for osteogenic differentiation in vitro. To study the in vivo effects, cleft palates were created in rat maxilla. The defect was treated with one of the following: 1) collagen with BMP-2 (high dose), 2) collagen with BMP-2 (low dose) and PAs 3) collagen with PA only (control) or 4) no treatment. After 8 weeks, the maxilla was harvested for radiographic analysis with micro-computed tomography and for histology.

Results: BMSCs treated with BMP-2 with PAs had increased up-regulation of markers of osteogenesis demonstrating osteogenic differentiation. The cleft palate implanted with collagen sponge and low dose BMP-2 showed bone regeneration comparable to the collagen with high dose BMP-2 on micro CT and histologic analysis.

Conclusions: PAs with BMP-2 have the ability to induce osteogenic differentiation in BMSCs as demonstrated by these results. The in vivo and in vitro studies demonstrate the osteogenic capacity of PAs with BMP-2. This data may represent the use of PAs with low dose BMP-2 as a viable alternative to current uses of clinical BMP-2 in tissue engineering.

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COMPARISON OF FACIAL PHENOTYPES BETWEEN NON-SYNDROMIC INFILTRATING LIPOMATOSIS AND CLOVES SYNDROME
Presenter: Reid A Maclellan M.D.
Author: Usha Beijnen, Ahmad I Alomari, Arin K Greene, John B Mulliken, Reid A Maclellan M.D.
Institution: Boston Children’s Hospital/Harvard Medical School

Abstract:
Background: CLOVES syndrome and facial infiltrating lipomatosis (FIL) are congenital, nonhereditary disorders caused by PIK3CA somatic mutations. The purpose of this study was to determine whether CLOVES and FIL have an overlapping facial phenotype.

Methods: The database of the Vascular Anomalies Center was searched for patients with FIL and CLOVES with facial overgrowth. We included patients with available clinical data, photographs and imaging studies. The findings were categorized by location of abnormal fat, as well as musculoskeletal, intracranial and other anomalies.

Results: Nine patients with FIL and 22 patients with CLOVES met the inclusion criteria. The characteristic finding in both disorders was overgrowth of the cheek: 95% in CLOVES and 100% in FIL. In CLOVES, 29% (n=5) patients had fatty proliferation in the subcutis, buccal fat pad, and adjacent cervical spaces, compared to 67% (n=6) in FIL. Ipsilateral masseteric hypertrophy was present in CLOVES (52%) and in patients with FIL (56%). Parenchymal abnormalities in the brain were noted in half of patients with CLOVES but none were found in FIL.

Conclusion: Unilateral facial asymmetry is present in CLOVES and FIL and caused by overgrowth of the fat and musculoskeletal structures; intracranial abnormalities are found only in patients with CLOVES. FIL could be considered a regional form of CLOVES, likely explained by expression of a PIK3CA mutation that occurs later in embryonic development and possibly involving neural crest.
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EXOME SEQUENCING REVEALS NOVEL GENETIC SUBTYPES OF NON-SYNDROMIC MIDLINE CRANIOSYNOSTOSIS
Presenter: Andrew T. Timberlake M.D.
Author: Andrew T. Timberlake M.D., Charuta Furey, Derek M. Steinbacher, Michael L. DiLuna, Dawid Larysz, John A. Persing, Richard P. Lifton
Institution: Yale University

Abstract:
Non-syndromic craniosynostosis (NSC) affects 1 in every 2,300 live births, with cases of sagittal and metopic NSC accounting for more than half of all craniosynostosis cases. Whereas the genes causing syndromic craniosynostoses are well-characterized, the genetic etiology of NSC is highly heterogeneous and largely unexplored. More than 95% of children with NSC have no family history of disease, suggesting a contribution from both de novo mutation and extremely rare transmitted variants to disease risk. We performed whole exome sequencing of 384 children with non-syndromic midline craniosynostosis, including 291 case-parent trios, to identify novel genetic causes of craniosynostosis.

From the observed excess of sporadic mutations in craniosynostosis cases, we establish that at least 10% of NSC cases are due to protein altering de novo mutation. We identified damaging variants in SMAD6, an inhibitor of BMP-induced osteoblast differentiation, in ~6% of all midline NSC cases, making it the most frequent genetic cause of NSC identified to date. We also identified significant enrichment in damaging de novo mutations affecting intracellular regulators of several developmental signaling cascades that converge on common nuclear targets to induce osteoblast differentiation and promote bone formation, establishing 4 new molecular subtypes of NSC. The results establish a genetic cause in 11% of cases studied, and associate several pathways known to be involved in syndromic craniosynostoses with their non-syndromic counterparts.

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3D PRINTED BIOACTIVE CERAMIC SCAFFOLDS DEMONSTRATE INTRINSIC OSTEOGENIC PROPERTIES IN AN UNDISTURBED OSSEOUS ENVIRONMENT
Presenter: Christopher D. Lopez, BA
Author: Christopher D. Lopez BA, Jonathan M. Bekisz BA, Lukasz Witek, MSci PhD, Leyla Y. Cavdar, Fady G. Gendy, Paulo G. Coelho, DDS PhD
Institution: Icahn School of Medicine at Mount Sinai, New York NY

Abstract:
Purpose: 3D-printed bioactive ceramic (3DBC) scaffold osteogenicity has been demonstrated in several models. Scaffolds can fit defect sites while directing osteogenesis via micro-environmental cues of violated, healing bone. However, preoperative access to large segments of accessory bone replacement could be of significant benefit in settings of planned oncologic resection or congenital correction. Despite this, the osseoconductivity of biomaterials synthesized with 3D printed geometric design has not been explored in an intact bone model. This study used a sheep model to evaluate the ability of 3DBC scaffolds to drive bone growth on an undisturbed calvarium.

Methods: Cylindrical 3DBC scaffolds, 8-mm in diameter and 3-mm height, composed of 100% β-tricalcium phosphate, were designed with an inner lattice network. Dorset-Finn sheep (n=5) underwent surgical placement of four 3DBC scaffolds on top of the calvarial bone of each sheep, after periosteal retraction and stabilized by periosteal closure. Scaffolds were placed anteriorly/posteriorly on both the right-left sides of the calvarium, with the right-left distinction corresponding to treatment period length (3- vs. 6-weeks). Samples were evaluated through histologic quantification of bone and scaffold as a function of time in vivo. Statistical analysis was conducted between means with 95% confidence intervals and significance set at alpha (α)=0.05.

Results: Bone growth from calvarium into interior lattice and up the outer walls of the scaffold in an inferior-superior directionality was noted. At 6-weeks, samples demonstrated significantly greater mean of available space occupied by bone than 3-weeks (23.33±3.4 % vs 14.35±3.72%; p<0.01). Over time, bone and scaffold together had no significant difference in mean space occupancy (p=0.43), suggesting stable scaffold degradation/osseous remodeling. Conclusion: 3DBC scaffolds composed of β-TCP are capable of inducing bone growth in an undisturbed.
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SOMATIC PIK3CA MUTATIONS ARE PRESENT IN MULTIPLE TISSUES OF FACIAL INFILTRATION LIPOMATOSIS
Presenter: Arin K. Greene, MD, MMSc
Author: Javier A. Couto, Dennis J. Konczyk, BS, Matthew P. Vivero, BA, Harry P.W. Kozakewich, MD, Joseph Upton, MD, Xi Fu, MD, Bonnie L. Padwa, DMD, MD, John B. Mulliken, MD, Matthew L. Warman, MD, Arin K. Greene, MD, MMSc
Institution: Department of Plastic and Oral Surgery, Boston Children's Hospital, Harvard Medical School

Abstract:
Background: Facial infiltrating lipomatosis (FIL) is a rare congenital disorder that causes overgrowth of one side of the face. We previously reported that subcutaneous adipose tissue from the affected side contains cells having somatic activating mutations in PIK3CA. The purpose of this study was to determine if mutant cells are also present in other enlarged facial tissues.

Methods: We obtained FIL tissues from 3 patients during a clinically-indicated procedure. Resected specimens were dissected to enrich for cells from skin, subcutaneous tissue, orbicularis oris muscle, buccal fat, zygomatic bone, and mucosal neuroma. We also enriched for endothelial cells within affected tissue using CD31-microbeads. Lastly, we performed laser capture microdissection on formalin-fixed paraffin-embedded histologic sections to collect specific cell types. Genomic DNA was extracted from each tissue and cell type, and measured for the abundance of mutant PIK3CA alleles using droplet digital PCR.

Results: We detected mutant PIK3CA alleles in every tissue and cell type tested from each overgrown face; frequencies ranged from 1.5% to 53%. There were fewer mutant endothelial cells compared to non-endothelial cells, and the stromal cell compartment had the highest frequency of mutant cells in each tissue.

Conclusions: PIK3CA mutations are not restricted to a single tissue or cell type in FIL. Therefore, overgrowth in this condition is likely due to the mutation arising in a cell that contributes to several different facial structures during embryogenesis, rather than by paracrine signaling from adipose tissue causing secondary overgrowth of adjacent structures.

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NON-MINERALIZED AND MINERALIZED COLLAGEN SCAFFOLDS INDUCE DIFFERENTIAL OSTEOGENIC SIGNALING PATHWAYS IN HUMAN MESENCHYMAL STEM CELLS
Presenter: Justine Lee M.D.
Author: Justine Lee, Qi Zhou, Xiaoyan Ren, Jessica Chang, David Bischoff, Daniel W. Weisgerber, Dean T. Yamaguchi, Timothy A. Miller, Brendan A.C. Harley
Institution: University of California Los Angeles

Abstract:
The instructive capabilities of extracellular matrix components in progenitor cell differentiation have recently generated significant interest in the development of bioinspired materials for regenerative applications. Previously, we described a correlation between the osteogenic capabilities of nanoparticulate mineralized collagen glycosaminoglycan scaffolds (MC-GAG) and an autogenous activation of Smad1/5 in the canonical bone morphogenetic protein receptor (BMPR) pathway with a diminished ERK1/2 activation when compared to non-mineralized scaffolds (Col-GAG). In this work, we utilize a canonical BMPR inhibitor, DMH1, and an inhibitor of the MEK/ERK cascade, PD98059, to characterize the necessity of each pathway for osteogenesis. While DMH1 inhibited Runx2 and BSPII gene expression of primary human mesenchymal stem cells (hMSCs) on MC-GAG, PD98059 inhibited BSPII expression on Col-GAG independent of Runx2 expression. DMH1 inhibited mineralization on both Col-GAG and MC-GAG, however, PD98059 only inhibited mineralized on Col-GAG. DMH1 inhibited both Smad1/5 phosphorylation and Runx2 protein expression, whereas PD98059 inhibited ERK1/2 and JNK1/2 phosphorylation without affecting Runx2. Thus, activation of the canonical BMPR signaling is necessary for osteogenic differentiation and mineralization of hMSCs on Col-GAG or MC-GAG. The MEK/ERK cascade, intimately tied to JNK activation, is necessary for Runx2-independent osteogenesis on Col-GAG, while completely dispensable in osteogenesis on MC-GAG.
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WHOLE GENOME SEQUENCING FOR IDENTIFICATION OF MISSENCE MUTATION IN MAML3 INVOLVED IN HYPERTELORISM PATIENTS-A SERIES STUDY IN 5 MONOZYGOTIC TWINS
Presenter: Jie Yuan M.D.
Author: Jie Yuan
Coauthors: Min Wei, Don Li, Shanshan Bai, Zheyuan Yu, Liang X
Institution: Craniofacial Center, Department of Plastic and Reconstructive Surgery, Shanghai 9th People Hospital
Abstract:
Background: Hypertelorism is one of the most common congenital craniofacial deformities in China. The genetic mechanism has been unclear till now. The goal of this study was to identify candidate genes or genomic regions directly associated with the hypertelorism caused by facial cleft, via employing whole genome sequencing.
Methods: 5 pairs of monozygotic twins who were discordance for hypertelorism was recruited, composed of 5 affected and 5 unaffected individuals. After identifying missense mutations in gene encoding MAML3, all its exons were resequenced by sanger sequencing in 17 hypertelorism patients and in 30 normal controls. Cell proliferation and osteoblastic differentiation of the periosteal cell in patients and controls were also investigated.
Results: Whole genome sequencing analyses showed that all 5 hypertelorism individuals of monozygotic twins had a missense mutation c.G1479A in the exon 2 of MAML3 (GenBank: NM_018717). Sanger sequencing results revealed that 8 in 17 cases carried this mutation and none of the controls did. Realtime-PCR and Western Blot results indicated the expression of MAML3 in 8 patients were all down-regulated. Periosteal cell of the patients presented more potent osteoblastic differentiation.
Conclusion: A missense mutation c.G1479A of MAML3 were significantly associated with hypertelorism realted to facial cleft by whole genome sequencing.

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CRANIOFACIAL FIBROUS DYSPLASIA: A MULTI-CENTRE STUDY OF THE BEHAVIOUR OF LESIONS AND THEIR TREATMENT
Presenter: Khalid El Ghoul M.D.
Author: Khalid El Ghoul M.D., Asher, C., Jivraj, B., Dunaway, D., Koudstaal, M.J., Ong, J.
Institution: Erasmus Medical Centre
Abstract:
Background: Fibrous dysplasia (FD) is a rare fibro-osseous condition of bone caused by a mutation in the GNAS gene. In the craniofacial region, it causes significant variation in functional and aesthetic morbidity. The variability in the presentation, natural history and response to treatment of this condition makes the choice and timing of surgical treatments challenging. The optimal management has yet to be defined.
Patients & Methods:
A retrospective review of the medical records and clinical imaging was conducted of patients diagnosed with craniofacial fibrous dysplasia in major craniofacial units in London and Rotterdam. All fibrous dysplasia lesions were identified and parameters of functional morbidity and aesthetic indications for treatment recorded. Medical and surgical interventions for fibrous dysplasia were documented and the outcomes of these interventions analysed.
Results: 120 patients with Fibrous dysplasia affecting the craniofacial region were identified. More females (68%) than males were found in this study. In 65% a single focus of disease was found. Of the 35% of patients with multifocal disease, a third had an identified and treated endocrinopathy. A single case of malignant transformation was seen. A wide range of different surgical interventions were recorded (e.g. recontouring procedures to radical excision and autologous reconstruction) with patients undergoing a mean of 2 surgical procedures before the age of 30 (Range 0 - 9).
Conclusion: Fibrous dysplasia is a benign condition affecting the craniofacial skeleton that results in significant functional and aesthetic morbidity in adolescents and young adults. Surgical interventions are a significant component of disease management. Optimal care requires consideration of numerous factors such as anatomical location, disease progression and the presence of endocrinopathies. Further research is needed to refine clinical pathways in the management of craniofacial fibrous dysplasia.
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ABLATIVE PROCEDURES OF THE HEAD AND NECK OFTEN RESULT IN SUBSTANTIAL DEFECTS THAT REQUIRE LARGE VOLUME TISSUE TRANSFER FOR RESTORATION OF FORM AND FUNCTION
Presenter: Mark W. Stalder M.D.
Author: Mark W. Stalder M.D., Matthew Bartow, Austin Pharo, Charles Patterson, Rizwan Aslam, Gerhard S. Mundinger, Hugo St. Hilaire
Institution: Division of Plastic and Reconstructive Surgery, Louisiana State University Health Sciences Center

Abstract:
Introduction: Ablative procedures of the head and neck often result in substantial defects that require large volume tissue transfer for restoration of form and function. Free tissue reconstruction is the accepted contemporary standard of practice. For complex composite defects multiple simultaneous free flaps may be required, but these procedures are frequently avoided due to the perception of an increase in associated surgical complications and morbidity. We present here our experience with the use of simultaneous multiple free flaps for head and neck reconstruction.

Methods: 38 patients underwent single flap (SFF) reconstruction, and 21 patients underwent multiple flap (DFF) reconstruction for major head and neck defects. All patients had a history of head and neck malignancy. Statistical analysis was conducted comparing demographics, comorbidities, etiology of disease, and surgical outcomes between the two patient groups.

Results: Operative time and length of hospital stay were both longer in the DFF group (12.4 hours and 29.2 days) versus the SFF group (10.3 hours and 13.3 days). There were 10 (24%) complications that required re-operation in the DFF group, 2 partial flap losses (5%), and 1 total flap loss (2%). There were 10 (26%) complications that required re-operation in the SFF group, and 3 total flap losses (8%). There were 2 (4.8%) operable donor site complications in the DFF group and 3 (8.1%) in the single flap group. There was a 19% incidence of overall donor site morbidity in the DFF group versus a 56.8% incidence in the SFF group.

Conclusions: The use of multiple free flaps for reconstruction of major head and neck tissue defects is sometimes necessary to achieve adequate reconstructive results. These procedures have slightly longer operative and recovery times, but no significant increase in overall flap-related complications.

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ENDOSCOPIC ENDONASAL SKULL BASE SURGERY IN PEDIATRIC PATIENTS AND IMPACT ON MIDFACE GROWTH
Presenter: Lindsay A Schuster M.D.
Author: Lindsay A Schuster M.D. Wendy Chen, Shih-Dun Stanley Liu, Yue Fang Chang, Barton Branstetter, Paul Gardner
Institution: Childrens Hospital of Pittsburgh

Abstract:
Intro: Cranial base development plays a large role in anterior and vertical maxillary growth through age 7, but the effect of early cranial base surgery on midface growth is unknown. We present our experience with pediatric cranial base surgery and long-term midface growth.

Methods: This is a retrospective review (2000-2016). Pediatric patients were grouped by age at first endoscopic endonasal cranial base tumor resection (<7yo and >7yo). Patients had pre- and post-op (>1yr) imaging. Radiologists performed cephalometric measurements (S-N, SNA, SNB, ANB), which were compared to age- and sex-matched Bolton standards. Z score was used; significance set at p<0.05.

Results: The <7yo group (n=11) averaged follow-up of 5yrs. Most tumors were benign; one patient with a panclival AVM was a significant outlier for all measurements. Compared to <7yo group to Bolton standards (SD parenthesized), average pre-op difference in S-N was 3.0mm (SD 2.2); SNA, 1.8° (SD 3.4°); SNB, 4.1° (SD 2.8°); and ANB, 2.4° (SD 1.7°). Average post-op difference in S-N was 4.0mm (SD 2.5); SNA, 2.0° (SD 3.0°); SNB, 1.7° (SD 2.7°); and ANB, 0.4° (SD 1.8°). Compared to norm, there was no significant difference in post-op SNA (p=0.1), SNB (p=0.1), or ANB (p=0.7). S-N was reduced both pre- and post-op (SD=-1.5, p=0.01 and p=0.01). Sex had no significant effect. Compared to patients in the >7yo group, the <7yo group had no significant difference in pre- to post-op changes in S-N (p=0.87), SNA (p=0.89), and ANB (p=0.14). Tumor type had no significant effect in either age group.

Conclusion: Though our patients had some pre-op deviations from normal, the post-op measurements fall within normal range and generally have no significant difference compared to patients who underwent operations at an older age. Sex and tumor type did not have an effect on abnormal growth. Therefore, our results do not show any iatrogenic midface growth issues after early endoscopic endonasal skull base surgery.
SURGICAL MANAGEMENT OF A CONGENITAL CRANIOFACIAL TERATOMA VIA EXIT PROCEDURE AND EN BLOC RESECTION
Presenter: Tuan A. Truong, MD
Author: Tuan A. Truong, MD, Sarah A. Frommer, MD/PhD, Steven L. Henry, MD, Patrick K. Kelley, MD
Institution: Baylor College of Medicine

Abstract:
Introduction: Teratomas involving the airway are rare and associated with a high neonatal mortality rate. With an incidence reported at 1 in 35,000-200,000, the perinatal and perioperative management of these patients must be strategic to ensure successful outcomes. We present the case of a neonate with a congenital teratoma obstructing the airway occupying the temporal fossa, oropharynx and neck and our multidisciplinary approach and integration of virtual modeling tools.

Case Report: A 34-week premature infant was found in-utero to have a large cranio-cervico-oropharyngeal tumor equaling the size of the baby's normal craniofacial anatomy. Staged management included performing an ex-utero intrapartum treatment (EXIT) procedure by a multidisciplinary team. Once a definitive airway was established, the child was safely delivered and stabilized. An MRI and CT scan were performed to evaluate the extent of the disease and used to create medical models to facilitate surgical planning. Surgical resection via a combined craniofacial and neurosurgical approach commenced at 6 days of age. The patient did well postoperatively. However, he developed metachronous teratomas of his zygoma and mandible at 2 months and 7 months of age, respectively, requiring resection. At 9 months of age, he developed a recurrence of the mandibular teratoma requiring a radical resection with partial mandibulectomy, condylectomy, resection of temporal bone, and temporomandibular joint. Rib graft reconstruction of the mandible and a free ALT musculocutaneous flap was performed. Postoperatively, the patient recovered well and is monitored with clinical and radiologic surveillance.

Discussion: Head and neck teratomas are rare entities and can be immediately life-threatening. Early diagnosis during the antenatal period allows for the establishment of a multidisciplinary team to successfully secure the airway and to allow for optimal surgical planning and medical management.
WORK-RELATED PHYSICAL DISCOMFORT IN ASCFS AND ASMS MEMBERS: A SURVEY
Presenter: Ashley L. Howarth, MD
Author: Ashley L. Howarth, MD, Davinder J. Singh, MD, Susan Hallbeck, PhD, Valerie Lemaine, MD, Shelley S. Noland, MD
Institution: Mayo Clinic Arizona

Abstract:
Introduction: The risks of physical discomfort and injury are high in cranio/maxillofacial surgeons (CMS), who often perform long surgeries with headlights and loupe magnification. The inherent ergonomic difficulties increase cervical strain. Identifying the prevalence and impact of work-related physical discomfort (WRPD) will guide strategies to prolong surgeon well-being, job satisfaction, and career duration.

Methods: After IRB approval, a 30 question survey was designed to evaluate surgeons and their current physical discomfort. The survey was sent to the American Society of Craniofacial Surgery and the American Society of Maxillofacial Surgery members. It was administered and responses were collected by the Mayo Clinic Survey Center.

Results: There were 95 respondents, 75% male, 56% aged 31-50 years old. The practice profile was 73% academic. On a scale of 0-10 (0 no pain, 10 worst pain), WRPD had a median of 3 (surgery without loupes/microscope), 4 (loupe surgery), and 5 (microscope surgery). Pain during, immediately after, and day after surgery was most common in the neck. Pain within four hours of surgery was present in 55%. Pain influencing future surgical performance was experienced by 38%. Operating time was more than six hours per day (68%) and more than three days per week (72%). Surgeon discomfort affects posture (72%), stamina (32%), sleep (28%), surgical speed (24%), relationships (18%), and concentration (17%). Medical treatment for discomfort was sought by 22%. Time off work for treatment occurred in 9%.

Conclusion: WRPD is a critical and urgent issue amongst CMS. Nearly all surveyed experience physical discomfort regularly. This negatively impacts daily life and often requires medical treatment. 38% of respondents felt that WRPD would limit their future careers, perhaps the most concerning finding. It is imperative that CMS employ preventive strategies to combat WRPD.

QUALITY OF LIFE IN ADULTS WITH NON-SYNDROMIC CRANIOSYNOSTOSIS
Presenter: Daniel Mazzaferro M.D.
Author: Daniel Mazzaferro M.D, Ari Wes, Sanjay Naran, Scott Bartlett, Jesse Taylor
Institution: The Childrens Hospital of Philadelphia

Abstract:
Background: While various studies have analyzed quality of life (QOL) in children with non-syndromic craniosynostosis (NSC), to date nobody has investigated long-term QOL in adults with NSC. The purpose of this study is to compare QOL in adult NSC patients with a cohort of unaffected controls.

Methods: We queried our institution's prospectively maintained craniofacial registry for NSC patients 18 years and older and administered those patients the World Health Organization Quality of Life (WHOQOL-BREF) questionnaire. Responses were compared, using a two-sample t-test, to an age-matched, United States, normative database provided by the World Health Organization.

Results: 151 adults met inclusion criteria of whom 46 were successfully contacted and of whom 30 completed the WHOQOL-BREF. Average age of respondents was 22.9 years old (range, 18.1 to 42.1). There were 12 metopic, 13 unicoronal, and 5 sagittal subjects. On the whole, NSC patients had a superior quality of life in the physical health domain (87.4±17.2 vs. 66.8±14.5, p<0.0001), social domain (81.4±16.8 vs. 73.2±17.1, p=0.0313), and environment domain (83.1±16.2 vs. 72.8±14.2, p=0.0023). There were no differences in the psychological domain (78.2±16.9 vs. 73.5±13.7, p=0.1547). A subset analysis of each NSC type revealed metopic and sagittal patients to have a similar quality of life as controls in all domains except physical health, which was superior (p<0.05). Unicoronal patients were shown to have a superior quality of life in physical health, social, and environment domains (p<0.05).

Conclusion: Adult patients previously treated for NSC perceive their quality of life as superior to that of a normative, age-matched, United States sample, a result that was somewhat surprising. Future work will seek to analyze additional patients and better understand the reasons behind these findings.
TOTAL HUMAN EYE ALLOTRANSPLANTATION: PROTOCOL OPTIMIZATION OF IMAGING MODALITIES IN A NON-HUMAN PRIMATE MODEL

Presenter: Edward H Davidson MA (Cantab) MBBS
Author: Edward H Davidson MA (Cantab) MBBS, Jonathan Carney PhD, Brian Lopresti PhD, Maxine Miller MD, Kia M Washington MD
Institution: Montefiore Medical Center/Albert Einstein College of Medicine

Abstract:
Background: Our group has developed the first orthotopic eye transplant model in the rat for testing of immunomodulation and neuroregeneration. We have designed protocols for donor and recipient procedures in human cadavers ahead of advancing to a non-human primate model. Non-invasive methodologies of graft monitoring are paramount to development of this model as well as for future clinical practice.

Methods: Rhesus macaques (3-4 years) were subjected to positron emission tomography (PET) and computed tomography (CT) imaging. Structural CT assessments were performed to provide biometric morphology assessments of the orbit. Contrast-enhanced CT angiography (CTA) was used to map the vasculature of the orbital region to define vascular territories. In each imaging session, assessment was made using [15O]H2O PET (for soft tissue perfusion), [18F]2-fluoro-2-deoxyglucose (FDG) PET (for tissue viability indexed by tissue metabolic rate of deoxyglucose), [18F] sodium fluoride PET for osteogenic viability and selective dopamine D4 radiotracer [11C]CPMB PET for retina viability. Relative intensities of tracer generated by PET studies were analyzed with qualitative imaging as well as through quantitative PET techniques.

Results: CT biometric data confirmed high fidelity morphological compatibility between globes and bony orbits of subjects. Maximum variation was 6% (not to be clinically significant for any donor-recipient morphology mismatch). CTA generated arterial and venous territory maps of orbit and peri-orbita relevant to surgical planning for eye transplantation were created. [15O]H2O, [18F] FDG, [18F] sodium fluoride and [11C]CPMB PET can quantitatively measure soft tissue perfusion, soft tissue viability, osseous viability and retinal viability respectively.

Conclusions: These protocols serve as a benchmark for further development of nonhuman primate models for VCA of the eye, and for ultimately potentiating a clinical program of vision restoration transplantation.

CASE REPORT AND TEN-YEAR FOLLOW-UP: UNSUCCESSFUL ATTEMPT AT STAGED SURGICAL SEPARATION OF CRANIOPAGUS TWINS AFTER VENOUS SINUS COIL EMBOLIZATION

Presenter: Elbert E Vaca, MD
Author: Elbert E Vaca, MD, Donald J. Harvey, MD, Chad A Purnell, MD, Arun K Gosain, MD
Institution: Division of Plastic & Reconstructive Surgery, Lurie Children’s Hospital, Chicago, IL

Abstract:
Introduction: Craniopagus twin separation presents numerous technical and ethical challenges. According to a 2015 systematic review of attempted craniopagus twin separations, a 21% perioperative mortality rate was reported. Knowledge of the expected long-term outcomes of non-separated twins is crucial for risk profile assessment of craniopagus twins being evaluated for separation.

Methods: We present a case report of craniopagus twins (angular orientation) treated by the senior author. At 30 months of age, the patients underwent extensive surgical planning and two cerebroendovascular embolization procedures to reroute shared venous sinus drainage. This was followed by attempted surgical separation; however, separation was aborted due to intraoperative hemodynamic instability. The present report documents their 10-year follow-up without separation.

Results: Surgical separation of the twins was not possible due to hemodynamic instability in which one twin was hypotensive and the other hypertensive, and intraoperative treatment of one twin had deleterious effect on the other. In addition, the twins shared one kidney, and separation would have required dialysis for one twin. Ten-year follow-up without separation shows the twins to be developing well in regards to social, cognitive, and neural development - both having performed above the 80th percentile in standardized aptitude tests.

Conclusion: Long-term follow-up of non-separated twins is rare. The separation of craniopagus twins is fraught with technical, medical, and ethical challenges. Surgical separation is not always possible without significant risk of devastating consequences to one or both twins. Knowledge of expected functional outcomes, both with and without separation, is valuable information for risk profile assessment. We report 10-year follow-up of craniopagus twins for whom their present quality of life may be significantly better than had surgical separation been completed.
Abstracts

142 ETHNICITY AND CRANIOSYNOPISTOSIS: IS THERE A CONNECTION?
Presenter: Gina Sacks
Author: Gina Sacks, Albert Oh, Amir Dorofshar, Christian Vercler, Steven Buchman, Kamlesh Patel
Institution: University of Michigan

Abstract:
Background: Very little is known about nonsyndromic craniosynostosis and no study in the United States to date has specifically investigated the role of ethnicity in craniosynostosis despite a clear discrepancy in craniosynostosis rates among different ethnicities. The current study was undertaken as the first multi-center investigation into the prevalence of nonsyndromic craniosynostosis among different ethnic groups in the United States and the correlation between ethnicity and craniosynostosis type.

Methods: This is a retrospective case study in which all patients diagnosed with craniosynostosis at four major children’s hospitals were identified. Chart review was performed to obtain ethnicity data and analysis was preformed based on ethnic group as well as craniosynostosis subtype. The KID database (1997 - 2012) was searched to identify all cases of craniosynostosis on a national level. This data was analyzed against birth rates by ethnicity obtained from CDC WONDER natality database.

Results: 2112 cases of craniosynostosis were identified. Ethnicity data was available for 98.4% of cases. Caucasians and African Americans were consistently the predominant ethnic groups. There was a statistically significant difference in the distribution of affected suture with African Americans were more likely to present with unicoronal synostosis and Caucasians more likely to present with metopic synostosis (p = 0.005). Nationally, ethnicity data was available for 43,337 cases. There were more cases of craniosynostosis in Caucasians and fewer in African Americans than expected when compared to population birth rates.

Conclusion: Ethnicity does play a role in craniosynostosis with Caucasian race associated with increased rates of synostosis.

143 INCREASED TOTAL RETINAL THICKNESS; A PRECURSOR FOR INTRACRANIAL HYPERTENSION?
Presenter: S.D.C. van de Beeten M.D.
Author: S.D.C. van de Beeten M.D., S.E. Loudon, I.M.J. Mathijssen, M.L.C. van Veelen
Institution: Erasmus MC Rotterdam

Purpose: With the introduction of the Spectral-domain Optical Coherence Tomography (OCT), changes in the retina can be detected with a high precision. The aim of this study was to determine whether there is a difference in the peripapillary retinal thickness (TRT) between scaphocephaly patients without intracranial hypertension (ICH) and age-matched healthy children.

Method: We performed a prospective cohort study at the Dutch Craniofacial Centre. We included 67 patients with non-syndromic scaphocephaly and 66 control subjects without known optic nerve disease aged 3-13 years. OCT and fundoscopy were obtained in all patients. In scaphocephaly patients, occipitofrontal head circumference was measured as part of the regular treatment protocol. Skull growth arrest was defined as downward deflection or lack of change in occipitofrontal head circumference trajectory. TRT of patients without signs of ICH were evaluated and compared with the TRT of healthy controls.

Results: Scaphocephaly patients without signs of ICH had a significantly increased TRT compared to the control group (p<0.01 CI 5,8-48,2). However, this difference can be explained by a cluster of 6 patients with a TRT above 520 µm.

Conclusion: The TRT in scaphocephaly patients without ICH is comparable with the TRT in healthy children. However, this study determines a cluster of patients without signs of ICH, but with an increased TRT. In these patients increased TRT might be a precursor of ICH.
FIRST-IN-HUMAN INTEGRATION OF NEUROMODULATION DEVICE WITHIN COMPUTER-DESIGNED CUSTOM CRANIAL IMPLANT
Presenter: Chad R. Gordon, D.O.
Author: Chad R. Gordon, D.O. Gabriel F. Santiago, M.D., Judy Huang, M.D., Gregory K Bergey, Mehran Armand, Ph.D., Henry Brem, M.D. William S. Anderson, M.A., M.D., Ph.D.
Institution: Johns Hopkins University Department of Plastic and Reconstructive Surgery

Abstract:
Background: The NeuroPace System is an FDA-approved device recently developed for closed-loop direct brain stimulation in patients with drug-resistant partial seizures. Current methods employ placement above the confines of the skull. This produces noticeable contour deformities and scalp pressure from underneath, with the potential to cause wound dehiscence and infection leading to premature explantation. As such, we introduce here a first-in-human technique for device placement within a custom cranial implant thereby avoiding such complications and improving cranial contours.

methods: We report here a series of 3 patients with resorbed bone flaps and drug-resistant epilepsy despite attempted resection of seizure foci and maximized medical therapy. All patients underwent NeuroPace device implantation incorporating all components within a clear cranial implant made of poly-methylmethacralate (PMMA). Using a multidisciplinary approach, all recovered well with satisfactory wound healing and absent deformity. No complications have been reported to date with an average follow-up of 100 days (3.3 months).

conclusions: Cranial contour irregularities, implant site infection and bone flap resorption/osteomyelitis are significant adverse events associated with the RNS Neurostimulator device. The incidence of infection has been reported to be in the range of 9% in long-term follow-up. Infection risks are associated with repeat craniotomies for battery and pulse generator replacements, scalp extrusion and implant micromotion. Furthermore, abnormal amounts of pressure on the scalp from underneath, especially in the re-operation cases where the vascularity has been compromised, is of significant concern. Thus, this new technique âEUR incorporating the neurostimulation device within the confines of a computer-designed cranial implant âEUR” has the potential advantage of eliminating cranial contour irregularities and may result in improved outcomes with increased patient satisfaction.

ANALYSIS OF FOLLICLE-STIMULATING HORMONE RECEPTOR EXPRESSION IN INFANTILE HEMANGIOMA
Presenter: Arin K Greene MD, MMSc
Author: Reid Maclellan MD, MMSc, Fu Xi MD, Javier A Couto MD, Lan Huang PhD, Joyce Bischoff PhD, Arin K Greene MD, MMSc
Institution: Boston Childrens Hospital / Harvard Medical School

Abstract:
Purpose: The life-cycle of infantile hemangioma and follicle-stimulating hormone (FSH) secretion are identical. We have shown that infantile hemangioma expresses the receptor for follicle-stimulating hormone (FSHR). The purpose of this study was to identify which cell type(s) in infantile hemangioma contain FSHR.

Methods: Human infantile hemangioma sections and cells were subjected to immunofluorescence for FSHR. Tissues were co-stained with DAPI and either anti-PDGFR-β or anti-CD31 antibodies to identify nuclei, pericytes, and endothelial cells, respectively. Specimens also were fractionated by fluorescence-activated cell sorting (FACS) into hematopoietic, endothelial, perivascular, and mesenchymal stem cells and were tested for the presence of FSHR by using FSHR antibody. Control specimens consisted of sertoli cells (positive) and normal skin/subcutis (negative).

Results: FSHR was expressed in the endothelial, perivascular, and stem cells of infantile hemangioma by immunofluorescence and FACS. Receptor expression by FACS was greatest in stem cells (37.2%), compared to pericytes (13.5%) or endothelial cells (8.4%).

Conclusions: Endothelial cells, pericytes, and stem cells in infantile hemangioma express FSHR. A precursor cell giving rise to endothelial cells and pericytes expressing FSHR might contribute to the pathogenesis of infantile hemangioma.
A NEW CLASSIFICATION OF PARRY-ROMBERG SYNDROME

Presenter: Reena Bakshi M.D.
Author: Reena Bakshi M.D., Brad Gandolfi, Kameron Rezzadeh, Henry K. Kawamoto, Reza Jarrahy
Institution: Department of Plastic Surgery, University of California, Los Angeles

Abstract:
Background: Parry-Romberg Syndrome (PRS) is a rare condition characterized by progressive hemifacial atrophy of cutaneous and/or skeletal structures. There is little consensus regarding the optimal type and timing of treatment of PRS, nor is there any globally accepted classification system. Based upon our 30-year experience in managing PRS at our tertiary referral center we propose a classification system with diagnostic, prognostic, and therapeutic utility.

Methods: All patients referred to the UCLA Craniofacial Clinic for evaluation of PRS between 1980 and 2015 were included in this study. A retrospective review of medical records was performed. Patient demographics were collected and analyzed. All surgical interventions were recorded, including types of operations performed, total number of procedures per patient, and surgical outcomes. Provider notes were reviewed to assess progression of disease and indications for subsequent procedures.

Results: 25 patients with PRS from our center were included in this study. Mean age at evaluation was 13.6 years. Based on initial examination, indicated procedures, and subsequent progression of disease, we developed a classification scheme that stratified patients according to the presence of soft tissue hypoplasia (Type A), skeletal involvement (Type B), and the presence or absence of malocclusion (Type C). Type A patients underwent an average of 6.9 surgical procedures. Type B patients underwent an average of 9.1 procedures. Type C patients underwent an average of 8.9 procedures.

Conclusions: We present a classification scheme for PRS with diagnostic, prognostic and therapeutic relevance. The system is flexible and easy to apply: patients can continually be reassessed as their disease progresses and assigned a new category as indicated. This classification system will allow surgeons to counsel patients and their families regarding prognosis and improve communication between healthcare professionals who care for PRS patients.

CLEFT WIDTH RATIO AND PALATAL LENGTH: A SIMPLE, PROGNOSTIC SEVERITY SCALE FOR CLEFT PALATE

Presenter: Meghan McCullough M.D.
Author: William P Magee, Caroline Yao, MS, MD, Meghan McCullough, MD, Jordan Swanson, MD
Institution: University of Southern California

Abstract:
Background: Pre-operative severity in cleft palate impacts surgical technique and outcomes, yet we lack of a standardized, objective severity scale. A growing body of literature shows that cleft width correlates with postoperative fistula rates, however these series do not address palatal length. In a multi-ethnic population, we expand the concept of cleft severity to include both cleft width and palatal length.

Methods: Anthropometric measurements, photographs and surgical data were prospectively collected from cleft palate patients from Morocco, Bolivia, Vietnam and Madagascar during medical missions. Cleft width at the hard-soft palate junction, alveolar cleft width, vertical alveolar discrepancy and palate length (posterior pharynx to the uvula or hard palate) were measured pre and postoperatively. Cleft width ratio (CWR) was defined as the width of the cleft divided by the entire palate.

Results: 76 patients were evaluated. Mean and median CWR were 0.50 (SD 0.12) and 0.48. CWR was not associated with pre-operative palate length, alveolar cleft width or alveolar asymmetry. Larger alveolar clefts were associated with larger vertical discrepancies in the two alveolar segments (p=0.04). Multivariate analysis found that wider pre-operative cleft widths and shorter pre-operative palates were significantly correlated with decreased ability to lengthen the palate through surgery (p=0.01 and p<0.01, respectively). Wider clefts were also associated with shorter palates pre-operatively (p<0.01). In all regressions we controlled for surgeon experience, surgical technique, patient weight and cleft laterality.

Conclusion: We corroborate cleft width ratio as a representation of preoperative severity and introduce the importance of palatal length. With an increased emphasis on evidence-based practice in cleft care, such objective measurements are important to classify severity in order to study treatment algorithms, surgical education and cleft care delivery systems.
PROLIFERATIVE CAPACITY OF HUMAN CHONDROCYTES IN 3D BIOPRINTED CARTILAGE IN VIVO
Presenter: Lars Kölby M.D.
Author: Lars Kölby M.D., Peter Apelgren, Matteo Amoroso, Anders Lindahl, Camilla Brantsing, Paul Gatenholm
Institution: Institute of Clinical Sciences, Department of Plastic Surgery, University of Gothenburg, Sahlgrenska University Hospital, Gothenburg, Sweden

Abstract:
Cartilage repair and replacement is a major challenge in plastic reconstructive surgery. The development of a process, able to create patient specific cartilage framework, would be a major breakthrough.

Objective: To quantitatively evaluate, in vivo, the proliferation capacity and cartilage formation ability in mono- and cocultures of human chondrocytes and human mesenchymal stem cells in a 3D bioprinted hydrogel scaffold.

Methods: 3D bioprinted constructs (5 x 5 x 1.2 mm) were produced using nanofibrillated cellulose and alginate in combination with human chondrocytes and human mesenchymal stem cells with a 3D extrusion bioprinter. Immediately following bioprinting, the constructs were implanted subcutaneously on the back of 48 nude mice and explanted after 30 and 60 days, respectively and examined morphologically and immunohistochemically.

Results and conclusion: After implantation the constructs retained their mechanical properties and were easy to handle. Constructs with human nasal chondrocytes only showed good proliferation abilities and after 60 days 17.2 % of the surface area was covered with proliferating chondrocytes. In constructs with a mix of chondrocytes and stem cells an additional proliferative effect was observed. The chondrocytes produced glucosaminoglycans and collagen type 2. This study shows a technique to create 3D bioprinted cartilage in a clinically relevant setting with human cells in vivo.

SALVAGE EAR RECONSTRUCTION OF THE UNSATISFIED PATIENT: AN AUTOGENOUS APPROACH
Presenter: Akira Yamada M.D.
Author: Akira Yamada M.D.
Institution: World Craniofacial Foundation

Abstract:
Salvage Ear Reconstruction of the Unsatisfied Patient: An Autogenous Approach

Introduction: Primary construction is the key surgery to achieve optimal outcome in total ear construction. Once patients have unhappy outcomes, they try to hide their ear for the rest of their lives unless they receive satisfactory secondary reconstruction. Most unfavorable ear constructions are salvaged only by a complete reconstruction because three key components of ideal ear construction are so often missing: well vascularized skin envelope, precise 3D framework, and proper ear location/projection.

Methods/Outcome: Thirty patients (from the years 2005-2016) are included in this retrospective review. Outcomes were analyzed by clinical photography, medical charts, and complications. Twenty-eight cases were microtia, and two were trauma cases. The follow-up period was 1-10 years (averaging 5.6 years). Salvage was satisfactory to both surgeon and patients in 28 of 30 cases. There were two cases of tertiary ear reconstruction, due to the necrosis of fascia flap. There were two surgical infection cases (MRSA). Both infections were localized and healed conservatively.

Discussion: Intra-operative findings revealed that the vast majority of previous cartilage frameworks were deformed and disintegrated. The author’s observation is that the frameworks fixed by sutures were more often destroyed than were frameworks fixed with wires. The wrong ear location occurred more often in hemifacial-microsoma cases. The location of the antero/inferior dislocated vestige lobule seems to confuse surgeons. In low hairline cases, surgeons attempt to avoid the hairline, then place the ear too low. Placing the new ear inside the face mask is a common source of unsatisfied ear construction.

Conclusion: The author’s personal approach for secondary ear construction is presented. Meticulous pre-operative planning is mandatory to achieve sustainable and satisfactory secondary ear construction.
OBSERVATIONS ON THE DIFFUSION MAGNETIC RESONANCE IMAGING IN CHILDREN WITH CRANIOSYNOSTOSIS
Presenter: Alexandrou K. M.D.
Author: Alexandrou K. M.D., Mentzelopoulos A., Karanasiou I., Matsopoulos G., Uzunoglu N., Panagopoulos K.
Institution: Hellenic Craniofacial Center and National Technical University of Athens

Abstract: The issue of local intracranial pressure and affected local brain metabolism, in children with craniosynostosis, is under research by means of direct and indirect methods. In the present study we collected data from diffusion magnetic resonance imaging and analyses them. Children with craniosynostosis were recruited. T1-weighted, T2-weighted and Diffusion Tensor Imaging (DTI) magnetic resonance images were acquired in a Siemens Avanto syngo B17 1.5T. DTI were obtained with the following parameters: 1 3D image with b=0 for baseline purposes, 12 gradient directions with b=1000, acquisition matrix 128x128, slice thickness 3mm, voxel-size 1.8x1.8mm^2, FOV 240x240mm^2, flip angle 90 degrees. Analysis of DTI data was performed in FMRIB's Software Library and fractional anisotropy, mean diffusivity and apparent diffusion coefficient were calculated in different regions. Statistical analysis was carried out between the brain areas with morphological alterations and the rest of the brain. Conclusions of the above findings are presented.

USE OF ANTE-NATAL ULTRASOUND TO DIAGNOSE SAGITTAL SYNOSTOSIS
Presenter: Peter Anderson M.D.
Author: Peter Anderson M.D., David David, Sarah Constantine
Institution: Australian Craniofacial Unit

Abstract: Background: Further to our report of the use of ante-natal ultrasound to diagnose sagittal synostosis, we have continued to investigate ante-natal head morphology and growth which remain poorly understood. This was done with the view to establish if there is a predictable growth pattern present in affected children by reviewing the scans of infants with a confirmed diagnosis of sagittal synostosis.

Method: Antenatal imaging for children with sagittal synostosis between 2000 and 2014 were reviewed. Head circumference and bi-parietal diameters were recorded along with the gestational age and gender of the child.

Results: A total of 89 cases were reviewed, 60 male and 29 female. The cephalic index at routine morphology scan (17-22 weeks) was variable and this didn’t change on those who had repeat scans (growth) at 28 weeks or more. However, the biparietal diameter measurements in those with serial scans demonstrated a falling off of centiles on growth charts with increasing age and resulted in a sustained decrease on the calculated Cephalic Index.

Conclusion: The routine calculation of Cephalic Index and a single value outwith the normal range or a change on serial scans should raise the possibility of sagittal synostosis and detailed scan undertaken to clarify. The obstetric team may then use this information to discuss delivery options with the parents.

Pursuing a 3D Cephalometric Norm in Eumorphics: Evaluation Method and Preliminary Results

Presenter: Giovanni Badiali M.D.
Author: Giovanni Badiali M.D., Federica Ruggiero, Cristiana Saporosi, Claudio Marchetti, Alberto Bianchi
Institution: Oral and Maxillo-facial Surgery Dept, S.Orsola University Hospital Bologna, DIBINEM, Alma Mater Studiorum University of Bologna

Abstract:
Achieving an eumorphic facial appearance is one of the main goals of orthognathic surgery. Even after the introduction of 3D planning, this aspect continues to be assessed mostly merging surgeon’s clinical experience and bi-dimensional cephalometric measurements transferred to a 3D environment. A 3D norm has not yet been established with general consensus. The aim of this study is to suggest possible criteria to assess a 3D norm and to present our preliminary results. Although we cannot administer x-rays to healthy eumorphic people, we can analyze skeletal features of our patients using routine postoperative CBCT scans. The assumption is to select genuine eumorphic surgical results. We enrolled fifty consecutive patients admitted from January to December 2015 at the Maxillofacial Surgery Unit, Sant’Orsola University Hospital (Bologna) for orthognathic treatment. Inclusion criteria were: caucasian race, non-syndromic, no comorbidity. All patients underwent postoperative CBCT scan 6 months after surgery. Standard postoperative photographs of the selected patients were shown to unbiased jury composed by two plastic surgeons, two orthodontists and two communication specialists, not linked to patients and treatments; the jury has been asked to answer a questionnaire about beauty and proportions. The questionnaire provided a final score in order to skim the eumorphic sample, separating female and male traits.

Three-dimensional cephalometric analysis was then performed on those patients judged as œeumorphicœ after the survey. Skeletal, dental and soft tissue cephalometric values were considered. Average and range was defined for each contemplated value. In conclusion, this study introduces a viable method to define a 3D cephalometric norm which can be useful as an aid for planning orthognathic surgery. A largely wider sample is mandatory to validate these results and to really establish an actual norm with general consensus.

A Validated Computational Model of Normal Calvarial Growth in Humans

Presenter: Mehran Moazen M.D.
Author: Joseph Libby, Arsalan Marghoub, David Johnson, Roman Khonsari, Michael Fagan, Mehran Moazen M.D.
Institution: University of Hull, UK

Abstract:
Introduction: Computational models are powerful tools that can inform us on the optimum reconstruction method for a particular craniofacial abnormality. However, such models need to be validated to build confidence in their predictions. The aim of this study was to develop a validated computational model of human calvarial growth in the first year of human life.

Methods: A 3D computational model, based on the finite element method, was developed from a micro-computed tomography (microCT) scan of a newborn infant skull. Bone, sutures and brain were modelled and calvarial growth was predicted at intervals of 1 month up to 12 month of age. Computational results were compared to a series of in vivo clinical CT-scans of infants without craniofacial conditions (n=56). Comparison was made in terms of skull width, length and circumference, while overall shape was quantified using 3D distance plots.

Results: Statistical analysis yielded no significant differences between the computational predictions and in vivo male skull models. The FE model and in vivo data correlated well, with the largest percentage difference in size being 8.3%. 3D distance plots revealed that for the 4-12 month models, the overall skull shape was reliably predicted with the main difference being located at the anterior and posterior fontanelles.

Discussion: Overall, the FE model results matched well with the in vivo data. With further development and model refinement, this modelling method could be used to assist in pre-operative planning of craniofacial surgery procedures for conditions such as craniosynostosis. In the long term this might then lead to a reduction in the number of re-operations and enhance the quality of life of the children.
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DIFFUSION TENSOR IMAGING FIBER TRACTOGRAPHY IN YOUNG NON-OPERATED CRANIOSYNOSTOSIS PATIENTS
Presenter: B.F.M. Rijken M.D.
Author: B.F.M. Rijken M.D., J.M. Florisson, M. Bedar, A. Leemans, K. van Montfort, M.H. Lequin, I.M.J. Mathijssen
Institution: Erasmus MC, Rotterdam, the Netherlands

Abstract:
Purpose: Children with craniosynostosis syndromes and treated with a cranial vault expansion, have different white matter diffusion parameters compared to controls. However it remains unknown whether this difference is due to their genetic mutation or secondary as a result of episodes of intracranial hypertension. Therefore, we studied white matter diffusion parameters in young, non-operated craniosynostosis patients, whom had no episodes of intracranial hypertension yet.

Methods: We included 39 patients with different craniosynostosis syndromes (Apert, Crouzon-Pfeiffer, Muenke, Saethre-Chotzen and complex craniosynostosis), mean age: 2.2. None of them were operated on. Nine control subjects, with a mean age of 3 years, were included as well. DTI datasets were acquired with a 1.5T MR imaging system. White matter tracts studied included: corpus callosum, cingulate gyrus, fornix, corticospinal tracts, and medial cerebellar peduncle. Tract pathways were reconstructed with ExploreDTI. We used the same tracking protocol as in our previous published DTI study (Rijken et al., AJNR 2015). Data were compared to those of controls. Frontal occipital width ratio was used as indicator for ventricular volume and included in the analysis.

Results: Preliminary results, definitive results will be presented at the conference. We included 33 craniosynostosis patients and 28 healthy controls. Preoperatively, in metopic and sagittal synostosis, the ratio between mean blood flow velocities in the internal cerebral vein and the superior sagittal sinus was higher than in controls, indicating a diminished blood flow in the superior sagittal sinus in metopic and sagittal synostosis. Blood flow velocity and perfusion waveforms of all craniosynostosis patients were compared to healthy controls and within different craniosynostosis types.

Conclusion: Metopic and sagittal synostosis seems to lead to diminished venous outflow at the level of the superior sagittal sinus. The deep venous system seems to remain unharmed. Future research should clarify the role of venous outflow obstruction in the prevalence of intracranial hypertension in single suture craniosynostosis.

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ULTRASOUND ASSESSMENT OF THE CRANIAL VENOUS DRAINAGE IN SYNDROMIC AND NON-SYNDROMIC CRANIOSYNOSTOSIS: A PROSPECTIVE CASE-CONTROL PILOT STUDY
Presenter: Martijn Cornelissen M.D.
Author: Martijn Cornelissen M.D., Robbin de Goederen, Priya Doerga, Marie-Lise van Veelen, Jeroen Dudink, Irene Mathijssen
Institution: Erasmus University Medical Center, Rotterdam, the Netherlands

Abstract:
Introduction Craniosynostosis leads to intracranial hypertension in 0 “ 60% of cases, depending on the type of craniosynostosis. Venous outflow obstruction is thought to be one of the factors of influence on intracranial hypertension in craniosynostosis. The aim of this study was to assess blood velocity profiles in the superficial (superior sagittal sinus) and deep (internal cerebral vein) venous drainage system of patients with syndromic and non-syndromic craniosynostosis and healthy controls.

Methods: Transfontanellar ultrasounds were performed at the first out-patient clinic visit and after surgery, if applicable, to assess blood flow velocity and perfusion waveform at the superior sagittal sinus and internal cerebral vein. Blood flow velocity and perfusion waveforms of all craniosynostosis patients were compared to healthy controls and within different craniosynostosis types.

Results: Preliminary results, definitive results will be presented at the conference. We included 33 craniosynostosis patients and 28 healthy controls. Preoperatively, in metopic and sagittal synostosis, the ratio between mean blood flow velocities in the internal cerebral vein and the superior sagittal sinus was higher than in controls, indicating a diminished blood flow in the superior sagittal sinus in metopic and sagittal synostosis, which seems to normalize postoperatively. Perfusion waveform did not differ between cases and controls, pre- or postoperatively.

Conclusion: Metopic and sagittal synostosis seems to lead to diminished venous outflow at the level of the superior sagittal sinus. The deep venous system seems to remain unharmed. Future research should clarify the role of venous outflow obstruction in the prevalence of intracranial hypertension in single suture craniosynostosis.
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CHARACTERIZATION OF BILATERAL PARIETAL THINNING
Presenter: Paymon Sanati-Mehrizy, M.D.
Author: Paymon Sanati-Mehrizy, M.D., Marisa Cornejo, Hope Weissler, Michael J Ingargiola, Thomas Naidich, Peter J Taub
Institution: Icahn School of Medicine at Mount Sinai

Abstract:
Purpose: Bilateral parietal thinning (BPT) of the calvarium is uncommon but can lead to morbidity, including pain or communication through the thinned bone. This project aimed to define and characterize a novel grading system for BPT.

Methods: Coronal CT scans of patients with BPT were retrospectively analyzed, measuring (1) thinning ratio, defined as calvarial thickness at the thinnest point divided by the thickness of the surrounding bone and (2) width of the defect.

Results: Forty-five patients were identified, with an average age of 72±18 years and 71.1% were female. Table 1 depicts a grading scheme based on progressively smaller thinning ratios (p<0.0001) and increased defect width (p<0.0001). With every year of increased age, thinning ratio decreased by 0.488mm (p=0.051) and defect width increased by 0.193mm (p=0.031), controlling for gender, osteopenia/osteoporosis, smoking status, hypertension, and diabetes mellitus. Females had larger defect widths than males (p=0.044). Diabetes and osteopenia/osteoporosis were not associated with change in thinning ratio or defect length. Twenty (44%) patients had multiple scans (range 5 months-5 years). The most recent scans had significantly smaller thinning ratios than the earliest scans (p=0.0285), showing progressive thinning of the defect with time.

Conclusions: This project proposes a novel quantitatively-characterized grading scheme for BPT, which can aid in diagnosis and management. As shown here, thinning worsens over time. This grading scheme can help to monitor progressive thinning.

Grade  Depth  % Identified  Thinning Ratio (mm)  Defect Width (mm)
0  Bone Hypertrophy  14.8%  81.47 ± 9.37  27.72 ± 7.55
1  Outer table  28.4%  74.26 ±10.43  31.00 ± 7.72
2  Into diploic space  11.4%  59.36 ±11.18  37.20 ± 7.72
3  Down to inner table  31.8%  32.23 ±11.03  40.97 ± 9.83
4  Breach of inner table 13.6%  0 ± 0

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PERFUSION OF THE BRAIN IN CHILDREN WITH SYNDROMIC CRANIOSYNOSTOSIS AND HEALTHY CONTROLS
Presenter: Priya Doerga M.D.
Author: Priya Doerga M.D., M. Wagner, A. Poretti, R. Tasker, M.H. Lequin, I.M.J. Mathijssen
Institution: ErasmusMC

Abstract:
Background and Purpose: Arterial spin labeling (ASL) is a magnetic resonance imaging (MRI) technique to quantify cerebral blood flow (CBF) without the use of a contrast agent. In this study we aim to examine the perfusion of the brain in children with syndromic craniosynostosis and compare it with that of healthy controls.

Methods: The CBF was measured in several different areas of the cerebrum and cerebellum, in treated and untreated patients with syndromic craniosynostosis and compared to healthy controls. We used pseudo continuous ASL to assess the resting CBF. The ASL images were co-registered with the T1 and T2 weighted images.

Results: We included 86 healthy controls and 76 craniosynostosis patients. In children under 1 year old, untreated patients had a significantly lower perfusion than healthy controls for blood flow territories of the anterior cerebral artery and medial cerebral artery, and for the frontal lobe, parietal lobe, temporal lobe, grey matter, and white matter.

Conclusions: In this study we examined the CBF values in the brain in patients with syndromic craniosynostosis and in healthy controls. Perfusion differences found between patients and healthy controls possibly indicate a slower maturation of these brain areas and brain matters in craniosynostosis patients.
158 MODELING CRANIOSYNOSTOSIS SEVERITY AND PROGRESSION IN INFANTS USING HIDDEN MARKOV MODELS

Presenter: David Khechoyan M.D.
Author: David Khechoyan, Salem Karani, Ron Goldman, John Phillips
Institution: Children's Hospital Colorado

Abstract:

Purpose: The progression of severity of cranial deformity in infants with craniosynostosis in the first year of life or in untreated cases is poorly understood. The hidden Markov model algorithm is applied for predictive modeling. Methods: Within the hidden Markov model, the observed layer is defined as changes in cranial curvature along the sutures, and the hidden layer is defined as estimated condition severity. By setting up this probabilistic model, we can run Bayesian inference-based algorithms to approximate future curvature and condition severity in order to potentially identify the best time for surgical intervention based on severity progression. Results & Conclusion: We present a novel method for statistically modeling growth and severity progression for a child diagnosed with craniosynostosis. This approach provides physicians with the ability to predict the next month's severity and degree curvature abnormality both parallel and perpendicular to the sutures in the infant's skull, and to view the patient's historical severity progression. We demonstrate the method's viability by achieving a fair level of prediction accuracy over the test sets, and have provided a measure to evaluate the amount of abnormal growth in planes of interest relative to the fused sutures. Expansion of training data, fine-tuning of the model architecture, and manipulating the choice of observed and hidden states will greatly improve our understanding of the effectiveness of this model. To our knowledge our model is the first of its kind and will begin providing a statistical framework for physicians to make more informed decisions by harnessing historical data. Future work will involve exploring a continuous vocabulary for the observed layer, a larger vocabulary for the severity grading, and a richer architecture for our probabilistic model.
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3D VIRTUAL PLANNING IN CRANIOMAXILLOFACIAL SURGERY
Presenter: David Genecov, MD
Author: David Genecov, MD, Carlos Raul Barcelo De La Isla
Institution: International Craniofacial institute

Abstract:
3D Virtual Planning in Craniomaxillofacial Surgery
Introduction: 3 Dimensional computer aided design and manufacturing (CAD-CAM) advances over the last twenty years have produced increased software access to surgeons and other health care providers. Complex surgical computer planning, custom guide creation and implant manufacture allow the surgeon to improve precision to 1/100 of a millimeter. Additionally, different surgical approaches, change to existing plans and improved teaching opportunities are notable benefits. We will present the experience of the International Craniofacial Institute's use of 3D virtual planning, custom guide creation and surgical outcomes. We will explore the applications, benefits and disadvantages of virtual surgical planning (VSP) in craniomaxillofacial surgery.

Materials and Methods: 56 craniomaxillofacial surgical procedures were planned using VSP involving 3 separate corporate systems. Patients ranged in age 3 months to 48 years old. Time period was 5 years, 2012-2016. Care distribution ranged from mandibular distraction to complex facial reconstruction with free tissue transfer. Orthognathic surgery was also included as well as cranial vault procedures.

Results: 55/56 surgical cases were completed using the surgical plan created using the VSP. All surgical guides, splints and implants were routinely used except one orthognathic case early in the planning process. Improvements in anesthesia time, surgical procedure time and outcomes were noted.

Conclusion: 3 dimensional virtual planning was very effective in craniomaxillofacial surgical practice. During the planning and modeling phases the relationship between the engineer and the surgeon was found to be most important. That relationship and the communication is key to lowering time costs, improving plan outcome and design. In summary, 3D VSP leads to decreased operating (anesthesia) time, increased accuracy, lower overall cost, and improved results.

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CT LANDMARKS FOR THE MORPHOLOGICAL ASSESSMENT OF UNICORONAL CRANIOSYNOSTOSIS
Presenter: H. Shido, M.D.
Author: Hiroshi Nishikawa, H. Shido M.D., D. Rodrigues, M. Evans, N White, S Dover
Institution: Birmingham Children’s Hospital

Abstract:
Introduction: This paper concerns a new cephalometric method using landmark points on axial and coronal CT scans to describe objectively the characteristics of the calvarial deformity caused by Unicoronal craniosynostosis (UCS).
Method: The pre-operative CT scans of all 21 patients with UCS seen in our unit, between 2007 to 2015, were assessed. Axial and coronal bone windows were analyzed. A landmark, that we have we have called S point, was used as a constant reference mark on the axial plane. The S point lies at the midpoint of the anterior end of the Clivus. A line extending on each side of the anterior border of the Clivus was used as the S line. A statistical regression analysis was carried out to determine whether there were any meaningful relationships between these landmarks and the frontal and posterior tangent angles as well as acoustic and nasal angles. A correlation coefficient (r) was calculated and p-values were obtained for each angular parameter.

Results: There was a positive correlation between the degree of ipsilateral posterior occipital flattening and the frontal tangent angle indicating that this is part of the overall pattern of UCS. The nasal angular deviation was not related to frontal bone deformity. There was no relationship between the acoustic angles to either the anterior or posterior tangent angles indicating that the true base line reference is the S line around which the entire calvarial deformity revolves. Conclusion: This cephalometric analysis is a simple and reproducible method to quantitatively describe the complex calvarial deformities caused by UCS and sheds some new light on the nature of calvarial deformity in UCS.
Abstracts

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DIAGNOSTIC IMAGING OF SKULL DEFORMITIES WITH BLACK BONE MRI
Presenter: Anne Saarikko M.D.
Author: Anne Saarikko M.D., Kuusela Linda, Brandstack Nina, Autti Taina
Institution: Cleft and Craniofacial Unit, Dep Plastic Surgery

Abstract:
Computer tomography is commonly used for diagnostic imaging and postoperative follow-up of patient with abnormal skull shape and premature closure of the cranial sutures (craniosynostosis). Because these patients may be imaged several times during their childhood, the usage of nonionizing modality would be preferred.

Purpose of the study was to develop a MR sequence suitable for imaging of the skull bone and cranial sutures (œBlack Bone Eley et al. Brit J Radiology 2014), simultaneously with DTI and rs-fMRI imaging.

Materials & Methods: MRI imaging has been used preoperative imaging of 15 patients with posterior plagiocephaly and two patients with scaphocephaly. An in-phase T1 volume interpolated 3D gradient echo (VIBE) sequence with fat saturation was acquired on a 3T Siemens Verio (Erlangen, Germany). Acquisition resolution was 1x1x1 mm³ and an acquisition time of approx. 5 min. Skull segmentation was performed with 3D-Slicer software2, which included basic thresholding, morphological binary closing and erosion image operations. Finally the segmentation was manually refined.

Results: Black Bone imaging allows visualization of skull bone, cranial sutures and impressions of the skull bone. The main challenges for black bone imaging have been the intensity fluctuation and the chemical shift artifact, which both complicate the image segmentation.

Conclusion: We have developed MRI sequence that can be routinely used in pre- and postoperative evaluation of patients with skull deformities. This allows us to collect information not only from the skull bone and suutures, but also from the brain tissue by DTI and resting state-fMRI methods. Further comparison of the pre- and postoperative DTI and rs-fMRI data will provide new tools for us to evaluate impact of the operative treatment in patients with craniosynostosis.

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OPEN CALLUS MANIPULATION: A STEP FORWARD IN DISTRACTION OSTEOGENESIS RECONSTRUCTION OF THE MANDIBLE AND MAXILLA
Presenter: Alberto Pereira M.D.
Author: Alberto Pereira M.D., Paulo Neves
Institution: Portuguese Armed Forces Hospital

Abstract:
A new technique is presented, that permits to reduce the total time of treatment, the number of surgical procedures and to avoid additional bone grafts usually needed in reconstructive cases treated with distraction osteogenesis (DO). A retrospective study with 14 patients treated with DO and open callus manipulation (OCM) is presented.

First surgery is performed for osteotomies and internal distractor devices fixation with monofocal or multifocal systems as required.

Through open approach, the second operative procedure is performed before consolidation after finishing distraction phase. Devices are removed, callus manipulated and bone segments fixated in the ideal position guided by pre-molded plates. This allows to obtain the best shape and symmetry. The consolidation phase with devices in place is eliminated allowing for reduction of the total treatment time. Intermediate surgical procedures for creation of the compression focus are also eliminated, avoiding additional bone grafting.

All of the patients present complex 3D defects, with ages ranging from 16 to 62 years old, 11 males and 3 females. Seven patients had mandibular defects ranging from 4 to 8 cm and seven had maxillary defects ranging from 3 to 6 cm. OCM was performed between 7th and 22nd day after the end of distraction phase. Also the duration of hospitalization, number of surgeries, total treatment time and perioperative complications were considered.

Six cases were selected to show the preoperative planning and surgical techniques.

All defects were fully reconstructed only with DO without bone grafting. Facial symmetry and balance was achieved. Follow-up ranging from 2 to 7 years highlights stable results regarding bone continuity and occlusion. DO represent in author’s opinion, one important reconstructive option for mandibular and maxillary complex defects.

OCM after the end of distraction phase adds quality to the final result, reduces total time of treatment and the number of surgical procedures.
ANATOMIC CONSIDERATIONS FOR THE FIRST TEMPOROMANDIBULAR JOINT VASCULARIZED COMPOSITE ALLOTRANSPLANTATION

Presenter: Nima Khavanin M.D.
Author: Nima Khavanin M.D., Diana Lee, Amir H Dorafshar, Patrick Byrne, Edward H Davidson
Institution: Johns Hopkins Hospital

Abstract:

Background: Given the specialized function of the TMJ and its unique anatomical components, concomitant TMJ transplant is an obvious adjunct in the reconstructive armamentarium for face transplantation in scenarios involving TMJ pathology. The objective of this study is to investigate the fidelity of anatomic morphology to identify key parameters to guide patient section and mitigate donor-recipient anatomic mismatch.

Methods: Geometric analysis was performed on 100 skeletally mature maxillofacial CT scans. Exclusion criteria included mandibular trauma and dentoalveolar disease. Parameters measured were posterior height, ramus tilt, anterior height, intercondylar widths, condyle height, coronoid height, interglenoid distances, symphyseal and gonial angles, condyle and glenoid volumes, and condyle shapes. Parameters were compared by gender and ethnicity using chi-squared, independent sample t-tests, and one-way ANOVA. Correlation with age was assessed using Pearson correlation coefficients. Bilateral measurements were compared using paired-sample t-tests.

Results: Mean intercondylar width was 102.5 mm (SD 7.0 mm), anterior height 21.5 mm (5.5), and posterior height 65.3 mm (7.7). Males demonstrate larger geometric parameters e.g. intercondylar width (4 mm mean difference, p=0.005), anterior height (2.3 mm, p=0.032), posterior height (5 mm, p=0.001). Asians demonstrated statistically larger intercondylar width (8 mm difference to Caucasians, p<0.001). Increased age was associated with greater anterior height, gonial angle, and symphyseal angle; decreased glenoid height; and change in condyle shape. Despite significant disparity of laterality measurements within individuals, posterior height, glenoid and condyle volumes are equivalent.

Conclusions: Mandibular morphology is highly variable. Patient selection for TMJ transplant must consider age, ethnicity and gender as well as individualized geometric parameter profiles to ensure anatomic compatibility.

GROWTH POTENTIAL OF FREE FIBULA FLAP FOR MANDIBULAR RECONSTRUCTION IN PEDIATRIC AGE

Presenter: Gerardo Chavez-Perez M.D.
Author: Eric Santamaria, Soledad Rubio-Mainardi, Damian Palafox, Gerardo Chavez-Perez, Candelaria Cueto
Institution: Hospital General Dr Manuel Gea Gonzalez

Abstract:

Mandibular deformities may be secondary to congenital malformations, cancer or vascular malformations in childhood. There are several reconstructive options, the fibula free flap is the gold standard in children and adults nowadays. Mandibular growth occurs through the epiphyseal proliferation found in the condyle and remodeling. The fibula has endochondral growth through ossification centers, located proximally in the epiphysis, another medial, and distal. The aim of this study is to report the long-term follow-up of patients with maxillary or mandibular reconstruction with free fibula flap in infancy.

Material and Methods: All patients treated at the Hospital General Dr Manuel Gea Gonzalez, with fibula flap in pediatric age between 1999 and 2014, were included. In the follow-up the length of the fibula and clinical and skeletal facial symmetry were determined through clinical photographs, panoramic x-rays and serial tomography.

Results: Twenty patients were included, who were operated at an average age of 8.25 years old, with an average follow-up of 6 years, maximum 13, minimum of 2 years. The 70% of the patients had a diagnosis of hemifacial microsomia, 25% of cancer, 5% of facial fissure 3-11 associated with hemifacial microsomia, and 5% of mandibular arteriovenous malformation.

The total of the fibula flap were used for head and neck reconstruction. 10% for maxillary and 90% for mandibular reconstruction. In 25% of the cases the fibula length was smaller than the one that had been placed, reason why it is suspected resorption of the same one. In 75% of the cases, the fibula flap was equal to the fibula placed, however, in 95% of the patients, there was no growth evidence.

Conclusion: The free fibula flap is the best reconstructive option for maxillary and mandibular defects in children, however the flap has no growth potential per se. That is why secondary procedures such as distraction of the flap are necessary to obtain better symmetry and functional r
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A RETROSPECTIVE REVIEW OF FREE FIBULA FLAP FOR PEDIATRIC MANDIBLE RECONSTRUCTION AFTER TUMOR RESECTION
Presenter: Ruth Lumbuun M.D.
Author: Prasetyanugraheni Kreshanti, RuthLumbuun M.D., Dewi Mukkaramah, Parintosa Atmodiwirjo
Institution: Plastic Reconstructive and Aesthetic Surgery Division, Department of Surgery, Cipto Mangunkusumo Hospital - Faculty of Medicine, Universitas Indonesia

Abstract:
Background: Head and neck tumors are quite rare in pediatric population. It represents approximately 5% of all pediatric tumors. In cases of tumors originating from orofacial skeleton, mandible is the most common bone which involved. The use of free fibula flap for mandible reconstruction has been shown to be an excellent choice in adults. However, this kind of reconstruction remains challenging in pediatric population. The main concerns are the postoperative growth potential of the reconstructed site and the donor site morbidity.

Methods: We did a retrospective review of patients underwent free fibula flap reconstructions for head and neck tumors in pediatric population from August 2010 to March 2017. We analyzed patient demographics, the extent of the defect (based on Jewer classification), outcome, and long term follow ups of both the reconstructed site and the donor site.

Results: We performed 8 reconstructions in 8 patients, median age was 11.5 years old (range 5 to 16 years old), male to female ratio was 1:3. Seven cases were primary reconstructions, while one case was secondary reconstruction. The most common pathology was ameloblastoma (37.5%). The results of bone defect were as follows: 3 LCL, 2 HCL, 2 H, and 1 HLCL. All flaps were vital. There were 2 hypertrophic scars, 1 wound infection, 1 wound dehiscence, and 1 plate exposed on the follow up. Long term morbidities on the donor site (gait, growth, and scar) will be reported.

Conclusion: Mandible reconstruction in pediatric population using a free fibula flap after tumor resection appear to be safe and reliable. It benefits not only for the functional purpose, but also the esthetic purpose. Normal growth of the donor site is expected, but normal growth of the transferred bone may not occur.

Keywords: free fibula flap, pediatric mandibular tumor

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DEVELOPMENT OF A FULLY BURIED PERSONALISED 3D INTERNAL MANDIBULAR DISTRACTION DEVICE
Presenter: Will Rodgers M.D.
Author: Will Rodgers M.D., Owase Jeelani, Alessandro Borghi, Silvia Schievano, David Dunaway
Institution: Great Ormond Street Hospital for Children

Abstract:
Aim: A novel method of modifying the shape of the deformed jaw to a prescribed, predetermined shape that is specific to the patient and that does not require external manipulation is outlined.

Background: Distraction osteogenesis -DO- induces bone formation without the need for bone grafting and allows for guided shape change in addition to expanding the overlying tissue envelope. DO as described by Ilizarov in the limbs has been used to correct deformities of the mandible as described by McCarthy and others.

Problems with current devices used for DO in the mandible include:

- Bulky design: Although there has been incremental improvement to device design since conception with an evolution from external devices, as used in limb DO, to internal semi-buried devices they remain bulky. There is therefore a risk of infection, which may jeopardise the outcome of distraction.
- Limited geometry: Current devices are restricted by a limited geometry of possible distraction, those devices most commonly used distract only in a single plane and cannot accommodate rotational deformity or complex multiplanar 3 dimensional distraction.
- Variability of distraction: In spite of pre-surgical planning the outcome of the distraction is heavily reliant on the surgeon's eye, a judgement which introduces bias.
- Discontinuous distraction: Currently used devices distract the callus discontinuously, usually twice per day. Advantages of continuous distraction include: lower distraction forces; potential for faster rates of distraction; improved quality of bone regeneration.
- Patient compliance: Devices used today require the patient or parent to actuate the distractor by means of daily winding.

Conclusion: The project develops and tests a prototype that can achieve multiplanar continuous, quasi constant-force DO without the need for patient involvement that is fully buried and thus reduces the potential for wound problems and allows for patient specific programmed distr...
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LEFORT 2.5 OSTEOTOMY WITH MIDFACE DISTRACTION FOR THE TREATMENT OF NAGER SYNDROME
Presenter: Sagar Mehta M.D.
Author: Sagar Mehta M.D., Barbu Gociman, Faizi Siddiqi, Neal Moores, Duana Yamashiro
Institution: University of Utah

The current management of midface hypoplasia in the setting of facial dysostotic Nager and Treacher-Collins syndromes remains a significant challenge. This is due to the complex bony deformities present in these patient populations, including a posterior malrotation of the midface in relation to the cranial base. This malrotation leads to retrusion of lower maxilla, while the central upper midface with the nasal pyramid projects forward. In addition, the malar areas often show various degrees of hypoplasia. Most commonly, the maxillary malrotation and retrusion is addressed with Lefort 1 osteotomies and repositioning, but in rare circumstances requires a Lefort 2 technique. Neither technique addresses the malar deficiency, which is treated secondarily with bone grafting.

We present here a novel technique used in an 11-year-old Nager Syndrome patient to address his midface bony deformities. The facial skeleton was approached through minimal incisions, using only an upper buccal sulcus incision and transconjuctival incisions with lateral canthotomy extensions. The inferior maxilla and zygomas were osteotomized en-bloc. The osteotomies were started medially at the piriform aperture and carried through the medial orbital walls, orbital floors and the lateral orbital walls. Distraction of the en-bloc midface was successfully carried out using an external distractor. This technique projected the inferior maxilla forward, leveled the occlusal plane, and concomitantly improved the malar anatomy without pushing the nasal anatomy further anterior. We had no complications associated with this technique.

We have named the maxillary osteotomy presented here, the Lefort 2.5 osteotomy and conclude that this modified Lefort osteotomy technique in conjunction with distraction osteogenesis can be very useful in the treatment of facial dysostosis syndromes.

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ICHOM CRANIOFACIAL MICROsomia - THE DEVELOPMENT OF A STANDARD SET BY GLOBAL MULTIDISCIPLINARY WORKING GROUP
Presenter: Justine O’Hara M.D.
Author: Justine O’Hara M.D., Dunaway, D, Arora, J, Koudstaal, M
Institution: Great Ormond Street Hospital for Sick Children

Abstract:
Craniofacial microsomia (CFM) as the second most common craniofacial anomaly involves a multitude of clinical specialties. The outcomes for these patients have historically suffered due to the fragmentation of their care. Centralization and standardization of care utilizing identical tools enabling meaningful outcomes and benchmarking was recognized.

Optimisation of the process through the International Consortium of Health Care Outcome Measurement (ICHOM) platform enabled a global multidisciplinary working group to be convened and a standard set to be proposed in a ten-month period. This involved defining the population of patients with CFM to benefit; the functional, appearance, psychological and burden of care domains to include and the best tools to measure these domains. The selection of tools included a literature review, consideration of reliability, validity, cost and languages translated of the tools before working group discussion and decision by Delphi process.

The collection of this dataset for CFM patients at five prescribed time points includes case mix variables to collect meaningful data to enable comparison with outcomes of patients internationally.

The implementation of the available set is now progressing across the globe with clinician and patient reported outcomes producing remarkable response to collection and not always agreement on a good outcome. The ongoing improvement and refining of the set continues through the steering committee. This set enables clinicians to treat patients by their acumen whilst collecting outcomes that matter most to patients and have the potential for improving care at benchmarking. The detailed and involved process to develop this robust set to best co-ordinate the care for CFM patients was valuable to demonstrate to the clinicians providing the care.
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COMBINED SOFT AND SKELETAL TISSUE MODELLING
OF NORMAL AND DYSMORPHIC MIDFACE POSTNATAL
DEVELOPMENT
Presenter: Amel Ibrahim M.D.
Author: Amel Ibrahim M.D., Michael Suttie,
Roberto L. Flores, David Dunaway,
Peter Hammond, Patrizia Ferretti
Institution: UCL Great Ormond Street Institute of Child Health,
University College London

Abstract:
Background: Congenital midface malformations can
significantly impair appearance, function and psychosocial
outcomes. This spectrum of midface dysmorphism is typified
by Treacher Collins Syndrome (TCS) and maybe exhibited
in Craniofacial microsomia (CFM). Affected children may
require multiple invasive reconstructive surgeries with variable
long-term outcomes. This study aims to describe normal
and dysmorphic midface postnatal development through
combined modelling of skeletal and soft tissues in order to
aid surgical evaluation and planning.

Methods: Retrospectively collected routine computed
tomography scans were volume rendered to simultaneously
extract both midface skeletal and soft tissue surfaces from
control (n=52), TCS (n=14) and CFM (n=6) children aged
0-16 years. Landmarked surfaces were analysed using dense-
surface modelling. The model was used to describe normal
dysmorphic midface postnatal development through
combined modelling of skeletal and soft tissues in order to
aid surgical evaluation and planning.

Results: In all three groups there was close alignment between
skeletal and soft tissue development. The parameters
responsible for the greatest variation in midface size and
shape showed significant dysmorphology and hypoplasia in
TCS compared with matched controls. Asymmetry was also
significantly higher in TCS midfaces compared with controls
and CFM. Combined modelling was then used to evaluate
the outcomes of bone graft surgery in TCS which, showed
normalisation immediately after surgery but reversion towards
TCS dysmorphology 1 year later.

Conclusions: This is the first quantitative study to model
the relationship between skeletal and soft tissue growth
of the midface during normal and dysmorphic postnatal
development. The model also permits evaluation of surgical
outcomes and lays the foundations for developing a surgical
simulation tool.

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EXPERIENCE OF HEMIFACIAL RECONSTRUCTION WITH
PREFABRICATED EXPANDED SUPRACLAVICULAR FLAP
Presenter: Cheng Chun Wu M.D.
Author: Cheng Chun Wu M.D., Jui Pin Lai
Institution: Chang Gung Memorial Hospital Kaohsiung

Abstract:
Background: Facial reconstruction after trauma, burn injury
or cancer resection remains a great challenge to craniofacial
surgeon. Although giving better aesthetic results, local
tissue transfer is sometimes unavailable or unable to provide
enough tissue after previous operation or trauma due to scar
contracture. With advance of microsurgery, free tissue transfer
provides sufficient soft tissue volume and the possibility
of bony reconstruction. However, color mismatching,
asymmetric facial contour and visible scar are almost inevitably
encountered. By combing tissue expansion, prefabrication
and free tissue transfer, better outcomes could be achieved.
The authors report the experience of hemifacial reconstruction
with prefabricated, expanded supraclavicular flap.

Materials And Methods: From 2014 to 2016 in Kaohsiung
Chang Gung Memorial Hospital, all patients undergoing
hemifacial reconstruction with prefabricated, expanded
supraclavicular flap were included. The patient demographics,
initial diagnosis, operations prior to reconstruction of the
prefabricated, expanded supraclavicular flap were recorded.
Based on the aesthetic units, the characteristics of the
hemiface, including tissue deficiency, scar contracture was
assessed. The supraclavicular flap was prefabricated with
fascia flap from anterolateral thigh (ALT) and a tissue expander
was placed beneath the fascia flap in the same operation.
The expansion was started two weeks postoperatively
and the duration of expansion was 3 months in average.
After expansion was completed, the supraclavicular flap
was transferred to reconstruct the deformed hemiface.
Postoperative results were compared to preoperative status
aesthetically and functionally.

Results: Three patients were included in the study. The
hemifacial deformity of two patients resulted from cancer
resection and subsequent radiation therapy while the other
patient was trauma-related deformity. All three patients had
undergone reconstructive surgeries
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BALANCING DISTRACTION FORCES IN THE MANDIBLE: NEWTON'S THIRD LAW OF
Presenter: Sameer Shakir, MD
Author: Sameer Shakir, MD, Sanjay Naran, MD, Kristen M. Lowe, DDS, MS, Jesse A. Taylor, MD, Scott P. Bartlett, MD
Institution: Children's Hospital of Philadelphia

Abstract:
Background: In children undergoing vertical mandibular distraction to address occlusal cant, downward distraction cannot effectively occur until the proximal segment abuts the cranial base. Distraction force is often wasted in rotation before being exerted on vertical gain. We hypothesize that utilization of a cheek L-plate on the coronoid process to engage the zygomatic arch at time of osteotomy minimizes unwanted rotation.

Methodology: Patients with hemifacial microsomia, seen at the Children's Hospital of Philadelphia from 2012-2016 undergoing unilateral vertical mandibular distraction with placement of cheek L-plate along the coronoid process to engage the zygomatic arch (n=3) were compared to a sample of those similarly undergoing distraction without use of the plate (n=3). Preoperative and postoperative cephalometric measures included (1) vertical distance of the affected coronoid process from the unaffected Frankfort horizontal plane, (2) angle based on this relationship, and (3) length of total distraction measured from condylion to gonion.

Results: Age, Pruzansky classification, and time between preoperative and postoperative CT imaging did not differ between groups to a significant degree. Vertical distance from the coronoid process perpendicular to the Frankfort horizontal did not differ between groups (p<0.07), however postoperative distance significantly differed with coronoid process rotating upwards into the cranial base in all patients without a cheek plate (p<0.005). Preoperative angle of the coronoid process based on the Frankfort horizontal did not differ (p<0.06), however postoperative angle significantly changed, confirming upward rotation into the cranial base (p<0.01). Total regenerate did not significantly differ (p<0.08).

Conclusions: Vertical mandibular distraction results in undesirable upward rotation of the proximal segment into the cranial base. This can be prevented by fixing a cheek L-plate to engage the zygomatic arch.

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SIGNIFICANCE OF MIDFACIAL DISTRACTION FOR INFANTS WITH SYNDROMIC CRANIOSYNOSTOSIS
Presenter: Nobuyuki Mitsukawa M.D.
Author: Nobuyuki Mitsukawa M.D., Yoshitaka Kubota, Shinsuke Akita, Kaneshige Satoh
Institution: Dept. of Plastic and Reconstructive Surgery, Chiba University

Abstract:
Purpose: A tracheotomy is often performed at an early stage in cases of severe syndromic craniosynostosis due to respiratory disorders from airway constriction not long after birth. This results in response to midfacial distraction being relatively slow. In this review, we will be considering the significance of midfacial distraction for infants with syndromic craniosynostosis.

Subjects and Methods: The subjects were six syndromic craniosynostosis with severe maxillary hypoplasia at our facility in the past five years. There were five children with Pfeiffer syndrome, one child with Beare-Stevenson syndrome. A tracheotomy had already been performed for all cases. For these cases, a front-orbital advancement was prioritized from an early stage and a posterior expansion using distraction and midfacial distraction was performed afterward. The surgery period for midfacial distraction was from one year to three years after birth. The distraction devices used all employed a transfacial pinning technique.

Results: Distraction amount aimed at 20mm and over as a guideline, which was taken to be the degree for which a Class III malocclusion would sufficiently improve. There were no major complications following surgery and equipment was removed roughly half of a month after the consolidation period. Significant expansion of the airway was observed in all cases, further 2 patients who had tracheostomy in the past were weaned from it within 2 years. In addition, improvement was noticed for swallowing and speaking.

Consideration: In recent years, posterior expansion utilizing distraction has often been prioritized for cases of severe syndromic craniosynostosis in which there is significantly increased intracranial pressure. A front-orbital advancement and midfacial distraction or monobloc distraction is performed afterward, but the period for this is still under debate. While we have reviewed midfacial distraction in early childhood for cases of severe syndromic craniosynostosis.
174 COMPARISON OF COMPLICATION RATE BETWEEN MONOBLLOC ADVANCEMENT AND LEFORT III OSTEOTOMY, WITH OR WITHOUT DISTRACTION OSTEONEOSIS, IN THE TREATMENT OF CRANIOSYNOSTOSIS
Presenter: Rebecca Knacksted M.D.
Author: Rebecca Knacksted M.D., Bahar Bassiri, Antonio Rampazzo
Institution: Cleveland Clinic Foundation

Abstract:
Background: A LeFort III osteotomy or monobloc advancement, with or without distraction, can be utilized to address craniosynostosis. This report is a meta-analysis of the complication rates following monobloc advancement or LeFort III osteotomy, with and without distraction.

Methods: A PubMed search was conducted to identify articles addressing craniosynostosis treated with a monobloc advancement or LeFort III osteotomy in which complications were delineated. Complications were considered major if they required a second operation or were potentially life threatening. Statistical analysis was performed with t-tests.

Results: Twenty-three studies fit inclusion criteria. There were 377 and 42 patients treated with a monobloc or LeFort III, respectively. There were 377 and 42 patients treated with a monobloc or LeFort III with distraction, respectively. There was a statistically higher rate of CSF leaks with a monobloc (p=.006). There were 247 and 25 patients treated with a monobloc or LeFort III without distraction, respectively. There was a statistically higher rate of major complications (p<.001), death (p=.008), CSF leaks (p=.003) and re-operation (p=.001) with a monobloc and a statistically higher rate of minor complications (p<.001) with a LeFort III.

Conclusion: Monobloc advancement has been historically associated with a high complication rate. This analysis demonstrated the highest incidence of major complications with monobloc with advancement. When comparing approaches without distraction, there was a statistically significantly higher incidence of multiple major complications with a monobloc versus LeFort III. Although each patient must be addressed individually, and there are potential complications associated with utilizing distraction, this review highlights the risk of major complications when a monobloc advancement is utilized, especially when distraction is not planned.

175 FUNCTIONAL OUTCOME COMPARISON OF LENGTHENING TEMPORALIS MYOPLASTY AND FREE GRACILIS MUSCLE TRANSFER IN CHILDREN WITH FACIAL PALSY
Presenter: Phuong Nguyen, M.D.
Author: Phuong Nguyen, M.D., Dan Mazzaferro, Kristin Faschan, Sameer Shakir, Oksana Jackson, Scott Bartlett
Institution: Childrens Hospital of Philadelphia

Abstract:
Intro: Lengthening temporalis myoplasty (LTM) and cross-face nerve graft with free gracilis muscle transfer (CFNG-FGMT) are both used to restore dynamic facial animation and improve facial symmetry. There has not been direct comparison or consensus. Here, we compare our experience with respect to muscle activity, symmetry, and excursion.

Methods: A retrospective review was performed of patients with facial palsy who had CFNG-FGMT or LTM from 2008-2016 at a single institution. Postop surface EMG was recorded at maximum open smile. Normal (N) and paralyzed (P) sides of the face were analyzed with Facial Assessment by Computer Evaluation (FACE-gram) software, evaluating for commissure displacement (Z-vector).

Results: Five patients with LTM and 10 with CFNG-FGMT met inclusion criteria. Muscle activity was first identified in LTM patients after 3 months (44.4±12.2mV, p<0.001) and CFNG-FGMT patients after 2 months (38.3±17.4mV, p=0.028). Beta-coefficient regression showed a faster increase in sEMG in LTM compared to CFNG-FGMT patients (9.2mV/month vs. 2.3mV/month). In CFNG-FGMT patients preoperatively, there was a Z-vector of 25.8±1.2mm (N) vs. 20.9±1.4mm (P) at rest, increasing to 35.7±1.4mm (N) vs. 21.4±1.5mm (P) on smile. Postop improved symmetry at both rest: 24.6±3.5mm (N) vs. 24.8±3.5mm (P), and smile: 28.9±0.6mm (N) vs. 33.4±0.6mm (P), p=0.0001. LTM preop showed 31.4±6.5mm (N) vs. 20.1±1.1mm (P) at rest, changing to 37.2±5.6mm (N) vs. 19.1±1.1mm (P) on smile. Postop showed improved symmetry at both rest 27.5±4.4 (N) vs. 32.8±3.9 (P), and during smile: 32.8±6.2mm (N) vs. 33.7±5.3mm, p=0.83

Conclusion: Facial symmetry and animation improved in both surgical groups. LTM demonstrates a faster rate of muscle recruitment compared to CFNG-FGMT with better smile symmetry though there is greater smile excursion in the CFNG-FGMT. Both LTM and CFNG-FGMT demonstrate muscle activity at 2-3 months.
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THE MONOBLOC FRONTOFACIAL ADVANCEMENT; THE FORTY-YEAR EXPERIENCE OF A SINGLE CENTRE
Presenter: Tomas O’Neill, M.D.
Author: Tomas O’Neill, M.D., Walter Flapper, Vani Prasad, Alistair Jukes, Lynette Moore, Steve Santorenous
Institution: Australian Craniofacial Unit

Abstract:
A monobloc frontofacial advancement is a major undertaking in craniofacial surgery requiring a large investment both on behalf of the patient, their families, the surgical team and the healthcare economy.
We provide an illustrated account of The Australian Craniofacial Unit’s single centre 40 year experience of the monobloc frontofacial advancement. We describe the associated syndromal diagnoses, country of origin, age at operation, previous craniofacial surgery undertaken, outcomes and complications experienced.
We describe how our technique has evolved over our unit’s history in order to mitigate the complications experienced and also to incorporate emerging technology.

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COGNITIVE, BEHAVIOURAL, SPEECH, LANGUAGE AND DEVELOPMENTAL OUTCOMES ASSOCIATED WITH MUTATIONS OF THE ERF GENE
Presenter: Helen Care M.D.
Author: Helen Care M.D., Carrie Luscombe, Louise Dalton, David Johnson, Steven Wall, Andrew Wilkie
Institution: Oxford Craniofacial Unit, Oxford University Hospitals NHS Foundation Trust, Oxford UK

Abstract:
Mutations of the ERF gene were previously associated with craniosynostosis, craniofacial dysmorphism, and Chiari malformation (Twigg et al 2013). This study investigates cognitive, behavioural, speech, language and developmental outcomes in the first five children identified as having ERF-related craniosynostosis, together with three of their carrier parents.

Method:
Case note reviews, followed by semi-structured clinical interviews, were undertaken with 5 identified families (5 children, 3 parents). Formal assessments were made of cognitive skills, verbal memory, attention, fine motor control, speech and language.

Results:
There were no consistent findings related to overall intelligence. However, a pattern of cognitive difficulties is described, which includes poor attention, impulsivity, and difficulties with functional fine motor skills, such as handwriting. A high frequency of speech, language and communication delay or disorder was evident, which was most often related to early language delay, speech disorder, hyponasal resonance and concern regarding social communication skills and emotional immaturity.
It was common for these children to have needed input from ear, nose and throat services. Problems with tonsils and/or adenoids and/or fluctuating conductive hearing loss, are highlighted.

Conclusions:
The aim of this report is to give clinical guidance to clinicians who have care of patients with the ERF-related mutation. A pathway of care for children who are suspected or confirmed to have ERF-related craniosynostosis is proposed.
Abstract:
Background: Corneal anesthesia may be congenital or acquired. Resultant neurotrophic cornea leads to scarring, ulceration, perforation, and vision loss. Corneal neurotization using sural nerve grafts can restore protective sensation. Herein, we performed corneal neurotization for younger children in the amblyopic age range using a new scleral tunnel technique and previously undescribed assessment with confocal microscopy.

Methodology: Corneal neurotization was performed in two eyes in two children with acquired unilateral corneal anesthesia using sural nerve grafting from the contralateral supratrochlear nerve. Primary outcomes were central and peripheral corneal sensation assessed with a Cochet-Bonnet esthesiometer, improvement in corneal clarity, corneal nerve density quantified by confocal microscopy, and postoperative complications.

Results: Neurotrophic cornea with ulceration and scarring developed following traumatic brain injury (patient A) and resection of a posterior fossa tumor (patient B). Both eyes had non-measurable corneal sensation preoperatively. Corneal neurotization was performed on patients A and B at ages 6 and 7 years, respectively. Patient A had measurable corneal sensation and slight decreased in corneal scar density at 3 months postoperatively and a 55% increased in average corneal nerve density at 6 months postoperatively. At 1 month postoperatively, patient B did not yet have a measurable increase in corneal sensation but did have a decrease in corneal scar density. There were no postoperative complications.

Conclusions: We report the two youngest patients to have undergone corneal neurotization by nerve grafting. Both children showed clinical evidence of successful corneal re-innervation even at early postoperative follow-up.

Abstract:
179  CORRECTION OF SECONDARY CRANIOSYNOSTOSIS DEFORMITIES WITH AUTOLOGOUS FAT
Presenter: Bryant A Toth, M.D.
Author: Bryant A Toth, M.D., Peter Sun
Institution: UCSF-Benioff Children’s Hospital, Oakland, California

Abstract:
It is not infrequent that a patient who has undergone craniectomy and frontocranial remodeling for craniosynostosis is in need of secondary surgery. When there are signs of elevated intracranial pressure the only solution is to redo the intracranial procedure and expand the calvarial fault. In most of our patients though the indication for secondary surgery is more of a cosmetic one due to asymmetry, cranial irregularity, and most commonly due to a predictable absence of growth of the skull and forehead in specific areas predicated on the suture that was involved.

Over the past five years a total of 50 consecutive patients underwent autologous fat transfer to the forehead, midface, and skull region to correct a secondary craniofacial deformity. A total of 220 facial areas were addressed in this series. In this series the total amount of fat injected ranged from 7cc's to 90 ccs depending on the diagnosis, the location, and the deformity.

Growth-related facial deformity secondary to craniosynostosis surgery is predictable. Patients that have had an open sagittal suture procedure frequently are left with bifrontotemporal pinching with facial growth. Unicoronal synostosis patients commonly have persistent frontal and orbital asymmetry that was impossible to correct at the time of initial surgery or developed later in life secondary to facial growth. Metopic synostosis patients frequently outgrow their initially satisfactory correction and develop not only bitemporoparietal pinching, but frontal bone flattening and overall irregularity. Midface hypoplasia with frontal bone flattening and overall asymmetry is even more common in children with bicoronal suture synostosis particularly in those that are syndromic.

We will review our series and talk about indications for secondary surgery, the surgical technique and long-term follow-up. We feel that autologous fat transfer to the face is an excellent technique for correction of secondary craniofacial deformities.
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FAT GRAFTING: THE FINAL TOUCH IN CRANEOFACIAL DEFORMITIES
Presenter: Pablo Arrieta, M.D.
Author: Pablo Arrieta, M.D., Damián Palafox, Fernando Molina

Abstract:
Grafted fat tissue has been used for years as an excellent filler to treat volume and contour deficiencies in aesthetic and reconstructive surgery. Patients with congenital craniofacial malformations and trauma sequelae present with complex challenges for reconstruction and the lack of facial volume is a particular characteristic in this patients. Individualized treatment often involves rebuilding of the facial skeleton, as well as correcting the overlying soft tissue deficiencies in final stages. Serial autologous fat grafting performed during staged reconstruction is the prefered method in the craniofacial clinic. 97 patient retrospective study with craniofacial malformation diagnosis including Parry Romberg Sd. (n=36), craniofacial Microsomia (n=16), Facial clefts (n=17), Non syndromic craniosynostosis (n=17), Syndromic craniosynostosis (n=38), and trauma sequelae (n=13) treated by fat grafting between March 2010 and March 2013. The most common donor sites were the upper abdominal area and groin. The fat was harvested through the same incisions made for infiltration of anesthetic solutions of 1:200,000 of epinephrine in Ringer's Lactate. A blunt tip harvesting cannula was 2mm in diameter and 15cm in length, connected to a 10-mL siringe. Preparation was performed media washing using Ringer's solution. Application of the graft was made with a 17-gauge blunt cannula connected to a 3-cc siringe and using a “fanning out” technique in the superapierostial, intramuscular and superficial planes. Lipoestructuration was performed between 16 and 25 years of age ad in each patient 3 to 4 sessions were requiered with a time period between each session was 5 to 6 months. Analysis was conducted on standarized pre and Postoperative photographs to determine facial symmetry and correction of soft tissue defects. The amount of injected fat per facial area was 8 to 40ccc depending on the facial area. Malar, Temporal and forehead regions were the most grafted. Based on the experience there is an important improvement in facial morphology, shape and volume in patient's appearence. facial asymetry and contour correction with fat grafting is attainable and must be individualized according to patient needs and characteristics.

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PREDICTORS OF AUTOLOGOUS FREE FAT GRAFT RETENTION IN THE MANAGEMENT OF CRANIOFACIAL CONTOUR DEFORMITIES
Presenter: Cassio Eduardo Raposo Amaral M.D.
Author: Cassio Eduardo Raposo Amaral M.D., Rafael Denadai, Cesar Augusto Raposo Amaral
Institution: SOBRAPAR

Abstract:
Background: Autologous free fat graft outcomes are not always predictable, and variables that can potentially influence the fat graft retention are still not well understood and investigated. The purposes of this study were to assess fat graft retention in management of the craniofacial contour deformities and to identify possible predictive factors of this retention.

Methods: A prospective analysis was conducted of consecutive patients with unilateral craniofacial contour deformities who underwent autologous free fat grafting between 2012 and 2015. Standardized ultrasonographic craniofacial soft-tissue thickness measurements were adopted for determining the fat graft retention. Bivariate and multivariate analyses were applied to identify independent predictors of 12-month postoperative fat graft retention. RESULTS: One hundred and forty-two patients were enrolled. There was significant (all p<0.05) and progressive reduction of the fat graft retention within the first 3 postoperative months and maintained retention (all p>0.05) at 3 through 12 months postoperatively, with the 12-month fat graft retention at 67.7 percent. Age, Parry-Romberg syndrome, previous craniofacial bone surgery, grafted volume, and forehead unit were independently negative (all p<0.05) predictors of the fat graft retention, whereas cheek unit was an independently positive (all p<0.05) predictor of retention. CONCLUSION: Craniofacial fat graft retention is achievable, but remains somewhat unpredictable with age, Parry-Romberg syndrome, previous bone surgical intervention, grafted volume, and recipient sites affecting this retention.

Key words: Craniofacial contour asymmetry; Free fat grafting; Outcomes; Predictors; Retention
Level of evidence: II
INTRAOPERATIVE THREE-DIMENSIONAL VIRTUAL REALITY AND COMPUTED TOMOGRAPHIC GUIDANCE IN TEMPOROMANDIBULAR JOINT ARTHROPLASTY OF SYNDROMIC CRANIOFACIAL DYSOSTOSES

Presenter: Thomas Willson M.D.
Author: Thomas Willson M.D., Miles Pfaff, Julia Ayeroff, James P. Bradley, Justine C. Lee
Institution: University of California Los Angeles

Abstract:
Background: Bony ankylosis of the temporomandibular joints occurs in up to 28% of patients with syndromic mandibular dysostoses. Release of complete osseous ankylosis is particularly challenging due to the lack of tissue planes separating the mandible from the skull base and the presence of congenital skeletal abnormalities. One recent advance in surgical imaging technology is three-dimensional virtual reality (3D VR), now in common use in neurosurgical resections. In this work, we describe the usage of 3D VR in TMJ arthroplasty and compare 3D VR to traditional CT guidance.

Methods: Pediatric patients with syndromic mandibular micrognathia including Treacher Collins, Nager, and cerebrocostomandibular syndrome were retrospectively evaluated between 2008-2016. Patient characteristics, complications, inpatient times, and operative times were recorded.

Results: Of the 29 children with syndromic mandibular micrognathia treated between 2008-2016, 7 were diagnosed with temporomandibular joint ankyloses. Four consecutive pediatric patients (mean 8.7 years) undergoing interpositional TMJ arthroplasty with Matthews device placement were retrospectively evaluated. Two patients underwent traditional CT-guided versus 3D VR-guided TMJA. No statistically significant differences were found between the age, complications, or inpatient hospitalization times. The average operative time in the traditional CT guidance group was 300 min versus 134 min in the 3D VR group.

Conclusions: Three dimensional virtual reality is a useful preoperative planning and intraoperative guidance tool. The major difference between VR and older technologies is the improved imaging in three dimensions for guidance, thereby potentially decreasing operative times.

SURGERY-FIRST ORTHOGNATHIC SURGERY FOR FACIAL ASYMMETRY USING INTERNAL MANDIBULAR 3D-TYPE DISTRACTOR

Presenter: Yorikatsu Watanabe M.D.
Author: Yorikatsu Watanabe M.D., Takahiro Yamamoto, Ryo Sasaki, Tanetaka Akizuki
Institution: Tokyo Metropolitan Police Hospital

Abstract:
Background: Severe facial asymmetry in adults with hemifacial macrosomia or temporomandibular joint ankyloses has been challenged to treat using simultaneous maxillomandibular distraction osteogenesis (DOG) using external distractor placed with intermaxillary fixation (IMF). However external distractor also produces significant distress for patients during at least 8 weeks. Furthermore mandibular-driven distraction tends to elongate the mid face with difficulty in positioning the Le Fort I segment in ideal position. To overcome these disadvantages, based on Surgery-First concept to minimize the duration of orthodontic treatment and maximize the facial appearance and occlusion, we performed repositioning of Le Fort I segment intraoperatively to restore maxillary roll levering followed by mandibular distraction using three dimensional (3D)-type of internal distractor for better control and tolerable postoperative DOG.

Method: The Le Fort I segment was fixed with plates in ideal position according to the computer-aided surgical simulation. Before mandibular osteotomy, 3D-type of internal mandibular distractor was placed on the affected side. Finally the vertically rams osteotomy of the unaffected side was performed. Seven days after surgery, IMF with the final occlusal splint was placed with elastic bands or metal wires for the distal segment of the mandible to be elongated, keeping the treatable malocclusion with Le Fort I segment, and the affected side of the mandible was distracted at a rate of 1 mm/day. After the completion of distraction, IMF was released. The internal distractor was removed after 6 months postoperatively.

Result: 4 adult cases with severe facial asymmetry were successfully treated without complication with minimal orthodontic treatment.

Conclusion: Simultaneous repositioning of Le Fort I segment and mandibular distraction using internal mandibular 3D-type distractor based on Surgery-First concept successfully restored severe facial asymmetry.
NEW TECHNIQUE TO MANAGE NARROWED MANDIBULAR RAMI IN PEDIATRIC PATIENTS
Presenter: Filipp Vladimirov M.D.
Author: Filipp Vladimirov M.D., Dmitry Komelyagin, Dubin Sergey, Topolnickiy Orest, Dergachenko Anna, Krasheninnikov Leonid
Institution: Moscow State University of Medicine and Dentistry

Abstract:
Topicality
Underdeveloped mandibular rami may be shortened and significantly narrowed. A generally accepted technique to manage this abnormality in pediatric patients is ramus horizontal osteotomy and vertical distraction. The graft formed is narrow. Its capability is in sufficient in mandible movements, which results in graft reduction and underdevelopment relapse.

Research aim
To prevent reduction of the graft obtained by ramus lengthening through compression-distraction osteosynthesis (CDO).

Materials and methods: Underdeveloped (both shortened and narrowed) mandibular rami were managed in 31 patients aged 6 to 18 (including 14 patients with congenital underdevelopment and 17 patients with acquired underdevelopment).

Mean difference between normal and abnormal sides was 44.7% in width and 40.5% in length in the unilateral underdevelopment groups. Mean deviation (as compared to age norms) was 40.9% in width and 40.8% in length in the bilateral underdevelopment groups.

Stage 1 was CDO ramus widening, stage 2 was its lengthening. A device to widen the ramus was removed simultaneously with installing a device to widen the ramus. Specially designed devices were used to widening the mandibular rami.

Results: The outcomes were good in 27 patients, satisfactory in 4 patients, and unsatisfactory in none. No distracted bone graft was reduced throughout the follow up period (3 years). All the grafts were fully functioning bones sized 13-20 mm in ramus widening and 18-30 mm in its lengthening.

Conclusion: The technique proposed enables surgeons to make the functionally capable mandibular ramus graft to decrease significantly underdevelopment relapse risks and increase treatment effectiveness.

CHANGING THE FACIAL FEATURES OF PATIENTS WITH TREACHER COLLINS SYNDROME PROTOCOL FOR 3-STAGE TREATMENT OF HARD AND SOFT TISSUE HYPOPLASIA IN THE UPPER HALF OF THE FACE
Presenter: Filipp Vladimirov M.D.
Author: Nobuyuki Mitsukawa M.D.,Atsuomi Saiga, Yoshitaka Kubota, Kaneshige Satoh
Institution: Dept. of Plastic and Reconstructive surgery, Chiba University

Abstract:
Treacher Collins syndrome is a disorder characterized by various congenital soft tissue anomalies involving hypoplasia of the zygoma, maxilla, and mandible. A variety of treatments have been reported to date. These treatments can be classified into two major types. The first type involves osteotomy for hard tissue such as the zygoma and mandible. The second type involves plastic surgery using bone grafting in the malar region and soft tissue repair of eyelid deformities.

We devised a new treatment to comprehensively correct hard and soft tissue deformities in the upper half of the face of Treacher Collins patients. The aim was to change facial features and make it difficult to tell that the patients have this disorder. This innovative treatment strategy consists of three stages: (1) placement of dermal fat graft from the lower eyelid to the malar subcutaneous area, (2) custom-made synthetic zygomatic bone grafting, and (3) Z-plasty flap transposition from the upper to the lower eyelid and superior repositioning and fixation of the lateral canthal tendon using a Mitek anchor system. This method was used on 4 patients with Treacher Collins syndrome who had moderate to severe hypoplasia of the zygomas and the lower eyelids. Facial features of these patients were markedly improved and very good results were obtained. There were no major complications intra- or postoperatively in any of the patients during the series of treatments. In synthetic bone grafting in the second stage, the implant in some patients was in the way of the infraorbital nerve. Thus, the nerve was detached and then sutured under the microscope. Postoperatively, patients had almost full restoration of sensory nerve torpor within five to six months. We devised a three-stage treatment to change facial features of patients with hypoplasia of the upper half of the face due to Treacher Collins syndrome. The treatment protocol provided a very effective way to treat deformities of the upper half of the face.
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TREACHER COLLINS SYNDROME ECTROPION CORRECTION WITH MICRO MITEK CANTHOPEXY: A NEW OPTION - PRELIMINARY, LONG-TERM FOLLOW-UP
Presenter: Albaraa Aljerian M.D.
Author: Marie Lucie Lessard, Albaraa Aljerian M.D., Hassan AlNaeem
Institution: McGill University Health Center

Abstract:
Introduction: Eyelids are affected in up to 96% of patients with Treacher Collins Syndrome (TCS). Surgical techniques have been reported to address the associated antimongoloid palpebral fissure, coloboma combined with ectropion and canthal dystopia.
The senior author has considerable experience using anchored Micro-Mitek sutures in eyelid ectropion correction (12 in total), hand surgery (25 in total), and facial oncologic reconstruction in adults for several years. This is a new application and solution for TCS in the pediatric craniofacial population. We present the first two cases of patients with TCS undergoing lateral canthopexy with a Micro-Mitek suture anchor as a solution with a special surgical technique in context of the associated lateral bony deformity of the orbits.

Methods: Two Treacher Collins cases are reported with the technical details of the use of the Micro-Mitek suture (micro Quickanchor Plus©) to correct ectropion in this well-known syndrome.

Results: No short or long-term complications were noted with our 3-year stable follow-up. Pre and Post-operative radiological and photographic documentation will be presented (Plain radiograph, CT-Scan, 3D reconstructions & 3D-Printer models) to describe the details of the surgical technique. In regards to the patient with the longest follow-up, the procedure has removed the visual periorbital stigmata of the TCS, and has been stable. The patient is now satisfied and comfortable with his appearance in public as a singer.

Conclusions: To the best of our knowledge, this is the first clinical report of a Micro-Mitek solution for this difficult problem of ectropion/eyelid deformity in TCS patients. We hope that it will benefit patients in the future as a new modality in the less than satisfactory historical armamentarium of surgical options for this problem in Plastic Surgery.

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ALGORITHM FOR EAR RECONSTRUCTION AFTER RADICAL RESECTION OF ARTERIOVENOUS MALFORMATION OF THE AURICULAR REGION
Presenter: Dov Charles Goldenberg M.D.
Author: Dov Charles Goldenberg M.D., Marina Vilela Chagas Ferreira, Rolf Gemperli
Institution: Division of Plastic Surgery Hospital das Clinicas University of Sao Paulo Medical School

Abstract:
Introduction: Arteriovenous malformations (AVM) of the auricular region have singular features and are rare. Progressive growth or inadequate management may lead to bleeding, infection, cartilage exposure and ultimately, loss of structure. The purpose of this study is to present a treatment algorithm based on a clinical classification, including options for resection and reconstruction.

Methods: From 2004 to 2016, 9 patients with AVMs were treated from resection to reconstruction. Five were female, ages ranged from 10 to 34. Parameters considered for resection and reconstruction were compromise in extension (1/3, 2/3 or total), thickness (cutaneous and/or cartilage) and symptoms (bleeding, infection, ulceration and cartilage exposure). Total resection of AVM was always planned as a first step, followed by primary closure. Auricular resection was classified in partial (cutaneous or partial amputation) or total. Definitive reconstruction was planned according to the resultant defect, from primary immediate to delayed total ear reconstruction, with/without use of temporopatietal fascia (TPF) flap. In complex cases and after amputation, reconstruction was delayed for 6 months to warrant no regrowth of AVM.

Results: In all but 1 patient preoperative embolization was performed. Resection was partial in 3 cases (2 cutaneous resections and 1 partial amputation) and in 6 patients, total ear amputation was performed. In partial resection cases reconstruction was performed using local flaps. From 6 total ear amputations, delayed reconstruction was performed in 4. In 3 cases soft tissue coverage was adequate for autologous reconstruction without need of TPF flap and in 1 case TPF flap was associated to skin graft as primary reconstruction. No AVM regrowth was observed in the reconstructed ears.

Conclusions: Total resection of auricular AVMs warrant a safe definitive reconstruction. Delayed total reconstruction allows evaluation of soft tissue conditions and signs of regrowth.
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AUTOMATIC PLANNING OF CRANIAL VAULT RECONSTRUCTION FOR METOPIC CRANIOSYNOSTOSIS TREATMENT
Presenter: Antonio R. Porras M.D.
Author: Antonio R. Porras M.D., Beatriz Paniagua, Andinet Enquobahrie, Robert Keating, Gary F. Rogers, Marius, George Linguraru
Institution: Childrens National Health System

Abstract:
Purpose: To develop a framework that automatically calculates the optimal patient-specific surgical plan during fronto-orbital advancement for metopic craniosynostosis treatment, using objective and quantitative metrics of cranial malformations.

Methods: Our automated framework obtains the patient's cranial shape by segmenting the cranial bones from CT images. Malformations are quantified using two indices calculated by comparison with the patient's closest normal cranial shape from a normative atlas built from 100 healthy cases: (1) distance malformations, which measure local distances between the patient's cranial shape and its closest normal, and (2) curvature malformations, which measure local curvature discrepancies. We developed a shape-based registration algorithm that calculates the physical transformation that minimizes both distance and curvature malformations on the patient's cranium. The algorithm models the optimal translation, rotation and bending of the frontal bones and supra-orbital bar. The change in distance and curvature malformations was computed on the frontal bones before and after surgical planning simulation.

Results: We evaluated the simulated outcome of our framework for 15 patients with metopic craniosynostosis (age 2.87±2.58 months). Average distance malformations were reduced by 51.43% (from 2.45±1.57mm to 1.19±0.87mm) to previously reported healthy ranges (1.48±0.99mm, p=0.13). Average curvature malformations were reduced by 35.09% (from 1.14±0.94mm-1 to 0.74±0.58mm-1) to healthy ranges (0.72±0.61mm-1, p=0.65). Bone surface in the frontal bones was reduced in average by 0.02% due to the osteotomy, and the total cranial surface was increased by 0.58% as a result of advancing the frontal bones.

Conclusion: Our optimal automated framework, which implements the basic operations performed during fronto-orbital advancement, has potential to increase the objectivity and precision of cranial vault reconstruction for metopic craniosynostosis.

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IMPROVING AESTHETIC OUTCOMES UTILIZING IMAGE-GUIDED SURGICAL NAVIGATION IN FRONTAL BONE CONTOURING
Presenter: Brian T Andrews MD
Author: James D Vargo MD, James P Bradley MD, Brian T Andrews MD
Institution: University of Kansas Medical Center

Abstract:
Purpose/Aim: The upper facial third is often an underappreciated area of aesthetic concern in many patients. The forehead aesthetics are strongly impacted by the frontal bone anatomy, and as such, frontal bone contouring (ie. frontal cranioplasty) is challenging craniofacial procedure utilized to improve aesthetic outcomes.

Methods: A retrospective chart review was performed at two tertiary academic medical centers. All craniofacial procedures of the frontal bone using image-guided surgical navigation were included.

Results: Seven subjects were identified who underwent surgical navigation procedures of the frontal bone. Indications for surgical procedure included: frontal sinus setback (n=2), fibrous dysplasia (n=2), and benign tumor excision (n=3). Surgical navigation was successfully utilized in all patients to avoid the frontal sinus (n=5) or to anatomically enter the frontal sinus (n=2). Surgical navigation was used to accurately confirm the aesthetic outcomes in all seven patients.

Conclusion: Surgical navigation is an often overlooked but useful tool in craniofacial surgery. Its use in frontal cranial surgery can improve patient safety and outcomes. In particular, this technology can improve surgical landmark identification such as the frontal sinus as well as confirm anticipated aesthetic results.
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INNOVATIVE APPLICATION OF ROBOTIC (ROSA) ASSISTANCE IN LE FORT III DISTRACTION OSTEGENESIS
Presenter: Pramod Subash M.D.
Author: Pramod Subash M.D., Suhas Udayakumaran, Ashok Pillai, Arjun Krishnadas
Institution: Amrita Institute of Medical Sciences, Kochi, India
Abstract:
Background: Management of craniofacial dysostosis syndromes is complex due to the multiple functional and aesthetic issues associated with it. Le fort III level distraction provides immediate relief to airway distress and stable advancement to provide support to globe, improvement in aesthetics being a bonus.
Objectives: Mid-face distraction in paediatric population utilizing a trans-facial pin borne distractor is a safe, and cost effective technique. However, the significantly hypoplastic zygoma and presence of tooth buds high up and close to the shallow orbits make free hand passing of the trans-facial pin, a difficult proposition. The aim was to assess the effectiveness of robotic assistance in precision planning and execution of pin placement in Lefort III level mid-face distraction.
Methods: During the period of September 2015 and April 2017, 10 patients with craniofacial dysostosis having varying degree of functional issues underwent Le Fort III level Mid-face Distraction using a trans-facial pin borne distractor device. The unique capability of neurosurgical robot (ROSA) to plan a linear trajectory and provide intra-operative guidance was utilized to pass the trans-facial pin without causing damage to the vital structures in close proximity.
Findings: No life threatening complications were encountered. Robotic assistance ensured the passage of the trans-facial pin in a single attempt. Adequate distraction was achieved in all the 10 patients.
Conclusion: Robot (ROSA) assisted trans-facial pin insertion is a safe and accurate method to place mid-face distractors that provides predictable and reproducible results.

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ORBITAL MORPHOLOGY IN CROUZON SYNDROME: A 3D ASSESSMENT BEFORE AND AFTER FRONTO-FACIAL MONOBLOC ADVANCEMENT WITH INTERNAL DISTRACTION
Presenter: Khonsari M.D.
Author: Khonsari M.D., Roman Hossein Khonsari, Johan Nysjö, Ronak Sandy, Ingela Nyström, Giovanna Paternoster, Eric Arnaud
Institution: Hôpital Universitaire Necker - Enfants Malades, Paris, France
Abstract:
Aim: Oculo-orbital disproportion is a major concern in Crouzon syndrome (CS), leading to insufficient eyelid closure and eventually functional visual impairment. Fronto-facial monobloc osteotomy aims to correct craniofacial growth deficiencies including oculo-orbital disproportion.
Material and methods: Twenty-four patients with CS and 48 controls were included. Four time points were considered: pre-op., early post-op. (within one month after the procedure), 6 months after surgery and 12 months after surgery. Orbits were segmented using a semi-automatic mesh-based method. Mean models were generated using a registration-based technique and were compared visually and quantitatively using colour coded distance maps, Maximum Absolute Distance (MAD), Hausdorff Distance (HD) and Dice Similarity Coefficient (DSC). Orbital symmetry was assessed by mirroring the left side on the right side and computing the volume overlap. We tested MAD ≤ 1.0 mm, HD ≤ 4.0 mm, and DSC ≥ 0.9 between CS and control groups for each time point and used the same criteria to assess symmetry.
Results: Shape normalisation was obtained qualitatively in all groups after fronto-facial surgery. Volumes were significantly more similar to normal in the 5-12 years age group after surgery and stayed stable. Volumes were significantly larger than controls in the 0-5 age group before surgery and remained stable. Quantitative assessment based on MAD, HD and DSC showed that normalisation was obtained after 1 year of follow-up in the 5-12 years group but not in the 0-5 years group, where the 3D shape of the orbits remained different from controls despite significant normalisation. There was to tendency for relapse in both age groups.
Conclusion: Fronto-facial surgery significantly normalises orbital shape and volume in Crouzon syndrome. The 3D assessment of the orbital inner mould is an indicator of the multifactorial effects of monobloc advancement and a method to monitor its stability.
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EVALUATION OF THE ACCURACY OF A 3D IMAGING SYSTEM IN CRANIOFACIAL PATIENTS
Presenter: Ben Robertson, M.D.
Author: Christian Duncan, David Richardson, Joern Wittig, Chris Parks, Ben Robertson, M.D., Ajay Sinha
Institution: Alder Hey Childrens Hospital NHSFT

Abstract:
Introduction: 3D photography is an established tool for measurement and documentation in craniofacial patients. To date, little data exists about the accuracy of measurements of the whole head in 3D photography, particularly where hair beneath an elasticated cap may influence measurements acquired from an image.

Methods: 21 patients who had a CT scan and 3D imaging (3dMD cranial system®) within a maximum timeframe of 10 days were selected retrospectively from the craniofacial database at Alder Hey Children's Hospital. Surface scans of the CT data and 3D image were superimposed in the 3dMD Vultus® software. A dataset of 6 anthropometric head measurements was collected from both images for each patient. In addition, 15 cranial indices were calculated for every dataset. The measurements and the cranial indices of the CT scans were compared with the 3D images using the Wilcoxon rank signed test for related samples.

Results: All direct measurements acquired from the 3D images showed significantly higher values than those collected from the surface scans. The comparison of the cranial indices showed no significant difference in 13 of the 15 indices.

Conclusion: Head measurements between craniofacial landmarks acquired from 3d imaging were inaccurate when compared with CT data, producing higher values possibly due to the presence of hair beneath an elastic cap. However, cranial indices were preserved in both image formats. This supports the conclusion that overall shape is accurately described by 3D photography.

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HOLOGRAPHIC CRANIOFACIAL SURGICAL PLANNING APPLICATION: EVALUATION OF USABILITY
Presenter: Kihyun Cho, MD, MSc
Author: Kihyun Cho, MD, MSc, Jeff Yanof, PhD, Graham S Schwarz, MD, FACS, Karl West, MS, Bahar Bassiri Gharb, MD, PhD, Francis A. Papay, MD
Institution: Plastic Surgery, Cleveland Clinic, Cleveland, Ohio, USA

Abstract:
Background: Conventional craniofacial surgical planning (CFSP) software can be limited to 2D flat-screen visualization and can lack intuitive operator interaction. We have developed a novel CFSP application with enhanced visualization of complex craniofacial anatomy using HoloLens (Microsoft). HoloLens is a modern, augmented-reality (AR) head-mounted display device that enables interaction with holographic projections (Holograms) of anatomical structures merged into the real-world planning suite.

Purpose: To evaluate the general- and application-specific usability of novel CFSP HoloLens application.

Methods: The application displayed 3D holograms which were derived from preoperative computed tomography datasets. The application enabled AR assisted skin, bone and vasculature repositioning with adjustable opacity shading for the skin layer. Evaluators performed drawing, distance measurement, zoom in-out functions with voice commands, hand-gestures. A Likert scale questionnaire was used to survey 18 plastic surgeons or residents. The questionnaire consisted of 10 validated standard system usability (SUS) questions and 10 application-specific usability (ASU) questions grouped as Visualization, Interface, Navigation, Tools, and Overall application validation. Results were recorded and summarized with average and standard deviation (STD). We tested the hypotheses that mean SUS and mean ASU over all participants were > 3 (p<0.01, one-sided).

Result: Evaluators were able to gaze 360 degrees around and navigate through 3D holographic craniofacial structures. The average SUS and ASU over all questions and participants were 3.81 (STD = 0.83) and 4.06 (0.74), respectively, and were greater than 3 (p=0.0004 and p<0.0001), respectively.

Conclusion: The novel application meets standard criteria for usability. Future research will include pre-clinical studies to assess the accuracy of registration of holographic planning results to physical anatomy in the operating room.
Abstract:

**Aim:** Orbital-palpebral reconstruction is a challenge in the management of Treacher Collins syndrome (TCS). This study investigates orbital phenotypes in TCS using dedicated cephalometric methods and 3D shape analyses of the inner mould of the orbital cavity.

**Material and Methods:** 15 TCS patients (6.85 ± 6.91) and 54 controls (2.43 ± 3.32) were included and separated into two groups: 0-5 and 5-19 years. Orbital morphology was investigated using 3D cephalometry based on 20 anatomical landmarks, defining 10 planes, 16 angles and 22 distances. Orbits were segmented using a semi-automatic mesh-based method. Age-specific mean models were generated using a registration-based technique. The models were aligned and compared using color-coded distance maps, Maximum Absolute Distance (MAD), Hausdorff Distance (HD), and Dice Similarly Coefficient (DSC). Orbital symmetry was assessed by mirroring the left side on the right side and computing the volume overlap.

**Results:** Mean volume was 17.27 ± 5.53 ml for the TCS and 15.08 ± 5.04 ml for the controls, with no significant difference between the two groups. We report HD > 1.5 mm in both age groups. We found MAD > 1.5 mm for ages < 5 but similar to controls for older patients. DSC was < 1 for all age groups. Central orbital depth (COD) and medial orbital depth (MOD) allowed classifying 100% of the skulls in the right category in discriminant analysis: COD & MOD ≥ 39.4 mm selected 0% TCS and 76.4% controls; COD < 39.4 mm & MOD ≤ 39.4 mm selected 64.3% TCS and 0% controls. Furthermore, COD and lateral orbital depth LOD were significantly different from controls in TCS (p < 0.0001).

**Conclusion:** This is the first 3D description of the orbital phenotype in TCS. Our study emphasized the importance of combining different morphometric approaches in the phenotype characterisation of non-trivial 3D structures.
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196 MANAGEMENT OF THE INADEQUATELY MANAGED ENDOSCOPIC ASSISTED CORRECTION OF CRANIOSYNOSTOSIS - ROTTERDAM EXPERIENCE
Presenter: Vani Prasad M.D.
Author: Vani Prasad M.D., Abdullah Khawar, Marie-Lise van Veelan, Sarah Versnel, Irene Mathijssen
Institution: Sophia Children's Hospital, Rotterdam

Abstract:
Background: Management of Craniosynostosis requires comprehensive evaluation by a multidisciplinary team. Endoscopic assisted correction of craniosynostosis with post-operative helmet therapy was described to reduce operative time, intraoperative blood loss, hospital stay and costs. However, reoperation after endoscopic correction of craniosynostosis is not well discussed in literature. The aim of this study is to review and share our experience with redo surgery after endoscopic assisted correction of Craniosynostosis.

Patients and Results: A total of seven patients presented for second opinion after initial endoscopic assisted correction of craniosynostosis. Out of the seven patients, three had non-syndromic and four had syndromic craniosynostosis. Three non-syndromic synostosis included one sagittal and two unicoronal. The child with sagittal synostosis presented with both functional (with signs of raised intracranial pressure) and aesthetic concerns. Parents of the two unicoronal synostosis patients were unhappy with the result after endoscopic correction and post-operative helmet therapy. The four syndromic craniosynostosis patients included - Apert Syndrome, Muenke Syndrome and two patients Complex Multisutural Craniosynostosis. Three patients with Syndromic craniosynostosis presented with signs of raised ICP. The child with Muenke syndrome presented with uncorrected unicoronal synostosis 12 months after endoscopic correction. All the seven patients underwent open cranial vault procedures to correct their deformities.

Conclusion: Management of Primary Craniosynostosis is a complex multidisciplinary team effort. Redo surgery for Craniosynostosis is a much more complex process. Our experience demonstrates that Endoscopic correction of Craniosynostosis may result in inadequate correction of the primary deformity and should not be advocated.

197 SECONDARY DISTRACTION LE FORT 3 AFTER FRONTOFACIAL MONOBLOC IMPROVES RESISTANT SLEEP APNEA
Presenter: Sam Haber, M.D.
Author: Sam Haber, M.D. Junnu Leikola, Daniel Saiepour, Brigitte Fauroux, Hossein Khonsari, Eric Arnaud
Institution: Hospital Necker craniofacial unit

Abstract:
Faciocraniosynostosis (FCS) can present with severe Obstructive Sleep Apnea (OSA) due to midface retrusion. When correction of OSA using Frontofacial Monobloc Advancement (FFMBA) is insufficient, secondary Le Fort 3 osteotomy (LF3) can be required.

Methods: This is a monocentric prospective cohort study on 15 children with FCS operated by LF3 and external distraction after a primary FFMBA. The primary outcome was achieving a normal Apnea Hypopnea Index (AHI) (less than 5/hour) on polysomnography without additional surgery. The secondary outcome was more than 50% improvement in AHI. Mean age was 40.0 ± 31.1 months at FFMBA and 76.9 ± 47.0 months at LF3. Time between FFMBA and LF3 was 46.2 ± 36.0 months. Mean follow-up was 70.2 ± 49.2 months after LF3.

Results: Seven patients (46.7%) reached the primary outcome 24.1 ± 17.2 months after LF3 and eight patients (53.3%) reached the secondary outcome 35.0 ± 29.4 months after LF3. There was a trend towards decreased AHI at 6, 12 and 36 months postoperatively compared to preoperative values. Three patients (20.0%) eventually relapsed (AHI≥5) giving a 42.9% partial relapse rate after 51.3 months. However, their improvement in AHI persisted (≥50% improvement) and a single subsequent procedure was needed in these 3 cases to achieve AHI<5.

External traction and bipartition were associated with the primary outcome and with faster time until response. Younger patients took more time to normalize their AHI. A shorter time between FFMBA and secondary LF3 was associated with a longer time until normalization. There was a trend towards an association between higher preoperative AHI and relapse (p=0.068).

Conclusion: Based on this prospective cohort, secondary LF3 considerably improves residual OSA after primary FFMBA.
EVALUATION OF ENDOSCOPIC STRIP CRANIECTOMY FOR BILATERAL CORONAL CRANIOSYNOSTOSIS AT TWO INSTITUTIONS

Presenter: Gary Skolnick M.D.
Author: Conor Williams, Matthew Smyth, Gary Skolnick M.D, Sybill Naidoo, Mark Proctor, Kamlesh Patel
Institution: Washington University School of Medicine in St. Louis

Abstract:
Background: Bilateral coronal craniosynostosis is the premature fusion of both coronal sutures, often causing turricephaly and brachycephaly. Traditionally this condition is treated by frontal-orbital advancement (FOA). Endoscopic strip craniectomy and cranial orthotic therapy, which has gained popularity in treating single suture craniosynostosis, has recently been adapted for treatment of bicoronal synostosis. There have been few studies documenting the outcomes of this treatment.

Purpose: The objective of this study is to compare the morphological outcomes of endoscopic strip craniectomy and FOA in patients with bicoronal synostosis.

Methods: A retrospective case series was done on twenty four patients with bilateral coronal synostosis treated with endoscopic strip craniectomy or FOA at two institutions. Patients with pre-operative and one year post-operative CT scans were included. CT images were analyzed for morphologic variables.

Results: Mean age of patients at time of operation was 2.7±1.1 mos. in the endoscopic group and 4.2±1.8 mos. in the FOA group. Mean turricephaly index in the endoscopic group changed from 1.3±0.1 to 1.4±0.1; In the FOA group it changed from 1.4±0.2 to 1.5±0.1 (normal range 1.5-2.0). Mean cranial index in the endoscopic group changed from 0.92±0.04 to 0.86±0.05; In the FOA group it changed from 0.93±0.10 to 0.88±0.12. In the endoscopic group median circumference Z score changed from 0.2 to 1.5; in the FOA group it changed from 0.2 to 0.0 in the endoscopic group median CVV changed from 1.1 to 2.8; in the FOA group it changed from 0.5 to 2.5. Student’s t-tests showed no statistically significant differences between the two patient groups.

Conclusions: The endoscopic approach to treating patients with bicoronal synostosis led to statistically similar morphological results as the FOA one year after repair.
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THE MORPHOMETRICS ABOUT ORBITAL AND MAXILLARY AREA AFTER CRANIOFACIAL OPERATION IN CHILDREN WITH PREMATURE CRANIOSYNOSTOSIS
Presenter: Shen Weimin M.D.
Author: Shili Jun, Shen Weimin, Gaoqing Wen, ongliang Liang
Institution: Department of Plastic Surgery, Children’s Hospital of Nanjing Medical University

Abstract:
Purpose: One of the most characteristic features in premature craniosynostosis is fronto-orbital retrusion. The standardized surgical technique of fronto-orbital advancement (FOA) can treat this(some) deformity, such as bilateral coronal synostosis. The purposes of this study were to use an accurate way to assess the effect after craniofacial surgery.

Methods: From 2010 to 2015, five years, 20 pediatric patients were taken the FOA operation in the department of burn and plastic surgery in the children’s hospital of Nanjing medical university. All the patients completed the CT scan preoperatively and postoperatively. These CT data processed by DICOM files into MIMICS 16.0 software were automatically calculated into orbital volume and orbital roof surface area. The T test was used to compare measured values before and after surgery. P<0.05 was considered statistically significant.

Results: The average preoperative orbital volume was 13930.70mm, and the average postoperative orbital volume was 18578.67917mm. After operation, the volume of orbital was significantly increased (P <0.05) . The mean area of the orbital roof surface was 753.989025mm preoperatively, and the average orbital roof surface area was 1122.074583mm postoperatively. The difference was statistically significant (P <0.05).

Conclusions: this study, fronto-orbital advancement (FOA) can improve morphological orbital deformities in children with premature craniosynostosis. Computer-assisted surgery can be an intuitive evaluation of fronto-orbital advancement preoperatively and postoperatively.

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THE EFFECT OF PREOPERATIVE MOLDING HELMET ON CALVARIAL GROWTH OF PATIENTS WITH SAGITTAL SYNOSTOSIS
Presenter: Shen Weimin M.D.
Author: Asra Hashmi, MD, Asra Hashmi, MD, Sandeep Sood, MD, Nicole Steele, Arlene Rozzelle, MD
Institution: Wayne State University/Detroit Medical Center

Abstract:
Aim: Aim of this analysis was to study the effect of preoperative molding helmet on intracranial volume of patients with Sagittal synostosis, with the hypothesis that helmet does not have a restrictive effect on calvarial growth.

Methods: After IRB approval, 16 patients underwent preoperative molding helmet therapy prior to surgery, and had a pre-helmet as well as a post-operative 3D scan for comparison. 3D head shape and anthropometric data was quantified using laser data acquisition system. Data was obtained on intracranial volume ICV, head circumference HC, cephalic index CI and symmetry indices.

Results: At the initial scan, mean age was 2.5 months and CI was 0.75. Scan was performed at a mean of 10 days prior to starting helmet therapy, and at that time mean HC of 41.9 cm was at 75th percentile on growth curve and ICV of 753 cc was between normal and +1SD on Lichtenberg normative cranial volume growth curve. Patients received helmet therapy for a mean of 4 months. Mean age at calvarial vault remodeling surgery was 6.4 months. Post-operative laser scan was obtained at a mean of 10 days after surgery. At this time, mean age was 6.9 months, mean HC of 46.3 cm was at 95th percentile and ICV of 1066 cc was slightly above +1SD on volume growth curve. Two patients in our study cohort only had helmet therapy and did not undergo surgery. Patient A presented at the age of 2.8 months, with a CI of 0.67, HC of 42.3 cm and ICV of 690 cc. After helmet therapy of 5.5 months, his CI improved to 0.74, HC was 47 cm and ICV was 1170 cc. His Cranial Vault Asymmetry Index improved from 39.5 to 4.5. Patient B presented at 2.5 months with CI of 0.82, HC of 41.5 cm and ICV of 761 cc. After helmet therapy of 8 months, CI improved to 0.84, HC was 45.7 cm and ICV was 1144 cc. Cranial Vault Asymmetry Index improved from 2.2 to 1.4.

Conclusion: Preoperative molding helmet allowed normal calvarial growth/intracranial volume and improved head symmetry.
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SPRING-MEDIATED CRANIoplasty IN SAGITTAL SYNOSTOSIS: DOES AGE AT PLACEMENT AFFECT RESULTS?
Presenter: Sanjay Naran M.D.
Author: James Sun, Netanja S ter Maaten, Daniel M Mazzaferro, Sanjay Naran M.D, Scott P Bartlett, Jesse A Taylor
Institution: Childrens Hospital of Philadelphia

Abstract:
Background: With an increasing number of centers performing spring-mediated cranioplasty (SMC) for sagittal synostosis, the authors conducted this study to evaluate how age at spring placement correlates with change in cephalic index (CI).

Methods: A retrospective chart review was performed for all sagittal synostosis patients treated with SMC from July 2011 to March 2017. Patient demographics, pre- and latest post-operative CI, operative details including number and force (N) of springs, and peri-operative complications were collected and compared using Wilcoxon rank-sum.

Results: A total of 59 patients underwent SMC with 36 patients having a pre- and post-operative CI. Average age at placement of springs was 3.9 months (range, 1.9 to 9.2); average time of follow-up after placement was 1.4 years (range, 0.3 to 5.2). Average length of surgery was 1.4 hours (range, 0.7 to 2.3) with a mean blood loss of 53 ml (range, 5 to 250). An average of 2.7 springs (range, 2 to 4) were used with a total strength of 24.6 Newtons (range, 12.7 to 37.0). Mean CI increased from 0.71 ± 0.01 preoperatively to 0.77 ± 0.01 postoperatively (p<0.001). The patients’ age at placement of the springs significantly affected the CI, whereas for every increased month of age the change in CI decreased by 0.01 (p=0.031). The number of springs used and total strength of springs did not correlate with changes in CI (0.846 and 0.843, respectively). One patient developed a subgaleal collection following removal; another patient underwent subsequent posterior cranial vault remodeling due to significant residual scaphocephaly.

Conclusion: Treatment of sagittal synostosis with SMC effectively and reliably normalizes CI independent of number of springs used and total spring strength. Interestingly, in our cohort in which age at spring placement generally ranged between two and five months, younger age correlated with greater improvement in CI, which has significant implications on timing of treatment.

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AN APPRAISAL OF THE CEPHALIC INDEX IN SAGITTAL CRANIOSYNOSTOSIS, AND THE UNSEEN 3RD DIMENSION
Presenter: Jeffrey Fearon M.D.
Author: Jeffrey Fearon M.D., Kanlaya Dittakasem, MNS, RN, Morley Herbert, PhD, John Kolar, PhD
Institution: The Craniofacial Center

Abstract:
Background: The cephalic index is often utilized to evaluate sagittal craniosynostosis corrections; however, validation of this measure remains untested.

Methods: A three-part study was designed to: 1. Determine the normal distribution of cephalic indices in untreated sagittal craniosynostosis; 2. Examine index values in treated children, subsequently determined to require secondary surgery; and 3. Explore the correlation between a photographic-based assessment of scaphocephaly severity and the cephalic index.

Results: Of 392 preoperatively measured patients (CI: 70.7, 57.4 to 89.5), 343 (87.5 percent) had Z scores falling within two standard deviations of the mean; only 49 (12.5 percent) fell more than two standard deviations below the mean, while 13 percent exceeded the mean. For 10 patients requiring secondary surgery (CI: 74.8, 68.1 to 83.4), the mean Z score was -0.5 (-2.5 to 1.6). The polled results of 10 observers revealed no significant correlation between subjectively ranked severity scores and cephalic indices.

Conclusions: Although the average preoperative cephalic index in children with sagittal craniosynostosis was below normal, the majority of measurements fell within a statistically normal distribution. Furthermore, many children requiring secondary corrections were found to have relatively normal indices, suggesting that normal values are not necessarily predictive of satisfactory outcomes. We also found no correlation between this index and a subjective assessment of severity. These findings suggest that the cephalic index is not a reliable outcome measure, perhaps because of the inability for this ratio to capture the amount of correction of the reduced posterior skull height associated with sagittal craniosynostosis.
LONG TERM FOLLOW UP IN CRANIOFACIAL OSTEOGENIC DISTRACTION WITH RESORBABLE DEVICES

Presenter: Hector Malagon, M.D.
Author: Hector Malagon, M.D., Vilchis Roberto, Ayala Fernan
Institution: Head of Plastic Surgery/ Craniofacial Surgery

Abstract:
Introduction: To the plastic surgery division of Centro Medico ISSEMyM has an experience of more than 15 years with the use of resorbable devices for osteogenic distraction of the craniofacial skeleton. In the early experience of our team with cranial distractors we faced with complications such as exposure, dislocation and migration of the devices, therefore we switched to the use of distractors with rigid fixation system, by this mean reducing the mentioned complications, however there was still morbility in the procedures for surgical removal of the devices, mainly because due to the apositional growth of the cranial bones. In 2004, we designed a distractor compatible with absorbable mesh and screws, and in the years to go it had several modifications until the obtention of an ideal distractor with bigger meshes that could be tailored to the exact size and vector in which it will be used.

Material and Methods: All patients had a resorbable distractor, a total of 17 patients were treated, ten patients had a fronto-orbital advancement procedure and distraction, five patients overwent cranial vault distraction and two patients had a monobloc surgery with distraction. The anomalies treated in these patients were as follows: ten patients with plagiocephaly, three with scaphocephaly, two had trigonocephaly, one with Apert syndrome, and one patient with Saethre Chotzen syndrome. In all cases the follow-up time was between 2 years and 15 years. Afterwards some patients had orthognatic surgery or correction surgery for residual asymmetry. Follow-up was made by same surgeon, with photographic record and tomographic studies.

Results: Seroma presented in 5% of the patients, in all cases were solved either spontaneously or by needle punction, none of the patients requierd surgery in an operating room for the extraction of the distractor or other devices. The tomographic studies show constant results, with full resorption of the material, no complications in the long term, and no interruption of the cranial growth was identified, same as no migration of material. Advancements of 27 mm were made in some patients.

Conclusion: In our study we insure that this technique is useful, and that the long term results advocate a safe surgery.

We had no need for reoperations to extract any material, and neither cases of migration of the materials into the cranial cavity. We recommend the use of this resorbable devices for obtaining results similars to those reported in other studies with other non absorbable material, but with the benefit of no complications of those devices.
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OUTCOMES OF ENDOSCOPIC-ASSISTED SPRING-MEDIATED CRANIOPLASTY COMPARED TO OPEN SPRING-MEDIATED CRANIOPLASTY
Presenter: Kyle Steven Gabrick
Author: Christopher Michael Runyan, Kyle Steven Gabrick, Jungwon Genevieve Park, Edreca Allison Thompson, Daniel Couture, Lisa Renee David
Institution: Wake Forest Baptist Medical Center
Abstract:
Introduction: The standard for surgical correction of sagittal synostosis before five months of age is suturectomy with post-operative cranial orthosis or spring-mediated cranioplasty (SMC). SMC can be performed endoscopically using a short scar, or with an open incision along the sagittal suture. This study is a retrospective outcomes-based study comparing endoscopic-assisted suturectomy to open suturectomy in SMC.

Materials and Methods: A retrospective database of patients with sagittal synostosis who underwent SMC at Wake Forest Baptist Medical Center from 2001 to 2016 was compiled for review. Demographics, operative details, cephalic indices and clinical images were compared.

Results: 181 patients were included in the analysis. Of those, 59 underwent endoscopic suturectomy and 122 patients underwent open suturectomy. The age at suturectomy, interval between suturectomy and age at spring removal were identical in both groups. The endoscopic group had a significantly longer anesthesia and operative times than the open group (133min/63min, vs. 110min/38min), respectively. A significantly shortened operative time was observed among the last half of those receiving endoscopic SMC compared with the first half (56.65 vs. 72.17 min, p=0.03), and this shortened time was not different than the open procedure. The open group showed a trend of more major complications in the interim between spring placement and removal (7.8% vs 1.6%, OR 4.6, p=0.15). Improvement in cephalic indices were present in both groups without significant differences.

Conclusion: SMC is an acceptable technique for the correction of sagittal synostosis. With experience, an endoscopic approach has equivalent operative times and outcomes compared with a open approach, with the advantage of a shorter scar.

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COGNITIVE ASSESSMENT IN SCHOOL AGE CROUZON AND PFEIFFER AFTER FRONTOFACIAL MONOBLOC
Presenter: Martin Rachwalski
Author: X. Dahiez, L. Pamphile-Tabuteau, K. André, N. Angeard, M. Zerah, E. Arnaud, M. Rachwalski
Institution: Hospital Necker CF unit-Psychology
Abstract:
Syndromic faciocraniosynostoses are generally believed to be associated with severe cognitive impairment, due to FGFR2-related brain malformations, prolonged episodes of intra-cranial hypertension and chronic hypoxemia. Crouzon syndrome (CS) and Pfeiffer syndrome (PS) patients were evaluated to provide further details on the superior brain functions in these children.

Patients and methods: 8 Children with Crouzon (age 8.62 ± 1.25) and 6 with Pfeiffer (mean age 8.18 ± 2.29), all between 6 and 12 years of age, underwent several psychological testing, for evaluation of executive function, attention deficits as well as elaboration capacities: Specific cognitive tests for executive functions (WISC-IV, WNV, Animal Stroop Test, TEA-Ch, Tower of London Test, Corsi block-tapping test), attentional functions (TEA-Ch) and social cognition (NEPSY-II) were conducted after an initial assessment using Raven's Progressive Matrices (PM-47). A BRIEF questionnaire was filled by the parents of the children before every assessment. All of them had been operated on of a frontofacial monobloc advancement with distraction at a mean age of 34 months.

Results: Patients with CS and PS both have satisfactory cognitive abilities, based on the parents reports (BRIEF) and the patients own assessments. Patients with PS do not have poorer test results than patients with CS: the two main affected functions were divided attention in CS and PS, and cognitive inhibition only in CS.

Conclusion: CS and PS are not associated with poor cognitive prognosis. Specific rehabilitation programs should be designed for CS and PS in order to focus on their predominantly affected cognitive functions.
FRONTAL WIDENING AND REMODELING FOR SCAPHOCEHALIC CHILDREN OLDER THAN ONE

Presenter: X. L. Jing M.D.
Author: Eric Arnaud, X. L. Jing M.D., G. Paternoster, S. James, X. Liu, M. Zerah
Institution: Hospital Necker craniofacial unit

Abstract:
Surgical correction for scaphocephaly is recommended before 6 months of age to provide more complete skull remodeling with a better mental outcome. However, in late presenting patients, alternative techniques may be used to address transverse frontal narrowing and anterior bulge.

Patients and methods: Among a larger group of operated patients, eighteen children aged between 15 months and 6 years were retrospectively evaluated because of sufficient imaging. Mean age at surgery was 28 months and follow up was 23 months (Minimum 1 year and maximum 4 years). The forehead was splitted in two halves and a 1 cm wide strip of bone was fixed in the middle. A bilateral advancement was provided by sagittal split in both lateral aspects of upper orbits. The morphology of the forehead was assessed by two measurements on the imaging before surgery and immediately after in most patients, and 1 year after in 5 patients only because of the limitation of irradiation.

1) The anterior bulging was assessed by the fronto-nasal angle (FNA), corresponding to the angle between the lines tangential to the nasal bone and to the most prominent part of the forehead taking the nasion as the summit.
2) Transverse diameters of the forehead were assessed by ratios of the most transverse width over transverse distance between fronto-zygomatic junctions.

Statistical analysis was carried out using Student paired and unpaired t-tests.

Results: In all patients but one a transverse widening and a posterior tilting of the forehead were obtained (p<0.05). In one patient, the midline sagittal strip of the forehead consolidated with a midline ridge. The transverse dimension of forehead increased and remained stable at time of follow-up.

Discussion: It is recommended to undertake sagittal synostosis correction before 6 months of age. However in patients operated late after 12 months of age, some forehead remodeling needs to performed in order achieve better aesthetic results.

UNTANGLING ASSOCIATIONS BETWEEN SURGICAL PARAMETERS AND HEAD SHAPE IN SPRING-ASSISTED CRANIOPLASTY

Presenter: NU Owase Jeelani M.D.
Author: Naiara Rodriguez-Florez, Jan L Bruse, Alessandro Borghi, Silvia Schievano, NU Owase Jeelani M.D, David J Dunaway
Institution: UCL GOS Institute of Child Health and Great Ormond Street Hospital for Children

Abstract:
Whilst spring-assisted cranioplasty has become a widespread technique to correct scaphocephaly in children with sagittal synostosis, associations between initial surgical parameters and post-operative 3D head shapes are difficult to comprehend. This study aimed at applying computational modelling to gain insight into how the choice of surgical parameters such as craniotomy size and spring positioning affects post-surgical head shape.

Patients with sagittal synostosis who underwent spring-assisted cranioplasty at Great Ormond Street Hospital for Children (London, UK) were prospectively recruited (n=20, age at insertion=5.2±1.2 months). During spring insertion, the following surgical parameters were recorded: antero-posterior and lateral craniotomy dimensions, anterior spring position and distance between anterior and posterior springs. Head shapes were captured with a 3D handheld surface scanner immediately after spring removal (age at removal=9.5±1.4 months). Post-removal head shapes were analysed using a 3D statistical shape modelling framework in combination with regression techniques. 3D head shape features correlated with the recorded surgical parameters were extracted.

Results demonstrated that antero-posterior (Pearson’s r=0.64, p=0.002) and lateral craniotomy dimensions (Spearman’s ρ=0.67, p<0.001), as well as the position of the anterior spring (r=0.70, p<0.001) and the distance between both springs (r=0.67, p=0.002) on average had significant effects on post-removal 3D head shape features. Such effects were visualised on 3D models.

In conclusion, population-based analysis of 3D post-operative head scans via computational tools allowed detection of novel associations between surgical parameters and head shape features achieved by spring-assisted cranioplasty. The adopted techniques could be extended to other craniofacial procedures to assess post-operative outcomes and facilitate surgical decision making.
Abstracts

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THE USE OF CAD/ CAM TMJ PROSTHESSES IN PATIENTS WITH CONGENITAL CRANIOMAXILLOFACIAL DEFORMITIES
Presenter: Ignacio Garcia Recuero, MD
Author: Ignacio Garcia Recuero, A.I. Romance MD, M. Redondo Alamillos, G.S. Aniceto MD.PhD.
Institution: Oral and Maxillofacial Surgery Service H.U

Abstract:
Introduction: Facial and TMJ Congenital deformities are one of the most challenging patient condition with the maxillofacial surgeon has to face, specially when the patient is syndromic. Younger patients are also a difficult topic in order to reconstruct any of craniomaxillofacial skeletal framework alteration due to the shortage of bone graft donor sites and the necessity of avoid future growth disturbances. The integrity and normal function of the temporomandibular joint (TMJ) is crucial to assure a normal breathing, eating and socialization of the patient at any age. Shortening of the vertical ramus of the mandible implies a lingual retrusion and severe narrowing of the upper airway with the onset of the sleep apnea compromising the patient vital condition. Clinical problems in the occlusion, jaw dysfunction and masticatory musculature pain are other aspects that have to be managed.

Methods: We present four cases of younger patients between 15 to 21 years old, with severe facial asymmetries and serious alteration or absence of the TMJ. Two with hemifacial microsomia, one with TMJ ankylosis sequel and one with bilateral severe condile resorption in a Hadju-Cheney syndrome and sleep apnea. In all the cases Custom Made TMJ prostheses were used at the same time that bimaxillary orthognatic procedure with counter clockwise rotation of the occlusal plane were achieved, according with Prof. L.Wolford protocol.

Results: All the patients improved to a normal occlusion, facial symmetry and normal breathing. Up to a year of follow-up period there is no incidence of infection, pain or malfunction of the TMJ custom made prostheses applied.

Conclusions: Custom made prostheses for TMJ reconstruction in combination with bimaxillary orthognatic procedures is a secure and trustworthy form of treatment in those cases with congenital or acquired severe facial asymmetries with TMJ distortion.

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MANDIBULAR OSTEOGENIC DISTRACTION IN NEONATES WITH PIERRE ROBIN SEQUENCE - SEVENTEEN YEARS EXPERIENCE - RESULTS ON FIRST TWENTY CASES
Presenter: Marcus Collares M.D.
Author: Marcus Collares M.D, Mariana M Fraga, Denise Manica, Temis Felix, Jorge Morán, Simone Fagondes, Aline Tovo, Silvia Dorneles
Institution: University of Rio Grande do Sul – Brazil

Abstract:
Pierre-Robin sequence clinical spectrum is variable. Long-term follow up of its management is not common. We studied a series of OUR FIRST TWENTY CASES of PRS neonates, submitted to osteogenic mandibular distraction from 1999-2002. The elongation is performed with external distraction devices with four pins (external approach and osteotomy). The traction started on the 1st postoperative day, 0.5 mm twice a day. The consolidation period was 2-4 weeks. The following aspects were assessed: distraction duration and distance, complications, time to extubation, nutritional improvement, palatal outcomes, facial growth, presence of apnea and mean oxygen saturation before, after distraction and up to fourteen years after surgery.

The distraction range was 10-19mm, during 10-22 days; there were no important acute complications associated with the method. Sustained resolution was observed in the respiratory parameters analyzed (polissonography, IAH, SaO2) and also in the nutritional pattern after distraction and up to fourteen years follow-up. There were no complications regarding TMJ or facial growth. All but one patients were class I (Angle) in the long-term. There were no complications on the palatoplasty in this group of patients (mild hypernasality in 3 cases), all operated before 18 months of life. There was no impairment of the trigeminal (V III) function. There were mixed results regarding the molar disruption (4 damaged second molars and a crowded 34/35/36 in one patient).

Our study suggests osteogenic distraction is an effective treatment for PRS patients by sustainably solving the trigger problem of the sequence, mandibular growth, from neonate to early teenage.
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CRANIOCERVICAL INSTABILITY IN PIERRE-ROBIN SEQUENCE ASSOCIATED WITH SKELETAL DYSPLASIA: CASE REPORT
Presenter: Jack E. Brooker M.D.
Author: Xiao Zhu, Jonathan Y. Lee, Jack E. Brooker M.D., Jesse A. Goldstein, Joseph E. Losee
Institution: University of Pittsburgh Department of Plastic Surgery

Abstract:
Introduction: The genetic association between Pierre-Robin Sequence (PRS) and skeletal dysplasia is well-documented. However, very little literature exists related to their clinical co-occurrence, and far fewer report craniocervical instability or the potentially devastating consequences if unrecognized. We present one such case in a 3 year old male with PRS and skeletal dysplasia.

Case report: Due to early airway obstruction, the patient underwent mandibular distraction at 11 days of life, followed by multiple airway procedures that required spinal manipulation before craniocervical instability was recognized. After hardware removal, the patient’s course was complicated by respiratory failure. Imaging due to concerns of a centrally-mediated process showed severe cervical stenosis caused by displacement of a fractured odontoid. Despite decompression surgeries and cervical fusion, there was progressive cord compression. As a result of irreversible C1-C2 injury, he remains quadriparetic. His skeletal dysplasia was later confirmed as spondyloepiphyseal dysplasia congenita.

Discussion: His craniocervical instability was likely atlantoaxial in origin; however, it is unclear if the final spinal manipulation caused this injury, or if it was a progressive effect from prior procedures. Regardless of mechanism, the risk for craniocervical instability in skeletal dysplasias is high, and should be highlighted in the setting of PRS where airway procedures can require significant spinal manipulation. Genetic evaluation is key to early identification, and cervical imaging of all children with skeletal dysplasia is warranted.

Conclusion: Craniocervical instability is a potentially devastating complication in children with skeletal dysplasia, especially with co-occurring PRS. Children with PRS and suspicion for skeletal dysplasia should receive early genetic evaluation, followed by appropriate spinal imaging to identify those who are at high risk for craniocervical instability.

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REACHING LINGUAL ORTHOTOPY IN OROPHARYNGEAL OBSTRUCTION - A TECHNIQUE PROPOSAL
Presenter: Jullyana Heinen Peixoto M.D.
Author: Vera Lucia Nocchi Cardim, Jullyana Heinen Peixoto M.D., Alessandra dos Santos Silva
Institution: Beneficência Portuguesa de São Paulo

Abstract:
The triad of micrognathia, glossoptosis and airway obstruction as resultant, known as the Pierre Robin Sequence, designates mandibular growth restriction as the responsible for tongue retroflexion, which encumbers the palatine sides to descent and fusion, leading to palatal fissure. The authors, intrigued by the divergence between eating distress, respiratory obstruction and mandibular retrognathism degrees, focused their attention to an eventually found anomaly within the genioglossus muscle, which appears shorter and retractile, sometimes with a cicatricial bridle appearance. This anomaly is responsible for the anterior portion of the tongue verticalization, therefore inhibiting its protrusion, and pushing its volume posteriorly, resulting in supraglottic obstruction and causing mandibular body growth-stimulating forces overturn. Mandible osteogenic distraction plays an important role in the treatment, nevertheless growth-stimulating forces reorganization and oropharynx direct desobstruction are also necessary. The authors propose a lingual ortothopy establishment technique, completely desinserting the genioglossus muscle, which liberates the tongue to raise its anterior third, permitting the basis volume to reach the mouth floor. The basis anterior repositioning is done by absorbable transfixted stitch passing through the lingual V and anchoring by cerclage through the mandibular symphysis. The detachment of the lingual midline allows an anterior positioning of the anatomical musculature, that can then occupies area that previously detained the tongue anterior portion.

The study presents the results of the last 6 years application of the proposed technique.”
213 MANDIBULAR MORPHOLOGY AFTER DISTRACTION OSTEOGENESIS IN SYNDROMIC PIERRE ROBIN SEQUENCE PATIENTS

Presenter: Renata Maricevich M.D.
Author: Renata Maricevich M.D., Wendy Chen, Jeffrey G Trost, Jr. Jesse A Goldstein, Joseph E Losee
Institution: Texas Childrens Hospital

Abstract:
Intro: Pierre Robin Sequence (PRS) patients exist on a vast spectrum of baseline mandibular morphology, as well as individual and syndrome-specific responses to mandibular distraction (MDO). Growth trends of these abnormal mandibles are controversial. We aim to compare syndrome PRS patients who have and have not undergone MDO and to characterize the effect of MDO and subsequent growth.

Methods: Patients included were diagnosed with PRS, diagnosed by medical genetics as syndromic, underwent MDO, and had pre- and post-operative (>1y) CT scans. Controls were age-/sex-matched syndromic PRS patients who had not undergone MDO. Gonial angle and ratio of mandible length-to-height were measured. Averages were compared using t-test, significance set at p<0.05.

Results: Of 250 PRS patients, 114 underwent genetics evaluation, 84 were syndromic, and 41 underwent MDO. Six met imaging criteria; one was excluded for inadequate scan. There was no difference in average gonial angle at preop (Control Right, left hemi-mandibles: 132, 137; PRS, Right, Left: 137, 153), but angle was increased at post op scan (p=0.05, 0.009; control: 127, 127; PRS: 134, 138). There was no difference in pre- or post-op length-to-height ratio (Control 1.64, 1.50; PRS 1.45, 1.49), but approached significance for increase after distraction (p=0.17, 0.09; control 1.27, 1.32; PRS 1.64, 1.61). There was no difference in %change in gonial angle (p=0.05, 0.26; control -0.26, 0.40; PRS -0.26, -0.40), but approached significance.

Conclusion: Compared to non-MDO patients, patients after MDO demonstrated increased gonial angle, increased length-to-height ratio, and increased %change in length-to-height ratio. There was no difference in %change of gonial angle between MDO vs non-MDO group and no difference in %change of length-to-height ratio, but approached significance.

214 PIERRE ROBIN SEQUENCE: STRATIFYING FEEDING DYSFUNCTION AND IDENTIFYING VARIABLES AFFECTING OUTCOME

Presenter: Wei Wei Lee M.D.
Author: Wei Wei Lee M.D., Wendy Chen, Joshua Barnett, Matthew Ford, Christal V Steinbach, Jesse A Goldstein
Institution: Childrens Hospital of Pittsburgh

Abstract:
Background: Feeding/swallowing dysfunction poses significant morbidity to patients with Pierre Robin Sequence (PRS). We present a critical evaluation of feeding/swallowing outcomes in a large cohort of PRS patients.

Methods: A retrospective review of all PRS patients at our institution (2010-2016) gathered medical/surgical histories, detailed clinical/radiographic evaluations, and polysomnography data.

Results: Eighty-five of 111 PRS patients (40 F/45 M) met inclusion criteria. At initial evaluation, 61 patients (72%) were found unsafe for oral intake, with higher mean total apnea-hypopnea index (AHI, 26.06 vs. 17.17, p=0.04). On preoperative modified barium swallow studies, 12 patients (52%) had laryngeal penetration, 16 (50%) frank aspiration. Three (5%) underwent tracheostomy only, 16 (26%) MDO, 1 (2%) TLA, 9 (15%) endoscopic ENT airway procedures, 22 (36%) combined airway procedures, 10 (16%) no airway-related intervention. Across the intervention groups, 36 patients (72%) showed feeding improvement, with decreased gastrostomy-tube dependence after intervention (48% vs. 28%, p=0.04). Rates of pre- and postoperative aspiration (50%, 32%, p=0.15) and penetration (52%, 33%, p=0.26) remained similar. Patients requiring tracheostomy improved least (0%, p=0.01); all other groups had >75% rates of improvement. Medical history/syndromic status did not correlate with improvement in any group. In our overall cohort, the 22 patients (26%) who underwent MDO only had significant improvement of pre- and postoperative AHI (29.40 vs. 5.46, p=0.01), lowest rate of G-tube requirement (18%, n=4, p=0.048), and highest rate of feeding improvement (93%, n=13, p=0.04) vs. ENT procedure alone or combined procedures.

Conclusions: Patients with PRS have a high rate of preoperative feeding/swallowing dysfunction. Detailed multimodal clinical evaluation is crucial for ongoing care. Patients undergoing MDO had the highest rate of feeding improvement compared to other interventions.
FRONTAL SINUS FRACTURES: EVALUATION OF 19 CASES OF A UNIVERSITY HOSPITAL IN CAMPINAS, SÃO PAULO, BRAZIL

Presenter: Rogerio A. Modesto de Abreu  
Author: Rogerio A. Modesto de Abreu, Daniella N. Camargo, Leticia Watanabe  
Institution: Pontifícia Universidade Católica de Campinas

Abstract:

Introduction: Frontal sinus fractures account for 5% to 15% of all facial fractures. Their etiology may vary according to the population studied, as well as by gender, age, and socioeconomic level. The main causes of frontal sinus fractures involve high-impact injuries and may affect the anterior and/or posterior wall and may or may not involve the frontonasal duct. Additional facial fractures are often associated. The objective of this study was to present the epidemiological data and treatment choices for patients with frontal sinus fractures in our department.

Methods: This is a retrospective study of 19 patients with frontal sinus fractures from the Celso Pierro University Hospital and Maternity Center of the Pontifical Catholic University of Campinas (PUC Campinas) in Campinas, São Paulo, Brazil.

Results: The most frequent cause of the fractures was motor vehicle accidents, which occurred in 10 cases (52.64%). When the fracture sites were determined, 19 patients (100%) had a compromised anterior wall of the frontal sinus, and 1 case (5.26%) included involvement of the posterior wall. Facial fractures were found to be associated in 14 cases (73.68%), and 7 patients (36.84%) received the conservative treatment. In 8 cases (66.67%), the fracture was accessed via the wound; in 4 cases (33.33%), the fracture was accessed via the upper edge of the brow ridge with fracture reduction and fixation.

Conclusion: Demographic data has remained unchanged for decades. The main cause of frontal sinus fractures is still motor vehicle accidents; however, the percental representation of this cause has decreased, and other etiologies have increased. Additional facial fractures are often associated. Treatment depends on the complexity of the fracture. The priority of isolated anterior table fractures is the restoration of cosmetic facial contours. Improper treatment of frontal sinus fractures can lead to many complications.
A SYSTEMATIC REVIEW OF ENDOSCOPIC REPAIR OF MANDIBLE FRACTURES

Presenter: Paymon Sanati-Mehrizy M.D.
Author: Paymon Sanati-Mehrizy M.D., Benjamin B Massenburg, Rami D Sherif, Michael J Ingargiola, Saba Motakef, Peter J Taub
Institution: Icahn School of Medicine at Mount Sinai

Abstract:

Introduction: Fractures of the mandibular condyle represent more than 30% of all mandible fractures. If required, reduction has been performed using either a closed or open technique with similar outcomes. Endoscopic fracture repair is a minimally-invasive approach for open reduction, but there is data regarding indications and outcomes. This study aims to systematically review the demographics, features, and outcomes following endoscopic repair of mandibular fractures in adult patients.

Methods: The following databases were searched from their inception to Dec 31, 2016: PubMed, Cochrane, Web of Science, and the WHO Global Health Library, using terms related to endoscopy and mandibular fractures. Articles were screened and data was extracted by two independent reviewers. Disagreements arbitrated by discussion or a third reviewer.

Results: Twenty-two manuscripts were included, representing 509 adult patients who had endoscopic repair of a mandibular fracture over 18 years. The sample-sized weighted mean age was 33.5 years with 74.5% males in the study population. All endoscopic repairs were of the mandibular condyle, including both subcondylar and condylar neck fractures. The most common mechanism of injury was assault (44.8%). Permanent facial nerve injury was reported once (0.20%) and occlusive complications was reported in 30 patients (5.9%).

Conclusions: This systematic review identifies a large cohort of patients who underwent endoscopic repair of their mandibular fractures. Complications were rare and usually temporary, with permanent complications occurring at a respectable rate. The demographics and outcomes identified in this study can be used as an epidemiological baseline for future research on endoscopic repair of mandibular fractures.

THE HYBRID ARCH BAR IS A COST-BENEFICIAL ALTERNATIVE IN THE OPEN TREATMENT OF MANDIBULAR FRACTURES

Presenter: Visakha Suresh, BS
Author: Renata Khelemsky, DDS, MD, David B Powers, DMD, MD, FACS, FRCS, Seth Greenberg, DMD, Ellen Johnson Silver, PhD, Visakha Suresh, BS, Michael Turner, DDS, MD
Institution: Albert Einstein College of Medicine

Abstract:

Introduction: Obtaining maxillomandibular fixation (MMF) is essential in the management of maxillofacial trauma to achieve fracture reduction, functional occlusion, and osseous healing. Numerous techniques have been utilized to establish MMF, such as Erich arch bars, intermaxillary fixation screws and more recently, hybrid arch bars. The aims of this retrospective review were to 1) compare total time spent in the OR when using Erich versus hybrid arch bars in unilateral and bilateral mandible fractures and 2) perform cost-benefit analysis (CBA) using data for both systems in both fracture categories.

Methods: The study sample included patients over the age of 18 years who underwent ORIF of mandible fractures at two separate institutions over a five year period. The primary outcome variable was total surgical time in minutes, defined as the time from incision to the completion of closure.

Results: Average operative time was significantly longer for the Erich device compared to the hybrid (186.74 ± 70.73 vs 135.98 ± 2.69 min; p<0.001). A significant amount of time was saved by using the hybrid product for unilateral (37.17 ± 13.19 min; p=0.007) and bilateral fractures (55.83 ± 18.89 min; p=0.005). No significant relationships between fracture location, injury laterality, study site, and either device were detected. In-depth CBA showed that, for average OR fees of $60/min, the hybrid arch bar produced savings of at least 4.01% and 11.63% of the total cost of surgery for unilateral and bilateral fractures, respectively.

Discussion: These results support the hypothesis that the hybrid arch bar is a time-saving maneuver in the open treatment of mandible fractures. The hybrid device generates a larger surplus of saved time in bilateral fracture cases despite longer overall operative times. This study shows the differential time-saving effect of the hybrid device regardless of fracture laterality as well as its cost-minimization benefit compared to traditional ar
219 MANAGEMENT OF HIGH-ENERGY AVULSIVE BALLISTIC FACIAL INJURY: A REVIEW OF THE LITERATURE AND ALGORITHMIC APPROACH
Author: Elbert E Vaca M.D, Justin L Bellamy, Sammy Sinno, Eduardo D Rodriguez
Institution: Northwestern Memorial Hospital, Division of Plastic and Reconstructive Surgery
Abstract:
Purpose: High-energy avulsive ballistic facial injuries pose one of the most significant reconstructive challenges. We conducted a systematic review of the literature to evaluate management trends and outcomes for the treatment of devastating ballistic facial trauma. Furthermore, we describe the senior author’s early and definitive staged reconstructive approach to these challenging patients.
Methods: A Medline search was conducted to include studies that described timing of treatment, interventions, complications, and/or aesthetic outcomes of ballistic facial injuries published through February 28, 2017. Exclusion criteria included: (1) publications prior to 1980, (2) studies that did not separately report outcomes of ballistic trauma patients if other forms of trauma were included, and (3) reports with fewer than 5 patients
Results: Initial query revealed 40 articles, of which 16 articles met inclusion criteria. A single comparative study revealed that early versus delayed management resulted in a decreased incidence of soft tissue contracture, required fewer total procedures, and resulted in shorter hospitalizations (Level 3 Evidence). Five of the seven studies (71%) that advocated delayed reconstruction were from the Middle East, while five of the six studies (83%) advocating immediate or early definitive reconstruction were from the United States. No study compared debridement timing directly in a head-to-head fashion, nor described flap selection based on defect characteristics.
Conclusions: Existing literature suggests that early and aggressive intervention improves outcomes following avulsive ballistic injuries. Further comparative studies are needed - however, while evidence is limited, the senior author presents a 3 stage reconstructive algorithm advocating early and definitive reconstruction with aesthetic free tissue transfer in an attempt to optimize reconstructive outcomes of these complex injuries.

220 COMPARATIVE ANALYSIS OF CUSTOM VS MANUALLY SHAPED IMPLANTS FOR ORBITAL FLOOR RECONSTRUCTION
Presenter: Reid Chambers M.D.
Author: Reid Chambers M.D., Joel Davies, Glenn Edwards, Amani Ibrahim, Michael Hardisty, Oleh Antonyshyn
Institution: Sunnybrook Hospital, University of Toronto
Abstract:
Objective: To compare custom fabricated to manually bent implants for the purpose of orbital floor reconstruction on the basis of volume restoration, accuracy of conformance and position.
Methods: The study series comprised 6 orbits in 3 fresh frozen cadavers. Imaging was preformed using standard volume head CT, 0.5 mm slice separation, 320 slice reconstructions. Skull topology and geometry accuracy were improved by quantitative iterative deconvolution using an estimated point spread function. 3D quantitative analysis of orbital volume and dimensions were determined by segmentation using a semi-automated approach (thresholding, 2D and 3D hole filling) followed by marching-cube triangulation to create 3D surfaces. Implant Design: The image data was imported into 3D modeling software (Mimics v18.0 and Magics v18.0; Materialise, Leuven, Belgium) to model custom forming tools based on the mirror image of the pre-morbid contralateral side. The 3D models were then exported to rapid prototyping machinery (ZCorp 510, Stratasys Fortus 400mc and Roland MDX-40) for manufacture. Orbital Defect and Repair All orbits were imaged to obtain controls. Orbital defects were then created using a trans-conjuctival approach followed by CT scan. A second surgeon next performed a repair by manually shaping and cutting of a titanium implant followed by CT scan. Implants were then removed and a second repair was performed with the fabricated implant followed by a forth scan.
Results/Conclusion: CT image data was compared with respect to:
1. Volume restoration of the orbital cavity
2. Presence or absence of residual defect
3. Accuracy of orbital shape restoration
Implant shape and position was determined by semi-automated threshold-based segmentation and 3D surface triangulation. Accuracy of the implant design was assessed by further registration of the design surface to the pre-morbid orbital floor surface followed by volumetric analysis.
ORBITAL FLOOR FRACTURE RECONSTRUCTION MATERIALS - A SYSTEMATIC REVIEW AND META-ANALYSIS

Presenter: Sean Cameron Smith M.D.
Author: Sean Cameron Smith M.D., Alain J. Azzi, Ashley Ignatiuk, Daniel A. Peters
Institution: University of Ottawa

Abstract:
Background: Different materials are available for orbital floor fracture repair. We set out to identify studies comparing outcomes of these repair materials and perform a meta-analysis of data regarding postoperative enophthalmos. We assessed autogenous, alloplastic, resorbable and non-resorbable materials.

Methods: We searched Ovid MEDLINE, EMBASE and the Cochrane library for relevant articles. Authors independently selected, assessed and verified data extracted from the articles. Comparative studies assessing postoperative enophthalmos in two or more repair materials were selected for review. A meta-analysis was performed using a fixed and random effect models to report a pooled effect estimate from weighted odds ratio calculations. We quantified heterogeneity among studies using the I2 method.

Results: Our search resulted in 757 articles. A total of 11 articles, assessing 927 orbital floor fractures met the selection criteria. Postoperative enophthalmos occurred less frequently with titanium versus bone graft (odds ratio (OR) 1.96 with 95% confidence interval (CI) 1.04 to 3.70), less often with resorbable versus bone graft (OR 1.40 with 95% CI 0.29 to 6.84), less frequently with porous polyethylene (PPE) versus bone graft (OR 1.53 with 95% CI 0.77 to 3.04) and less often with PPE-titanium versus bone graft (OR 1.95 with 95% CI 0.76 to 4.98).

Conclusions: Systematic review and meta-analysis suggests statistically significant superiority of titanium when compared to bone graft. This analysis also favors resorbable implants, PPE and PPE-titanium over bone graft regarding postoperative enophthalmos following orbital floor fracture reconstruction.

35 CONDYLAR FRACTURES IN 29 CHILDREN: DEMOGRAPHICS, TREATMENT, OUTCOMES, AND LONG-TERM GROWTH

Presenter: Wendy Chen M.D.
Author: Wendy Chen M.D., Jack E Brooker, Wei Wei Lee, Lindsay A Schuster, Jesse A Goldstein, Joseph E Losee
Institution: University of Pittsburgh Medical Center

Abstract:
Background: The condyle has been described as an important growth center for the mandible. Fractures to the condyle could affect occlusal relationships, jaw growth, and orofacial functions. To date, few reports have assessed long-term growth after pediatric condylar fractures.

Methods: This is a retrospective study at our institution (2000-2016) reviewing pediatric condylar fractures with >1yr follow-up cephalograms. Bolton cephalometric standards served as controls.

Results: Twenty-nine patients (18 male, 11 female; average age at injury 7.5yo, average f/u 63mos) were identified, representing a variety of injury mechanisms, sustaining a variety of condylar fractures (comminuted n=8, displaced n=9). Management was largely conservative (rest/PT, n=18; external stabilization, n=6; closed reduction with elastics/MMF, n=10; ORIF, n=1). Complications were minor (slight deviations from dental midline/occasional clicking at TMJ, n=19; hardware malposition, n=1).

Cephalograms were compared to Bolton cephalometric norms. Average differences were calculated for SNA (3.7deg), SNB (2.9deg), ANB (3.6deg), gonial angle (6.3deg), ramal height (0.7cm), body length (0.5cm). SNB, ANB, ramal height, and body length values were within the range of Bolton norm standard deviations. Frontal cephalograms were used to internally compare hemimandibles. The average ratios of ramal height, body length, and Ar-Me distances were, respectively, 1.01, 0.94, and 1.00, indications minimal differences between hemimandibles.

Conclusion: We present the longest-duration follow-up found in current literature assessing mandible growth in patients who suffered condylar fractures prior to skeletal maturity. Our cohort demonstrates minimal operative intervention, minimal complications, and no obvious growth abnormalities. Our data challenges the growth disturbances reported in existing pediatric condylar fracture literature.
A REVIEW OF FRONTAL SINUS FRACTURES AND ASSOCIATED OCULAR COMPLICATIONS
Presenter: Rafael Galli, MD
Author: Alex Viezel-Mathieu, MD, Rafael Galli, MD, Lucie Lessard, MD, FRCSC, FRCSC, FACS
Institution: McGill University Health Centre

Abstract:
Purpose: Frontal fractures result from high force injuries and have significant morbidity and mortality. By gaining a thorough understanding of the mechanism, associated injuries and related complications of this diagnosis, clinicians will be better able to provide optimal treatment of these patients and improve outcomes.

Method: A comprehensive review of the McGill University Health Centre (MUHC) database was performed. All adult patients presenting with frontal sinus fracture were identified. Patient demographics, mechanism of trauma, fracture type, associated facial injuries, management and related complications were identified. All cases of ocular injury or sequela were identified and an in-depth review was performed.

Results: Between 2008 and 2014, 1277 patients presented to the MUHC Level 1 trauma centre with a facial fracture, 140 of whom had a frontal sinus fracture and met the inclusion criteria. Mean age was 43.5 years, 90% were male and mean hospitalization time was 16.2 days, including those who required prolonged ICU admissions. A significant proportion suffered concomitant craniomaxillofacial fractures including orbital (79%), maxillary (66%), nasal (64%), zygomaticomaxillary complex (34%), nasoorbitoethmoid (31%), Lefort types I-III (18%) and mandibular (8%). Associated cervical spine injuries were seen in 16% of patients. Ocular injuries were present in 29% of subjects. Fifty percent were extraocular in nature, 30% were due to mechanical force, and 6% involved palsy of cranial nerves.

Conclusion: Due to the intimate association of the frontal bones with the brain and the orbits, frontal sinus fractures rarely occur in isolation and demand a sophisticated multidisciplinary approach. Given this high rate of ocular injury, the authors propose a modified treatment approach and algorithm.

AN ALGORITHMIC APPROACH TO RECONSTRUCTION OF THE ANTERIOR CRANIAL BASE IN DEVASTATING TRAUMA
Presenter: Sameer Shakir M.D.
Author: Sameer Shakir M.D., Phuong D. Nguyen
Institution: University of Pennsylvania

Background: Anterior cranial base injuries may present with severe bony and soft tissue defects that pose unique reconstructive dilemmas separating intracranial contents from the contaminated respiratory tract and repair of CSF leak. We review our experience with pericranial flap and bone graft reconstruction and present an algorithm for repair.

Methodology: Patients seen at the University of Pennsylvania Presbyterian Hospital from 2016-2017 with traumatic injuries or non-cancerous disease necessitating anterior cranial base reconstruction (n=4) were included. Demographics and perioperative data were collected and analyzed.

Results: Four patients met inclusion criteria with anterior cranial base reconstruction from gunshot wound (n=2), motor vehicle accident (n=1), and traumatic head injury (n=1). Mean age at surgery was 39.4 (23-79) years with 3:1 F:M ratio. Mean follow-up was 7.8 ± 5.6 months. All patients (n=4) had dural tears with CSF leak requiring repair. Patients underwent bone grafting with split calvarial bone (n=4) and morselized bone (n=1) to reconstruct the anterior cranial base and separate intracranial and nasal contents. Patients underwent inferiorly-based (n=3) and laterally-based (n=1) pericranial flap reconstruction based on the supraorbital and superficial temporal arteries, respectively. No postoperative CSF leaks were noted. One patient developed an intracranial abscess 4 weeks postoperatively, managed with washout and soft tissue reconstruction using a laterally-based galeal frontalis flap. There were no deaths.

Conclusions: Traumatic injury to the anterior cranial base can be successfully managed in the acute setting using split cranial bone graft and pericranial flap reconstruction, obviating the immediate need for pedicled myocutaneous or free tissue transfers. The pericranium offers a well-vascularized bed for autologous bone grafting while mitigating CSF leak and infection risk.
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LONG-TERM RESULTS AFTER 25 YEARS EXPERIENCE WITH INTERDISCIPLINARY TREATMENT OF MIDLINE FACIAL CLEFTS
Presenter: Ricardo Bennun M.D.
Author: Ricardo Bennun M.D., Julia Harfin
Institution: National University of Buenos Aires, Maimonides University, Asociacion PIEL

Abstract:
Background: Midline facial clefts can be subdivided into two major categories: the first group has signs of hypoplasia or agenesis of midline craniofacial structures and amentia. The second group which does not affect the intelligence is of a milder variety. In comparison to other facial clefts; median facial clefts are rarely associated with extracranial abnormalities (Starck WJ and Epker BN, 1994) Median facial clefts represent reconstructive challenges, requiring multiple surgical procedures throughout life. Long-term results are often still far from ideal and could be improved. Due to surgical intervention and diminished intrinsic growth potential, surgical results may change from initially good into a progressively disappointing outcome. If, however, the ideal timing and type of surgery are known, in combination with the intrinsic growth potential, the results can be ameliorated.

Methods: A series of patients with a pure symmetrical median cleft were evaluated on long-term surgical results. The final result was scored based on severity of the initial and the remaining facial deformities, and the need for corrective surgery.

Results: The long-term surgical outcome was good for each of the affected facial parts and the face in general. An adequate and stable result of all corrections was observed.

Conclusions: The intrinsic growth restriction is mainly localized in the central midface. This leads to a complex and often unpredictable growth of the maturing face. An interdisciplinairy protocol oriented to stimulate facial development during the growth period is essential. Once the face has matured, midface advancement and secondary nose correction should be considered for satisfactory projection. Early referral to a specialized center is mandatory to achieve correct reconstructions.

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AN INTEGRATED APPROACH TO THE MANAGEMENT OF MENINGIOENCEPHALOCELE
Presenter: Greg Thomas M.D.
Author: Greg Thomas M.D., Eric Tan, Jay Jayamohan, Peter Richards, Steven Wall, David Johnson
Institution: Oxford Craniofacial Unit

Abstract:
Introduction: Meningoencephalocele (ME) is a remarkably rare congenital defect in the Western Hemisphere, occurring far less frequently than in Asian populations. As a result, specialist centres in Europe and the Americas may have limited experience in treating these complex cases, risking sub-optimal outcomes for affected patients. With this in mind, we performed a 30-year review of all ME cases treated at our unit to analyse outcomes and identify best practice.

Methods: A retrospective review was undertaken of all primary cases of ME presenting to Oxford University Hospitals from 1986. Patients with secondary ME were excluded.

Results: 29 patients were identified, with a median age of 11 months at presentation. 20 patients were of Caucasian ethnicity, 7 Asian, 1 Middle Eastern and 1 Afro-Caribbean. 13 Patients had a frontal EM, 9 occipital, 5 basal and 2 parietal. 26 patients underwent surgery; 9 were treated by a single speciality, 3 by otolaryngology and neurosurgery, and the remaining 14 by a combined neurosurgical craniofacial approach. Of this last group 11 had a single stage transcranial procedure. Complications requiring a return to theatre occurred in only 2 cases (CSF leak, wound dehiscence). Panhypopituitarism occurred in one patient with a basal ME. No deaths, meningitis, strokes, ME recurrence or growing fractures were encountered. 13 cases remain under active follow-up with one discharged.

Conclusion: This is largest reported series from a single institution treating a predominantly Caucasian population in Europe. The spectrum of anatomical loci of ME in this series is similar that of larger Asian series. A combined speciality surgical approach with a one stage surgical correction whenever possible delivered good results with a low complication rate, despite the inherent complexity of cases. Designated craniofacial units with access to multidisciplinary specialties provide a safe and optimal setting for management of ME.
MANAGEMENT AND ETHICAL CONSIDERATIONS OF LARGE POSTERIOR ENCEPHALOCELE

Presenter: Ingrid Ganske, MD, MPA
Author: Ingrid Ganske, MD, MPA, Samantha E. Hall, BA, John G. Meara, MD, DMD, MBA, Mark Proctor, MD
Institution: Boston Children’s Hospital

Abstract:

Background: Encephalocele is a congenital malformation of the skull, with protrusion of meninges and/or brain tissue. Complex vertex and posterior encephaloceles containing brain tissue pose unique management challenges and ethical concerns. Because of the uncertainty of neurologic prognosis, children seen at other institutions have often been deemed inoperable. We present our experience treating four such patients.

Methods: Four patients with complex posterior encephalocele containing brain tissue were evaluated in the past two years and ultimately deemed to be operative candidates. This retrospective study examines the perioperative experiences, post-operative outcomes, and ethical considerations in caring for these patients. Patients with large posterior encephalocele who were evaluated and deemed inoperable are also reviewed.

Results: Average age (n=4) at time of repair was 2.7 months and weight was 3.4 kg. One patient presented with ruptured encephalocele and required preoperative correction of electrolyte abnormalities. The remaining three patients underwent drainage of the encephalocele (average volume of 1200 ml) at the time of surgical resection. Operative time varied from 2.2 to 5.3 hours (average 3.7 hours). Average blood loss was 45 ml; three patients were transfused an average of 88 ml of packed cells. There were no deaths. One patient had a single seizure postoperatively. Average duration of hospital stay was 9 days, and all patients were discharged directly to home. Two patients required placement of permanent shunts for hydrocephalus. For all patients, the neurologic status returned to baseline or improved. Average duration of follow up has been 19 months.

Conclusions: Patient with large, complex encephaloceles warrant evaluation by an experienced craniofacial center. The decision to proceed with surgical management should include an interdisciplinary team of surgeons, anesthesiologists, neurologists, social work, and medical ethics.

MUSCLE EXPANSION FOR TESSIER N3 AND N4 CRANIOFACIAL CLEFT TREATMENT

Presenter: Adriana Guerrero M.D.
Author: Romulo Guerrero, Adriana Guerrero M.D.
Institution: Hospital Metropolitano de Quito

Abstract:

Tessier 3 and 4 craniofacial cleft treatment has always been a challenge. There are multiple procedures involving z plasty and local flap rotation that tries to correct this flaw; however the main problem has always been a lack of suitable tissue to cover the defect. In the past, tissue expansion had been use to obtain adequate tissue of the same color and consistency to reconstruct these clefts, the results obtained in major clefts had been unsatisfactory, due to the fact, that tissue expansion was made only in the superficial layers, leaving visible hollows and scars. Muscle defects in Tessier n3 and n4 clefts most of the time is not repaired. Our objective is to describe our muscle expansion technique used in Tessier 3 and 4 clefts in which we expand the muscle and reconstruct it.

From January 2000 to January of 2017, 5 patients with Tessier cleft 3 and 4 have been treated. All of them were primary cases and tissue expansion was used from the first surgery. We have 4 bilateral and 1 unilateral patients. The average cleft was 12 mm, our largest cleft was a 25mm. 3 semilunar expanders were placed in the cheeks and frontal region. In all the cases the expanders were placed subperiostal. They all underwent muscle expansion, which was measured using a soft tissue tomography image. Our main goal was to obtain an adequate superficial tissue that matches the patient color and consistency, but also to obtain significant muscle so we can reconstruct the muscle layers, restore the muscle vectors and its function. Reestablishing the muscle vectors, facial symmetry was obtained at rest, but also normal facial expressions were restored. Using this technique we can obtain adequate muscle tissue that allows us to perform a better reconstruction with a competent muscle layer that restore normal facial function and allows the skin flap to camouflage in natural folds with a tension free closure that in the end, results in a more aesthetic face.
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TRANSPHENOIDAL ENCEPHALOCELE REPAIR: TIMING, TECHNICAL, AND PERIOPERATIVE CONSIDERATIONS
Presenter: Amir Elbarbary, MD
Author: Amir Elbarbary, MD, Henry Kawamoto, MD, DDS, James P Bradley, MD
Institution: Ain Shams University, Cairo

Abstract:
Background: Patients with trans-sphenoidal encephalocele suffer from medial craniofacial dysraphia (midline craniofacial cleft) and a cystic-like herniation. Correction of this basal encephalocele poses many challenges to the craniofacial surgeon; yet, because of their rare nature, defined protocols do not exist. We reviewed clinical outcomes of trans-sphenoidal encephalocele cases to address controversies of timing and technique of repair.

Methods: We reviewed trans-sphenoidal encephaloceles treated with intracranial and extracranial (transpalatal) approach and staged correction (n=6). Evaluations, MRI and CT imaging, technical details, perioperative course and complications were recorded.

Results: Preoperatively, patients varied in degree of severity; had intermittent episodes of meningitis (66%). Age range: 11 months-12 years; Two patients had mild developmental & speech delays. Radiographic abnormalities consisted of glial mass protruding into oral cavity, agenesis of the corpus callosum, a cingulated gyrus, hypotelorbitism (83%) and cleft palate (83%). Intraoperative reduction of encephalocele resulted in communication through the palate. Bipartition aided in exposure and narrowing of the anterior defect. Closure of posterior defect done with cranial bone graft, pericranial flap, fibrin glue, transpalatal nasal mucosal closure. Complications: Endocrine abnormalities (100%), Seizures (33%), CSF leak 17%. Persistent ataxia (17%); mean hypertelorbitis correction (39mm to 17mm); Speech worsened after correction of encephalocele but improved after cleft palate repair with pharyngeal flap. No recurrence 6 months to 6 years.

Conclusions: Staged correction of trans-sphenoidal encephaloceles with intra and extracranial approach, facial bipartition, subsequent cleft palate repair with particular attention to endocrine abnormalities in the perioperative period resulted in successful reduction of encephalocele herniation.

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CRANIOFACIAL CLEFTS LESSONS FROM A DECADE OF EXPERIENCE WITH 107 CASES
Presenter: Charles Davis M.D.
Author: Charles Davis M.D.
Institution: Wellington Craniofacial Unit

Abstract:
Craniofacial clefts Lessons from a decade of experience with 107 cases. Craniofacial clefts have many varied presentations even with the same Tessier classification within the same anatomic field. While there are no didactic treatment protocols, the author has established general principles based on a retrospective review of the treatment of over 100 cases over a 12 year period. Evolving Plastic Surgical techniques have eclipsed some historic treatments. Cases have been selected to illustrate important treatment philosophies.

- Analyse the skeletal and soft tissue components of the cleft separately.
- Onlay bone graft often resorbs unless loaded.
- Preferentially use costal cartilage for bone contour.
- Repair cartilage donor site to preserve contour & enable reharvest.
- Early cranial harvest for orbital reconstruction in infants.
- Vascularized parietal bone flaps ideal for zygomatic reconstruction in infants.
- Mandibular elongation with rotation-distraction using transmandibular wire & floating distal device gives good vector.
- Use facial bone growth for tissue distraction by earlier closure of large clefts
- First stage soft tissue closure may be required for bone graft envelopes.
- Sequential fat graft grafting has replaced most indications for free flaps and tissue expanders.
- Vertical facial lengths more critical than horizontal widths.
- Nasal alar - medial canthal length is key for planning nasal correction
- Mid face rotation advancement flaps use vectors of closure to protect eye, prevent ectropian and lengthen the midface.
- Over elevate the medial canthus. Drift occurs vertically and laterally.
- Expand eyelids early to simulate normal eye growth. The orbit can be enlarged at any age.
- Use serial conformers if tissue expanders are ineffective
- Overcorrect bony IOD in hypertelorism correction.
- Adapt skin to the nasofacial groove as excess dorsal skin usually redrapes
- Nasal skin can be progressively expanded to avoid forehead flaps
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A NOVEL RECONSTRUCTION TECHNIQUE FOR THE TESSIER 4 FACIAL CLEFT
Presenter: Roberto Flores M.D.
Author: Roberto Flores M.D., Christopher Runyan, Pradip Shetye, Elcin Esenlik, Lawrence Brecht, Barry Zide
Institution: NYU Langone Medical Center

Abstract:
Background: We present a novel repair technique for the wide Tessier #4 cleft.

Methods: A neonate with a Tessier #4 facial cleft presents with an over 2/3rd lower eyelid loss. A Tenzel flap extended to a deep plane Schrudde cervicofacial flap was planned to radically mobilize the lower eyelid to the medial canthus in a tension-free manner.

Results: Surgical repair was performed at 3 months of age. No tissue expansion was used. A Tenzel pattern flap was mobilized in the subcutaneous plane. This flap was raised in continuity with a Schrudde cervicofacial flap raised in the deep plane. A conjunctival flap was raised from the floor of the orbit to use to reconstruct the posterior lamella of the lower eyelid. The Tenzel/Schrudde flap was rotated, without tension over the facial cleft and to the nose/cheek junction. At the time of inset, there was redundant flap skin superiorly at the level of the lower eyelid and medially at the area of the medial canthus. This redundancy was incorporated into the reconstruction to prevent ectropion and medial canthus disruption. Suspension sutures were applied to the infraorbital rim and pyriform aperture. A rotation-advancement repair was used to reconstruct the lip. The flap demonstrated 100% take despite radical mobilization. The final scar followed the philtral line, the nasal/cheek junction, the subciliary line of the lower eyelid and the anterior auricular/retro auricular border. Lower eyelid and medial canthal position was stable after 6 months. Facial nerve function was preserved with this approach.

Conclusion: A Tenzel/Schrudde deep-plane cervicofacial flap can be safely applied to infants with a wide Tessier #4 facial cleft. No tissue expansion is needed. This is the first repair technique which places final scars perfectly along the subunit borders of the face while loss, preserving lower eyelid and medial canthal position, even in the patient with significant lower eyelid.

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THE INTERNATIONAL CRANIOPAGUS REGISTRY: DEVELOPING A DATABASE OF ALL CRANIOPAGUS TWINS
Presenter: Eugene Park, M.D.
Authors: Eugene Park MD, Arun K. Gosain MD
Institution: Ann and Robert H. Lurie Childrens Hospital of Chicago

Abstract:
Craniopagus twins are rare, with an incidence of 0.6 per 1 million births. Due in part to their rarity and in part to the extremely complex nature of the condition, there is no consensus on best management. In order to effect continued quality improvement in the care of craniopagus twins, we have initiated an international registry of past and present craniopagus patients, both separated and unseparated. The goal is to identify factors associated with successful separations, and to correlate preoperative and intraoperative findings with various types of outcomes. Here we will describe the formation of the registry and discuss the clinical questions we will attempt to answer.
DETERMINING THE MOST CLINICALLY BENEFICIAL DONOR SITE FOR ALVEOLAR BONE GRAFTING IN CLEFT PALATE PATIENTS: A CRITICAL REVIEW OF THE LITERATURE

Presenter: Kirun Baweja, BS
Author: Kirun Baweja, BS
Institution: University of Edinburgh

Abstract:
Alveolar bone grafting in cleft palate patients restores stability of the maxillary arch and provides bone matrix for tooth eruption. The graft donor sites in current clinical use are the iliac crest, tibia, calvarium, olecranon, and mandible; unfortunately, without a clearly defined primary option, site selection is left largely to the surgeon’s personal preference and varies greatly between hospitals. This review seeks to detail the relative risks and benefits of each donor site option, and to suggest one donor site as the most clinically beneficial for both patients and cleft teams.

Methods: A literatures search, using MEDLINE and Ovid Embase, was performed using MeSH terms Cleft Palate /or/ Alveolar Process [Abnormalities] /or/ Bone Transplantation /or/ Alveolar Process [surgery] /or/ Alveolar Bone Grafting, and keyword Graft*, for literature from the past 20 years.

Results: The findings of this review indicate that concerns about donor site morbidity for the iliac crest are often overstated, and are based upon older literature. Pain and gait disturbances after harvest of the iliac crest can be minimised through conservative operative technique, making it a safe donor site with rapid recovery. While other donor sites provide reliable sources of good quality bone, they are associated with major complications that limit their clinical benefit to the patient, and they may not supply adequate bone volume for grafting to larger defects and bilateral clefts.

Conclusion: Although randomised controlled trials with large patient pools are warranted to more accurately compare donor sites, current literature supports the iliac crest as the most clinically beneficial donor site. These findings provide insight for cleft teams about factors that influence donor site selection and patient outcomes, and lay the foundation for the development of a protocol or algorithm for donor site selection that would minimise complications and standardize high quality patient care.

DEVELOPMENT OF A SMARTPHONE-BASED APPLICATION FOR MORPHOLOGIC CLEFT LIP DATA COLLECTION

Presenter: William P. Magee M.D.
Author: Meghan McCullough M.D., Caroline Yao, MS, MD, Jordan Swanson, MD, Allyn Ausländer, MPH, Thomas Imahiyerobo, MD, William P. Magee III, DDS, MD
Institution: University of Southern California

Abstract:
Background: The spectrum of disease morphology varies greatly within cleft lip, but objective characterization is challenging given the relatively low disease incidence, precision required for assessment and practical challenges of examining young children. We present a novel smart phone-based application designed to improve the ease and standardization of data collection to better study the spectrum of cleft morphology.

Methods: An encrypted iPhone-based application was developed to collect demographic information, anthropometric measurements and standardized photographs. The app was utilized for prospective data collection in Morocco, Bolivia, Vietnam and Madagascar during medical missions. Schematics and data collection screens were created with an international user-base in mind, maximizing the use of universally understood diagrams and buttons.

Results: Data on 147 patients was collected over the course of two years and the app underwent five prototypes with two beta-test trials. Each prototype was designed to improve: user interface, data entry to mimic the sequence of events in pre-operative, operative and post-operative environments, ease of use inputting facial morphology measurements, consistency of medical photography and efficiency of data uploads/download/backup. With each trial, two junior and two senior surgeons from three different countries used the app on mission-based surgeries. Our team analyzed the accuracy and completeness of their data collection and qualitative interviews with each user were conducted to identify areas for necessary improvement.

Conclusions: The finalized app represents a novel technology which streamlines and standardizes data capture to make collection more accessible to a wider group of users. Such a technology is important for obtaining consistent and representative aesthetic measures over time and for large patient populations in order to better study cleft morphology.
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ALVEOLARCLEFTSIZEONPRENATALULTRASONOGRAPHYPREDICTSCLEFTOFTHERSECONDARYPALATE
Presenter: Eva Rubio M.D.
Author: Albert K. Oh, Eva Rubio M.D., Kenneth L. Fan, Anna Blask, Erin M. Rada, Gary F. Rogers
Institution: Childrens National Health System

Abstract:
Background: Prenatal ultrasonography (US) is an important tool for fetal screening and connecting patients to craniofacial centers. While identification of cleft lip and accompanying cleft of the alveolar ridge is relatively straightforward, diagnosing clefts of the secondary palate remains challenging. The objective of this study is to review our experience and correlate prenatal alveolar cleft width with the likelihood of a cleft of the secondary palate.

Methods: With IRB approval, we retrospectively reviewed charts from January 2012 to February 2016. Exclusion criteria included incomplete postnatal follow up and bilateral complete cleft lip/palate. Prenatal and postnatal data were examined. Prenatal imaging findings of the alveolar ridge and any defects were compared with postnatal phenotype.

Results: Of 74 fetuses referred for cleft lip/palate evaluation, 42 had complete prenatal and postnatal data. Excluded were 6 with bilateral defects and 6 with inadequate alveolar visualization. Thirty patients with unilateral lip defects were analyzed. In 10 patients, the alveolar ridge was intact by prenatal US, all with postnatally confirmed intact secondary palate and cleft lip. Small alveolar defects <4 mm were noted prenatally in 3 patients, and postnatal examination documented complete or near complete cleft lip/palate in 3, all 3 had postnatal phenotypes. The remaining 17 patients had alveolar defects of >4 mm on prenatal US; 15 had complete cleft lip and palate on postnatal exam, and the remaining 2 had an intact secondary palate. Based on these data, an alveolar defect >4 mm on prenatal US indicates significantly greater odds of a cleft of the secondary palate (OR=130.2, p=.0023, 95% CI 5.7-2995.7).

Conclusion: Our review demonstrates that prenatally documented defects of the alveolus >4 mm are highly predictive of the presence of a cleft of the secondary palate. Per contra, a normal alveolar ridge is associated with intact secondary palate.

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BMP-2 ALVEOLAR BONE RECONSTRUCTION HAS IMPROVED BONE HEALING WITHOUT SIGNIFICANT DIFFERENCES IN DENTAL OUTCOMES
Presenter: Alexander Y. Lin, MD, FACS
Author: Jeremy A. Goss, Dave S. Ho, BS, Jeremy A. Goss, MD, Margie S. Hunter, BS, Ross E. Long, Jr, DMD, Erics Armbrecht, PhD, Alexander Y. Lin, MD, FACS
Institution: Saint Louis University School of Medicine

Abstract:
Background: A former surgeon at our institution often used bone morphogenetic protein-2 (BMP-2) instead of autograft for alveolar cleft repair. We hypothesized that bone and dental outcomes may be affected by BMP-2 and compared outcomes in his patients who had autograft versus matched cases who received BMP-2.

Methods: Available pantomograms post alveolar surgery were analyzed. BMP-negative pantomograms (controls) were case-control matched to identify BMP-positive pantomograms with similar cleft type, age at alveolar surgery, and age at pantomogram. Outcomes: Bergland grade for bone (1-4, 1 is best), Chelsea score for bone (0-8, 8 is best), canine root development (0-6, 6 is best), canine eruption, lateral incisor impaction risks. Paired t-tests were performed on continuous outcomes and Chi-square tests were performed on categorical outcomes.

Results: 72 pantomogram cleft sites were evaluated: 36 BMP-negative controls (BN); 36 BMP-positive (BY) case matches. Average followup time 4.70 years. Age at pantomogram (year): BN 8.97, BY 9.17, P=0.452. Bergland grade: BN 2.04, BY 1.38, **P=0.001. Chelsea score: BN 4.87, BY 6.75, ***P<0.001. Canine root development: BN 3.18, BY 3.28, P=0.616. Canine eruption seen in: BN 8/36 (38.1%), BY 13/36 (61.9%), P=0.195. Lateral incisor missing in: BN 13/36 (46.4%), BY 15/36 (53.6%), P=0.629. The remaining 51 cleft sites that did not exhibit permanent canine eruption were assessed for: vertical impaction risk BN 4/28 (57.1%), BY 3/23 (42.9%), P=0.898; lateral impaction risk BN 6/28 (54.5%), BY 5/23 (45.5%), P=0.979.

Conclusions: This study suggests that BMP-2 alveolar bone reconstruction has improved alveolar bone height, without significantly affecting dental outcomes. These findings need to be incorporated with growth studies of risk-benefit analysis of BMP-2 alveolar cleft repair.
A QUALITY-BASED APPROACH TO OPTIMIZE THE ALVEOLAR BONE GRAFT: AN IMPROVED PERI-OPERATIVE PAIN MANAGEMENT PROTOCOL

Presenter: Justin Dagget, M.D.
Author: Michael Bykowski, Wesley Sivak, Catey Garland, Franklyn Cladis, Jesse A Goldstein, Joseph E Losee, Dr. Justin Dagget, M.D.
Institution: Children's Hospital of Pittsburgh

Abstract:

Purpose: Cleft patients undergoing alveolar bone graft (ABG) procedures predictably experience high levels of postoperative pain resulting in prolonged hospital length of stay. This study aims to demonstrate the efficacy of an ABG protocol implementing peri-operative pain control measures.

Methods: A retrospective comparative cohort series was conducted with traditional open iliac crest bone graft (ICBG; Group 1) versus minimally-invasive ICBG with multimodal peri-operative analgesia protocol (Group 2). This protocol included: indwelling ropivacaine pump at harvest site, intraoperative IV steroids, IV ketorolac, IV acetaminophen, and infraorbital nerve blocks with bupivacaine. The primary outcome was hospital length of stay. Secondary outcomes were operation duration, postoperative pain scores, opioid use at home, and treatment-associated costs. Results: Group 1 (n=22) underwent ABG between October 2004 and December 2006 and Group 2 (n=25) was treated between January 2015 and August 2015. The average hospital stay for Group 1 was 2.4 days compared to 0.5 days for Group 2 (p<0.0001). All patients from Group 1 were admitted to the hospital for at least one day whereas, 12 patients (48%) from Group 2 were discharged home on the day of surgery. Average operative time per cleft was 180.4 mins for Group 1 and 128.7 mins for Group 2 (p<0.01). Maximum post-operative pain score averaged 7.3 out of 10 in Group 1 vs 1.8 out of 10 in Group 2 (p<0.0001). Indwelling ropivacaine pump leaked post-operatively at the incision site in 6 patients (24%). For the 18 patients who did not have a pain pump leak, 16 patients (89%) did not require more than one dose of opiate medication at home. Using our multimodal protocol, an estimated $6353.24 can be saved for a unilateral ABG and $8923.76 for a bilateral ABG.

Conclusions: Our protocol is associated with low morbidity, short operative times, shorter hospital stay, and lower cost compared to patients that have undergone traditional ABG.

PRIMARY CORRECTION OF THE NASAL DEFORMITY IN UNILATERAL CLEFT LIP PATIENTS: Merging the Past with the Present to Achieve a Satisfactory Outcome

Presenter: Maria del Carmen Moreno Alvarez M.D.
Author: Jordi Puente Espel, Maria del Carmen Moreno Alvarez M.D.
Institution: Hospital General de Mexico Eduardo Liceaga

Abstract:

Although important advances have been made from the aesthetic and functional perspectives, in treating the cleft lip deformity, there are still gaps to be closed in the primary correction of the nasal deformity in patients with unilateral cleft lip.

The original concept of not manipulating the nasal structures during the initial cleft lip repair has been abandoned. Multiple cleft surgeons have demonstrated a substantial improvement in the treatment of cleft nasal deformity.

The objective of the following study is to analyze the technical aspects described by cleft surgeons treating the nasal deformity and to demonstrate which principles have shown to work in our institution. From April 1st, 2015 to March 31st, 2017, 22 pts met the inclusion criteria. Medical photography, frontal and basal (worm's) views were performed. For the subjective evaluation, 3 experts analyzed, independently and blindly, the photos at 6, 12 and 18 months post-surgery. 19 pts (86.36%) were graded as an adequate and two (9%) with an inadequate result. An objective evaluation based on five aspects: a collapsed ala was found on 5 pts (22.7%); a larger nasal opening on the cleft side (6 pts, 27.27%); a notch (3 pts, 13.6%), alar-cheek junction displaced caudally on the cleft side and alar-cheek junction displaced laterally on the cleft side were found on 4 (18.1%) and 6 ts (27.27%), respectively. 4 pts presented with an excellent outcome, 17 pts with a satisfactory outcome, and 1 pt presented with a poor outcome; with an adequate internal consistency coefficient and correlation (p=0.005), according to a binary grading system (0 point = absent, 1 point= present); a score of 0 -1 was considered an excellent outcome, 2-3 points were considered a satisfactory and scores of 4-5 points, a poor outcome.

Correction of the nasal deformity during the initial cleft lip repair is feasible. Nasal reconstruction during cheiloplasty, crucial moment to repair the lip and nasal abnormalities.
COMPARISON OF CASO4 TO CAPO4 IN PRIMARY ALVEOLAR CLEFT REPAIR

Presenter: Spiros Lazarou MD
Author: Spiros Lazarou
Institution: Chief, Pediatric Plastic & Craniomaxillofacial Surgery, Iaso Pediatric Hospital

Abstract:
Purpose: This prospective study was designed to compare the efficacy of the bone substitute materials CaSO4 and CaPO4 in primary alveolar cleft reconstructions.

Materials & Methods: 32 patient’s undergoing primary alveolar cleft reconstructions with either CaSO4 or CaPo4 constitute this study. 11 patients had cleft lip and alveolus and 21 had complete unilateral cleft lip and palate. All patients underwent cleft lip repair in the first week of life and palatal repair at 6 months. Primary alveolar reconstruction was performed in all patients between 6 and 13 months. The first 18 consecutive patients in this study were grafted with CaSO4 and the next 14 consecutive patients were grafted with CaPO4. The SO4 group had 11 complete clefts and the PO4 10. Panorex radiographs were obtained on all patients at 4 years of age. Occlusal relationships for all patients were recorded by the treating orthodontist throughout the follow-up period. SO4 follow-up ranged 9-15 years and PO4 7-11 years.

Results: 14/18 SO4 patients and 8/14 PO4 patients had normal eruption of secondary dentition into the reconstructed alveolus. Following eruption of secondary dentition at the cleft site 9 patients in the SO4 group and 12 patients in the PO4 group had class III malocclusion’s. All patients in the PO4 group also had crossbites. All patients are currently under orthodontic treatment with the utilization of reverse headgear as indicated.

Conclusions: SO4 is superior to PO4 in bone formation and in the ability to allow tooth eruption into the reconstructed alveolus. Alveolar arch stabilization is superior with SO4 with less arch collapse and resultant crossbites compared to PO4. The results obtained utilizing SO4 in primary alveolar reconstruction mirrors results reported with autogenous bone graft reconstructions, with the many advantages of avoiding secondary donor sites.

ROLE OF DISTRACTION OSTEOGENESIS IN THE MANAGEMENT OF CRANIO- AND DENTOFACIAL ANOMALIES

Presenter: Nicolai Adolphs M.D.
Author: Nicolai Adolphs M.D., Nicole Ernst
Institution: Dept. of Craniomaxillofacial Surgery, Charit University Medicine, Berlin

Abstract:
Background: Distraction osteogenesis (DO) has been applied to the field of craniomaxillofacial surgery (CMF) for more than two decades. Although relevant factors for successful distraction osteogenesis are well known there are ongoing controversies about indications and limitations of the method and there is still a lack of evidence based data.

Materials & Methods: Since 2003 distraction osteogenesis has been applied by the same surgical team to patients affected by cranio- or dentofacial anomalies within staged individualised treatment protocols. The records of these patients have been reviewed in order to assess the role of DO within the spectrum of a major CMF surgery unit.

Results: Within 14 years more than 167 patients have been treated by distraction techniques corresponding to less than 1% of all patients (>30,000) of the department during that period. A wide variance of parameters was found impeding evidence based statements.

DO for the correction of transverse maxillary deficiency was the main application (bone borne n=107, tooth borne n=22) providing stable and reliable results. In 31 syndromal patients distraction was successfully applied in order to correct inherent craniofacial growth deficiencies. However staged additional surgeries were typically required in the majority of patients. In two patients (1,2%) relevant infective complications occurred leading to persistent tissue damage. Computer-assisted technologies were helpful for planning, transfer and evaluation of gradual frontofacial advancement procedures.

Conclusion: According to this review the principle of gradual expansion by DO plays a minor role with regard to the overall patient counts of a CMF department. However DO is a powerful tool for the reconstruction of patients affected by cranio- or dentofacial anomalies within individually staged treatment concepts.
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BIPLANAR MANDIBLE CONTOURING: DESIGN AND NAVIGATED OSTEOTOMY
Presenter: Min Wei, M.D.
Author: Min Wei, M.D., Zheyuan Yu, Liang Xu, Jie Yuan
Institution: Dept. of PRS, Shanghai Ninth People Hospital

Abstract:
Background: Mandible contouring has been a hot point in Chinese plastic clinics for more than ten years. With the development of digital medical techniques, the authors raised a new method named Biplanar Mandible Contouring and achieved satisfied results.

Methods: A spiral CT scan was performed to the patient with elastic intermaxillary fixation. The image data was then imported into Rapidform and reconstructed to a 3D model.

Design: two cutting lines were planned on the 3D model. The first line was draw at anterior-posterior view and projected to the outer layer mandibular cortex, which presented the desired anterior view after surgery. The second line was draw laterally and projected to the inner layer of mandible, which showed the lateral curve of the desired outcome. These two lines formed a continuous changed cutting plane. This plane was then saved into a STL file and imported into Brainlab Navigation system.

Surgery: the navigation tag was fixed on the parietal bone and registered. After intra-oral subperiosteum dissociate, the intermaxillary wire ligation was applied and the mandibular osteotomy was performed under navigation according to the designed plane.

The 6-month follow-up CT data was collected and compared to the pre-operative image and digital design.

Results: 37 female cases of mandible contouring were performed with Biplanar Mandible Contouring in our department in the past 3 years. The average error between design and follow-up is 1.6mm. No secondary modification was needed. No severe complications founded.

Conclusion: the outer and inner cortex of mandible play different roles in mandible contouring. The outer layer gives the anterior width of the face while the inner layer maintains the posterior length of the face from lateral view. In Biplanar Mandible Contouring, these two layers are modified separately to achieve their own expectation and operated accurately under navigation. It shows a new design philosophy in mandible contouring.

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USE OF DISTRACTION OSTEGENESIS IN CLEFT PATIENTS SKELETAL SEQUELS
Presenter: Carlos Marcelo Cerullo M.D.
Author: Carlos Marcelo Cerullo M.D., Tohus Guillermo Andrés
Institution: Hospital Italiano de Buenos Aires

Abstract:
The following presentation is focused on the treatment of cleft patients skeletal sequelae through the use of distraction osteogenesis, not only to correct vertical and sagittal maxillary hypoplasia, but also to treat alveolar defects. We will show our experience in the use of intraoral devices, in Le Fort I osteotomies, and custom-made devices for alveolar bone transport, with segmental osteotomies, performed using piezosurgery. Complications will be also shown, and the chances to deal with them, with different additional procedures.
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CHANGES TO THE CLEFT NOSE AESTHETIC AFTER
LEFORT I ADVANCEMENT: A 3D ANALYSIS
Presenter: Irene Ma, M.D.
Author: Irene Ma, Jonathan Lee, Loni Mae Brueckmann,
Ian Chow, Joseph Losee, Jesse Goldstein
Institution: University of Pittsburgh Medical Center

Abstract:
Background: In the cleft patient, scarring from prior corrective
surgery along with the anatomic aberrancy in the cleft nose
leads to poor predictability of nasal changes after midface
advancement. Nasal changes in the non-cleft patient after
LeFort I advancement is well documented. Those changes are
characterized by an increase in alar base width, tip projection,
and nasolabial angle. Conversely, the study of nasal changes
in cleft orthognathics is limited.

Methods: A retrospective chart review was performed of
all patients at a single institution who had a cleft lip/palate
undergoing LeFort I advancement with pre and postoperative
3-dimensional (3D) photos. With 3D imaging software, pre and
postoperative measurements were obtained, facilitating both
2D and 3D analysis of nasal changes. Results: 19 patients (10
girls, 9 boys) met inclusion criteria. Alar base and flare width both
increased significantly (1.3mm, p<0.001; 2.3mm, p=0.003),
while both total tip projection and relative tip projection decreased (2.0mm, p=0.001; 3.4mm, p<0.001). In addition,
3D analysis of the nose demonstrated an advancement of
the entire nasal complex surface postoperatively (1.0mm,
p<0.0005). Bilateral cleft patients had a wider alar base
following surgery than bilateral clefts (-4.06±3.41, -0.98±2.15,
p=0.032). On multiple linear regression, presence of a cinch
stitch decreases the nasolabial angle (p=0.024), but increases
nasal length (p<0.001). Bilateral cleft morphology decreases
total tip projection (p=0.024), but increases 3D nasal change
(p=0.028).

Discussion: There are discrepancies in the nasal changes that
occur after Lefort I advancement between the cleft and non-
cleft population, primarily regarding projection and rotation
of the tip. Although the entire nasal surface is advanced
postoperatively, tip projection is reduced and rotation limited,
potentially indicating scar burden as a significant contributor
to changes in nasal aesthetics after cleft orthognathic surgery.

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COMBINED LE FORT 3/LE FORT 1 ORTHOGNATHIC
PROCEDURES IN PATIENTS WITH CLEFT LIP AND
PALATE: ESTHETIC RESULTS IN THE GLOBALLY MIDFACE
DEFICIENT PATIENT
Presenter: Michael Lypka
Author: Michael Lypka, Kevin Xiao
Institution: Children’s Mercy Hospital

Abstract: Background/Purpose: Arguably, a majority of
patients with cleft lip and/or palate could benefit from
orthognathic surgery. Most patients exhibit varying degrees
of midface deficiency. A small subset of patients, however,
have severe global midface deficiency that could benefit
from maxillary osteotomies other than conventional Le Fort 1
osteotomy. Le Fort 3 osteotomy can be useful to advance the
deficient infraorbital rims and nasal root in this select group.
The purpose of this presentation is to review patients with cleft
lip and palate with global midface deficiency who underwent
combined Le Fort 3/Le Fort 1 procedures.

Methods: Four patients with cleft lip and/or palate with global
midface deficiency, who had undergone combined Le Fort 3/
Le Fort 1 procedures, were reviewed. Three were male with
bilateral cleft lip and palate, and one was female with isolated
cleft palate. Age ranged from 12-18. In all cases, the face was
advanced at the Le Fort 3 level definitively with rigid fixation
and cranial bone grafts. Simultaneously, three patients had
definitive Le Fort 1 advancement with rigid fixation and one
underwent Le Fort 1 advancement with internal distractors.
Two patients also underwent bilateral sagittal split osteotomies
with genioplasty. Submental intubation was utilized in three
cases. Pre and postoperative photos and radiographs
were analyzed. Occlusal results were documented and
complications were reviewed. Median follow up was 2 years.

Results: Average advancement at the Le Fort 3 level was 6
mm. At the Le Fort 1 level, average advancement for was
11.5 mm for the three rigidly fixated cases and 15 mm for the
distraction case. Positive overjet was achieved in all cases
initially. At one year follow up, three maintained sagittal
projection and one relapsed into an end to end incisor
relationship. Three patients underwent transverse relapse.
One patient had pre and postoperative sleep studies, with an
AHI of 23 and 7 respectively.
TREATMENT OF OBSTRUCTIVE SLEEP APNEA WITH ORTOGNACTIC SURGERY IN PATIENTS WITH CLEFT LIP AND PALATE

Presenter: Diana Marcela Diaz Lopez M.D.
Author: Diana Marcela Diaz Lopez, Rolando Prada, Diana Gómez, Tatiana Palomino
Institution: Fundación Universitaria de Ciencias de la Salud

Abstract:

Obstructive sleep apnea (OSA) is an alteration found in among 10-35% of patients with cleft lip and palate (CLP). It is considered that the maxillary and/or mandibular advancement allows the reduction of the Apnea Hiponea Index (AHI) to be highly effective in these patients although there are few clinical reports of isolated cases. Between January 2013 and January 2015, ten patients with CLP were evaluated during the pre and postoperative period (six months) to determine changes in AHI severity, cephalometric measurements and quality of life. The average age was 20.4 years (16-32 years) and the average preoperative AHI was 18.7. The majority of cases had moderate OSAS (10-25.8) with predominantly obstructive apneas. Two of the patients had previously used CPAP for an average period of two years and most had received previous management of maxillary expansion with Hyrax or protraction masks. The main procedure was the mandibular maxillary advancement with chin advancement and the single maxillary advancement with an average advancement of 7mm for the maxilla, 6mm for the mandible and 5mm for the chin, thus achieving a marked AHI decrease of a postoperative rate of 3.5 apneas per hour (0-5) as well as total absence of symptoms, a marked increase in retropalate and retrolingual space and a 100% improvement in the quality of life according to the Quebec Scale.

Conclusion: The maxillary and mandibular advancement successfully resolves OSAS among adults with cleft lip and palate, resulting in 100% effectiveness in the quality of life, and 81% improvement in the AHI in addition to a marked improvement in cephalometric measurements.
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ORTHOGNATHIC SURGERY IN PREVIOUSLY DISTRACTED MANDIBLES
Presenter: Adriana Guerrero M.D.
Author: Jacobo Felemovicius, Adriana Guerrero M.D., Sara Contreras
Institution: Hospital General Dr. Manuel Gea Gonzalez

Abstract:
Craniofacial microsomia is a variable hypoplasia of the skeleton and soft tissues of the middle and lower face. It is the second most frequent congenital deformity of the head and neck, with an incidence as high as 1 in 2,500 new borns. Its clinical presentation varies according to the anatomical region.
Studies of patients with untreated unilateral hemi facial microsomia have shown that facial asymmetry is a progressive deformity that correlates with the severity of the initial mandibular deformity. The deformity can be mild to severe, depending on the degree of genetic expression.
Early correction of the mandibular hypoplasia is advocated by those who believe in the progressive nature of the syndrome and the need to reduce the secondary deformity.
Numerous surgical procedures have been suggested to address the facial deformities in these cases. Mandibular distraction remains the gold standard for the correction of the skeletal and soft tissue deformities in these pathologies during early and mixed dentition. After following these patients all the way to skeletal maturity we have encountered some cases with sub optimal functional and aesthetic results.
For many years we shared the believe that the previously distracted mandible was not able to sustain a new osteotomy that could be indicated to improve the final occlusion and overall symmetry in syndromic craniofacial disorders. After performing a retrospective review of the last 5 years, we found 48 patients with skeletal maturity that underwent mandibular sagittal split osteotomies at our clinic. Five patients (3 with hemi facial microsomia and 2 with Goldenhar’s syndrome) underwent at least one mandibular distraction, during childhood.

Patients And Methods:
We performed a retrospective review of clinical records of all patients that received a mandibular sagittal split osteotomy at the Division of Plastic and Reconstructive Surgery of the Hospital General Dr. Manuel Gea Gonzalez

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LONG TERM STABILITY OF LE FORT 1 DISTRACTION OSTEOGENESIS IN PATIENTS WITH CLEFT LIP AND PALATE
Presenter: Carlos Raul Barcelo M.D.
Author: Carlos Raul Barcelo M.D., David G. Genecov
Institution: International Craniofacial Institute, Dallas TX

Abstract:
The objective of the following study was to evaluate the long-term stability and relapse rates in unilateral CLP [UCLP] and bilateral CLP [BCLP] 95 patients with class III malocclusion submitted to distraction osteogenesis.

Material and methods: This is a retrospective study of 95 pts. with UCLP or BCLP, were treated at the International Craniofacial Institute, Dallas, TX, from 2004 to 2016. Indications for Le fort 1 with Distraction Osteogenesis were: 1) severe >12 mm negative over jet) 2) obstructive sleep apnea [OSA] AHI >20 3) The need for maxillary advancement >10 mm. in re-operative maxillary surgery or in the presence of severe scarring of the soft tissue at the level of the soft palate that would compromise advancement of the maxilla.
Two groups were created: Group 1 N: 28 patients with internal distraction devices and, Group 2 N: 67 patients with external (halo) distraction devices.
The protocol consisted on performing a Le fort I osteotomy with consecutive placement of a distractor device, followed by activation of active distraction at 4 days 0.5mm per day with a consolidation period of 8 to 10 weeks.

Results: The results were evaluated based on cephalometric analysis (before, immediately after DO and at 1-year follow-up. Success was defined as maxillary stability with relapse less than 10% at one year or persistent class I occlusion.

Conclusions. No significant differences in sex, cleft type or causal of initial negative over jet were encountered. There was a significant difference (p<0.05) in length of distraction distance, overcorrection, consolidation period, presence of previous alveolar ridge bone grafting and age was found to be of importance. The fact that internal or external distraction devices are used, does not have long term effects in the outcome if an appropriate consolidation period is followed.
DISTRACTION OSTEOGENESIS IN THE GROWING MAXILLA: LONG TERM RESULTS IN 41 CONSECUTIVE PATIENTS

Presenter: Eugenia Page M.D, Joseph Williams, Fernando Burstein, Paul Ghareeb, Stefanie Hush, Brentley Taylor
Institution: Emory University School of Medicine

Abstract:
Severe maxillary growth restriction affects a significant portion of children with cleft lip and palate, but no consensus exists in the timing or technique of its correction. Maxillary distraction may be indicated in children with severe class III malocclusion who have restrictive soft tissues, significant advancement distance to achieve, or marginal velopharyngeal competence. The aim of this study is to evaluate whether maxillary distraction in the growing maxilla enables long-term correction of malocclusion and avoidance of further orthognathic surgery.

Forty-one patients underwent maxillary distraction by two surgeons between 2010 and 2016. Thirty-three patients (81%) were male, the average age 12.9 years, and 38 (93%) had a history of prior cleft lip and palate repair. Six patients (15%) developed a complication within 30 days, and 8 patients (20%) eventually required speech surgery (mean 9.75 months). Eight children (20%) required orthognathic surgery at 2.3 years after distraction; regression analysis showed age over 13 as a predicting factor (p=0.039).

We further analyzed patients undergoing distraction before age 13 who were followed out to skeletal maturity (age 14+ in males, 13+ in females). Among the eight patients (mean age 11.1), two patients (25%) required further maxillary advancement 4.5 years after distraction and one is in active orthodontic treatment. Three patients (38%) developed velopharyngeal incompetence requiring speech surgery 9 months after distraction. Follow up through skeletal maturation shows that early distraction is effective and may allow a unique opportunity for orthodontic treatment prior to necessitating secondary skeletal surgery.

CURRENT INDICATIONS AND EXPERIENCE WITH MAXILLARY DISTRACTION AT A HIGH VOLUME CENTER

Presenter: Paul Ghareeb M.D.
Author: Paul Ghareeb, Joseph K Williams
Institution: Emory University School of Medicine, Division of Plastic Surgery

Abstract:
Current indications and experience with maxillary distraction at a high volume center.

Introduction: Maxillary hypoplasia is typically corrected with LeFort osteotomies and maxillary advancement. However, some patients are not able to achieve full correction with isolated maxillary movement. Historically, these patients have required two-jaw surgery for adequate correction. Distraction osteogenesis is a newer method of correction that has been utilized in both maxillary and mandibular movement with good results. The aim of this analysis is to present our indications and experience with maxillary distraction osteogenesis in the treatment of severe maxillary hypoplasia.

Methods: A retrospective review was performed on a consecutive series of patients undergoing maxillary distraction from 2010 to 2016. Patient demographics were documented, and outcomes and complications were recorded. Results: 41 patients were identified who underwent maxillary distraction for hypoplasia. 35 patients had unilateral cleft lip and palate, 3 had bilateral cleft lip and palate, and 3 had non-cleft associated maxillary hypoplasia. 6 complications were reported overall (14.6%). 3 (7.3%) infectious complications were reported, and 3 (7.3%) device malfunctions requiring intraoperative inspection was found. 6 (14.6%) patients required further orthognathic surgery, and 8 (19.5%) patients developed velopharyngeal incompetence requiring operative correction. Maxillary distraction is a safe, reliable, and effective method of correcting severe maxillary hypoplasia. Our indications have expanded to patients with large planned advancement distances, younger patients in the period of mixed dentition, and in patients with a high suspicion for a scarred, immobile maxilla. These results demonstrate an acceptable rate of revision orthognathic surgery, and a potentially lower rate of subsequent velopharyngeal incompetence when compared with traditional orthognathic techniques.
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THE COMMON NEEDS OF ADULT PATIENTS WITH CLEFT LIP AND/OR PALATE
Presenter: Stephen Beals, MD
Author: Nicole Kurnik, MD, Stephen Beals, MD, Katharine Connolly, MD, Davinder Singh, MD, Patricia Glick, DMD, Tuan Truong, MD
Institution: Mayo Clinic Arizona, Department of Plastic Surgery

Abstract:
Introduction: Adult patients who have undergone rehabilitation for clefts of the lip and/or palate have functional and aesthetic needs that are unique compared to the pediatric population. There is a paucity of literature regarding this patient population and the long-term influence of a multidisciplinary team-based approach to cleft care on adult functional and aesthetic needs has not yet been defined. Therefore, we aimed to identify the common needs of this population and to evaluate the relationship of team-based care in meeting those needs.

Methods: A retrospective chart review was performed to identify adult patients over the age of 16 with a diagnosis of cleft lip and/or palate. Patients were further organized by their declaration of team status. We then analyzed the concerns and clinical needs of adult patients and stratified them based on who received cleft-team-based care by a single, multidisciplinary cleft team; multiple multidisciplinary cleft teams; or no formal cleft team.

Results: We analyzed 142 patients. The most common patient concerns were lip aesthetics (64%), nose aesthetics (61%), septal deviations (47%), nasal obstruction (44%), malocclusion (32%), oronasal fistulas (29%), and speech (21%). Oronasal fistulas were more commonly reported in the group that had care by multiple teams (42.9%) compared with the groups that had care by a single team (10.7%) or no formal team care (36.7%) (P<.001). Malocclusion was also more commonly reported in the group of patients who had care by multiple teams (50%, P=.001).

Conclusions: Adult cleft patients appear to have a common set of needs that may be increased when no continuity of care is provided. Function and appearance are recognized areas for issues of self-esteem, social avoidance and distress in patients. The utilization of multidisciplinary adult-cleft-team-based care appears to influence these needs and may be warranted to address the needs of this relatively unrecognized patient population.

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AESTHETIC OUTCOMES IN UNILATERAL CLEFT LIP: COMPARISON OF MODIFIED MILLARD VERSUS FISHER REPAIR
Presenter: Kirstin Miteff, M.D.
Author: Carly Fox, M.D., Kirstin Miteff, M.D., Yun Phua, M.D., Susan O’Mahony, M.D., Richard Theile, M.D., Stuart Bade, M.D.
Institution: Lady Cilento Children’s Hospital, Brisbane Australia

Abstract:
Introduction: The goal of cleft lip repair is to minimise the stigma of the cleft deformity. The modified Millard and Fisher cleft lip repairs are two widely used techniques. Proponents of the Fisher repair state that it achieves superior lip height and respects aesthetic subunits.

This study aimed to compare aesthetic outcomes in patients with Millard and Fisher repairs. Two scoring systems were utilised for this comparison, and inter- and intra-rater reliability of these systems was assessed as a secondary aim.

Methods: 36 patients who underwent unilateral cleft lip repair with either modified Millard or Fisher repair between January 2010 and June 2015 were randomly selected for inclusion. 12 assessors undertook blinded rating using the Asher-McDade and Perth scale on two separate occasions. Analysis was performed to determine if a difference in aesthetic scores existed between the two groups, and to establish the inter- and intra-rater reliability of each scoring system.

Results: There was a statistically significant difference between the repair method overall scores as measured on the Asher-McDade (p<0.043) and Perth scale (p<0.006), with Fisher repairs scoring more favourably. There was good inter-rater agreement for the Asher-McDade scale and fair inter-rater reliability of the Perth scale.

Discussion/Conclusions: Cleft lip repairs undertaken using the Fisher technique have a superior aesthetic outcome to those performed using a modified Millard technique. The scoring system proposed by Asher-McDade has good inter-rater reliability. Reliable scoring systems are essential to facilitate inter-centre comparison of cleft lip techniques and outcomes.
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253 VOLUMETRIC EVALUATION OF ALVEOLAR CLEFT GRAFTING METHOD: BONE SUBSTITUTES VS AUTOLOGOUS BONE
Presenter: Federica Ruggiero, M.D.
Author: Federica Ruggiero, M.D., Giovanni Badiali, Enrico Costabile, Claudio Marchetti, Alberto Bianchi
Institution: Oral and Maxillo-facial Surgery Dept, S.Orsola University Hospital Bologna, Universities of Parma Bologna Ferrara

Abstract:
Secondary alveolar cleft repair using autologous bone graft is currently gold standard in treating residual alveolar clefts. Although effective, this technique may result in considerable donor-site morbidity, most commonly pain and the potential for long-term sensory disturbances. In order to reduce patient morbidity, bone substitute has been successfully used as an alternative. The aim of this Study is to compare the viability of bovine based replacement bone material vs autologous bone graft in alveolar cleft reconstruction. From 2011 to 2016 16 patients were admitted to our Department for alveolar cleft. 10 patients responded to the including criteria. 5 patients received autologous bone graft and 5 a bovine bone substitute graft. Preoperative and immediate postoperative orthopanoramic x-rays were recorded. CBCT scans were recorded both pre and postoperatively. On bidimensional images, the bone filling was evaluated with the Bergland scale. Then volumetric evaluation on three-dimensional CBCT images was performed. Two raters performed volumetric measurements of both residual and cleft fill, with good Interrater and Intrarater realiability. Alveolar clefts repaired using Substitute bovine bone/biological membrane scaffold had a mean fill of 68.97% of total cleft volume, while this figure was of 71.61% with autologous bone grafting. Radiographically, initial repairs with substitute bovine bone/biological membrane scaffold were superior to autologous bone grafting according to Bergland scale on orthopanoramic x-rays. The immediate postoperative course and subsequent discharge were uneventful for both groups, with difference in timing. The cost of substitute bovine bone was offset by cost savings associated with a reduction in operative and postoperative and hospitalization time. On our sample, bone substitutes showed to be a promising solution in alveolar cleft grafting and no drawbacks were observed in comparison to the gold standards.

254 HIGH-FIDELITY CLEFT LIP SIMULATION - TAKING SURGICAL REALISM TO NEW HEIGHTS
Presenter: Francesca Saldanha, M.D.
Author: Francesca Saldanha, Andrew Hosmer, Maeve Geary, Peter Weinstock, Carolyn Rogers-Vizena
Institution: Boston Childrens Hospital

Abstract:
In an era of diminishing operative experience, simulation is increasingly important for teaching residents to perform procedures at no risk to patients. Cleft lip repair, a core operation learned in plastic surgery residency, is a prime candidate for simulation because precise technique is needed to achieve optimal outcome. Virtual reality cleft simulators have accelerated learning, but lack of haptic fidelity and inability to capture procedural subtlety limits their usefulness. This has given way to the recent trend of high-fidelity simulation. Through a unique transdisciplinary collaboration between plastic surgeons and a dedicated simulator program with materials engineering and special effects expertise (SimPeds), we sought to address the need for superior haptic fidelity and accurate anatomy in a cleft lip simulator. Existing imaging studies and impressions were retrospectively identified and melded using ZBrush 4R7P3 (Pixologic, Inc.) to construct a simulated patient with a typical unilateral complete cleft lip and alveolus deformity. Key internal anatomical elements, including the multi-layered structure of the lip, were characterized in detail. Emphasis was placed on recreating the surface anatomy crucial to marking a cleft lip repair. Radiographically, initial repairs with substitute bovine bone/biological membrane scaffold were superior to autologous bone grafting according to Bergland scale on orthopanoramic x-rays. The immediate postoperative course and subsequent discharge were uneventful for both groups, with difference in timing. The cost of substitute bovine bone was offset by cost savings associated with a reduction in operative and postoperative and hospitalization time. The simulator soft tissue anatomy is cast in silicone with a supportive scaffold. A modular design permits repetition and mastery of cleft lip repair. This simulator approximates the haptics and anatomy of a cleft lip, giving trainees the opportunity to perform all steps of a cleft lip repair, from marking, to incising and rotating, to closure with a new level of realism, thus addressing the reality of diminishing operative experience for resident surgeons.
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THE DILEMMA OF THE MANAGEMENT OF CLEFT PALATE IN AN APERT PATIENT: A RETROSPECTIVE ANALYSIS OF 43 PATIENTS
Presenter: Herman Jr Vercruysse, M.D.
Author: Herman Jr Vercruysse M.D., Juling Ong, Nivi Behari, Caroleen Shipster, David Dunaway
Institution: Craniofacial Unit, Great Ormond Street Hospital for Children, London, United Kingdom

Abstract:
Introduction: The correct management and timing of cleft palate surgery in patients with Apert Syndrome has been food for thought for many craniofacial multidisciplinary teams. An early surgical intervention, similar to non-syndromic cleft patients, might lead to obstructive breathing and increase the need for repeated adenotonsillectomies. Postponing palate repair until after the midface advancement surgery has been advocated in the past by some leading cleft surgeons. However, the current tendency to perform the midface advancement surgery later in childhood to avoid a redo procedure at an adolescent or adult age, brings this statement up for discussion. The literature on this dilemma is sparse and evidence-based recommendations are missing.

Patient Population & Methods: All patients treated by the Craniofacial Unit of Great Ormond Street Hospital for Children since 1991 with a confirmed diagnosis of Apert syndrome and any type of cleft palate (hard or soft palate, bifid uvula or submucuous cleft) were included in a retrospective analysis. 43 cases were identified. The timing of and the reason for the palatal repair were recorded, aswell as pre-existing or induced obstructive breathing, the timing of and reason for the midface advancement surgery and the number of adenotonsillectomies.

Results & Conclusion: A structured multidisciplinary workflow is presented for the management of cleft palate in Apert patients, based on the retrospective analysis of the 43 documented cases. The decision to perform cleft palate surgery is based on a meticulous consideration of airway issues, speech & language aspects and feeding concerns. A detailed flowchart of a systematic and chronologic approach is presented to assist multidisciplinary craniofacial teams in decision making concerning this matter.

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RHBMP-2/DBM VS. ICBG FOR SECONDARY ALVEOLAR BONE GRAFTS IN PATIENTS WITH CLP: REVIEW OF 501 CASES
Presenter: Daniel J. Gould, MD, PhD.
Author: Daniel J. Gould, MD, PhD., Artur Fahradyan, MD, Fan Liang, MD, William Magee III, MD, DDS, Mark M. Urata, MD, DDS, Jeffrey A. Hammoudeh, MD, DDS
Institution: Keck School of Medicine of USC

Abstract:
Background: Alveolar cleft reconstruction using iliac crest bone graft (ICBG) is considered standard of care for children with complete cleft lip and palate at the time of mixed dentition. Harvesting bone may result in donor site morbidity, additional operating time and length of hospitalization. Recombinant human bone morphogenetic protein (rhBMP)-2 with a demineralized bone matrix (DBM) was used as an alternative bone source for alveolar cleft reconstruction. We investigate the outcomes of rhBMP-2/DBM versus ICBG for alveolar cleft reconstruction by reviewing postoperative surgical complications and cleft closure.

Methods: A retrospective chart review was conducted for 258 rhBMP-2/DBM and 243 ICBG procedures on 414 patients over a 12-year period with a mean follow-up of 2.9 years (rhBMP-2/DBM) and 4.1 years (ICBG). We compared the complications, canine eruption and alveolar cleft closure between the two groups.

Results: In the rhBMP-2/DBM group, one patient required prolonged intubation due to intraoperative airway swelling not thought to be caused by rhBMP-2, 36 reported facial swelling and one required outpatient steroids as treatment, 12 had dehiscence; however, half of these complications resolved without intervention. 23/228 of the rhBMP-2/DBM and 28/242 of the ICBG groups required repeat surgery for alveolar cleft repair. The findings of canine tooth eruption into the cleft site through the graft were similar between the two groups.

Conclusions: rhBMP-2/DBM appears to be an acceptable alternative for alveolar cleft repair. We found no increase in serious adverse events with the use of this material. Local complications, such as swelling and minor wound dehiscence predominantly improved without intervention.
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THE SKOOG LIP REPAIR FOR UNILATERAL CLEFT LIP DEFORMITY - EXPERIENCE FROM 443 CASES
Presenter: Daniel Nowinski M.D.
Author: Daniel Nowinski M.D., Alberto Falk-Delgado, Anna Lang, Malin Hakelius, Valdemar Skoog, Daniel Nowinski
Institution: Department of surgical sciences, plastic surgery, Uppsala university

Abstract:
Background: The Cleft lip and palate team at Uppsala university hospital has consistently used the lip repair described by Tord Skoog to treat the unilateral cleft lip deformity. The primary aim of this study was to determine complications after primary lip repair and the incidence and indications for revisions in all patients born with unilateral clefts during the period 1960-2004. A secondary aim was to determine if the primary rhinoplasty as described by Tord Skoog come to reduce the need for secondary rhinoplasties.

Methods: We performed a retrospective study of all patients borne 1960-2004 with unilateral cleft lip (CL), cleft lip and alveolus (CLA) or cleft lip and palate (CLP). The timing, indication, complications to the primary procedure and type of secondary surgery was recorded. The study included 443 patients. The timing was stratified into 0-5 years, 5-10 years and more than 10 years after primary surgery. 110 patients had a Soog type primary rhinoplasty. Kruskall-Wallis and Fischer's exact tests were used with Bonferroni correction for multiple comparisons.

Results: The total rate of early surgical complications was 6% (n=28). Revision for short lip was performed in 3.8% (n=15) of all patients, 8.4 % (n=33) had reduction of excess vermilion and 8.6 % (n=35) underwent scar revision. Ten years and more after the primary lip repair revisions were most common in patients with CLA (CLA>CL (p = 0.0032), CLA>CLP (p = 0.0001). 45% of the patients had no secondary revisions at all. Primary rhinoplasty according to Skoog did not reduce the rate of secondary rhinoplasties.

Conclusions: Primary lip repair according to Skoog was rarely associated with a short lip deformity and attention to the scar and lip symmetry only required secondary surgery in a relatively small number of patients. Primary rhinoplasty according to Skoog did not seem to reduce the need for later secondary rhinoplasties.

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CONVERSION FURLOW PALATOPLASTY AND THE USE OF PRE-OPERATIVE VIDEO NASENDOSCOPY
Presenter: Alison Kaye, MD
Author: Alison Kaye, MD, Meghan Tracy, BA/BS, Kathryn Dent, MS, CCC-SLP
Institution: Childrens Mercy Kansas City

Abstract:
Purpose: This study examines a cohort of children with cleft palate requiring secondary palate revision for hypernasal speech performed with a Furlow double-opposing z-plasty technique. The use of pre-operative flexible fiberoptic video nasendoscopy (FFVN) to assess palatal structure and function was investigated to compare post-operative speech outcomes between patients who underwent FFVN and those who did not.

Methods: Retrospective review of cleft palate patients with hypernasal speech after primary straight-line palatoplasty who underwent secondary palatal lengthening with Furlow palatoplasty with and without pre-operative FFVN.

Results: 88 patients (59 with FFVN and 29 without) underwent conversion Furlow after primary straight-line palatoplasty with at least 12 months post-operative speech data. Mean age at diagnosis of hypernasality was 66.7 months. Mean age at FFVN was 73.98 months. Mean age for conversion Furlow was 81.96 months with FFVN and 73.48 months without. Pre-operative hypernasality ratings were mild=18.2%, mild-moderate=39.8%, moderate=15.9%, moderate-severe=20.5%, and severe=5.7%. Post-operative hypernasality ratings were none or borderline in 84.7% with FFVN versus 79.3% without. Post-operatively, no patients had severe hypernasality and only one in each group had worse hypernasality. Mean age at Furlow for those with normal post-operative resonance was 79.7 months with FFVN and 77.3 months without. A higher percentage of uncorrected patients were noted to have coronal closure patterns on pre-operative FFVN.

Conclusion: This data supports conversion Furlow palatoplasty as an appropriate procedure for hypernasality after straight-line repair. Standard pre-operative FFVN does not appear associated with improved outcomes in this population, but is associated with increased time to surgery after diagnosis of hypernasal resonance on perceptual speech evaluation.
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TEMPOROPARIETAL FASCIA FLAP FOR GIANT ORONASAL FISTULA RECONSTRUCTION IN CLEFT PATIENTS
Presenter: Enrique Olivares M.D.
Author: Enrique Olivares M.D., Saturnino Santo, Laura Larraga-Nieto, Natalia Munoz-Ollero, Beatriz Gonzalez, Meli, Maria Jose Cimadevilla
Institution: Universidad Europea. Hospital Universitario Nino Jesus. Madrid. Spain

Abstract:
Objective: Oronasal fistula is an important complication of cleft palate repair. The overall incidence of reported fistula is 8.6 percent. Furthermore the incidence of fistula in cleft lip-cleft palate is significantly higher than in cases of cleft palate alone. The closure of wide palatal clefts and recurrent oronasal fistulae may be challenging. After repeated failure of conventional techniques (local flaps or buccal flaps), microvascular tissue transfer may be indicated in the closure of such fistulae. We present the temporoparietal fascia flap (TPFF) as alternative of surgical treatment of giant oronasal fistula.

Materials and Methods: A review of two cases of giant oronasal fistula whose reconstruction was performed using temporoparietal fascial flap. The first case is a 2-year-old male, and the second an adopted 5-year-old male. Both patients had significant lack of palatine mucoperiosteal flaps.

Results: The follow-up period has been more than 3 years (mean 4 years). The closure of oronasal communication was achieved without recurrence of the fistula. No significant complications were seen. The donor site morbidity is minimal.

Conclusion: The TPFF is a well vascularized flap that can be used for closure of giant oronasal fistula. The TPFF can be raised with minimal associated morbidity.

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PREOPERATIVE AND POSTOPERATIVE POLYSOMNOGRAM IN CHILDREN underwent PRIMARY PALATOPLASTY
Presenter: Diana Carolina Gomez Prada, M.D.
Author: Diana Carolina Gomez Prada, M.D., José Rolando Prada, Patricia Panqueva
Institution: Hospital Infantil Universitario de San José

Abstract:
Objective: To identify OSAHS in children with cleft palate between 6 and 24 months before and after primary palatoplasty at the Hospital Infantil Universitario San Jose.

Design: Prospective cohort study

Patients: Patients between 6 to 24 months of age, for primary palatoplasty without any associated pathology or syndrome.

Intervention: Presence and severity of OSAHS by a polysomnogram in the month prior to surgery and compare it with 6 months postoperative,

Results: From January to December of 2016, 17 patients were enrolled. Variables were evaluated and it was found that the average age of performing primary palatoplasty was 11.6 months, most frequently in female patients (10:7). The cleft lip and palate was present in 6 patients (35.2%). Among the most outstanding results in the preoperative questionnaires we found that 9 patients (52.9%) presented with snoring, 8 (47%) had excessive sweating and 7 (41%) patients raised from the bed during sleep. Evaluating the polysomnogram prior to surgery, 11 of the patients presented a confirmatory OSAHS (64.7%), with an average of IAH 3.9, which would be classified as low for children of this age.

The more frequent surgical technique was Bardach in 82%. Most improved snoring, awakenings, excessive sweating.

Evaluating with the postoperative polysomnogram in the patients who have already completed the observation time of the study, we find that they improve in snoring and AHI.

Conclusions: This study is presented as the first to be published with the data relating primary palatoplasty to the diagnosis of OSAHS gold standard, polysomnogram. It is noteworthy that the patients assessed have a previous diagnosis of OSAHS.
261 SECONDARY PHARYNGOPLASTY: MANAGEMENT AND OUTCOMES
Presenter: John H. Pang M.D.
Author: John H. Pang M.D., Xiao Zhu, Isaac James, Jack E. Brooker, Jesse A. Goldstein, Joseph E. Losee
Institution: University of Pittsburgh Department of Plastic Surgery

Background: Failure rates of pharyngoplasty (PPF or SP) range from 15-20%. There is a paucity of literature on the role, technique, and, most importantly, speech outcomes of secondary procedures, which include repeating or revising the pharyngoplasty. We present our single center experience.

Methods: A retrospective review was performed of all patients who underwent pharyngoplasty by a senior surgeon from 2003-2016. We evaluated demographics, medical comorbidities, surgical details, complications, and speech history. Additionally, a subgroup analysis was performed on patients exclusively cared for by the senior author with a homogeneous treatment algorithm for velopharyngeal insufficiency (VPI).

Results: 258 patients who underwent a pharyngoplasty were identified (240 PPF, 18 SP). Index procedures included pharyngoplasty 39 (15%) or palatoplasty 219 (85%). Twenty-eight patients (26 primary PPF, 2 primary SP) required secondary pharyngoplasty; PPF (21) or SP (7). Nine (32.1%) were syndromic, 6 (21.4%) had PRS, 1 (3.6%) had VCF, and the most frequent cleft was a Veau II (35.7%). The most common complication requiring secondary pharyngoplasty was VPI 13 (46%). Average speech scores improved (12 vs 8) and were near normal (3) by the time of tertiary procedures.

A Subgroup analysis of patients exclusively cared for by the senior author (76) demonstrated a lower complication rate (19.7% vs 56.0% p=0.000), reoperation rate (7.9% vs 51.9% p=0.000), and need for secondary pharyngoplasty (1.3% vs 11.7% p=0.000), with similarly optimal speech outcomes.

Conclusion: Current literature lacks a comprehensive description of secondary pharyngoplasty. Our study demonstrates complex VPI patients requiring secondary procedures can have improved speech outcomes. Furthermore, the outcomes of our subgroup analysis validates our algorithm for VPI management.

262 ACCELLULAR DERMAL MATRIX IN PRIMARY PALATOPLASTY: A PROSPECTIVE TRIAL
Presenter: Alexander Govshievich M.D.
Author: Salah Aldekhayel, Alexander Govshievich, Mirko Gilardino
Institution: McGill University

Abstract:
Purpose: Palatal fistula remains one of the most cumbersome complications of primary palatoplasty. Recent research showed promising early results in using acellular dermal matrix (ADM) to minimize the incidence of palatal fistula. The objective of the current study is to determine whether routine use of ADM in primary palatoplasty would lower the incidence of palatal fistula.

Method: A prospective trial was conducted and compared to a historical control group. Group 1 (prospective) included all primary palatoplasty cases (2012-2016) where the use of ADM was routine. Group 2 (retrospective) included all cases (2009-2012) where the use of ADM was selective, namely for wide clefts (>15mm) or as an augmentation to a tenuous nasal mucosal repair. All procedures were performed by the senior author and when used, the ADM was placed between the oral and nasal mucosa anterior to the muscle repair. Patients aged 3mo to 3y with Veau II-IV clefts undergoing primary palatoplasty using Intravelar Veloplasty or Furlow Palatoplasty were included.

Result: In total, 129 consecutive patients were included; 65 in Group 1 and 64 in Group 2. There were no statistical differences between both groups in terms of age at operation, gender, adoption status, associated syndromes, Veau class, hospital stay and technique used (p>0.05). All patients in Group 1 had ADM compared to 34% of patients in Group 2 (p=0.000). Incidence of fistula was 1.5% in Group 1 and 14.1% in Group 2 (p=0.007). There was no difference in the incidence of fistula between Furlow and Intravelar Veloplasty techniques (p=0.8). Subgroup analysis showed a significant difference in the incidence of fistula in adopted patients (14% in Group 1 vs. 50% in Group 2, p<0.05). The difference in fistula remained significant in non-adopted patients (0% in Group 1 vs. 9% in Group 2, p<0.05).

Conclusion: The routine use of ADM in this study has been shown to reduce the incidence of postoperative fistula following primary palatoplas
Abstracts

263 SPEECH OUTCOMES IN FURLOW PALATOPLASTY VERSUS STRAIGHT-LINE INTRAVELAR VELOPLASTY
Presenter: Laura A. Monson, MD
Author: Tara Braun, Edward P. Buchanan, MD, Kristina D. Wilson, PhD, SLP, Ellen E. Moore, MA, SLP, Cristina Hernandez, RN, Laura A. Monson, MD
Institution: Baylor College of Medicine

Abstract:
Background: While some studies have demonstrated that velopharyngeal insufficiency (VPI) occurs less frequently after Furlow palatoplasty compared to other techniques for primary palate repair, other studies failed to show any difference in speech outcomes. The aim of this study was to compare speech outcomes in Furlow palatoplasty versus straight-line intravelar veloplasty (IVV).

Methods: A prior study in our department found comparable speech outcomes after two surgeons performed Furlow palatoplasty for secondary speech surgery, demonstrating similarities in surgical skill. In the current study, one of the aforementioned surgeons performed all straight-line IVV repairs and the other performed all Furlow palatoplasties. From 2010 to 2016, 80 patients underwent straight-line IVV and 38 patients underwent Furlow palatoplasty for primary palate repair. We included patients who had surgery at 8-24 months of age and a follow-up speech evaluation at 2-4 years. Primary outcome measures of velopharyngeal (VP) function and hypernasality were measured perceptually by a speech pathologist.

Results: After Furlow palatoplasty, 71.4% of patients had competent VP function, 7.1% had incompetent VP function, and 21.4% needed more time to develop. Hypernasality ratings after Furlow palatoplasty were as follows: 50.0% of patients were within normal limits, 14.3% borderline, 28.6% mild, and 7.1% unable to assess. After IVV, VP function was competent in 57.1% of patients, marginally competent in 2.0%, and incompetent in 18.4%. Additionally, 18.4% of post-IVV patients needed more time to develop and 2.0% had VP mislearning. Hypernasality ratings after IVV were as follows: 34.7% of patients were within normal limits, 26.5% borderline, 18.4% mild, 6.1% moderate, 2.0% severe, 2.0% mixed and 6.1% unable to assess.

Conclusions: Our post-Furlow population had a greater percentage of patients with competent VP function and normal hypernasality ratings compared to the post-IVV population.

264 IMPLEMENTATION OF THE ICHOM ESTÁNDAR SET AT MID-SIZED CLEFT CENTER IN THE UNITED STATES
Presenter: Peter G. Bittar, B.S., B.A.
Author: Peter G. Bittar, B.S., B.A., Alexander C Allori, MD, Pedro E Santiago, DMD, Anna R Carlson, MD, Jeffrey R Marcus, MD
Institution: Duke University

Abstract:
Background: The complexity of Cleft Lip and/or Palate (CL/P) care has made robust, long-term outcomes research very challenging in great part due to the lack of standardized outcome measures. To this end, we organized an international, multi-stakeholder working group in 2016 and defined a standard set of outcome measures for the comprehensive appraisal of cleft care. However, the standard set has not yet been translated into clinical practice. In this project, we describe the development and implementation of CleftKit, a practical framework for prospective data collection based upon the standard set, and evaluate its success at the Duke Cleft & Craniofacial Center.

Methods: The development and implementation of CleftKit took place in three phases: (1) An initial one-month stage for creating patient- and clinician-reported forms and protocols for gathering, storing, and reporting data; (2) a six-week period for training team members, testing the system with live data, and making adaptions based on feedback; and (3) deployment into production. The system was monitored for three months under the RE-AIM framework to assess Reach, Effectiveness, Adoption, Implementation, and Maintenance.

Results: Preliminary data show that 95% of eligible patients were approached, with a 95% consent rate (Reach). For eligible patients, 85% of standard set clinician forms and 100% of patient surveys were submitted (Effectiveness). All team members participated (Adoption). We describe provider consistency, and the system’s fiscal and time costs (Implementation).

Conclusions: In this presentation, we describe our experience with the implementation of CleftKit and appraise its success. Specifically, we discuss the challenges of converting a conceptual framework into a clinically practical system for outcomes measurement. Finally, we explore the applicability of CleftKit to future CL/P effectiveness research and multi-center collaborative research.
LONG TERM OUTCOMES IN INTERMEDIATE TIP RHINOPLASTY IN THE UNILATERAL CLEFT PATIENT

Presenter: Julia Ayeroff M.D.
Author: Julia Ayeroff M.D., Elizabeth J. Volpicelli, Thomas Willson, Sam Asanad, Rachel S. Mandelbaum, James P. Bradley, Justine C. Lee
Institution: University of California Los Angeles

Abstract:
Background: Intermediate tip rhinoplasty in the cleft patient is performed to improve symmetry of the lower lateral cartilages and tip projection during the most critical period of a child’s psychosocial development in late childhood. In this work, we review the longevity of intermediate correction using photographic measurements.

Methods: 28 patients (mean age 7.1 years) with unilateral complete cleft lip and palate who underwent tip rhinoplasty with conchal skin/cartilage composite grafts at the UCLA Craniofacial Clinic treated between 2003-2017 were reviewed. Pre- and post-operative (<1, 1-3, 3-5, and >5 years) measurements from photographs were compared using ANOVA with post hoc comparisons with the Tukey criterion.

Results: Alar symmetry, assessed by the ratio between distances from nasal tip to alar base on the cleft versus non-cleft side, was improved from 1.08 preoperatively to 1.01 immediately postoperatively (p=0.02). Nasal projection, measured by the nasal base width divided by the height from columnar base to tip, was improved from 2.22 to 2.02 after tip rhinoplasty (p=0.04), and results remained statistically significant at follow up to >5 years. Cleft nostril width and height also demonstrated statistically significant improvements between preoperative and all postoperative timepoints, whereas non-cleft nostril relationships were relatively constant with minor variations. Vertical relationships of the alar bases to the medial canthi between the cleft and non-cleft sides trended towards improved symmetry, however, this did not achieve statistical significance. In all relationships evaluated, no statistically significant differences were noted between the postoperative timepoints.

Conclusions: Tip rhinoplasty for cleft nasal deformities in late childhood resulted in immediate improvement of symmetry and projection. Postoperative improvement persisted from the immediate period without significant differences in long term followup.

THE PUSHBACK PHARYNGEAL FLAP: A 17-YEAR EXPERIENCE

Presenter: Robert M Menard M.D., FACS.
Author: Robert M Menard M.D., FACS., Danielle H Rochlin MD, Paul A Mittermiller MD, Clifford C Shekter MD
Institution: Division of Plastic and Reconstructive Surgery, Stanford University School of Medicine, Stanford, CA, USA; Northern California Kaiser Permanente Craniofacial Clinic, Department of Plastic Surgery, Kaiser Permanente Santa Clara, Santa Clara, CA, USA

Abstract:
Background: The pharyngeal flap is one of the oldest and most popular techniques for correction of velopharyngeal insufficiency (VPI). Operative failures often result from inadequate flap design, contracture, or inappropriate level or strength of inset. We describe the largest series utilizing a technique that combines a pharyngeal flap with a palate pushback to avoid these complications while restoring the velopharyngeal mechanism.

Methods: A retrospective review of patients who underwent a pushback pharyngeal flap by a single surgeon from 2000 to 2017 was conducted. All patients had a preoperative nasoendoscopy diagnostic of VPI. Operative technique involved elevation of the hard palate mucosa via a retroalveolar incision, passage of the flap through an opening in the nasopharyngeal mucosa, and inset with sutures through the hard palate mucosa.

Results: 40 patients (20 males, 20 females) were identified with a median age of 10 years at the time of surgery. Associated diagnoses included cleft lip/palate (n=22) with Pierre Robin Sequence (n=2) and Goldenhar Syndrome (n=1), submucous cleft palate (n=10), and non-cleft VPI (n=8). 10 patients had Veloccardiofacial Syndrome. Preoperative closure patterns were mostly coronal (86%) with poor posterior wall motion and an average gap size of 28 sq mm. Postoperatively, 2 patients developed moderate obstructive sleep apnea, 2 patients had transient dysphagia, and 2 patients required flap revision. At an average of 2.6 years postoperatively, 91% of patients achieved velopharyngeal adequacy with improvement or correction of hypernasality (88%), nasal air emission (97%), nasal acoustic energy (89%), and use of compensatory substitutions (83%).

Conclusion: The pushback pharyngeal flap is a safe and effective technique for treatment of VPI based on our 17-year experience. The advantages of this technique include high, secure inset with prevention of palatal scar contracture and shortening.
E-POSTERS
E-Poster 1

Three-Dimensional Assessment of Zygomatic Malunion Using Computed Tomography in Patients with Cheek

Presenter: Yung Ki Lee Authors: Yung Ki Lee, Baek Kyu Kim, Rong Min Baek, Chang Sik Pak
Institution: Kyung Hee University Hospital

Abstract:

Purpose: Malunion and cheek ptosis are known as major complications in reduction malarplasty. However, there have been few reports about their causes and patterns. The authors experienced many revision reduction malarplasty using the coronal approach, and could categorize the types of malunion by analyzing 3-dimensional CT imaging prior to revision surgery.

Methods and Materials: Twenty-four patients underwent revision reduction malarplasty. The operative procedures during revision surgery included repositioning of malar complex and obtaining bone-to-bone contact with rigid fixation.

Results: The types of zygomatic malunion could be categorized into four patterns according to the shape of displacement and the existence of fixation: (1) Type I: External rotated zygoma with the sign of oblique depression, (2) Type II: Displaced zygomatic arch with the sign of cheek ptosis and depression, (3) Type III: Clockwise rotated zygoma with zygomatic arch union along with the sign of cheek ptosis and loss of zygomatic prominence, (4) Type IV: Floating zygoma with bony resorption along with the sign of severe cheek ptosis and tenderness over non-union site.

Conclusion: On the review of 3D CT images showing malunion after reduction malarplasty, we found the correlation between cheek ptosis and zygomatic malunion, which could be categorized into four types according to the displacement shape and pattern. In those cases, revision reduction malarplasty with coronal approach should be considered as an ideal solution to overcome the difficult situation.

E-Poster 2

Use of Orthodontics for Maxilla-Mandibular Fixation in Pediatric Mandibular Fracture: A Case Series

Presenter: Renata S Maricevich
Authors: Wendy Chen, Lindsay A Schuster, Brian S Martin, Renata S Maricevich
Institution: University of Pittsburgh Medical Center

Abstract: Pediatric mandibular fractures are rare and treatment can be challenging. Clinicians must consider future mandibular growth, temporomandibular joint (TMJ) pathology, and occlusal and dental development. When a short period of maxillo-mandibular fixation (MMF) is indicated, orthodontic brackets may be a non-invasive alternative to arch bars, avoiding general anesthesia. This is a single-surgeon case series of three patients with sub/condylar fractures managed with closed reduction (CR) and MMF. Our algorithm involved placement of fixed orthodontic brackets or placement of hooks to preexisting braces, starting with heavy elastics bilaterally. Patients were followed closely for 4-6 weeks and, depending on occlusion, slowly weaned to looser elastics, contralateral placement, and advancement of diet. At their final follow-up (2-6 months), a Panorex was taken. Age at injury ranged from 7 to 16 yo (mixed and permanent dentition); injuries involved direct trauma from falls with a variety of fracture patterns (burst intracapsular, displaced subcondylar, bilateral). CR/MMF with elastics was the treatment of choice.

Considerations for management with orthodontic brackets included dental trauma requiring splints, poor dental anchorage units (such as primary teeth), and pre-existing braces. Our patients achieved class I occlusion and normal mouth opening by their last visit. One patient was too uncomfortable with initial occlusal restoration attempt in clinic and required CR under sedation; his final Panorex had slightly decreased condylar height without functional or cosmetic complaints. Mandibular fracture patients of different ages and stages of dental development were managed safely and successfully with non-invasive orthodontic bracket for MMF and elastics. In order to avoid surgical procedures and exposure to anesthesia, orthodontic fixed brackets can be considered for management of pediatric mandibular fractures.
**e-poster 3**

**Reconstruction of auricular defect after human bite using advanced auricular skin cartilage flap coverage**

Presenter: Ji Min Kim  
Authors: Ji Min Kim, Min Gyu Park  
Institution: Seoul St. Mary Hospital

**Abstract:** Reconstruction of auricular defects are remains a challenge to the plastic surgeon. The complex topographic shape of the cartilage and its poor blood supply represent a surgical challenge to its reconstruction. The location and the extent of the involved auricular structures and the condition of the tissue surrounding the defect have an important influence on the selection of an appropriate treatment planning. We present a case of reconstruction of auricular defects after near amputation from a human bite using the advanced auricular skin cartilage flap coverage, which is a favorable procedure due to simple and one-stage technique for ear reconstruction. Our case is that a 46-year-old male patient had admitted with 2 x 2 cm sized wedge shape skin and cartilage defect on right auricle due to human bite. On examination, the superior one-third of his right external ear was missing. Because he suffered from severe pain and had infectious sign on defect margin, we needed to use intravenous antibiotics for 6 days prior to surgery until skin and soft tissue infection was improved. To cover the 3 x 2 cm sized defect, we designed advanced auricular skin cartilage flap coverage. He showed the 3 x 2 cm sized initial defect on upper helix and part of anti-helix of right auricle (Figure 1).

After the debridement of the unviable tissue, skin was incised as designed line. The subcutaneous layer and ear cartilage were undermined for the approximation of the wound without tension. Patient was satisfied with the final results, especially the symmetry of the size and the shape of the ear compared to the other side. He was discharged on the post-operative day 7 without complications. In this case, we could simply reconstruct the auricular defect without any postoperative complication, conserving the symmetry of the ear. Thus advanced auricular skin cartilage flap coverage can be a considerable choice when covering the defect of auricle.

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**e-poster 4**

**Towards inclusion of parental assessments in nonsynostotic plagiocephaly research**

Presenter: Peter J. Taub  
Authors: Hope Weissler, Peter J. Taub  
Institution: Icahn School of Medicine at Mount Sinai

**Abstract:**

**Introduction:** NSP is treated primarily for cosmetic reasons with parents as the primary stakeholders, but no grading system has been shown to correlate with parental opinions. The authors hypothesized that the Argenta scale would correlate with parental assessments of severity as it is based on observable differences.

**Methods:** Parents of NSP patients rated their child's head shape and overall appearance on VAS scales (with one equal to completely normal and ten equal to completely abnormal at the initial consultation). The senior author filled out identical evaluations as well as the Argenta scale.

**Results:** 27 parents of NSP patients were included. Their children's average age was 5.6±2.2 months. Parents rated their child's head shape 5.10±1.99 and overall appearance 1.97±1.99. The surgeon rated these parameters 4.27±2.09 and 2.97±2.39, respectively. Caregiver and surgeon ratings of head shape and overall appearance were not significantly correlated (head shape p=0.054; overall appearance p=0.080). Surgeon rating of head shape abnormality and overall appearance correlated with Argenta classification (head shape correlation coefficient=0.590 and p=0.003; overall appearance correlation coefficient=0.642 and p=0.001). However, neither parental ratings of head shape nor overall appearance correlated with Argenta classification (head shape p=0.101; overall appearance p=0.490).

**Conclusions:** Research about treatment of NSP often relies on objective measurements that may be statistically significant yet of questionable clinical importance. Caregiver ratings of infant head shape and appearance are rarely, if ever, collected. The authors hypothesized that the Argenta classification might correlate with parental assessments, in which case it could be used as a proxy for parent-reported outcomes. However, this was not the case. Researchers must be rigorous about collecting parent-reported outcomes in future studies about the efficacy of NSP treatment.
**e-poster 5**

**Management of Frontal Sinus Fractures: A 12-Year Experience at a Level 1 Trauma Center**

Presenter: Ian C. Hoppe  
Authors: Ian C. Hoppe, Jerette Schultz, Jordan Halsey, Edward S. Lee, Mark S. Granick  
Institution: Rutgers, New Jersey Medical School

**Abstract:**

Purpose: The goals of frontal sinus fracture management are to provide an aesthetic outcome, restore function, and prevent complications, there is no universal consensus on best treatment strategies. The purpose of this study was to examine a level 1 trauma center's 12-year experience treating frontal sinus fractures.

Methods: A retrospective review of all facial fractures at a level 1 trauma center was performed for the years 2000 to 2012. Patient demographics, location of fractures, concomitant injuries, use of antibiotics and surgical management strategies were collected for all frontal sinus fractures.

Results: During this period, there were 291 frontal sinus fractures treated at our institution. The mean age of patients was 34.4 years with a male predominance (90%). The most common mechanisms of injury were assault in 82 (28.2%) and motor vehicle accident in 80 (27.5%). Anterior table fractures were seen in 261 patients (89.7%) and posterior table fractures were seen in 181 (62.2%). Treatment included ORIF with sinus preservation in 18 (6.2%), ORIF with sinus obliteration in 20 (6.9%), and cranialization in 18 (6.2%). Antibiotics were started on admission in 152 patients (52.2%). Complications included fatality (9.3%), meningitis (1%), frontal sinusitis (1%), early wound infection (0.3%), and mucopyelocele (0.3%). Open fractures were more likely to be started on antibiotics on admission (p<0.05) and patients started on antibiotics on admission were less likely to suffer a fatality (p<0.05).

Conclusion: Most frontal sinus fractures at our institution (82%) were treated conservatively with no surgical intervention and we observed a low rate of long term complications. Interestingly, patients started on antibiotics on admission were less likely to suffer a fatality, further complicating the role for prophylactic antibiotics in frontal sinus fracture management.

**e-poster 6**

**A Safe and Effective Method to Transfer Pedicle Vessels in Free Flap Reconstruction**

Presenter: Hyo Young Kim  
Authors: Hyung Suk Yi, Hyo Young Kim, Hong Il Kim, Jin Hyung Park  
Institution: Kosin University College of Medicine

**Abstract:**

Background: Free tissue transfer is a useful method to cover soft tissue defects following trauma or tumor excision in craniofacial regions. Recipient vessels are usually separate from the defect site. Most surgeons use a tunnel under the subcutaneous or submuscular layer to transfer the pedicle of the flap from the defect site to recipient vessels instead of the additional skin incision. The tunneling is a necessary method to avoid additional scar in craniofacial region. At the time of transfer through the tunnel, kinking or damage of the pedicle can occur. The aim of this study is to introduce a simple, safe, and effective method to overcome these problems using a Penrose drain.

Methods: After making a tunnel from the defect site to the recipient vessel, a Penrose drain was passed through the tunnel. Pedicle vessels were gently inserted into the Penrose drain using the entire tunnel length after harvesting the free flap. Before insertion, the inner surface of the Penrose drain was irrigated with normal saline as a lubricant. The end of the Penrose drain was smoothly pulled into the recipient vessel side. Both pedicle vessels and the Penrose drain were gently pulled together at the inserted portion of the pedicle vessels. After the Penrose drain was completely pulled out, a portion of the pedicle vessels emerged from the recipient vessel side.

Results: From January 2014 to October 2016, 13 patients had free flap reconstruction and pedicle transfer through a tunnel under the skin using a Penrose drain. There were 13 Craniofacial and neck reconstruction cases. There were 10 anterolateral thigh flaps and 3 radial forearm flaps. All flaps successfully survived on the defect site without vascular problems.

Conclusion: This method is easy, safe, and effective to transfer pedicle vessels. The present method helps craniofacial reconstructive microsurgeons transfer pedicle vessels through a tunnel without torsions or injuries.
**E-Poster 7**

Regression of Cephalic Index following Endoscopic Repair of Sagittal Synostosis

**Presenter:** Naidoo, Sybill D  
**Authors:** Pickersgill, Nicholas A, Skolnick, Gary B, Naidoo, Sybill D, Woo, Albert S, Smyth, Matthew D, Patel, Kamlesh B  
**Institution:** Washington University School of Medicine in St. Louis

**Abstract:**

**Introduction:** Patients with sagittal synostosis present with scaphocephaly due to directed cranial growth in the anteroposterior dimension. Two metrics used to quantify the severity of scaphocephaly are cephalic index (CI), the well-known standard; and the recently described adjusted cephalic index (aCI), which accounts for altered euryon location in patients with sagittal synostosis. Previous studies have determined the normal range of CI and aCI to be 75-85. The aim of this study is to determine whether CI and aCI declines after completion of helmet therapy in patients treated with endoscope-assisted strip craniectomy and postoperative helmet therapy (E+HT).

**Methods:** The authors retrospectively reviewed data of all patients with isolated sagittal synostosis treated with E+HT between 2006 and 2014. Imaging (computed tomography (CT) or 3D photo) preoperatively, 0-2 months postoperatively, and >24 months postoperatively was required. CI and aCI were calculated. Regression analysis assessed differences between time points.

**Results:** 41 subjects were found with CT (n=8) or 3D photos (n=33) that met requirements. Imaging occurred 1±1 months before surgery, 12±3 months post-op, and 44±14 months post-op. Helmet therapy lasted 7±2 months. A strong, positive correlation existed between CI and aCI (R=0.875). Mean CI and aCI increased from 71.8 to 78.2 and 62.8 to 72.4, respectively, during treatment (p<0.001). At final follow-up both mean CI and aCI had regressed from 78.2 to 76.5 and 72.4 to 69.7, respectively (p<0.001). CI regressed in 33 of 41 cases (80%) and aCI in 39 of 41 cases (95%). The majority of cases had regressed to below the normal range at conclusion of the study.

**Conclusions:** Regression following endoscope-assisted strip craniectomy and postoperative helmet therapy commonly occurs in patients with sagittal synostosis. Further studies are required to discover whether duration of helmet therapy and modifications in helmet design affect regression.

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**E-Poster 8**

Is there an epidemiological shift in non-syndromic, single-suture craniosynostosis? Results from a literature review and a national survey of craniofacial and neurosurgeons

**Presenter:** Michael Golinko  
**Authors:** Alex Han, Michael Golinko  
**Institution:** University of Arkansas for Medical Sciences

**Abstract:** The sagittal suture has long been touted as the most common subtype of craniosynostosis. Noting that many centers have treated more metopic craniosynostosis in recent years, we sought to investigate this trend nationally.

**Methods:** A PUBMED review was first performed and to identify articles that specifically examined epidemiology of single-suture craniosynostosis. A 9-item survey was emailed to 243 pediatric neuro and craniofacial surgeons in North America.

**Results:** Seven articles were reviewed, totaling 5885 patients in Australia, France and the US. While two studies confirmed sagittal as the most prevalent type of craniosynostosis—the remaining 5 noted an increase in incidence of metopic craniosynostosis, ranging between 7.1% to 27.3% increase as compared to sagittal. The survey response rate was 24%. The mean incidence of all cases (operative and non-operative) approximately 40% were metopic, 39% sagittal, and 14% coronal. Of all cranial vault remodeling (CVR) performed, 53% for sagittal, 24% metopic and 20% percent coronal. Nearly all of the coronal subtypes encountered underwent CVR. Of all non-operative cases seen, metopic craniosynostosis was 78% compared to 14% for sagittal. Respondents were asked if they perceived a shift in the most prevalent type of craniosynostosis over the course of their career. Only 6% of respondents indicated they previously perceived metopic as the most prevalent, compared to 23% in their current practice. Over 80% of respondents indicated that they would favor ICD-11 codes that differentiated suture-specific pathology, rather than head shape.

**Conclusions:** Sagittal craniosynostosis appears to remain the most common type operated for, however, there is evidence and expert opinion to suggest an epidemiologic shift in metopic craniosynostosis. Future study is needed with more precise diagnostic codes that could lead to more accurate epidemiological and etiologial study of craniosynostosis.
e-poster 9
Use of in situ simulation to improve management of massive hemorrhage during craniofacial surgery
Presenter: Sumit Das
Authors: Sumit Das, Arnwald Choi
Institution: Oxford Craniofacial Unit, UK

Abstract:
Background: Simulation based education has been used in the Oxford University Hospitals NHS Foundation Trust for the past twelve years, with the aim of improving technical and non-technical skills for medical and nursing staff. Providing these sessions in situ in the operating room (OR) allows rehearsal of critical incidents, learning as a team, and highlights potential patient safety issues.

Methods: Multidisciplinary teams consisting of anesthesiologists, plastic surgeons, neurosurgeons, anesthetic nurses, scrub nurses and porters attend sessions lasting 2 hours. The clinical scenario is based on a 1 year old child undergoing calvarial remodelling in the prone position (routine for our centre). During simulated surgery, there is a breach of the sagittal sinus and major hemorrhage ensues. After appropriate management of this complication, there is a team debrief. A high fidelity infant manikin is used alongside the actual equipment, drugs and protocols that are used in daily practice. Learning Objectives: Identifying anesthetic team in difficulty, calling for help, being able to speak up in a team, familiarisation with massive transfusion protocols, management of paediatric haemorrhage and potential cardiac arrest in prone position.

Results: Feedback has been compiled from delegates and faculty. Discussions around management of massive haemorrhage in children, protocols and process for ordering blood and blood products urgently.

Key Messages: We intend in situ simulation to become an important tool for quality and safety improvement in our unit via discussions following simulation training at the Craniofacial Clinical Governance meetings. We believe this to be the worlds first simulation of management of massive haemorrhage in a pediatric craniofacial theatre. Our unit would be happy to assist other units interested in running simulations in their own hospital.

e-poster 10
Surgical treatment of head and neck Ewing Sarcoma of the French population
Presenter: Natalie Kadlub
Authors: kadlub, Bouaoud Jebrane, Belhous Kahina, Galmiche Louise, Bolle Stephanie, Couligner Vincent, Arnaud Picard, Le Deley Marie-Cecile, Cozic Nathalie, Gaspar Nathalie
Institution: Necker-Enfants-Malades-Paris Descartes

Abstract:
Introduction: Ewing Sarcoma of the head and neck is rare. Management of local treatment for head and neck localization is challenging. The main objective was to evaluate the surgical approach for head and neck Ewing Sarcoma. The secondary aim was to evaluate outcomes for these operated patients according as they have received or not radiotherapy.

Design: Prospectively collected data and charts of the French patients with confirmed and operated head and neck Ewing Sarcoma registered in the Euro-Ewing 99 trial from 1999 to 2014 were retrospectively reviewed and analyzed by blinded expert surgeon, pathologist, radiation oncologist and oncologist. Event-free and Overall survival were statistically calculated using Kaplan-Meyer Method.

Results: 39 patients were included and analyzed. Primary surgery was performed for 13 (33%) patients, without any reconstruction and was most of time intralesional (R2= 8/13). All these patients received additional radiotherapy. 26 (67%) patients were operated after induction chemotherapy with immediate reconstruction in half of cases and without any intralesional surgical resection. In this group 11/18 (61%) surgical resection margins initially classified RO (radical) according to Euro Ewing 99, have been reclassified R1a according to Euro Ewing 2012 histological definition. No R2, 46% of R0 and reduction of R1a margins were observed only after surgery of initial volume of tumor called ghost surgery. No acute complication of surgery was fatal. 74% (29/39) of patients have developed significant long-term sequels. Overall and Event-Free survivals were respectively 92% and 79%. Four Local recurrences were found, 75% after primary surgery. Prognosis was poor, with death of 3 of them.

Discussion: Euro Ewing 2012 histologic definition focuses on two fundamental points: the oncological and functional benefits of ghost surgery that should to be adopted after chemotherapy and the improvement of the indication of postoperative radiotherapy.
e-poster 11
Vermillion only cross-lip flap for treatment of whistle deformity in secondary bilateral cleft lip repair
Presenter: Robert Menard
Authors: Danielle Rochlin, Clifford Sheckter, Paul Mittermiller, Robert Menard
Institution: Stanford

Abstract:
Bilateral cleft lip repairs can result in various secondary deformities. One more commonly seen deformity, the whistle deformity, is characterized by a reduced or absent tubercle, orbicularis muscle diastasis, and abnormalities of the philtrum with notched appearance of cupid’s bow. Various techniques have been described to address these problems. One common procedure is the lip-switch flap originally described by Abbe in 1898, which has been modified by various surgeons. In these procedures, lower lip vermilion, mucosa, orbicularis, and lip skin is transposed to the upper lip on a pedicle that is later divided. In all these variations of the lip-switch procedure, the transposed tissue involves the entire lower lip skin - leaving large, unsightly, and unnecessary scars. It also brings abnormal tissue into the philtrum further distorting the upper lip. A modified cross-lip flap that is limited to the taking only mucosa, vermilion, and orbicularis is feasible and provides an optimal reconstruction without compromising additional tissue.

e-poster 12
Airway management through submittal derivation. Safe and easily reproduced alternative for patients with complex facial trauma
Presenter: García Cano Eugenio
Authors: Malagón Hidalgo Héctor Omar, García Cano Eugenio, González Magaña Fernando, Vilchis López Roberto, Fentanes Vera Adriana, Ayala Ugalde Fernan Alejandra
Institution: Instituto de Seguridad Social del Estado de México y Municipios

Abstract: Airway management through submittal derivation. Safe and easily reproduced alternative for patients with complex facial trauma.

Introduction: The airway management in patients with complex facial trauma is complicated. Besides involving facial lesions, it compromises the airway and the intermaxillary fixation becomes difficult to secure through usual methods. The submental derivation is an alternative to nasotracheal intubation and tracheostomy, allowing to obtain a permeable airway in a simple manner with minimal complications.

Material and methods: Descriptive, retrospective study, based on the review of clinical records of patients with facial trauma from January 2003 to May 2015, all the patients with submental derivation were included.

Results: 31 patients were included, 16 with LeFort I fracture, 11 with LeFort II fracture, 3 with LeFort III fracture and 1 patient with a naso orbito ethmoidal fracture, all of them had concomitant injuries which did not allow the use of usual intubation. The submental derivation was performed through a sequence and critical steps identified by us. No complications were presented.

Discussion: The submental derivation is a simple and safe manner to secure the airway in patients with complex facial trauma. Based on our experience, if the sequence and relevant steps are followed, it is a safe and effective alternative for the airway management in these patients in which usual intubation is not possible.

Conclusion: Safe alternative for patients with complex facial trauma and easy to perform by any surgeon following these steps and sequence.
**e-poster 13**
Intermaxillary Fixation Efficacy With Titanium Screws In Patients With Facial Fractures And Dentofacial Deformities

**Presenter:** García Cano Eugenio  
**Authors:** Malagón Hidalgo Héctor Omar, García Cano Eugenio, González Magaña Fernando, González Chapa Diego Raúl  
**Institution:** Instituto de Seguridad Social del Estado de México y Municipios

**Abstract:** The current study evaluates the efficacy of intermaxillary fixation using titanium screws in patients that required this procedure. Seventy-three patients with craniofacial fractures or dentofacial deformities were treated with intermaxillary fixation and rigid bone fixation. All patients were approached by clinical evaluation and radiographic documentation, assessing dental vitality, teeth mobility, final occlusion, surgical time, and the presence or absence of vascular or nerve damage. The complications documented were attributed to rigid bone fixation or the nature of the fracture itself. No dental root damage or screw breakage was observed. Based on these results, we conclude that the use of titanium screws is a useful alternative in patients requiring intermaxillary fixation.

**e-poster 14**
Correction of severe hypertelorbitism with nasoethmoid encephalocele during infancy

**Presenter:** Amir Elbarbary  
**Authors:** Amir Elbarbary Coauthors: Walid Abdel Ghany, Assem Abdel Latif  
**Institution:** Plastic Surgery, Ain-Shams University

**Abstract:** The appropriate age surrounding the optimal timing for correction of hypertelorbitism is still controversial. An infant with nasoethmoid encephalocele & a wide Tessier no. 0 to 14 cleft (interdacryon distance 46 mm) is described. A successful short-term outcome of facial bipartition & simultaneous soft tissue correction of nose/lip conducted at the age of 11 months is reported. The infant had separation of the orbits, nasal, & maxillary regions and a large central mass herniating inferiorly through defective anterior cranial base. MRI & CT confirmed herniating brain parenchyma. Lack of oral competence & the presence of wide cleft palate created feeding problems. Therefore and because of the risk of injury to the unprotected herniating brain, emotional & psychological drive of the parents, it was elected to perform the definitive corrective surgery at this very early age. Through coronal incision, frontal craniotomy was performed & the accessory central bone between the orbits was resected.

The encephalocele was mobilized superiorly & the dura was dissected off medial orbital walls then repaired. Facial bipartition was carried out, then a pericranial graft was placed to re-enforce the dural repair & covered by part of the resected central bone to reconstruct the anterior cranial base. Intraoperative medialization of the facial halves was accomplished to an interdacryon distance of 22 mm and fixed. The medialized complex was then advanced for 15 mm, fixed to the temporal bone & secured with interposional bone grafts. Transnasal medial canthopexy was performed with bolsters placed externally. Fixing the frontal bone in its new position was done followed by closure of the coronal flap. K stitch technique was used to address excess glabellar soft tissue & brow width without external vertical scar. Soft tissue repair of his median cleft lip & nose completed the operative procedure. The postoperative period was uneventful & he underwent palatal repair three months.
**E-Poster 15**

Reossification of anterior skull base with pericranial flaps after frontofacial monobloc

Presenter: Anne Morice  
Authors: Anne Morice, G. Paternoster, A. Ostertag, S. James, RH Khonsari, E. Arnaud  
Institution: Hospital Necker craniofacial unit

**Abstract:** Frontofacial monobloc advancement surgery (FFMBA) creates retrofrontal dead spaces and a communication between the anterior cranial fossa and nasal cavities. Trans-orbital double pericranial pedicled flaps (PF) were performed to seal the anterior base. The post-operative ossification of the anterior skull base was evaluated.

**Patients and Methods:** All patients were operated on of a FFMBA between 2005 and 2015. Twenty-two patients were included: 14 with Crouzon syndrome (CS), 5 with Pfeiffer syndrome (PS), and 3 with Apert syndrome (AS). FFMBA was performed at 3.1 years (1.9 - 3.6). Thickness of skull base (SB) without PF and SB with PF (SB-OPF) were measured on CT-scan at nasofrontal (NF) and nasoethmoidofrontal junctions (NEF). VGStudio Max 3.0 was used and a qualitative defect score (DS) was computed.

**Results:** On immediate post-distraction CT-scans, PF and distraction gaps were not ossified and there was a difference in SB thickness between patients and controls at the NEF point (p = 0.02). One and five years after surgery, the distraction gap was completely ossified in the anterior midline in all patients. But SB-OPF was thicker than SB at these two timepoints (p<0.005 and 0.02). Pfeiffer had significantly thicker SB and OPF thicknesses (p = 0.01 and 0.03) than others. Defect score was lower in Pfeiffer than others (P = 0.03) at one-year post-operatively.

**Conclusion:** Our results show ossification of pericranial flaps and total reossification of the anterior SB midline in all patients. Pericranial pedicled flaps in FFMBA are recommended to seal anterior fossa.

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**E-Poster 16**

Evolution of Spring-Assisted Calvarial Expansion for Bicoronal Craniosynostosis

Presenter: Lisa Renee David  
Authors: Christopher Runyan, Kyle Steven Gabrick, Jungwon Genevieve Park, Edreca Allison Thompson, Daniel Couture, Lisa Renee David  
Institution: Wake Forest Baptist Medical Center

**Abstract:**

**Introduction:** Spring-assisted surgery for early treatment of patients with sagittal synostosis has become an accepted treatment option. The use of springs for calvarial expansion of multi-suture synostosis is not widely reported. We report our series of patients with bicoronal synostosis or kleblatschadel deformities, treated initially with spring-assisted calvarial expansion (SACE).

**Methods:** A retrospective database of patients with bicoronal synostosis who underwent SACE at Wake Forest Baptist Medical Center from 2005 to 2017 was compiled for review. Demographics, operative details, clinical photos and imaging were analyzed.

**Results:** Of 11 patients enrolled, diagnoses included Muenke (4), Crouzon (2), Pfeiffer (1), Apert (1), Loeys- Dietz (1), and non-syndromic (1). Mean follow up age is 7.6 years. Mean number of operations was 2.5. Two early patients underwent SACE at the coronal sutures. One of these had inadequate expansion of the orbital bandeau and re-synostosis of the coronal sutures. Thereafter we focused our SACE on the posterior vault, by placing springs at bi-lambdoid and sagittal sutures. Fronto-orbital advancement (FOA) was then performed at the time of final spring removal. Of those with Kleblatschadel deformity, one died before spring removal due to complications of intussusception, and the other had excellent correction of her deformity. Two unplanned revisions occurred: one for threatened spring exposure, and one for inadequate frontal expansion. Suboptimal outcomes included reported secondary effect of FOA including bitemporal narrowing, biparietal widening, and excessive vertical height.

**Conclusion:** Spring-assisted surgery is a useful tool for staged calvarial expansion in those with bicoronal synostosis. Best results are achieved when combining SACE for posterior expansion while employing standard open FOA to subsequently remodel the anterior cranium.
e-poster 17
Skoog Primary Periosteoplasty versus Secondary Alveolar Bone Grafting in Unilateral Cleft and Alveolus: Long-term Effects on Alveolar Bone Formation and Maxillary Growth
Presenter: Malin Hakelius
Authors: Fatima Jabbari, Malin Hakelius, Andreas Thor, Erika Reiser, Valdemar Skoog, Daniel Nowinski
Institution: Dpt of Plastic- and Maxillofacial Surgery, Uppsala University Hospital, Sweden

Abstract:
Background: Clefts involving the alveolus may be treated with two different methods: primary periosteoplasty, PPP, at the time of lip repair or secondary alveolar bone grafting, SABG, at mixed dentition. Few studies have compared the long-term outcomes of these two treatment alternatives.

Methods: Fifty-seven consecutive patients born with unilateral cleft lip and alveolus were studied retrospectively. All patients underwent primary lip repair according to Skoog. 28 patients were treated with PPP at the time of lip repair and 29 were treated with SABG at mixed dentition. Occlusal radiographs at 10 and 16 years of age were analysed for alveolar bone height. Cephalometric analysis assessed growth at 5, 10 and 18 years of age.

Results: Seventeen of 28 patients treated with PPP required later secondary bone grafting and the bone height at 16 years of age was lower in the PPP group. In the PPP group there was a more pronounced decrease in maxillary protrusion from 5 to 10 years. There was no significant difference in maxillary growth between the two groups at the age of 18 years.

Conclusion: Primary periosteoplasty did not seem to inhibit long-term maxillary growth, but was ineffective as a method to reconstruct the alveolar cleft.

e-poster 18
Comparison Between Oximetry and Polysomnography in Identifying Airway Obstruction in Infants with Robin Sequence
Presenter: Rafael Galli
Authors: Rafael Galli, Mirko Gilardino, Lucie Lessard, Aurore Côté
Institution: McGill University

Abstract:
Purpose: Polysomnography is the gold standard for the diagnosis of obstructive apnea in infants with Robin Sequence. However, its routine use is limited by cost and availability. The purpose of our study was to determine whether nighttime pulse oximetry (oximetry), an inexpensive and widely available technology, could be used as a surrogate for polysomnography in identifying obstructive apnea in infants with Robin Sequence.

Methods: We reviewed all polysomnographies done in infants with Robin Sequence treated at the Montreal Children's Hospital. We extracted the following standard data: Central Apnea Index and Mixed Obstructive Apnea Hypopnea Index (MOAHI) from polysomnography data and Desaturation Index (drops≥4%/hour, DI4%) from the oximetry done at the time of polysomnography. Symptoms of obstructive apnea were assessed with a standard questionnaire. A MOAHI≤5 was used to separate infants with no/mild obstruction from those with moderate/severe obstruction (MOAHI>5).

Results: We reviewed 39 polysomnographies (26 infants, age: 12.2±4.8 months). Central apnea with a mild decrease in oxygenation was a frequent occurrence. All infants with a DI4%<7 events/hour (22 studies) and no significant snoring had no or mild obstructive apnea on polysomnography. In patients with DI4%>7 events/hour, 53% had moderate or severe obstruction. In the remaining infants, central events with desaturation predominated.

Conclusion: In Robin Sequence, oximetry can identify those infants with no or mild obstructive apnea thereby decreasing the demand for polysomnography. With a DI4%>7 events/hour, polysomnography is required to differentiate between obstructive and central events.

Teaching Objectives: Learners will 1) evaluate the usefulness of different tests in the diagnosis of apnea in infants with Robin Sequence and 2) identify parameters of importance in polysomnography and pulse oximetry as it relates to obstructive sleep apnea in infants.
e-poster 19
Posterior Vault Distraction Osteogenesis: Rates of Ossification in Bone Gaps after Consolidation
Presenter: Sanjay Naran
Authors: Sanjay Naran, Daniel Mazzaferro, Natasja ter Maaten, Ari Wes, Scott Bartlett, Jesse Taylor
Institution: University of Pennsylvania

Abstract:
Background: The authors have observed significant bone gaps in the regenerate at the time of distractor removal in posterior cranial vault distraction osteogenesis (PVDO), and these gaps often close in the long-term. The purpose of this study is to quantify bone gaps at the time of distractor removal, determine whether increased bone gaps predispose to relapse, and investigate whether age at surgery affects re-ossification rates.

Methods: Our prospective craniofacial registry was queried for patients who underwent PVDO with CT scans at two timepoints: one immediately after completion of consolidation and another within two years of completion. Using Mimics® software, the cranial bone gaps created after PVDO were traced to calculate total surface area. A paired t-test and linear regression were used to compare size of bone gaps, presence of relapse, and rates of re-ossification.

Results: A total of 69 PVDO patients were identified, with 7 patients meeting inclusion criteria. Three were infants (<1 year) and 4 were older. Consolidation began 28.3+6.0 days after surgery and continued for 64.9+14.5 days. Length of time between the first and second set of CT scans was on average 7.5+2.7 months. A significant decrease in bone gaps occurred from the earlier to later CT (33.4+14.6cm² vs. 19.2+17.2cm², p=0.005). Regression analysis revealed, after consolidation, that ossification occurred at rate of 2.4cm² per month (p=0.046). The rate of bony regeneration after consolidation in patients under and over one year old was 4.3cm³/month (p=0.025) and 1.5cm³/month (p=0.552), respectively. Despite differential bony regeneration rates, no patients demonstrated relapse.

Conclusion: Calvarial bone gaps that are present after PVDO consolidation undergo re-ossification at a rate that appears to be faster in infants than those who are older. The presence of bone gaps does not correlate with relapse of cranial expansion which is in line with much of the reported literature on PVDO.

e-poster 20
Cost Effectiveness Analysis of Demineralized Bone Matrix and rhBMP-2 vs. autologus iliac crest grafting in Alveolar Cleft Patients
Presenter: Sagar Mehta
Authors: Sagar Mehta, Barbu Gociman, Faizi Siddiqi, Duane Yamashiro, Ross Blagg, James Willcockson
Institution: University of Utah

Abstract:
Aims: The standard of care for patients with secondary alveolar clefts is autologous bone grafting (ABG) using iliac crest graft. While ABG is effective, it has associated morbidities, including donor site pain and paresthesias. The combination of demineralized bone matrix with rhBMP-2 (DBX/BMP), as a substitute to ABG, has been shown to have similar results in regards to bony incorporation but no donor site morbidity. It has been argued that one of the drawbacks of using DBX/BMP is the higher cost. The aim of this study is to compare the cost, operative time, and hospital length of stay associated with these two treatment modalities.

Methods: A retrospective chart review was conducted for 73 patients who underwent secondary alveolar cleft reconstruction. 41 patients received ABG and 32 patients underwent reconstruction using DBX/BMP. Operative costs including materials, operative time and hospital length of stay were compared between the two groups.

Results: The average total operative cost was $7275.83 in the ABG surgery population versus $5035.94 in the DBX/BMP surgery population (p<0.01). In addition, a statistically significant decrease in anesthesia costs, pharmacy costs, and OR costs were found in patients who underwent the DBX/BMP surgery. Operative time decreased from an average of 97.0 minutes to 69.8 minutes (p<0.01), and length of inpatient stay decreased from an average of 30.9 hours to 10.5 hours (p<0.01). We conclude that DBX/BMP is a significantly more cost effective procedure in comparison to ABG, while associated with shorter operative time and hospital length of stay.
e-poster 21
The Clinical Effect of Surgery-first Approch for Correcting Adult Skeletal Class Three Malocclusion
Presenter: Guoping WU
Authors: Guoping WU, Cunlong Li, Wensong Shangguan, Bin Zhou, Hao Dai, Wenwen Zhang, Shu Wang
Institution: The Affiliated Friendship Plastic Surgery Hospital of Nanjing Medical University

Abstract:
Objective: To explore the clinical effect of surgery-first approach (SFA) for correcting adult skeletal class III malocclusion deformity patients.

Methods: 28 adult patients diagnosed with skeletal class III malocclusion were treated. Bilateral sagittal split ramus osteotomy (BSSRO) and geniplasty were performed without presurgical orthodontics treatment, postoperative orthodontics treatment was carried out after a healing period of 2-4 weeks. Lateral cephalometric radiographs were taken preoperatively (T1), within a week postoperatively (T2) and six months postoperatively (T3), cephalometric measurements were carried out by the software.

Results: All the patients were satisfied with the effect, no complications occurred. The mean postoperative orthodontics treatment duration was 13.2 months. The mean setback of mandible at Po and B point were 7.74±3.93 mm (P <0.01) and 8.13±3.84 mm (P <0.01), and superior movement were 2.73±1.83 mm and 2.76±1.67 mm, respectively. Compared to T2, Po and B point moved forwardly with 2.36±1.23 mm and 2.66±1.65 mm, and inferior movment were 2.16±1.37 mm and 1.21±0.87 mm, respectively. The mean decrease of SNB and GA were 3.74±1.61° (P <0.01), 3.41±1.87° (P <0.01), respectively. During postoperative period, both of them increased, although these were not statistically important.

Conclusion: SFA combined postoperative orthodontics therapy is feasible for the correction of adult skeletal class III malocclusion, which has shorter treatment duration than traditional joint orthognathic-orthodontic. With the advantages of earlier improvements in patient facial aesthetics and dental function, the reduction in difficulty and treatment duration of orthodontic management, and increasing patient acceptance, SFA is regarded as an ideal and valuable alternative for this potentially procedure.

e-poster 22
Abandoning the Supraorbital Bandeau: A Single-Piece Reconstruction for Anterior Craniosynostoses
Presenter: Jose Castro Garcia, MD
Authors: Jeffrey Fearon, Kanlaya Ditthakasem, MNS, RN, Jose Castro Garcia, MD, Morley Herbert, PhD
Institution: The Craniofacial Center, Dallas

Abstract:
Background: Following correction of the anterior sutural fusions, long-term forehead irregularities can become evident. Based on the premise that frontal bone reconstruction with a seamless construct could produce better long-term aesthetic results, the supraorbital bandeau was abandoned for a single-piece frontal reconstruction. The purpose of this review was to evaluate our series of anterior remodeling procedures in order to compare outcomes and complications between children reconstructed with the traditional supraorbital bandeau to those reconstructed with a single bony segment.

Methods: A retrospective sequential chart review was performed of all children undergoing anterior sutural fusion repairs to compare supraorbital bandeau to single bony segment reconstructions. Lengths of surgery, blood loss, hospital stay and complications were assessed, along with aesthetic outcomes and reoperative rates.

Results: Over 10 years, 199 patients with anterior sutural fusions were corrected: 124 with single bony segments and 75 with traditional supraorbital bandeaus. In comparing outcomes between groups, no significant differences were noted with respect to blood loss, complication rates, and hospital lengths of stay. Reoperative rates were lower (zero versus 2.7%), and aesthetic rankings were significantly more favorable, for those treated with a single bone flap; although, the lengths of follow up for this group were shorter compared to those treated with a supraorbital bandeau (16 versus 43 months).

Conclusions: Abandoning the traditional supraorbital bandeau for a single-piece frontal reconstruction appears to produce improved aesthetic outcomes, although longer-term evaluations are needed. This newer technique was not associated with longer surgical times, increased blood loss or complication rates.
e-poster 23
20 years using springs in craniofacial surgery
Presenter: Giovanni Maltese
Authors: Peter Tarnow, Giovanni Maltese, Madiha Bhatti, Softeland, Robert Olsson, Lars Kolby
Institution: Dept of Plastic Surgery, Sahlgrenska University Hospital, Gothenburg, Sweden

Abstract: The first craniosynostosis surgery using springs was done in our department in 1997. Since then, springs have become a frequent and valuable tool to reduce surgical morbidity and to enhance postoperative results.

Data were extracted from our craniofacial registry during the time period 1997-2017. Number of operations, perioperative data and complications were recorded. The scientific work at our unit during these years was reviewed.

More than 500 spring surgeries were done. The most frequent diagnosis was sagittal synostosis followed by metopic synostosis. Springs was frequently used in combined craniosynostosis and in syndromic cases. Complications included spring dislocation, skin penetration, dural tear, overcorrection and skin irritation. Scientific results show comparable or better outcomes accompanied by less morbidity as compared to non-spring techniques. Craniosynostosis surgery using springs is an established treatment in our unit as well as many others worldwide. It has produced better results in combination with less blood loss and shorter hospital stay.

e-poster 24
Lip reconstruction in animal and human bite injuries: a holistic approach
Presenter: Jordi Puente-Espel
Authors: Jordi Puente-Espel, Maria Del Carmen Moreno Alvarez
Institution: Hospital General de Mexico Dr Eduardo Liceaga

ABSTRACT
The lips represent one of the most important regions of the face, with regards to functional and aesthetic matters. Trauma constitutes one of the most common etiologies that affect lips. Bite injuries, due to animal or humans, are still a very frequent cause of lesion to this region. There are numerous reconstructive techniques available to repair lip injuries. In order to plan the reconstructive alternatives, the reconstructive surgeon must perform an inventory of the involved structures, based on the localization, size and thickness of the lesion. The objective of the following retrospective study is to present the treatment protocol of patients with animal and human bite injuries to the upper and lower lips treated at Hospital General de México “Dr. Eduardo Liceaga,” from February 1st, 2016 to January 31st, 2017. Twenty-seven patients were included in the study; demographic and clinical data is presented. From this series, two cases with extensive injuries involving the upper and lower lips, respectively, are demonstrated and discussed.

The treatment algorithm presented in this study is composed of three stages: 1. bite wound irrigation and debridement, with administration of antibiotics based on recommendations by the infectious disease department of the treating facility. 2. Establishing when the injury has no clinical features and paraclinical evidence of infection or contamination. 3. Determining the characteristics of the injury, specifically: a) affected region, b) size of the defect (1/3, 2/3 or 3/3), and c) thickness (partial-thickness vs full-thickness). With regards to the upper lip injuries, it is of utmost importance to identify if the modiolus (lateral aspect) or philtrum (central aspect) are involved, as reconstructive techniques differ. Local flap, regional flap (e.g. Karapandzic, Estlander, Abbe, Gillies, etc.) and free flap reconstruction is presented in the algorithm based on an individualized patient basis, the location, and the available tissues in the surrounding areas. The reconstructive goals to be met are: maintaining the oral competence, decreasing the formation of microstoma, preserving sensory function to the region, decreasing the disruption to the modiolus and obtaining an adequate aesthetic outcome. Important aspects about wound care, physical therapy and the use of conformers is presented.
A satisfactory reconstruction of the lips, from the functional (dynamic reconstruction) and aesthetic points of view, is feasible. The reconstructive surgeon must keep in mind the anatomic and functional principles; the most appropriate surgical technique is based on an individualized analysis and inventory for every single injury and patient's characteristics.

**e-poster 25**

**Four-year Experience In Treating Syndromic Craniosynostosis In Eastern Indonesia**

Presenter: Indri Lakhsmi Putri  
Authors: Magda Hutagalung, Lobredia Zarasade, Indri Lakhsmi Putri  
Institution: Department of Plastic Reconstructive and Aesthetic Surgery, Airlangga University,

**Abstract:**

**Background:** Syndromic craniosynostosis is a congenital cranial malformation in which one or more cranial sutures have prematurely fused with presentation of other birth defects. Indonesia is a developing country with a population of 250 million. Health problems are still a main issue associated with the low social economic class of the majority of citizens. Number of health professionals are less compared to that in developed countries. Since Indonesia has a tropical climate leading to many tropical diseases, government health policy focuses on treating those diseases. Delay of diagnosis and treatment of syndromic craniosynostosis often happens due to health professionals’ lack of experience and knowledge and patients’ low socioeconomic status.

**Methods:** Fourteen patients with syndromic craniosynostosis were treated in the author’s unit between 2012 and 2016. They underwent suturectomy, fronto-orbital advancement and cranial vault remodeling. Range of age at which surgery was done was between 2 months and 8 years old. Post-op evaluation in all patients showed improved global development and eye closure. Increased ICP was prevented or reduced in all. Vision was improved in all except in one Crouzon patient.

**Conclusion:** Establishing a good referral center for treating craniosynostosis is very challenging especially in developing country. It requires multidisciplinary team also good infrastructures. Until now the author’s unit has managed to treat all of the referred syndromic craniosynostosis patients showing improved global development, vision, eye closure, and prevention or reduction of increased ICP.

**Keywords:** Syndromic craniosynostosis, Developing country.
Treatment for the jaw deformity of hemifacial microsomia
Pruzansky grade I
Presenter: Takayuki Okumoto
Authors: Takayuki Okumoto, Yoshikazu Inoue, Takanori Miyajima, Suguru Kondo
Institution: Department of Plastic and Reconstructive Surgery, Fujita Health University School of

Abstract:
Next to the cleft lip and palate, hemifacial microsomia affects the most patients, but it is hard to say that a treatment procedure is already established. We treat hemifacial microsomia employing orthognathic surgery and orthodontic treatment during the growing period. It is important to select the plan suitable for the severity of deformity, based on the classification of Pruzansky. For Pruzansky grade I, we employ a one-stage elongation of the mandibular ramus on the affected side by vertical osteotomy. Surgical simulation is performed using a three-dimensional model with the dental cast mounted on it. Aiming the correction of the horizontal tilt of the occlusal plane and the centralization of the mentum, amount of the elongation is decided. It is mandatory to minimize the destruction of the occlusion brought by the elongation of the mandibular ramus alone. Therefore, the osteotomy is planned so as not to make any lateral cross bite. From our experience, less than 15mm of elongation is required in grade I patient. A bite splint is made preoperatively to retain the intermolar gap on the affected side resulting from the elongation of the ramus. During the operation, the bite splint is fixed to the upper jaw after the osteotomy of the ramus, and then the mandible is brought to fit the splint. The fixation of the bone segments is done without undue forces. The bite splint fixed to the maxilla is changed to the removable splint one month after surgery. The maxillary surface of the splint is shaved to pull the upper molar down gradually with orthodontic force. A stable occlusion is achieved within 6 months. Because the horizontal tilt of the occlusal plane is corrected soon after surgery, early reappearance of the deformity can be prevented. During a long-term follow-up period, orthodontic management of the occlusion is the most important to maintain horizontality of the occlusal plane for a successful outcome.

Craniotomy of the fused sagittal suture over the superior sagittal sinus is a safe procedure
Presenter: Sara Fischer
Authors: Sara Fischer, Maltese, Giovanni, Olsson Robert, Tarnow Peter, Kolby Lars
Institution: Department of Plastic Surgery, Institute for Clinical Sciences, Gothenburg University

Abstract:
Background: Spring-assisted cranioplasty to correct sagittal synostosis is based on midline craniotomy through the closed sagittal suture, over the superior sagittal sinus (SSS). The aim of the present study was to evaluate the perioperative safety of this technique.

Material and Methods: This is a retrospective study of all patients operated with midline craniotomy combined with springs from 1998 until the end of 2015. For comparison, all Pi-plasties performed during the same time interval were also evaluated. The safety measures were evaluated based on incidence of damage to SSS, incidence of dural tears, perioperative blood loss, operation time and hospital stay.

Results: In the group that had undergone midline craniotomy combined with springs (n=225) 4 perioperative damages to SSS and 1 dural tear were seen. The perioperative blood loss was 62.8 ± 65.3 ml (mean ± SD). The operation time was 67.9 ± 21.5 minutes and the hospital stay was 4.8 ± 1.1 days. In the group that had undergone Pi-plasty (n=105) no damages to SSS but 3 dural tears were seen. The perioperative blood loss was 352.8 ± 174.4 ml. The operation time was 126.0 ± 31.7 minutes and the hospital stay was 7.1 ± 1.4 days.

Conclusion: Craniotomy over the SSS in sagittal synostosis is a safe procedure with low morbidity in terms of damage to the SSS. Midline craniotomy combined with springs has significantly lower perioperative blood loss, operation time and hospital stay (p < 0.001 for all) compared to Pi-plasty.
**e-poster 28**

**SLCA22A5 Mutation in a Patient with Systemic Primary Carnitine Deficiency and cleft palate- Successful perioperative management**

**Presenter:** Ching -Wei Hu  
**Authors:** Lun-Jou Lo, Ching -Wei Hu, Ching-Hsuan Hu, Yah-Huei Wu-Chou  
**Institution:** Department of Plastic and Reconstructive Surgery, Chang Gung Memorial Hospital  

**Abstract:** Primary systemic carnitine deficiency (SCD) is an autosomal recessive disorder caused by SLC22A5 gene mutation resulting in defective cellular carnitine transporter OCTN2. Defective carnitine transporter causes renal carnitine wasting and low serum carnitine. Carnitine is an essential cofactor for the transportation of long-chain fatty acids into the mitochondria. Lacking of carnitine may cause metabolic decompensation and sudden death when the patient is exposed to prolonged fasting before operation. An asymptomatic 9-month-old boy with SCD with incomplete cleft palate was referred to our hospital for plastic surgery. With proper perioperative management, the operation was successful and subsequent clinical course was fine. The patient was discharged on postoperative day 3.

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**e-poster 29**

**Repeated Honeycomb Posterior Cranial Vault Distraction for Pfeiffer Syndrome: a case report**

**Presenter:** Yorikatsu Watanabe  
**Authors:**  Yorikatsu Watanabe, Mayu Takahashi, Tanetaka Akizuki, Shigeru Nishizawa  
**Institution:** Department of Plastic and Reconstructive Surgery, Tokyo Metropolitan Police  

**Abstract:** Background: Posterior cranial vault distraction osteogenesis (PDO) is one of the first choice of procedure for reducing intracranial pressure (ICP) in syndromic craniosynostosis. We reported infant case with Pfeiffer syndrome, who had two times of PDO successfully during 2.5 years of age. Case: A 4-month-old infant with Pfeiffer syndrome, presenting marked honeycomb posterior cranium, had PDO (distraction distance: 35mm) using 4 internal distractors. The attachment shape of the distractor was U-shaped, allowing to be inserted easily in the border edge of osteotomy without screws. To reduce ICP more effectively, the posterior bone was also partly removed. During the distraction period, the distracted posterior segment was deformed in shape of gull-wing due to its vulnerable honeycomb structure. However PDO was completed with 35mm-distraction by reducing the distraction rate from 1 mm to 0.5 mm per day. After 4 months of surgery, because the honeycomb morphology diminished and ICP decreased, the distractors were removed. After 2 years old, however, the increased ICP and thumb printing sing relapsed. Second PDO was performed (distraction distance: 26mm) using 4 internal distractors at the posterior site of previous osteotomy due to eliminate the effect of scar contracture in 2.5-year-old age. To reduce ICP more effectively, the posterior cranial bone was partly removed with some difficulty in completion of the foramen magnum decompression (FMD) due to scar contracture. Nevertheless the distractor placed at the left-lower posterior part was displaced during the distraction period, PDO was possible to complete, resulted in decreasing ICP and improving the cranial morphology. After 5 months of surgery, because the honeycomb morphology diminished and ICP decreased, the distractors were removed. The patient is followed up till next treatment for frontofacial area. Meticulous planning of osteotomy design, FMD and distraction rate are important for PDO in syndromic infants.
Preoperative Alveolar Segment Position as a Predictor of Gingivoperiosteoplasty in Patients with Unilateral Cleft Lip and Palate

Presenter: Jonathan M. Bekisz
Authors: Jonathan M. Bekisz, Elcin Esenlik, Travis Gibson, Court B. Cutting, Barry H. Grayson, Roberto L. Flores
Institution: New York University School of Medicine

Abstract:
Background: Gingivoperiosteoplasty (GPP) can avoid secondary alveolar bone graft (ABG) in up to 60% of patients with a cleft. However, preoperative predictors of success have not been characterized. This study reports on the preoperative alveolar segment position most favorable for successful GPP.

Methods: Single-institution, retrospective review of patients with a unilateral cleft who underwent NasoAlveolar Molding (NAM). Alveolar segment morphology was directly measured from maxillary dental models created before and after NAM. Statistical analysis was performed to identify parameters associated with the decision to perform GPP and its success, defined as the absence of an eventual need for ABG.

Results: 50 patients with a unilateral cleft who received NAM therapy were included in this study (40 underwent GPP, 10 did not). 18 alveolar morphology and position characteristics were tested including: cleft gap width, horizontal and vertical positions of the alveolar segments, alveolar step-off, and degree of alveolar segment apposition. Post-NAM vertical rotation of the greater segment and the percentage of segment alignment in the correct anatomical zone were statistically significant predictors to the decision to perform GPP (86% predictive power). Cleft gap, greater-lesser segment overlap, alveolar segment alignment, greater segment horizontal rotation, and alveolar segment width following NAM were significant predictors of GPP success (86.5% predictive power).

Conclusions: Greater segment vertical rotation and proper alveolar segment anatomic alignment are positive predictors to the decision to perform GPP. Post-NAM evidence of proper alignment and direct contact between the alveolar segments were significant predictors of successful GPP.
**e-poster 32**  
**An Impossible Case Made Possible**  
*Presenter:* Ingrid Ganske, MD, MPA  
*Authors:* Ingrid Ganske, MD, MPA, Noah Schulz, MSME, Katie Livingston, ME, Susan Goobie, MD, FRCPC, John G. Meara, MD, DMD, MBA, Mark Proctor, MD, Peter Weinstock, MD, PhD  
*Institution:* Boston Childrens Hospital

**Abstract:**  
**Background:** B.Y. was born full term with a large vertex encephalocele. Two regional children’s hospitals felt the complexity of his encephalocele was too high and the risk too great to operate. The unique challenge to repairing this encephalocele was a microcephalic skull and large proportion of likely functional extra-cranial brain tissue, which would need to be preserved. At Boston Children’s Hospital, a simulation-based presurgical planning process, using both digital and 3D printed models, enabled successful technical completion and outcome of an otherwise inoperable case.

**Methods:** An initial set of 3D digital models were printed from the head CT study, including B.Y.’s skull, brain parenchyma, and dura, to facilitate simulation of the surgical procedure. A volumetric analysis of the 3D model estimated that an additional 100 cc of intracranial volume would need to be created in order to re-position the extra-cranial brain back into the skull. After creating and out-fracturing osteotomies on the model, the model was re-scanned and digital volumetric models were produced. Initially, the increase in intracranial volume was insufficient, and several additional osteotomies were designed in software to achieve the necessary expansion of intracranial volume.

**Results:** The preoperative planning process facilitated an efficient approach in the operating room, with procedure time less than 5 hours, calculated blood loss of 125ml and total perioperative transfusion of 75ml packed red blood cells. Postoperatively, the patient required placement of a permanent shunt, but otherwise recovered well and returned to his baseline neurological status. He has been followed for over 9 months.

**Conclusions:** New suites of simulation-based approaches offer novel paradigms of planning, allowing for risk-free preparation of innovative procedures, and converting cases once deemed too risky to endeavor into novel, life-saving procedures offered to new populations of patients.

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**e-poster 33**  
**The Influence of Congenital versus Acquired Facial Palsy on Dynamic Facial Reanimation in Children**  
*Presenter:* Phuong D. Nguyen  
*Authors:* Phuong D. Nguyen, Kristin Faschan, Daniel M. Mazzaferrro, Tami Konieczny, Oksana A. Jackson, Scott P. Bartlett  
*Institution:* Childrens Hospital of Philadelphia

**Abstract:**  
**Intro:** Facial palsy presents as congenital or acquired. Treatment is based on age, severity, and surgeon preference. It is unclear whether etiology affects outcome. Herein, we compare outcomes after two-stage free gracilis muscle transfer (CFNG-FGMT) for long-standing facial palsy between patients with congenital versus acquired disease.

**Methods:** A retrospective review was performed of patients with facial palsy who had unilateral CFNG-FGMT from 2008-2016 at a single institution. Surface EMG was recorded postoperatively. A multi-level mixed-effects regression analysis was performed to compare congenital vs. acquired patients who underwent CFNG-FGMT. Analysis of the normal and affected sides of the face in repose and while smiling was performed using Facial Assessment by Computer Evaluation (FACE-gram) software.

**Results:** Thirteen patients met inclusion criteria. Six patients had congenital facial palsy and 7 patients had acquired. Causes of congenital disease included idiopathic (5) and birth trauma (1). Causes for acquired facial palsy were tumor resection (4), meningitis (1), and trauma (2). Muscle activity sEMG increased from 8.59±12.39 mV at the 3-6 mo period to 51.56±14.57 mV at the 6-9 mo period (p<0.001) in the congenital group. In the acquired group, there was a trend towards increase in sEMG from 19.65±23.48 mV at 3-9 mos to 31.07±23.50 mV at 9-12 mo (p=0.19). Smile excursion in the congenital group significantly increased at 3-6 mo (9.53±2.13 mm) compared to 0-3 mo (1.45±2.34mm), p<0.001. In the acquired group, there was minimal excursion in the first 12 months (0-2.86mm) but significantly increased at the >12 mo period (4.36±1.43mm), p<0.01.

**Conclusion:** Patients with congenital palsy appear to have earlier muscle activity and greater excursion compared to those with acquired palsy after CFNG-FGMT. This may be due to inherent greater brain plasticity. Future prospective studies are needed to further delineate these differences.
e-poster 34
Unsolvable cases Association of dynamic osteotomies in the treatment of the cloverleaf skull
Presenter: Alessandra dos Santos Silva
Authors: Alessandra dos Santos Silva, Anderson Rodrigo Souza, Vera Lucia Nocchi Cardim
Institution: Beneficência Portuguesa de São Paulo

Abstract: The Cloverleaf skull, or Kleeblattschädel-Deformity, is an uncommon cranial deformity, caused by the premature fusion of multiple cranial sutures resulting in a trilobed skull, with frontal and bitemporal bulging, a significant anteroposterior length reduction and a flattened occipital area. The etiology is still unknown. It is described in syndromic and non-syndromic craniosynostosis and it is considered as one of the most complex synostosis to manage. This study reports the follow-up and treatment of a patient with complex Cloverleaf craniosynostosis. In literature review stenosis of the coronal and lambdoid sutures are the most frequent disorders observed in Cloverleaf skull, presenting with an enlargement of the sagittal and / or metopic sutures and of the anterior fontanelle. The reported case has the peculiarity of presenting premature stenosis of all sutures in the upper region, displacement of the squamous sutures with horizontalization of the temporal bones. Other associated malformations in our patient are craniofacial dysmorphism, ocular proptosis, cutis gyrata, acanthosis nigricans, rectal prolapse and umbilical alterations, clinically consistent to the rare Beare-Stevenson Syndrome. Surgical treatment consisted of serial approaches (6 to 26 months of age) including osteotomies, internal cranial cysts shunts, posterior skull base decompression using cranial springs and elliptical osteotomies (œNautilus) that progressively corrected the bulges and regularized the cranial bones. This patient initially presented extensive craniolacunia with herniation of brain tissue (œhoneycomb pattern). Although there is a developmental delay due to amaurosis and excessive cranial weight, this child has demonstrated progressive cognitive gain, with social interaction compatible with her age. The use of dynamic osteotomies appears to be another alternative in the arsenal of treatment of complex craniosynostosis in cases that appear apparently unsolvable.

e-poster 35
Intracranial hypertension and neuropsychomotor development in craniosynostosis - preliminary study
Presenter: Anderson Rodrigo Souza
Authors: Anderson Rodrigo Souza, Alessandra dos Santos Silva, Denise Gonçalves Cunha Coutinho, Vera Lucia Nocchi Cardim
Institution: Beneficência Portuguesa de São Paulo

Abstract: Early closure of the cranial sutures causing brain growth restriction and developmental delay in complex craniosynostosis is a very common and known theory. The correlation between elevated intracranial pressure and delayed neuropsychomotor development was suggested by Reinier in 1982. This led to a consensus followed by most surgeons that cranial decompression in craniosynostosis should be performed in the first year of age in an attempt to minimize these effects. However, these two variables have major complicators in their assessments. Normal values for intracranial pressure in children are uncertain, in the literature. Values below 10mmHg are usually accepted as normal. Borderlines values lies; between 10 and 15mmHg (or between 10 and 20mmHg according some authors) and values; above 20mmHg are considered abnormal. Still there are some papers in which the opening pressure at a lumbar puncture in a pediatric population between 1 and 18 years of age is described as 20.6mmHg average. Considering neuropsychomotor development in the complex or syndromic craniosynostosis, many factors could act as confounders in its delay, like those associated with the neurological disorders (hydrocephalus, for example) or those associated with other disorders (arthrogryposis, syndactyly, respiratory or feeding impairments for example). This study correlates the preliminary results of preoperative neuropsychological evaluation and intracranial pressure values (measured by subdural catheter). Also aspects related with age of the patient, weight adequacy, kind of craniosynostosis, presence of clinical symptoms and indirect signs of cranial hypertension (papilledema and presence of venous pulse detected in eye fundus and computed tomography “beaten copper” or fingerprinting appearance) are discussed.
**e-poster 36**

**Dynamic osteotomies in mature skulls**  
Presenter: Georgia Maria de Carvalho Perez  
Authors: Vera Lucia Nocchi Cardim, Georgia Maria de Carvalho Perez, Alessandra dos Santos Silva, Anderson Rodrigo Souza  
Institution: Beneficência Portuguesa de São Paulo

**Abstract:** The urgency for cranial expansion does not cease at the end of the first year of life, and brain growth still requires sutural patency to maintain its development throughout childhood, even by reshaping osseous plates. Sutures osteogenic distraction with implantable springs (Lauritzen) recovers the sutural function, and when acting on the dura mater attached to the skull cap, it redistributes tensions, reshaping the osteogenic matrix. This greatly occurs in the first year of life, when the skull bones are still flexible enough to accompany dural remodeling: at this phase, the application of springs in the osteotomized stenotic sutures also corrects the cranial deformity caused by the compensatory growth of non-affected sutures. However, after this period bone tissue progressively looses its elasticity, and the simple sutural activation by springs employment within the liberating osteotomies no longer corrects the secondary deformity. Back-Table bone remodeling, even when used in fixed helical osteotomies, produces a virtual space between the dura mater and the bone graft, aggravating its integration eventually leading to osteomyelitis. The authors have performed the dynamic treatment of mature skulls by associating the helical osteotomies (Nautilus) to osteogenic distraction with springs within the osteotomized stenotic sutures in the areas of secondary deformity; this method requires minimal dural detachment without the necessity of immobilizing helicoid pitches. Absorbable plate shims placed on one of the osteotomy edges are only intended to ensure the direction of the desired movement, expansion or contraction. Our retrospective study presents the follow-up for this kind of treatment considering different types of craniostenosis in the last 6 years. Features as blood transfusion, recovery time, behavioral changes, and osseous tissue reahabilitation, such as cranial shape manintenance are addressed in this study.

**e-poster 37**

**Assessment of Cranioplasty and Flap Techniques Utilized for Composite Scalp/Skull Reconstruction**  
Presenter: James D Vargo MD  
Authors: James D Vargo MD, Wojciech Przylecki MD, Paul Camarata MD, Brian T Andrews MD  
Institution: University of Kansas Medical Center

**Abstract:**  
Purpose/Aims: Reconstruction of composite full-thickness scalp defects (skin and cranium) presents a difficult reconstructive problem. Surgeons can utilize many microvascular flaps for skin coverage and either autogenous bone or alloplastic implants for cranial reconstruction. To date, no “gold standard reconstructive method is universally accepted.

**Methods:** A retrospective review was performed at a tertiary medical center. Reconstructions were evaluated by the type of cranioplasty utilized (alloplastic vs. autologous) and the microvascular soft tissue flap performed (myofascial, myocutaneous, fasciocutaneous, or osteocutaneous). Comparisons were made between groups to assess outcomes related to cranioplasty and microvascular flap complications using Fisher’s exact test.

**Results:** Thirty-three cases of composite reconstruction were performed. Twelve autologous cranioplasties were performed using vascularized bone flaps (n=8), split cranial bone (n=3), and banked cranial bone (n=1). Thirteen alloplastic reconstructions were performed, including titanium mesh (n=8) and polyetheretherketone (PEEK) (n=5) implants. Complications occurred in 6 of 13 (46.2%) patients with alloplastic implants, whereas no subjects (0 of 12) with autologous skull reconstruction had cranioplasty complications (p=0.015). Complications requiring implant removal occurred in 6 of 8 (75%) titanium mesh cranioplasties compared to none using PEEK implants (p=0.021). No significant differences in outcomes were demonstrated among microvascular flap reconstructions utilized for soft tissue coverage including: myofascial (n=9), myocutaneous (n=7), fasciocutaneous (n=6), and osteocutaneous (n=6) flaps.

**Conclusion:** Composite reconstruction of the skull and scalp requires careful consideration, especially in regards to the method of cranial reconstruction. In our experience, complete autologous cranioplasty is preferable and demonstrates fewer complications than alloplastic reconstruction.
e-poster 38
The role of the Craniofacial orthodontists for treatment of patients with cleft lip and palate
Presenter: Suguru Kondo
Authors: Suguru Kondo, Yoshimi Sano, Takayuki Okumoto
Institution: Department of Orthodontics and Pedodontics, Plastic and Reconstructive Surgery

Abstract:
Objectives: It is a broadly accepted fact that the treatment of patients with cleft lip and palate should be carried out by the team consisting of doctors and many different specialists to obtain best results. In our institution, craniofacial orthodontists have led the team to perform the thorough treatments of the patients. Here, we present the clinical growth and developmental staging we use clinically and describe the roles each of the team members takes in the treatment;

Materials and Methods: In order to decide when to start our treatment, we use modified Hellman’s dental developmental stages. In clinical application, we categorize the developmental stages as follows; IA - IC: Dawn stage, IIA - IIC: Pre stage, IIIA - IIIC: First stage, IVA - IVC: Second stage, VA on: Developed stage. We then deliberately plan the treatment schedule in accordance with which stage we actually become involved in the treatment of respective patient;

Results: By recategorizing the developmental stages, we have been able to broaden the time period in which we can start getting involved in the treatment. Consequently, we have become able to afford more time to talk with the patients’ families for better understanding of their children’s condition and to obtain informed consent accordingly. As a result, we have been able to establish more intimate relationships with the patients’ families, resulting in much fewer dropout rates and less than 10% incidence of maxillofacial surgery and distraction osteogenesis in adulthood.

Discussion: We could not obtain our results just purely from the treatment skills and advanced medical technologies. Meticulously and individually planned treatment schedules in each and every developmental stage of the patients by the craniofacial orthodontist is critical, and his involvement as a team coordinator to bridge team members of different specialties to achieve one common goal is unquestionably essential.

e-poster 39
Postoperative evaluation of sagittal synostosis after spring-assisted surgery using 3D imaging
Presenter: Ruggero Bevilaqua
Authors: Ruggero Bevilaqua, Lars Kolby, Peter Tarnow, Giovanni Maltese
Institution: Plastic Surgery Department, Sahlgrenska University Hospital, Gothenburg, Sweden

Abstract: 3D photogrammetry has recently become a popular tool to objectively evaluate surgical outcomes in craniofacial patients. The aim of this study was to assess immediate and long-term cranial shape changes in patients affected by sagittal craniosynostosis treated with spring-assisted surgery (SAS).

Patients treated for isolated sagittal synostosis with SAS and with preoperative, postoperative (within 1.5 months), and 3-years-old follow-up 3d images were selected. Cranial length and width, cranial index (CI), sagittal and coronal lengths over the surface of the head, coronal-sagittal lengths ratio (CL/SL), and circumference were calculated at every control using 3D photogrammetry. After superimposing postoperative images on preoperative ones, growth ratio at frontal bossing (FB), occipital bulging (OCC), right and left eurions (EURdx, EURsx), vertex (V) and the mean growth ratio of the total vault were calculated. CI and CL/SL ratio were calculated in the 3-years-old follow up. 29 patients had preoperative and postoperative 3d images, and 11 of those had also 3- years-old follow-up images. All mean postoperative measurements were significantly bigger than the preoperative one except for cranial length (160.1±6.5 vs 160.7±7.2 mm). Mean CI improved from 74 to 78 while mean CI/SL improved from 79 to 85. The growth ratio in FB was 0.4 mm, OCC was -1.2 mm, EURdx and EURsx was 3.7 and 3.2 mm respectively, and V was 7.2 mm. At 3 years of age CI was significantly decreased (76 vs 78) while CL/SL ratio was not significantly changed (88 vs 86). 3d photogrammetry shows that SAS promote postoperative skull growth at Vertex and biparietally, secondarily limiting occipital and frontal growth and thus improving the overall cranial shape.

At three years of age the skull show some signs of relapse but it tends to maintain adequate heights at Vertex. 3D photogrammetry proved to be a satisfying radiation-free tool to analyse surgical outcome in patients affected by craniosynostosis.
**Abstract:**

**Objectives:** Maxilla Le Fort II fracture reconstruction plays one of the challenging surgery in the field of craniofacial trauma. As we know, nose is one of the most distinct features of the face. It could determines human races and its function is essential in everyday life. When someone are unhappy with the look of their nose, or have functional complications, it can compromise their quality of life. The goal of treatment of fracture is reduction and reposition. But sometimes, reduction and reposition is not enough, patients often complain about the fact that their nose is still flat, especially around the frontonasal area. The aim of the article is to propose the new innovation that can directly reconstruct the nose in Le Fort II fracture yet provides better aesthetic appearance.

**Patients and Methods:** Reporting three patients of maxilla Le Fort II fractures. All patients has undergone open reduction and internal fixation combined with open rhinoplasty using finely diced cartilage wrapped with temporal fascia or fascia lata. One of the patients had a septum fracture, so he has undergone septoplasty using costal cartilage graft.

**Results:** The graft provides a good function, a better nasal contour, shape of the nasal tip, and can camouflage irregularities. There was no clinical signs of graft absorption and no complain about the flat nose. The patient was very satisfied and could breathe normally again.

**Conclusion:** Le Fort II reconstruction using ORIF combined with augmentation rhinoplasty using autologous materials is a breakthrough in Le Fort II management. It brings off the incorporation between aesthetic surgery concept with reconstruction. It also offers greater flexibility, carries a minimal risk of warping, and obviates the need for a long and straight cartilage graft donor site. It is not only considering the reduction and reposition, but also the aesthetic appearance of the patient.

**Keywords:** Le Fort II, Rhinoplasty, Autologous Materials
e-poster 42
Transfusion Trends in Fronto-Orbital Advancement - An Analysis of 700 cases in the UK National Craniofacial Service
Presenter: Mr Chris Parks
Authors: Mr Christian Duncan, Mr Chris Parks, Dr Ed Carver, Dr Russell Evans, Dr David De Beers, Dr M.Stanley
Institution: Alder Hey Childrens Hospital NHS Foundation Trust

Abstract:
Introduction: Transfusion in Fronto-Orbital advancement was adopted as an indicator of safe practice in the UK national craniofacial service in 2014, following successive reviews commencing with a 4 unit audit in 2003.

Method: Data on donor exposures in fronto orbital advancement from successive years between 2012 and 2016 was analysed and presented in a standardised format. Comparison was made with the same dataset collected in 2003. Anaesthetic practice was benchmarked in 2011 and 2016.

Results: Analysis of 710 fronto orbital advancements showed that a statistically significant reduction in donor exposure per patient(DE/pt) from 2.35 to 1.11 occurred between 2003 and 2016. Variances between the four units were wider at the beginning of the audit cycle (range 2-2.84) and converged (0.88-1.27 in 2016). The pattern of reduction suggested that further reductions with current surgery and anaesthesia are unlikely. Anaesthetic benchmarking through the audit cycle provided a converging consensus in favour of reduced cross matching to a single unit, use of tranexamic acid in all cases, specific triggers to transfusion and type of blood products used. These will be discussed in the presentation.

Conclusion: Through continuous audit of high volume practice, the national craniofacial service has characterised and provided a strong consensus on best transfusion practice in fronto- orbital surgery.

e-poster 43
Craniofacial Necrotizing fasciitis in an infant
Presenter: Malagón Hidalgo Héctor Omar
Authors: Perez Dosal Marcia Rosario, Malagon Hidalgo Héctor Omar, García Cano Eugenio, Reynoso López Rocio Evangelina, González Chapa Diego Raúl
Institution: Instituto Nacional de Pediatría

Abstract: Necrotizing fasciitis is a rare, rapidly progressing bacterial infection that originates in the fascia and involves the muscles and subcutaneous fat, it evolves to necrosis of the overlying skin. The clinical diagnosis is difficult and involves a high mortality rate, despite treatment. We present the case of a 31-month-old male, who initiated with generalized dermatosis and fever for 6 days, beginning with bilateral parotid region and edema afterwards. Initially non-hemorrhagic dengue fever infection was diagnosed, without receiving any treatment whatsoever. He continued with fever, augmented facial edema, right palpebral cellulitis and soft tissue necrosis that involved the right orbital region, the right eyeball, the zugomaticomaxillary region and the frontotemporoparietal region with bone exposure. A diagnosis of necrotizing fasciitis caused by multi drug-resistant P. eruginosa infection + right eye corneal perforation + pancytopenia was made. Several surgical lavages and debridements were performed, including right temporoparietal region trepanation and the use of the VAC system. Exenteration of the right orbit was performed, afterwards a Dermal Regeneration Template Integra with VAC system was placed. Three weeks later we removed the Dermal Regeneration Template Integra, and placed a partial-thickness skin graft in all the affected area. The diagnosis of acute lymphoblastic leukemia was made by medullary aspiration; for which the patient is currently being treated. Necrotizing fasciitis is predominantly an adult disease. Only a few series describing its pediatric presentation are available. Factors predisposing children to necrotizing fasciitis are varicella virus infection, surgery, minor trauma and malnutrition. There are not any series reporting its presentation due to acute lymphoblastic leukemia as source of immunocompetence. Prompt surgical debridement and empirical broad-spectrum antibiotic therapy are the mainstays for treating necrotizing fasciitis.
**e-poster 44**  
**A Five Step Simplification of the Fisher Anatomical Subunit Cleft Lip Repair**  
Presenter: Anna Carlson, MD  
Authors: Anna Carlson, MD, Kate Buretta, MD, Jeffrey Marcus, MD  
Institution: Duke University Hospital Division of Plastic Surgery  

**Abstract:**  
**Introduction:** Techniques for unilateral cleft lip repair have evolved from simple straight-line repairs, to rudimentary geometric techniques, to contemporary rotation-advancement and advanced geometric anatomical subunit techniques. The Fisher anatomical subunit repair provides a dimension of mathematical precision in design and execution, avoids two three-point closures, and most importantly, does not require compromise in placement of Noordhoff’s point for a wide variety of cleft lip deformities. The Fisher repair has, however, been criticized on the basis of complexity. Herein, we describe a five-step simplification of the Fisher anatomical subunit repair intended to increase the comprehensibility of the repair and allow for wide attainment of the excellent results the repair affords.  

**Methods:** Step 1: Mark inferior anatomical landmarks including Cupid’s bow and commissures, and select Noordhoff’s point. Step 2: Mark superior anatomical landmarks including columellar bases, alar insertion points, alar bases, and nostril floor width. Step 3: Determine discrepancy between total lip height and greater lip height, thus required base width of the cutaneous triangular flap from lesser lip element. Step 4: Determine position of cutaneous triangular flap, without moving Noordhoff’s point. The triangular flap may be rotated to allow adaptability for nearly all lateral lip heights. The ability to adjust the cutaneous triangular flap to maintain Noordhoff’s point represents the critical advantage of the Fisher repair. Step 5: Complete design of the Noordhoff vermillion triangular flap and final incisions of the medial lip element. Accompanying intraoperative video demonstrates steps.  

**Results & Conclusions:** We have described a five-step simplification of the Fisher anatomical subunit repair intended to increase the comprehensibility of the repair and allow for wide accomplishment of the repair’s excellent results.

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**e-poster 45**  
**Navigation-Assisted Endoscopic Orbital Decompression for refractory Graves’ orbitopathy**  
Presenter: Hu, Ching hsuan  
Authors: Hu, Ching hsuan, Chia-Hsuan Tsai, Yu hsuan Hsieh, Chun-Hao Pan, Chein-Tzung Chen  
Institution: Chang Gung Memorial hospital  

**Abstract:**  
**Introduction:** Orbitopathy is the most frequent extrathyroidal manifestation of Graves’ disease. Some patients may need surgical treatment. With the currently performed surgical methods, endoscopic orbital decompression has proved to be an effective treatment for Graves’ orbitopathy. However there is lack of study talking about orbital decompression in patients with refractory Graves’ orbitopathy. In this report, we present one case suffering from recurrent exophthalmos in Graves’ disease, who received endoscopic balanced two wall orbital decompression surgery with aid of navigation system to achieve exophthalmos reduction.  

**Patient and method:** A 54- year-old female patient suffered from recurrent exophthalmos who had received inferior-medial wall orbital decompression of both eyes ten years ago. Pre-operation surgical planning is referred to navigation software (BrainLab). Balance two wall decompression and ethmoidectomy through transnasal and inferior transconjunctiva approach were performed. After operation, all reference points and the wall planned to be removed were rechecked by navigation according to the preoperative planning.  

**Result:** Exophthalmos was improved from 23mm to 21 mm for both eyes. Spiral computed tomography revealed increased orbital volume. There is no retro-orbital hematoma, new-onset diplopia, optic neuropathy or gaze restriction. Visual activity is no affected. Patient discharge 2 days after operation and satisfied the results.  

**Conclusion:** Navigation-Assisted endoscopic technique is ideal for orbital decompression. It appears to be a safe and effective procedure for the treatment of refractory orbitopathy in patients with Graves’ disease.
e-poster 46
The Rare Association of Cleft Lip/Palate and Wilms Tumor
Presenter: Alison Kaye, MD
Authors: Elizabeth Theng, Alison Kaye, MD
Institution: University of Missouri-Kansas City School of Medicine

Abstract:
Background: There is currently no recognized connection between cleft lip/palate and the Wilms’ tumor. Wilms’ tumor is the most common renal tumor in children with an incidence of 7.6 cases per million. Genetic abnormalities are seen in at least 40% of cases. It is associated with several syndromes: WAGR, Beckwith-Wiedemann, and hemihypertrophy. Cleft lip/palate, with an incidence of 1:750, is caused by a complex interplay of genetic and environmental influences. Like Wilms’ tumor, cleft lip/palate is also associated with syndromes, but they are not known to be linked together. There are only rare case reports of patients with both Wilms’ tumor and cleft lip/palate.

Methods: A retrospective review of cleft team records from 2001-2015 revealed 3 cases of children with concomitant diagnoses of cleft lip/palate and Wilms’ tumors, exceeding anticipated rates of co-occurrence.

Results: 3 male infants presented for cleft team care: 2 with cleft palate and Pierre Robin Sequence and one with bilateral cleft lip and palate. All 3 children were found to have multiple congenital anomalies with developmental and growth delays prompting genetic evaluation. Genetic evaluation revealed 3 different suspected cases of the children’s cleft-related conditions, none considered associated with Wilms’ tumor. All 3 patients were subsequently diagnosed with Wilms’ tumor between ages 1-4 years. In 2 cases it was bilateral disease and one was in a horseshoe kidney. All 3 patients underwent chemotherapy and partial nephrectomy for their Wilms’ tumor. All 3 patients have subsequently been cancer free for multiple years.

Conclusions: Cleft lip/palate is rarely associated with Wilms’ tumor despite the relatively common occurrence of these conditions separately. Both have recognized genetic associations. In our series the two conditions occurred in the presence of male gender with multiple congenital anomalies in the first 5 years of life. All children responded well to standard tumor treatment.

e-poster 47
Correlation of soft-tissue to bony landmarks during Le Fort I orthognathic surgery
Presenter: Derek Steinbacher, MD
Authors: Cynthia Tsay, Derek Steinbacher, MD
Institution: Yale School of Medicine

Abstract:
Introduction: Le Fort I orthognathic surgery requires precise 3D bony repositioning. Vertical changes are critical to the overall aesthetic result. 3D planning enables vertical measurements from the rendered CT scan, but intraop points are ascribed from soft-tissues. This study aims to compare intraop soft-tissue vertical measurements with pre and post CT based values. We hypothesize a non-linear, but predictable relationship exists.

Methods: We examined a cohort of orthognathic procedures over a 20-month period. Patients were excluded if measurements and/or pre and post CT scans were lacking. Demographic, measurement and perioperative data were tabulated. Clinical vertical measurements included: left medial canthus to central incisor, left medial canthus to left canine, and right medial canthus to right canine. Bone measurements were calculated using pre and post CBCT scans.

Results: 168 sets of measurements were analyzed among 42 patients. Mean age was 23 years, 57% were female, and 76% had wire braces. Average vertical measurements (mm) for preop soft-tissue were 64.4±5.5, 61.0±5.2, 60.9±5.3 and postop normal values were 66.4±5.8, 62.6±5.3, 62.4±5.3. Bony preops were 84.2±7.4, 82.6±7.2, 82.4±6.8 and postop normals were 84.6±8.4, 83.6±8.3, 83.8±8.4. There was no significant difference between the absolute value pre and postop between the two modalities (p<0.2, 0.1, 0.1) but a significant difference between bony and soft-tissue normal measurements (p<0.0001). Based on the average ratio of the preop and normal difference, a 1.0mm soft tissue change correlated to a 1.5mm bony difference. Subset analysis showed differences in normals between class II and III cases.

Conclusion: Vertical changes in Le Fort I provide a quantitative means to predict aesthetics. Our results demonstrated a linear relationship between vertical measurements changes. Therefore, intraop soft-tissue measurements can be used with a predictable relationship to achieve desired bony CT measurement.
e-poster 48
Wolf-Hirschhorn Syndrome with Cleft Lip/Palate: Patient Presentation and Management
Presenter: Shikhar Tomur
Authors: Shikhar Tomur, Alison Kaye
Institution: University of Missouri-Kansas City School of Medicine

Abstract:
Background: Wolf-Hirschhorn Syndrome is the manifestation of anomalies resulting from partial deletion of the short arm of chromosome 4 including WHSC1, LETM1, and MSX1 genes. The incidence is 1:50,000 births. Characteristic findings include Greek warrior helmet facies with hypertelorism, arched eyebrows, high forehead and broad nasal bridge. Microcephaly, hypotonia, and significant growth and cognitive delays are typically seen. Other associations include seizures, congenital heart disease, renal anomalies, hypospadias, ear abnormalities and ophthalmologic differences. Orofacial clefting reportedly occurs in half of cases. Reports of cleft lip/palate findings in Wolf-Hirschhorn are limited and do not dwell on alterations or considerations for management.

Methods: A retrospective review of cleft team records from 2010 to present revealed three cases of children with concomitant diagnoses of cleft lip/palate and Wolf-Hirschhorn syndrome treated at our institution.

Results: 3 children (2 males, 1 female) presented as infants for cleft team care with diagnoses of cleft palate, unilateral cleft lip and submucous cleft palate, and bilateral cleft lip and palate. All three children were found to have multiple congenital anomalies and growth delays prompting genetic evaluation to confirm suspected Wolf-Hirschhorn syndrome. All three have issues with feeding, seizures, brain abnormalities, and heart defects. They all have global developmental delays and severe expressive and receptive speech delays. All three patients have had delays or alterations in their cleft care related to their co-existing conditions.

Conclusion: Orofacial clefting is a common, but not universal feature of Wolf-Hirschhorn syndrome. These patients provide unique cleft care challenges due to other complications of the syndrome. Severe growth and developmental delays may require significant supportive services and highly individualized plans of care for timing and safety of necessary surgeries.

e-poster 49
The association between surgical complications and the POSSUM score in head and neck reconstruction
Presenter: Yohjiroh Makino
Authors: Yohjiroh Makino, Katsuhiro Ishida, Keita Kishi, Takeshi Miyawaki
Institution: The Jikei University school of Medicine

Abstract:
The Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (POSSUM) is an objective evaluation method to predict surgical complications affecting various organs. It is possible to objectively calculate the prediction level using a standard assessment method without adding burden to any medical facility. We could not find any reports with using POSSUM to evaluate head and neck reconstruction surgical risk. Prediction of surgical complication is essential to ascertain surgical risk and individual patient's general condition even in head and neck reconstruction surgery. In this study, we retrospectively examined the association between POSSUM score and actual surgical complications of head and neck reconstruction surgery. In total, 711 patients who underwent head and neck reconstruction after cancer extirpation from 2007 to 2015 were studied. The predicted risk of complications was calculated using the POSSUM score and compared with the actual rate of perioperative complications. Perioperative complications occurred in 178 (25%) patients. When patients were divided into a perioperative complication group and a no-complication group, a significant difference between the two groups was observed in the predicted postoperative rate calculated from the POSSUM score (p<0.0001). We concluded that POSSUM is a useful risk indicator for head and neck reconstruction surgery.
A Cranioemtric Analysis of Cranial Base and Cranial Vault Differences in Patients with Metopic Craniosynostosis
Presenter: Sanjay Naran
Authors: Sanjay Naran, Danial Mazzaferro, Ari Wes, Arastoo Vossough, Scott Bartlett, Jesse Taylor
Institution: University of Pennsylvania

Abstract:
The effect of synostosis is not confined to the immediate vicinity of the suture. We hypothesized metopic craniosynostosis results in migration of lateral structures from midline, and differences in segmental volume of the cranial fossa. A retrospective case-controlled cohort analysis of patients with nonsyndromic metopic craniosynostosis was performed. Cranioemetric angles, distances to landmarks from midline, cephalic index, and segmented volume ratios were calculated. A comparison group consisted of patients without cranial pathology or with mild positional plagiocephaly. 20 patients with metopic craniosynostosis and 19 controls were identified. The bifrontal angle was significantly more acute in metopic patients. Distance from midline to the medial carotid, the foramen ovale, and the hypoglossal canal, were all significantly longer in metopic patients. Ratio of anterior third to total cranial vault volume was significantly smaller in metopic patients; however, ratio of middle third to total cranial vault volume was significantly larger. As the bifrontal angle decreased by one degree, the volume of the anterior third of the cranial vault was observed to decrease by 0.17% (p<0.001).

Patients with metopic craniosynostosis show a distinct and significant transverse lateralization of structures of the anterior skull base relative to midline, significant restriction of the anterior third of the cranial vault, and compensatory expansion of the middle third. There is a linear relationship between the bifrontal angle and the subsequent change in anterior third cranial vault volume.

More Than Meets The Eye: The Effect of Intercanthal Distance on Perception of Beauty and Personality
Presenter: Sanjay Naran
Authors: Sanjay Naran, Ari Wes, Daniel Mazzaferro, Arastoo Vossough, Scott Bartlett, Jesse Taylor
Institution: University of Pennsylvania

Abstract:
In judging normalcy of the face, we rely on anthropometric measures and proportions established almost half a century ago. However, there exists a range of normal, and a degree of disproportion may be considered more attractive. We set out to determine how changes in only intercanthal distance affect the laypersons overall perception of beauty and personality traits of a face.

We utilized Amazon.coms Mechanical Turk (MTurk), a crowdsourcing tool, to determine how changes in intercanthal distance affect overall perception of beauty and personality. MTurk respondents provided demographic information and were asked to survey 16 female subjects, each digitally edited to be hypoteloric or hypertelorlic. Data were collected from 490 MTurk crowd raters. Paired t-test analysis found that respondents perceived subjects to be significantly more submissive, more friendly, and more attractive with increased intercanthal distance (p<0.05). Women respondents were significantly less likely to perceive change in regards to how unthreatening and how intelligent the subject appeared upon intercanthal distance widening, (p<0.05). Compared to Caucasian respondents, minorities (Asian- and African-American) were significantly more likely to perceive difference in submissiveness, threat, intelligence, and attractiveness with increased intercanthal distance, (p<0.05). All respondents >46 years of age were significantly less likely to perceive a change in any of the seven traits upon intercanthal distance widening, compared to respondents between 18-25 years of age (p<0.05).

The layperson perceives significant increases in a female subjects submissiveness, friendliness, and attractiveness with an intercanthal distance increase of 10% from normal. We should perhaps reconsider our threshold, and goal of correction of hypertelorism given the potential positive impact of a slightly increased intercanthal distance on perceived beauty and personality.
e-poster 52
Minor Suture Fusion in Syndromic Craniosynostosis
Presenter: Christopher Runyan
Authors: Christopher Runyan, Wen Xu, David Staffenberg, Roberto Flores, Jesse Taylor
Institution: Wake Forest Baptist Medical Center

Abstract:
Background: Infants with craniofacial dysostosis syndromes may present with midface abnormalities but without major (calvarial) suture synostosis and head shape anomalies. Delayed presentation of their calvarial phenotype is known as progressive postnatal craniosynostosis (PPC). Minor sutures/synchondroses are continuations of major sutures toward and within the skull base. We hypothesized that minor suture synostosis is present in infants with syndromic, progressive postnatal craniosynostosis, and is associated with major suture synostosis.

Methods: A two-institution review of infants (<1 year) with syndromic craniosynostosis and available CT scans. Major (metopic, sagittal, coronal, lambdoid) and minor suture/synchondrosis fusion was determined by two craniofacial surgeons and one radiologist using Mimics® or Radiant® software.

Results: Seventy-three patients with 84 scans were included. Those with FGFR2 mutations were more likely to lack any major suture fusion (OR 19.0, p=0.044). Minor suture fusion occurred more often in the posterior branch of the coronal arch (OR 3.33, p<0.001), squamosal arch (OR 7.32, p<0.001) and posterior intracranial synchondroses (OR 15.84, p<0.001), among FGFR2 vs other patients. An analysis of those (n=9) with multiple scans revealed a pattern of minor suture fusion followed by increased minor and major suture synostosis. Over 84% of FGFR2-patients had minor suture fusion, however 6 (13%) were identified with isolated major suture synostosis.

Conclusions: Minor suture fusion occurs in most patients with FGFR2-related craniofacial dysostosis. Syndromic patients with patent calvarial sutures should be investigated for minor suture involvement. These data have important implications for the pathophysiology of skull growth and development in this select group of patients.

e-poster 53
Speech Outcomes Following Midface Distraction in Syndromic Craniosynostosis
Presenter: James Sun
Authors: James Sun, Ari M Wes, Sanjay Naran, Daniel Mazzaferro, Scott P Bartlett, Jesse A Taylor
Institution: Childrens Hospital of Philadelphia

Abstract:
Purpose: The aim of this study was to examine the effect of midface distraction at the Lefort III and Monobloc level on speech in patients with syndromic craniosynostosis.

Methods: A retrospective review of patients with Apert, Crouzon, or Pfeiffer syndrome was performed. Speech outcomes, including nasal emission, facial grimace, nasality, phonation, and articulation, were evaluated using the Pittsburgh Weighted Speech Score (PWSS) prior to and following midface advancement by distraction at the Lefort III and Monobloc level.

Results: Thirteen patients met inclusion criteria. Six (46.1%) of the subjects received Monobloc advancement and seven (53.9%) received Lefort III advancement. Mean subject age at distraction was 8.2 years, and mean follow-up was 5.1 years. No significant difference was found between pre-operative and post-operative PWSS (0.46 vs 1.85, p=0.071). However, pre-operative scores for nasal emission (mean: 0.23 ± 0.23) were significantly lower than post-operative scores (mean: 0.85 ± 0.34) (p=0.046). Pre-operative scores for facial grimace (mean: 0.00 ± 0.00), nasality (mean: 0.15 ± 0.15), phonation (mean: 0.08 ± 0.08), and articulation (mean: 0.00 ± 0.00) were not significantly different from postoperative scores for facial grimace (mean: 0.00 ± 0.00), nasality (mean: 0.46 ± 0.22), phonation (mean: 0.31 ± 0.21), and articulation (mean: 0.23 ± 0.23). No difference was observed in change in PWSS across Apert (mean: 2.20 ± 1.02), Crouzon (mean: 0.75 ± 0.75), and Pfeiffer (mean: 1.00 ± 1.35) syndromes (p=0.542). Subgroup analysis by level of advancement did not demonstrate a significant difference (p=0.484) in mean increase in PWSS between Lefort III (1.14 ± 0.88) and Monobloc (1.67 ± 0.84).

Conclusion: Midface distraction at the Lefort III and Monobloc level does not appear to be associated with deterioration in speech, and in some cases, may correct for hyponasality. However, some patients may be at risk of developing increased nasal emission.
**E-Posters**

**e-poster 54**  
Cleft Repair in Pierre Robin Sequence Following Mandibular Distraction Osteogenesis  
Presenter: Matthew B. Lorenzo, BA  
Authors: Matthew B. Lorenzo, BA, Ari M. Wes, BA, Daniel Mazzaferro, MBA, Sanjay Naran, MD, Scott P. Bartlett, MD, Jesse A. Taylor, MD  
Institution: The Children's Hospital of Philadelphia  

**Abstract:**  
**Purpose:** This study aims to evaluate the timing and safety of cleft palate repair in patients with Pierre Robin sequence (PRS) who underwent mandibular distraction osteogenesis (MDO) for management of upper airway obstruction.  

**Methods:** A retrospective review was performed of all patients at The Children's Hospital of Philadelphia with PRS who underwent either MDO (study cohort) and cleft palate repair or tongue-lip adhesion (TLA) (control cohort) and cleft palate repair between 2011 and 2016, or between 2006 and 2010, respectively.  

**Results:** Thirty-three patients met inclusion criteria in the MDO group, while 9 patients met inclusion criteria in the TLA group. In the MDO group, 21 were male (64%) and 12 female (36%); this did not differ significantly from the TLA group (Male: N=6, 67%; Female: N=3, 33%; P=1.0). In the study cohort, comorbidities were present in the following frequencies: Stickler Syndrome (N=6; 18%), Treacher Collins Syndrome (N=1; 3%), Bifacial Microsomia (N=1; 3%), cardiovascular abnormality (N=6; 18%), separate airway abnormality (N=3; 9%), renal abnormality (N=2; 6%). Five patients (15%) had clefts of the soft palate only, while 28 patients (85%) had a cleft of both soft and hard palate. Repair was achieved via modified Furlow technique (N=23; 70%), VY Pushback (N=9; 27%), and two-flap palatoplasty (N=1; 3%). In the study cohort and control cohort, mean age at cleft repair was 13.1 ±2.1 months and 15.1 ±2.1 months, respectively (P=0.0096); mean follow-up was 19.8 ±17.0 months and 58.0 ±37.9 months, respectively (P<0.001). Despite the earlier age of cleft repair in the study cohort, both groups experienced equivalent complication rates of 0%.  

**Conclusion:** Our study cohort underwent cleft repair at an average age of 13 months, significantly earlier than our control cohort; nevertheless, our findings indicate that repair of the cleft palate at this age is safe in this patient subset treated with MDO.

**e-poster 55**  
Nasal Root Deviation in Unicoronal Craniosynostosis: A Cranio metric Analysis of Early and Late Postoperative Outcomes  
Presenter: Ari Wes  
Authors: Jason Wink, Ari Wes, Dan Mazzaferro, Sanjay Naran, Scott Bartlett, Jesse Taylor  
Institution: Children's Hospital of Philadelphia  

**Abstract:**  
**Purpose:** Current operative techniques for correcting unicoronal synostosis (UCS) leave the nasal bones untouched, resulting in an unclear long-term impact on nasal root deviation. The purpose of this study is to quantify nasal root deviation in the pre-operative and late post-operative setting in patients who have undergone conventional single-staged UCS correction.  

**Methods:** We performed a retrospective, craniometric analysis of nasal root deviation comparing preoperative CT scans, with those of the early, and late postoperative period. Three vectors were analyzed to measure nasal root deviation, one extending from the nasion to the rhinion (nasal bone vector), the second from the rhinion to the ANS (nasal aperture vector), and the third from the nasion to the ANS (nasal longitudinal vector).  

**Results:** Twenty-five subjects were included in the study. Average ages at the time of preoperative, early, and late postoperative imaging were 0.60.3 years, 0.90.6 years, & 9.32.7 years respectively. Improvement of angular deviation of both the nasal aperture vector and nasal longitudinal vector, was observed. Mean angular deviation of the nasal aperture vector was 6.01.9 degrees preoperatively, 6.02.1 degrees early postoperatively (p=0.952), and 2.42.1 in the late postoperative period (p=0.013). Mean angular deviation of the nasal longitudinal vector was 5.7+2.0 degrees preoperatively, 5.82.3 degrees early postoperatively (p=0.948), and 3.71.6 degrees in the late postoperative period (p=0.019).  

**Conclusion:** Nasal root deviation decreased significantly only in the late postoperative period, lending credence to the notion that though UCS correction does not directly address nasal root deviation, this pathology improves significantly over time.
**e-poster 56**

**Craniosynostosis Surgery: Does Hospital Case-Volume Impact Outcomes or Cost?**

Presenter: Rachel Mckenna  
Authors: Rachel Mckenna, Ari Wes, Dan Mazzaferro, Sanjay Naran, Scott Bartlett, Jesse Taylor  
Institution: Children’s Hospital of Philadelphia

**Abstract:**  
**Background:** The relationship between hospital/surgeon characteristics and operative outcomes and cost are being scrutinized increasingly. In patients with craniosynostosis specifically, the relationship between hospital-volume and outcomes has yet to be characterized.

**Methods:** Subjects undergoing craniosynostosis surgery between 2004 and 2015 were identified in the Pediatric Health Information System (PHIS). Outcomes were compared between two exposure groups, those undergoing treatment at a high-volume institution (>40 cases per year), and those undergoing treatment at a low-volume institution (40 cases per year). Primary outcomes were: any complication, prolonged length of stay, and increased total cost.

**Results:** Over thirteen thousand patients (N=13,112) from 49 institutions met inclusion criteria. In multivariate regression analyses, subjects treated in high-volume centers were less likely to experience any complication (OR 0.764, p<0.001), were less likely to have an extended length of stay (OR 0.624, p<0.001), and were less likely to have increased total cost (OR 0.596, p<0.001). Subjects undergoing strip-craniectomy in high-volume centers were also less likely to have any complication (OR 0.708, p=0.018), or increased total cost (OR 0.51, p<0.001). Subjects undergoing mid-vault reconstruction in high-volume centers were less likely to experience any complications (OR 0.696, p=0.002), have an extended length of stay (OR 0.542, p<0.001), or have increased total cost (OR 0.495, p<0.001).

**Conclusion:** In hospitals performing a high-volume of craniosynostosis surgery, subjects had significantly decreased odds of experiencing a complication, prolonged length of stay, or incurring increased total cost, when compared to those undergoing treatment in low-volume institutions.

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**e-poster 57**

**Analysis of Practice Settings for Craniofacial Surgery Fellowship Graduates in North America**

Presenter: Christopher Runyan  
Authors: Christopher Runyan, Jason Silvestre, Jesse Taylor  
Institution: Wake Forest Baptist Medical Center

**Abstract:**  
**Aims:** In North America, the number of craniofacial surgery fellowship graduates is increasing, yet an analysis of practice settings upon graduation is lacking. We characterize the practice types of recent graduates of craniofacial fellowship programs in the U.S. and Canada.

**Methods:** A six-year cohort of craniofacial fellows in the U.S. and Canada (2010 - 2016) were obtained from craniofacial programs recognized by the American Society of Craniofacial Surgery. Practice setting was determined at one and three years post-graduation, and predictors of practice setting were determined.

**Results:** 175 craniofacial surgeons trained at thirty-five fellowship programs. At one year post-graduation, 33.6% had an academic craniofacial position and 27.1% were in private practice (p = 0.361). A minority of graduates pursued additional fellowships (16.4%), non-academic craniofacial positions (10.0%), academic non-craniofacial positions (5.7%), and international practices (7.1%). At three years, the percentage of graduates in academic craniofacial positions was unchanged (34.5% vs 33.6%, p = 0.790). The strongest predictors of future academic craniofacial practice were completing plastic surgery residency at a program with a craniofacial fellowship program (OR 6.78, p < 0.001) and completing an academic craniofacial fellowship program (OR 4.48, p = 0.020). In conclusion, a minority of craniofacial fellowship graduates practice academic craniofacial surgery. A strong academic craniofacial surgery background during residency and fellowship is associated with a future career in academic craniofacial surgery. These data may assist trainees choose training programs that align with career goals and educators select future academic surgeons.
e-poster 58
A craniometric analysis of the posterior cranial base after posterior vault distraction
Presenter: Matthew B. Lorenzo
Authors: Matthew B. Lorenzo, Netanja ter Maaten, Daniel M. Mazzaferro, Sanjay Naran, Scott P. Bartlett, Jesse A. Taylor
Institution: The Childrens Hospital of Philadelphia
Abstract:
Posterior vault distraction (PVDO) is useful in turribrachycephaly patients to increase intracranial volume, treat increased intracranial pressure, and normalize head shape. The purpose of this study is to compare changes to the posterior cranial base with PVDO. Our prospective craniofacial registry was queried for patients who underwent PVDO with CT scans at two time-points: within 3 months preoperatively and 1 to 6 months postoperatively. Using Mimics® software, craniometric landmarks were identified and surface area of the foramen magnum was calculated. A comparison of pre- to post-operative craniometric measurements was done using Wilcoxon matched-paired signed rank tests and linear regression. A total of 69 PVDO patients were identified, 12 patients met inclusion criteria. Mean operative age was 3.0±4.0 years, of whom 6 were younger than one year and 6 were older. Cranial vault was distracted on average 25.0±6.0mm, with those under one distracted 29.5±4.9mm and over one 22.0±4.9mm (p=0.0543). There was a significant increase in pre- to post-operative foramen magnum surface area (52.1±63.2mm², p=0.002), length (0.9±1.4mm, p=0.050), and width (0.6±1.0mm, p=0.050). Similarly, linear distances between nasion (N) and the following cranial base landmarks increased over time: tuberculum sellae (TS) (1.8±2.3mm, p=0.012), foramen magnum (FM) (3.4±4.2mm, p=0.010), and occipital protuberance (OP) (9.05±9.6mm, p=0.003). Controlling for distraction length and time between CT scans, patients under age one had significantly greater growth in FM width, N to S and N to FM distance when compared to those over age one (p<0.05). Patients after PVDO experience a growth and lengthening of the foramen magnum and cranial base, respectively, with patients under one year of age experiencing a higher growth rate. Further work is needed to differentiate PVDO’s effect on the posterior cranial base from normative control posterior cranial base growth.

e-poster 59
Contribution of the periosteum mechanical properties in the mandibular distraction osteogenesis
Presenter: Kadlub Natacha
Authors: Debelmas Alexandre, Picard Arnaud, Diner Patrick Antoine, Nedjar Boumediene, Kadlub Natacha, Boisson Jean
Institution: APHP
Abstract:
Introduction: Standard mandibular distraction osteogenesis usually requires a transcutaneous or transmucosal rod to activate the device and can lead to various complications. In this context, we developed a magnetically activated osteogenesis distractor. To design a prototype for cadaveric and animal experimentation, we need a better knowledge of the torque required to perform a mandibular distraction (DO). As we assumed the stretch of the periosteum imposes the main stress opposing DO, our goal was to assess human mandibular periosteum’s mechanical properties and to compare them with the torque measured during mandibular DO.

Methods: Periosteum was harvested from fresh human mandible cadavers (left horizontal corpus). Uniaxial tensile tests were performed on the specimens using an elongation machine, according to the following protocol: (1) continuous traction at 0.25mm/s (2) Isometric relaxation during 300s (3) 5 cycles of elongation-relaxation at 0.5mm/sec (4) traction until rupture. In parallel, horizontal mandibular DO was performed in each cadaver using standard distractors. Torque was measured with a torquemeter placed on the device activation rod all along the DO process.

Results: Periosteum samples presented an anisotropic nonlinear viscoelastic stress-strain relationship. We observed three phases and a hysteric behavior on the stress/strain curves, which is common for collagen/elastin tissues. Then, we evaluated the stress involved in a DO device by the periosteum and compare with the average torque measurements on cadaveric experimentations. We also observed the relaxation characteristic time of periosteum was significantly under 24 hours.

Conclusion: The periosteum seemed to be the main contribution to DO, and the results we presented may be useful for the development of new types of distraction devices.
e-poster 60
Le Fort 3 in Pycnodysostosis: particularities of management in two cases
Presenter: Erick Arnaud
Authors: Erick Arnaud, Hossein Khonsari, Rodrigo Kouji, Sam Haber, Eva Galliani, Arnaud Picard
Institution: Hospital Necker craniofacial unit

Abstract:
Pycnodysostosis, described by Maroteaux in 1962, is a very rare genetic bony disorder associating dwarfism, incomplete ossification of the skull and retrusion of the face. The mandible is also abnormal with an open mandibular angle.

Severe obstructive respiratory impairment (OSAS) in infancy often leads to chronic use of CPAP that could be avoided with a Le Fort 3 advancement. Presentation Out of 4 cases, two have not been operated yet and are stabilized by CPAP. The two operated cases presented aged respectively 7 and 11. The most severe one presented with a lack of bone in half of the skull, and the second one with an occipital dehiscence only. All had a severe facial retrusion combined to a dysmorphic mandible with an open mandibular angle. Palate was also narrow in the transversal direction. The procedures carried out were Le Fort 3 osteotomies with midfacial split to enlarge the transversal width. In the one with a giant skull defect, two internal distractors alone (KLS Martin, Tuttlingen) were used, without possibility of placement of and external distractor. In order to stabilize the face, two crossed transfacial pins (K-wire, 2.1 mm) were used. In the other patient, an external frame (RED, KLS Martin) was used in combination with two internal distractors (Push-pull techniques). Distraction was carried out in a usual way with post-operative 1 mm daily advancement. The RED frame could be removed after 3 weeks and internal distractors were left for consolidation during 3 months. Both patients improved their breathing and appearance, and did not need CPAP anymore.

Conclusion: Pycnodysostosis is a complex disorder that involves skull defect and maxillo-mandibular anomalies. A cranioplasty must be undertaken to correct the skull defect whenever possible but Le Fort 3 is the main procedure to improve OSAS. Subsequently, maxillo-mandibular anomalies require specific management.

e-poster 61
Orthognathic surgery and rhinoplasty: Should they be simultaneous or staged?
Presenter: Alexander Sun
Authors: Alexander Sun, Derek Steinbacher
Institution: Yale School of Medicine

Abstract:
Purpose: Orthognathic surgery can significantly impact the nasolabial envelope. At times, a simultaneous or a staged rhinoplasty is required. The purpose of this study is to evaluate nasal morphology in a large cohort of orthognathic patients, focusing on predictive variables, and need for and timing of definitive rhinoplasty. Based on this data, an algorithm for implementation of adjunctive rhinoplasty in orthognathic patients will be proposed.

Methods: A review of cases over a two-year period was completed. Demographic, diagnostic, operative details, nasal morphology, and requirement/timing of rhinoplasty were compiled. Three-dimensional images [Canfield] were used to quantify the anatomic variables. Two-tailed z-tests were used to compare proportions with an alpha of 0.05.

Results: A total of 227 patients underwent orthognathic surgery during this period. Of these, 163 fulfilled inclusion criteria for this study. The mean age was 23.3 years. Patients without rhinoplasty either had no intrinsic deformity or had improved results with orthognathic surgery alone. In total, 41.7% of orthognathic cases received an adjunctive rhinoplasty. Of these, 82.4% were staged and 17.6% were simultaneous. The average time between staged procedures was 208 days. When simultaneous, 83.3% of the orthognathic procedures had little to no maxillary movement [advancement <4-5mm, impaction <2mm, no alar base excisions]; in comparison, only 7.1% of staged cases had little maxillary movement [p<0.0001].

Conclusion: Nasal and jaw deformities are intricately interlinked. In this large series, we identified a 44.2% prevalence of nasal deformity. The specifics of orthognathic movement and the presence/absence of intrinsic nasal deformity influenced the need for rhinoplasty. When rhinoplasty is indicated, concurrent nasal surgery is best for cases with minimal maxillary manipulation, while interval rhinoplasty is recommended for preexisting and surgery-induced nasal deformity.
e-poster 62
Facial Bipartition Under The Age Of Two For Severe Craniofacial Clefting
Presenter: Bryant A Toth, M.D.
Authors: Bryant A Toth, M.D.
Institution: UCSF-Benioff Childrens Hospital, Oakland, California

Abstract:
The literature varies as to what is the proper time to proceed with repair of a complex cleft both as to the soft tissue repair vs. the bony repair and at what age facial bipartition is appropriate. EBM is a child born with severe facial clefting and orbital malposition with severe hypertelorbitism. Following birth he was transferred to our institution awaiting timing of surgical repair in addition to life support. Developmentally the child was found to be only mildly delayed and full vision was documented in both eyes. We elected to proceed with the soft tissue reconstruction first followed by facial bipartition at 18 months of age.

We present a 12 minute video documenting the two procedures in addition to reviewing the decision making process during the surgery. The patient is now nine months post bipartition and up to this point in time doing well.

e-poster 63
Minimal Invasive Le Fort III Osteotomy
Presenter: Herman Jr Vercruysse
Authors: Herman Jr Vercruysse, Ramon Sieira-Gil, Alfonso Navarro, Eloy Garcia-Diez
Institution: Department of Pediatric Surgery, Hospital Sant Joan de Déu, Barcelona, Spain

Abstract:
Introduction: By popularising the Le Fort III osteotomy for the treatment of severe midface hypoplasia, Paul Tessier promoted the coronal approach for surgical exposure. Earlier authors had been using a combination of smaller incisions to acquire enough access to perform the different osteotomies. A bicoronal incision provided a closer visual control of the displacement of the midface in the 3 planes and allowed straightforward seating of bone grafts. The shift from static osteosynthesis and bonegrafting to distraction osteosynthesis, and the constant demand to further lower comorbidity, could make us reconsider the coronal incision however. Although still the golden standard, the coronal approach can be time-consuming and leaves an ear-to-ear scar. Reconsidering a combination of the minimal incisions of the earliest pioneers to move away from a coronal incision, should therefore be considered.

Materials: Two fresh non-frozen heads (one female and one male; one edentulous and one dentulous) were obtained from the department of Human Anatomy & Embryology.

Methods: An alternative to the coronal approach is presented that combines a minimally visible 8mm glabellar scar with an intra-oral and a transconjunctival incision. The glabellar vertical midline incision is used to have an uncompromised access to the nasofrontal bone and the nasal septum. The bilateral transconjunctival incisions without lateral canthotomy and a bilateral 1.5 cm intra-oral incision provide enough surgical exposure to perform an endoscopically assisted piezo-electric Le Fort III osteotomy.

Results & Conclusion: Operative times of the minimally invasive Le Fort III osteotomy were 125 min and 140 min. The endoscope proved its value in assisting the surgery and in verifying the completeness of the osteotomy. Based on the cadaveric set up described in this report, this minimally invasive Le Fort III approach has proven its feasibility and efficiency for clinical use.
**E-Posters**

**e-poster 64**
Results of spring-assisted cranioplasty in patients with scaphocephaly
Presenter: Leonid Satanin
Authors: Leonid Satanin, Ivan Teterin, Andrey Evteev, Alexander Ivanov, Alexander Sakharov, Vitaly Roginsky, Natalia Lemeneva
Institution: Moscow Burdenko Neurosurgery Institute, Russia

**Abstract:**
**Background:** The method of spring-assisted cranioplasty (SAC) is a widely used method of correction of craniosynostosis. However, the question of the comparative effectiveness of spring-assisted cranioplasty in patients with scaphocephaly remains unclear. The purpose of the study was to evaluate the results of treatment of patients with scaphocephaly carried out with the use of spring-assisted cranioplasty.

**Material and methods:** All children were less than 7 months of age (mean - 5 months) who were treated by SAC between 2015 to 2016 at the Moscow Neurosurgery Institute. In 14 cases, CT examinations were performed before surgery and before the removal of the springs (4-6 months after surgery). The CT scans were used to calculate intracranial volumes before and after surgery, and craniometric methods were employed as well. Morphology of the skull before and after treatment was assessed. The expansion distance of the spring was also evaluated. The time of surgical intervention and the volume of blood loss were assessed. The control group comprised of 20 patients with scaphocephaly after endoscopic surgery.

**Results:** The median intracranial volume before SAC was 850.9 ml, while after surgery it was 1130.6 ml. The increase in intracranial volume was 31.6 % (from 20 to 57%). Only 1 case required a blood transfusion. A good and satisfactory cosmetic result was obtained in all cases. Cranial measurements showed significant change of the cranial vault and base morphology. No significant complications were observed. Distance of distraction was an average 30 mm, which corresponds to the distance of distraction when using conventional, non-spring distraction devices.

**Conclusion:** Spring-assisted cranioplasty is an effective and minimally traumatic method for treating patients with scaphocephaly at the age of up to 6 months, which allows achieving good functional and aesthetic results. The only drawback of the method is the need to remove spring- distractors.

**e-poster 65**
Vertebral anomalies in craniofacial microsomia: systematic review and large multicenter cohort study
Presenter: Maarten Koudstaal
Authors: Maarten Koudstaal, Ruben Renkema, Linda Caron, David Dunaway, Chris Forrest, Bonnie Padwa
Institution: Erasmus MC

**Abstract:**
**Background:** Craniofacial microsomia (CFM) is characterized by a heterogeneous underdevelopment of the facial structures related to the first and second branchial arches, but extracranial malformations such as vertebral anomalies may occur. It is unclear which specific patients with CFM are at risk of vertebral anomalies.

**Objectives:** To study the prevalence and symptoms of vertebral anomalies in CFM, to determine which patients are at risk of vertebral anomalies, and whether these anomalies are associated with other extracraniofacial anomalies in CFM.

**Methods:** All patients diagnosed with CFM seen in four major craniofacial centers were included and reviewed. Data on vertebral anomalies, symptoms, treatment and presence of other extracraniofacial anomalies was extracted. Patient characteristics were documented. The O.M.E.N.S. and Pruzansky classification were used to grade the facial malformations in patients. The authors performed a systematic review to provide an overview of literature on vertebral anomalies in CFM.

**Findings and Conclusion:** A total of 991 patients with CFM were included; 28% of the patients had vertebral anomalies. The reported prevalence of vertebral anomalies in CFM in literature is 24% to 79%, and is mostly based on small patient numbers. Retrospective analysis showed that patients with a bilateral CFM, or a higher Pruzansky or O.M.E.N.S. classification were at higher risk for vertebral anomalies. Patients diagnosed with both CFM and vertebral anomalies, were also at higher risk for other extracranial anomalies, such as cardiac, renal, or brain anomalies. Screening on vertebral anomalies, by using upright radiographs, is indicated in patients with bilateral CFM, or in patients with CFM and a high Pruzansky or O.M.E.N.S. classification.
**e-poster 66**

**Comparison of Cognitive Developmental Outcomes in Late Presentation Metopic Craniosynostosis Repair**

Presenter: Stefani C Fontana  
Authors: Stefani C Fontana, Skylar Bellinger, Debora B Daniels, Paul J Camarata, Brian T Andrews  
Institution: University of Kansas Medical Center, Department of Plastic Surgery

**Abstract:**  
*Purpose:* Metopic craniosynostosis demonstrates: (1) an increasing incidence, (2) a wide spectrum of morphologic severity, and (3) concomitant developmental delays. Debate remains on how to best manage infants with moderate metopic phenotypes. Currently, surgical decision-making is made solely on aesthetic appearances prior to 12 months of age. The purpose of this study is to assess the impact surgery has on neurocognitive developmental outcomes.  

**Materials and Methods:** A prospective, non-randomized study was performed. Infants with non-syndromic metopic craniosynostosis presenting at >12 months of age were enrolled. The Bayley Scales of Infant and Toddler Development, Third Edition, (BSID III) was utilized to assess developmental status with delays defined as a scaled score of <85.  

**Results:** Eight infants with metopic craniosynostosis were identified. The average age at initial presentation was 26 months (13-43 months) and all had a moderate phenotype. Initial BSID III testing demonstrated the following delays: cognitive= 4 of 8 (50%) infants, motor= 2 of 8 (25%) infants, language 3 of 8 (37.5%) infants. Four of the eight infants underwent cranial vault expansion and all demonstrated improved BSID III scores post-operatively. Specifically, cognitive delays were present in three infants who underwent surgery with an average improvement of 67.3 to 78.3 post-operatively. The fourth infant remained cognitively normal but demonstrated language improvement from 62 to 94. Four infants did not undergo surgical intervention with 3 having serial testing for developmental outcomes comparison demonstrating the following developmental declines: cognitive= 1 of 3 (33%), language= 2 of 3 (66%), motor= 2 of 3 (66%).  

**Conclusion:** Infants with metopic craniosynostosis who present after 12 months of age often have developmental delays. This study demonstrates a positive association between cranial vault expansion and improved developmental outcomes when compared to observation.

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**e-poster 67**

**Role of computed tomography before and after nonsyndromic craniosynostosis surgery: a systematic review**

Presenter: Nayif Alnaif  
Authors: Nayif Alnaif, Alamri, Abdulrahman, Zhou, Mingsha, Galli, Rafeal, Gilardino, Mirko  
Institution: McGill University

**Abstract:**  
*Background:* Computed tomography (CT) is currently the most prevalent form of imaging pre and post nonsyndromic craniosynostosis surgery. The authors describe the current role of CT before and after nonsyndromic craniosynostosis surgery.  

**Method:** A comprehensive literature review of the National Library of Medicine (PubMed) database was performed. English-language studies involving the role of CT before and after paediatric cranial surgery were included. Extracted data included demographics, type of suture synostosis, imaging modalities, concordance of findings on imaging and on clinical exam, incidental findings reported on imaging, and the impact imaging had on subsequent management.  

**Results:** Twenty articles met the inclusion criteria, resulting in 809 patients with skull deformity investigated for nonsyndromic craniosynostosis. Mean age at surgery was 13.1 months. The most common diagnoses were sagittal (51.5 percent), metopic (25.7 percent), unicoronal (13.2 percent), multiple sutures (3.7 percent), bicoronal (3.3 percent), unilambdoid (2.4 percent), bilambdoid (0.1 percent), and frontosphenoidal (0.1 percent) synostoses. The benefits of CT are completing or correcting clinical diagnosis, preventing suboptimal surgery, and assessing clinically subtle anomalies. CTs define the location and degree of skull deformity. Five studies found 100 percent concordance of CT findings with clinical diagnosis. Three other studies reported concordance of CT findings with clinical exam at 93.3 percent, 98.5 percent, and 98.8 percent. Incidental findings and their utility are reported with great variability from one study to another. Seven studies concluded that the potential benefits of preoperative CT scans do not justify the harm from its radiation in the routine evaluation of nonsyndromic craniosynostosis. Two articles concluded that CT scans should be part of the routine preoperative evaluation of all patients with nonsyndromic craniosynostosis.
e-poster 68
Craniometaphyseal Dysplasia
Presenter: Tatiana Palomino Consuegra
Authors: Tatiana Palomino Consuegra, Rolando Prada
         Madrid, Diana Marcela Díaz López,
         Diana Carolina Gómez Prada
Institution: Hospital Infantil Universitario de San José, Bogotá, Colombia

Abstract: Introduction: Craniometaphyseal dysplasia is a rare genetically inherited pathology pattern which compromises ossification of the bones of the face, skull and extremities.

Materials and Methods: We present the experience gained through diagnosis, clinical and genetic evaluation, treatment and follow up of three treatments seen at Hospital Infantil Universitario de San José.

Results: In all cases the pattern of dominant inheritance was present. Patients presented the characteristic sclerosis form and hyperostosis of the bones of skull and face, in addition to the widening of the metaphysis in long bones. Two of the cases were managed conservatively, closely monitoring the evolution of the condition and awaiting complete facial growth. Another case was managed surgically through cranial remodeling obtaining very good aesthetic and functional results.

Conclusions: Craniometaphyseal dysplasia is a rare occurrence having variable bone involvement and may therefore be managed conservatively or surgically depending on the functional and aesthetic needs of each patient. Clinical and genetic evaluation is important for individualized accomplishment and for adequate genetic counseling to families. Key words: Craniometaphyseal dysplasia, ostheochondrodysplasia, hyperostosis.

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e-poster 69
Changes in Skull Dysmorphology with Age in Unilateral Coronal Synostosis
Presenter: Kirun Baweja, BS
Authors: Kirun Baweja, BS, Alexander H. Sun, BS, Rajendra Sawh-Martinez, MD, John A. Persing, MD
Institution: Yale School of Medicine

Abstract: The mechanism underlying the development of deformity in coronal craniosynostosis remains uncovered and largely uninvestigated. This study evaluates and chronicles midface and skull base growth at various stages of development, in infants with nonsyndromic unilateral coronal synostosis (UCS), in order to characterize the mechanistic progression of facial dysmorphology.

Methods: CT scans from 50 subjects (25 UCS, 25 controls) were digitized and reconstructed. A series of 42 measurements were taken using Materialise Mimics software (Leuven, Belgium). Statistical analysis was performed using SPSS (Armonk, NY).

Results: Asymmetry of the sphenoid wings was present across all age groups, noted initially in patients as young as 19 days old. The sphenoid wing ipsilateral to the fused suture consistently had a more acute angle from the midline, compared to the contralateral side. This difference was as high as 22 degrees in some patients. Also at 19 days of age, differences are noted and persist in nasal and cribriform plate deviation (p=0.003). The contralateral zygoma length is noticeably higher in patients at the one-month mark. At 2-3 months of age, the distance between the ipsilateral pterion to sella is increased (p=0.003) and persists over time. Differences in contralateral zygomatic height, and in orbital height and length, are noted to develop at 4-6 months of age and persist. Patients under two months of age also demonstrated more acute orbital rim angle (p=0.037) and reduced orbital width (p=0.039) with non-uniform re-development of significant differences at later time points.

Conclusion: Sphenoid wing asymmetry was consistent through all age groups; this supports the role of early skull base changes in the mechanistic progression of facial dysmorphology in unilateral coronal synostosis. The earliest changes in UCS are ipsilateral orbital changes and nasal deviation beginning before two months of age, followed by changes in the contralate.
**e-poster 70**  
**The changing indication for correction of metopic synostosis: the Rotterdam experience**  
Presenter: Hansje Bredero-Boelhouwer  
Authors: Martijn Cornelissen, Hansje Bredero-Boelhouwer, Irene Mathijssen, Sarah Versnel  
Institution: Erasmus University Medical Center, Rotterdam, the Netherlands  

**Abstract:**  
**Introduction:** Recent studies indicate that the prevalence of metopic synostosis is rising. However, the functional indication for operative correction is under debate in some cases, as the prevalence of intracranial hypertension in these patients seems very low. In our center, this has resulted in a change of indication for operative correction of metopic synostosis since 2016. This study aimed to demonstrate this change through a comparison of referred metopic synostosis patients seen by a single surgeon in 2011 and 2016.  

**Methods:** All new patients seen at the outpatient clinic referred for trigonocephaly to a single surgeon in 2011 and 2016 were included. Patients were categorized according to their treatment plan: operative correction, follow-up at the craniofacial center or discharge and no follow-up. Photographs of patients were compared with regard to severity of trigonocephaly, lateral retrusion and orbital shape. Parents' head shapes were also taken into account.  

**Results:** In total 52 patients were referred to this surgeon with suspicion of metopic synostosis. In 2011 40% of patients referred for metopic synostosis were operated on. This decreased to 22% in 2016. The decision for treatment or follow-up was mainly based on the width of the medial forehead in relation to the start of the lateral supra-orbital retrusion. The change of indication was seen in the patients with moderate trigonocephaly.  

**Conclusion:** The indication for functional operative correction of metopic synostosis is changing, reflected by the numbers of a single surgeon in our center. This change is based on the idea that a later closure of the metopic suture, resulting in a mild-moderate trigonocephalic skull shape, has no functional restrictions on the brain. Careful follow-up of mild and moderate trigonocephalic cases is important. Future follow-up data of these patients is of value in the evaluation of our new treatment protocol and exemplary for the natural course of trigonocephaly.

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**e-poster 71**  
**Engineering novel hydrogel adhesives for cranioplasty procedures**  
Presenter: John G Meara  
Authors: Ehsan Shirzaei Sani, Ehsan Shirzaei Sani, Seyed Hossein Bassir, Roberto Portillo Lara, John G Meara, Giuseppe Intini, Nasim Annabi  
Institution: Harvard School of Dental Medicine  

**Abstract:** Transplantation of autologous bone is considered the gold standard technique for cranioplasty. However, bone resorption after procedures of autologous bone transplantation is seen in up to 50% in the pediatric population and in up to 6.5% in adults. To prevent bone resorption, novel biomaterials have been proposed as carrier for autologous bone. An ideal bone carrier for cranioplasty should be biocompatible, mechanically stable, easy to shape, inexpensive, and able adhere to the wound defect even in presence of blood or other exudates. Conventional biomaterials are generally expensive, lack osteoinductivity, and lack adhesion to the native tissue. Therefore, we aimed at engineering novel osteoinductive and adhesive hydrogels, which can be readily utilized to carry autologous bone and promote bone regeneration of cranial defects. We generated gelatin methacryloyl (GelMA) hydrogels that can be rapidly photocrosslinked in situ using visible light, thus providing mechanical stability to the transplanted bone. In addition, we incorporated osteoinductive silicate nanoparticles (SNs) to the engineered hydrogels to promote bone regeneration. Our studies showed that, in vivo, the hydrogel precursors could be readily delivered and photocrosslinked in situ to seal calvarial bone defects in mice. We found that 14 days after implantation the hydrogels were still stably adhering to the surrounding tissues. Our in vitro and in vivo characterization also demonstrated that SN-loaded GelMA hydrogels exhibited high biocompatibility and adhesion to the native tissue. Mechanical characterization showed that the elastic moduli of hydrogels increase from $18.4 \pm 2.0 \text{kPa}$ to $70.3 \pm 6.6 \text{kPa}$ by changing the total polymer concentration from 7% to 15% (w/v) and that the addition of SN does not significantly affect their mechanical properties. The engineered hydrogel adhesives may represent an effective strategy to carry autologous bone during cranioplasty procedures.
e-poster 72
Progress in automated intracranial volume quantification from 3D Photography
Presenter: Antonio R. Porras
Authors: Liyun Tu, Antonio R. Porras, Deki Tsering, Robert Keating, Albert Oh, Marius George Lingurar, Scott R. Ensel, Beatriz Paniagua, Andinet Enquobahire, Gary F. Rogers
Institution: The Sheikh Zayed Institute for Pediatric Surgical Innovation, Childrens National

Abstract:
Background and Purpose: 3D photography offers simple, radiation-free evaluation of cranio-facial morphology. However, the quantification of intracranial volume is not possible with current imaging systems to evaluate brain development in children with cranial pathology. The purpose of this study is to develop an automated, radiation-free tool to quantify the intracranial volume and assess its accuracy against computed tomography (CT) imaging.

Methods: Pairs of retrospective head CTs and 3D photography (3dMDHead, 3dMD, Atlanta, GA) were collected from 15 subjects (average age 47 months, range 4 months - 16 years). All 3D photographs were taken at an average of 13 days (range 0-49 days) from their corresponding CTs. The cranium was automatically extracted from CT using previously reported methods. CT-based intracranial volume (V1) was computed between the cranial bones and base--defined by the nasion, posterior clinoid processes of the dorsum sellae and opisthion). Then, the 3D photograph and the CT of a same subject were aligned via automated rigid registration to correct for pose and identify landmark correspondence. The 3D photography-based head volume (V2, including bone and skin) was calculated between the head surface and the cranial base. Relationship between V1 and V2 was modeled via linear regression.

Results: The head volume measured from 3D photography (V2) overestimated the true intracranial volume (V1) with an average error of 41.52 +/- 12.95%. After applying our linear regression model, the volumetric error between V1 and V2 was reduced significantly to 5.33 +/- 3.49%, and yielded a correlation (R²) of 0.96.

Conclusions: We introduced an automated method to accurately evaluate intracranial volume from radiation-free 3D photography that correlates very strongly with CT-based measurements. Our method opens the possibility to follow up patients in the craniofacial clinic using risk-free longitudinal data for the evaluation of long term clinical outcomes.

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e-poster 73
Computer Simulations for Prediction of Sagittal Spring Cranioplasty
Presenter: Alessandro Borghi
Authors: Alessandro Borghi, Naiara Rodriguez Florez, Gregory James, Silvia Schievano, David Dunaway, Owase Jeelani
Institution: UCL GOS Institute of Child Health and Great Ormond Street Hospital

Abstract: Implantation of cranioplasty springs has become a widespread technique for the treatment of scaphocephaly. Although functionally and aesthetically effective, the procedure achieves suboptimal outcomes in 5% of the cases. A computer model that allows for patient specific simulation of sagittal spring cranioplasty is here proposed in order to help predict spring expansion in individual cases. 10 scaphocephaly patients who underwent sagittal spring cranioplasty (age at surgery 5.4±1.2 mts) following CT assessment (age at CT 3.8±1.7 mts) were prospectively recruited for this study. CT data were processed to create patient specific skull 3D models: to account for patient growth between time of CT and surgery, a cranial growth curve based on 24 unoperated patients (age 4.0±1.7 mts, range 1.6-7.2 mts) was produced and each 3D model scaled accordingly. Position and dimension of the osteotomies, and model of the springs recorded at surgery, were replicated on the 3D model. Spring mechanical characteristics from previously published data were used to simulate on-table expansion in computer modelling software (Ansys Mechanical). Simulated opening of the anterior and posterior springs for each patient were compared with data from theatre: the model predicted opening well for both anterior (38.9±3.8 predicted vs. 35.89±4.5mm on-table measurement; 14±13% difference) and posterior (36.7±3.4 vs. 39.4±5.4mm; 13±9% difference) spring. Predicted pre- to post-op CI variation (1.22%±0.5%) was in line with published data; simulated shortening of anterior-posterior craniotomy compared well with on-table measurements (18±4% vs. 25±15%). The model showed good prediction of the spring expansion experienced in theatre for all 10 patients. Application of viscoelastic material properties, following population-based material tuning, will allow modelling changes in skull dimension during follow up. Further testing in more patients will help prospective use of this tool for surgical plan.
e-poster 74
Understanding Patients Perspectives of Barriers to Accessing Care
Presenter: Meghan McCullough, MD
Authors: Meghan McCullough, MD, Allyn Ausländer, MPH, Caroline Yao, MS, MD, Jordan Swanson, MD, William P Magee III, DDS, MD
Institution: University of Southern California

Abstract:
Background: Most people who lack adequate access to surgical care reside in low- and middle-income countries, but few studies have analyzed the barriers that determine the ability to access surgical treatment in these settings. We seek to determine which cultural, structural and financial barriers prevent access to cleft care in a resource-limited country to potentially enable barrier mitigation and improve surgical program design.

Methods: A cross-sectional study of families accessing care for cleft lip and palate deformities was performed during a surgical mission in Esteli, Nicaragua in April 2016. A survey instrument containing validated demographic, healthcare service accessibility, and medical/surgical components was administered.

Results: 239 participants were surveyed. Of the ten cultural barriers assessed, 82% of participants felt they did not encounter any barriers, while only 10% experienced two or more. Of the eight financial barriers assessed, 53% of participants felt they did not encounter any while 12% experienced one barrier, 13% experienced two, 15% experienced three to five barriers, and 7% experienced greater than six. Of the 12 structural barriers assessed, 65% of participants felt they did not encounter any, 20% experienced between one and three barriers and 15% experienced four or more. Of the total 30 barriers assessed, cumulatively 45% of participants did not encounter any and 9% experienced only one.

Conclusion: The barriers to access care are complex, multi-factorial and poorly understood. The cultural, financial and structural factors that have traditionally been considered the greatest barriers affected only about half of patients who ultimately sought care through medical missions. Further study is underway through targeted focus groups to better elucidate the underlying factors that delay patients in receiving safe and timely care.

e-poster 75
The International Family Study: A Global Collaboration Advancing Genetic and Epidemiological Research
Presenter: Allyn Ausländer, MPH
Authors: Allyn Ausländer, MPH, Freddy Brindopke, Stephanie Ly, MPH, Pedro Sanchez, MD, Jane Figueiredo, MD, William P. Magee III, DDS, MD
Institution: University of Southern California

Abstract:
Background: Orofacial clefts are among the most common congenital defects globally and incidence rates differ geographically. While many global organizations focus on surgical cleft treatment, investments into research examining cleft etiology have become a top priority to move past the mission model. To reach these understudied populations and investigate factors unique to their communities, The International Family Study, a global multi-sector collaboration was formed.

Methods: A global partnership between academic, private, and non-profit partners was structured to further understand the complex factors contributing to cleft disease. A matched case-control study of trios (child, mother, and father) was designed to reflect gold standard research practice. Support was garnered at the community level within each country of operation and local co-investigators were identified to lead sites. Teams of volunteers were trained to collect data and train others creating a sustainable research team in each country.

Results: Data has been collected in over 30 cities across 9 countries among cleft cases and newborn controls including both genetic samples and extensive epidemiological information. Over 100 international researchers have been recruited, trained, and undertaken leadership roles. The culminating partnership has enrolled close to 5,000 diverse families comprising over 10,000 individual genetic samples.

Conclusions: These efforts have led to a research collaboration representing an unparalleled level of diversity from Latin America, Africa, and Southeast Asia. By empowering local entities as stakeholders on the project we ensure sustainable growth with the ultimate aim of understanding and preventing orofacial clefts.
e-poster 76
Evaluation of Bilateral Cleft Lip Patients Using Anthropometry in a Multicultural Setting
Presenter: William P Magee III, DDS, MD
Authors: William P Magee III, DDS, MD, Michelle Carriere, MD, Caroline Yao, MS, MD, Meghan McCullough, MD, Allyn Ausländer, MPH
Institution: University of Southern California

Abstract:
Background: Although a great variability exists in bilateral cleft lip severity, current classifications merely quantify clefts as complete versus incomplete, providing insufficient prognostic information. By objectively exploring the spectrum of disease in different ethnicities, we aim to identify predictive measurements of pre and postoperative severity.

Methods: Anthropometric measurements, photographs and surgical data were prospectively collected from bilateral cleft lip patients from Morocco, Bolivia, Vietnam and Madagascar during medical missions. Nostril width ratio, cleft width ratio, lip transverse length, philtral height and philtral angle were compared pre and postoperatively. Two experienced plastic surgeons and two non-medical lay persons subjectively ranked pre and postoperative photographs based on degree of deformity/aesthetics.

Results: In the 33 analyzed patients, nasolabial symmetry significantly improved for all measurements: nostril width (0.93±0.13 to 0.74±0.12) cleft width (0.74±0.23 to 0.23±0.08), lip transverse length (0.76±0.12 to 1.33±0.15), philtral height (7.04±2.06 mm to 8.09±2.02) and columellar-philtral angle (54±26 degrees to 93±17 degrees) (p<0.001 for all). Cleft ratios did not differ significantly among different countries. Significant positive correlations were found pre- and postoperatively between lay persons (Pearson r=0.786 and 0.819) between surgeons (Pearson r=0.773 an 0.669) and between both groups (Pearson r=0.901 and 0.752) (p<0.001 for all). Stepwise regression showed that cleft width and nostril width were the strongest predictors of preoperative rank scores (p<0.001, p=0.010). Postoperatively, none of the ratios significantly predicted rank scores.

Conclusions: Similar morphologies were observed across different ethnicities for unilateral cleft lip patients. We present pilot results demonstrating valid and reliable predictive measures that capture aesthetics both pre- and post-operatively across ethnicity.

e-poster 77
Refinements in secondary cleft lip and nose reconstruction: the simultaneous use of multiple grafts efficiently restores normal anatomical features reducing the reoperation rate
Presenter: Francesco Gargano
Authors: Francesco Gargano, Silvio Podda
Institution: St Josephs Hospital

Abstract:
Objectives: Secondary cleft lip and nose correction is often challenging because of the long-standing and severe associated deformities. Hypoplasia of the maxilla and the pyriform rim, lanting and deformity of the affected hypoplastic lower lateral cartilage, anomalous insertion of the surrounding muscles and severe soft tissues deficiencies are the major stigmata to be corrected, if possible, in a single surgical intervention. Aim of our study is to present our anatomically-oriented approach with the simultaneous use of multiple grafts to improve outcomes, reducing the reoperation rate.

Materials and Methods: The technique has been used in 17 patients from 2013 to 2015. Mean age was 16 and male to female ratio was 9:8. Informed consent was obtained before surgery. We repaired the cleft nose first and then the lip to avoid the locking down effect of the repaired lip. Dermal grafts (from the bone graft incision), fat grafts, cartilage grafts (chonchal, costal and/or septal) and bone grafts were all used in one stage to correct the deficiency of the pyriform rim, the affected alar cartilage, the upper lip and the surrounding soft tissues. The grafts were inserted in separate layer to facilitate graft take. Antibiotics were given in the perioperative period. During follow-up, symmetry, volume and projection were measured.

Results: Mean follow up was 12 months. No complications occurred. All patient showed adequate symmetry and appropriate volume augmentation. No significative graft resorption was noticed. Nose projection and alar cartilage position appeared to be reinstated. Bone augmentation at the piriform rim appeared to give a solid scaffold to support the affected ala position and the tip support. Augmented soft tissues with fat and dermal grafts were stable over time. Lip length was appropriate in all cases and did not require further revisions.

Conclusions: Adequate use of multiple grafts in secondary cleft lip and nose surgery can improve outcomes
Limited evidence in the literature for mandibular catch-up growth in Pierre Robin Sequence

Presenter: Chad A Purnell
Authors: Chad A Purnell Coauthors: Lindsay E Janes, Julian L Klosowiak, Arun K Gosain, Elbert E. Vaca
Institution: Lurie Childrens Hospital of Northwestern Feinberg School of Medicine

Abstract:
Background/Purpose: It is often quoted in the literature that patients with isolated Pierre Robin Sequence (iPRS) have the potential for accelerated catch-up growth that may result in resolution of micrognathia. We sought to review available data on facial growth in this population and determine if these data support the concept of catch-up growth.

Methods: A National Library of Medicine search was performed for studies evaluating mandibular growth in unoperated iPRS patients. Studies without objective numerical data reported or that included surgical patients were excluded. Titles and abstracts were evaluated by 2 independent researchers for full-text review. Article data were evaluated and classified using the American Society of Plastic Surgeons Evidence Rating Scale.

Results: The initial search delivered 607 English-language abstracts. 18 articles met criteria for inclusion. 8 articles followed longitudinal patient data and therefore allowed comparison of growth rates to controls, with a total of 143 patients. 10 articles presented cross-sectional or case report data and therefore could only evaluate a single timepoint, evaluating 232 patients. 2 of 8 longitudinal studies reported faster than normal growth of mandibular length in a significant portion of their cohort. 5 of 8 reported equal growth rates. 1/18 studies reported that mandibular length of iPRS patients normalized compared to controls. 2/18 studies reported no difference in ANB between iPRS and controls, whereas 10 reported a decreased ANB in iPRS. Significant differences in methodology, patient selection, and age ranges evaluated existed between studies.

Conclusions: While the concept of catch-up growth is often quoted, a minority of objective studies suggest it is typical in iPRS. Even fewer studies suggest that maxillomandibular discrepancy completely resolves. Prospective, well-designed cohort studies are required to fully evaluate if this phenomenon exists.

Modified Le Fort II Osteotomy - Minimal Incisions

Presenter: Hospital Infantil
Authors: Hospital Infantil, Jose Rolando Prada Madrid
Institution: Hospital Infantil Universitario de San Jose

Abstract: Objective: The aim of this study is to describe and evaluate the results of a modified LeFort III osteotomy technique.

Design: This is a descriptive, case series study. The patients included were diagnosed with arrhinia, Binder, Crouzon and Apert syndroms. The surgical indication was midface retrusion, exorbitism or Obstructive Sleep Apnea (OSA). All patients had been operated by the same surgeon J.R.P. Interventions: In this technique coronal incision is avoided, the incisions are performed at the nasofrontal junction, subciliary and vestibular areas. Also there is a modification in the zygomatic osteotomy which is not performed over the arc but right through the body of the zygoma.

Results: In all cases we used used an external distractor, the age at the time of surgery was between 2 to 19 years old, the time of surgery was about 140 to 300 minutes, distracted length achieved was 8 to 28 mm in average. All patients showed improvement in the anteroposterior projection associated to decrease in exorbitism measurements and no obvious scars.

Conclusions: This technique allows good aesthetic and functional results, the glabellar incision has an excellent aesthetic results. Key words: LeFort III osteotomy, nasofrontal incision, minimal incisions.
e-poster 80
Analysis of Acute Adverse Postoperative Outcomes after Craniosynostosis Surgery: Identifying Predictors of ICU care
Presenter: Jonathan Lee
Authors: Jonathan Lee, Shirley M Dong, Jonathan Y Lee, Mandeep Tamber, Joseph E Losee, Jesse A Goldstein
Institution: University of Pittsburgh Medical Center

Abstract:
Background: Postoperative adverse events after craniosynostosis (CS) repair have been described through the use of large national databases. These databases are limited in their clinical resolution, and cannot contextualize the acuity of adverse events nor the management and predicting factors. In this study, we review our experience with CS surgical repair to better characterize the acuity of postoperative adverse events and identify patient factors predictive of ICU care.

Methods: This is a single-center retrospective cohort study (2010-2016) reviewing a database of CS patients. Acuity of postoperative adverse events were rated as high (ICU-level care for management/diagnosis) or low (floor-level care) by 5 blinded physicians.

Results: One hundred twenty six patients met inclusion criteria. Twenty-one patients (16.7%) were syndromic. The average number of synostotic sutures was 1.36. Patients had an average stay of 1.57±1.11 days in the ICU. One hundred fourteen postoperative events were identified. Fifteen of those events were rated high acuity with moderate agreement among the physician panel (κ=0.551, 0.47-0.62). The most common event was respiratory distress. On univariate analysis, multi-suture fusion (p=0.004), length of the operation (p=0.039), ASA class (p=0.034), end-organ dysfunction (p=0.022), and withholding TXA intraoperatively (p=0.018) were independently associated with high acuity events, while age at surgery, weight at surgery, syndromic diagnosis, and intraoperative transfusion were not. In a multivariate logistic regression model, a multi-suture fusion (OR=2.59, 1.26-5.33) and withheld TXA (OR=0.147, 0.03- 0.82) were predictive of high acuity events.

Conclusions: The combination of multi-suture craniosynostosis and withheld TXA may be a strong predictor of postoperative ICU-level events. Future study characterizing the cost utility of the immediate postoperative hospital course can help determine the necessity of postoperative.

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e-poster 81
Optic Nerve Sheath Diameter measured by MR imaging and Computed Tomography in Craniosynostosis
Presenter: Mostafa Haredy
Authors: Mostafa Haredy
Coauthors: Giulio Zuccoli, Mandeep Tamber, Ken Kanwal Nischal, Jesse Goldstein
Institution: Children Hospital of Pittsburgh

Abstract:
Background: The aims of this study are to correlate ONSD measurements obtained by MRI with in patients with craniosynostosis and suspicion of high ICP, and to correlate the ONSD measurements obtained by MRI and CT scans.

Methods: A retrospective review was conducted of craniosynostotic patients who had MRI and CT within 30 days of each other between Jan 2010 to Apr 2017. ONSDs were measured using standard techniques on both modalities by a craniofacial surgeon and a neuroradiologist. The MRI measurements of ONSD were correlated with clinical data based on fundoscopy, imaging and invasive ICP measurements, when available. Measurements on each eye for MRI and CT pairs were correlated.

Results: The study identified 56 patients (21 females) with MRI done during the study period. Mean age at MRI scanning was 3.8 years (± 3.47 SD). The mean ONSD in patients with evidence of high ICP was 5.08 mm (± 0.83) and 6.38 mm (± 0.78) in patients below and above the age of 1 year respectively, while in patients without high ICP it was 3.99 mm (± 0.44) and 5.34 mm (± 0.72) in patients above and below 1 year of age (p= 0.0001). Twenty-six patients had CTs performed within 30 days of their MRI resulting in 44 single eye MRI/CT pairs. The mean ONSD measured by MRI and CT was 5.6 mm (± 1.2) and 5.64 mm (± 1.19) respectively. The mean difference between MRI and CT measurements was -0.039 mm (± 0.327). Concordance correlation coefficient showed substantial agreement between both modalities (r = 0.962 and 95% confidence interval for r 0.932-0.979).

Conclusion: In patients with craniosynostosis, MRI derived ONSD measurements represent a non invasive means of ICP assessment. Both MRI and CT measurements of ONSD gave comparable results, and given its lower cost, no requirement for anesthesia, and is frequently used in cases with craniosynostosis as a diagnostic confirming and preoperative planning tool, CT derived measurements of ONSD can give an idea about the ICP in these patients.
**e-poster 82**
Outcomes in Craniofacial Surgery - Making the intangible quantifiable and comparable
Presenter: Justine O’Hara
Authors: Justine O’Hara, Monteregge, S, Chua, D, Rooney, N, Dunaway, D
Institution: Great Ormond Street Hospital for Sick Children

Abstract:
Outcomes in Craniofacial Surgery are difficult to define beyond specific procedural measures and complications. Patient centred outcomes are the venerated tool to measure results and benchmark. A thorough literature review to determine the success of craniofacial surgery details tools to measure functional outcomes but no measures of change. Development of a new tool, a patient reported outcome measure (PROM) in affiliation with psychology and patient’s parents to determine outcome across many domains. This validated tool scored the motivating factors and concerns, both functional and appearance related, for parents pre-operatively of single suture synostosis patients. These results were compared with matched survey post-operatively rating results of head shape, function and concerns. Seventy patient surveys were collected with matching sets pre and post-operatively measuring change. Additionally, a patient reported experience measure was developed to improve communication and patient care across the surgical experience. The primary motivators for parents choosing to proceed with surgery are concern regarding raised intracranial pressure, addressing future bullying and overall head shape. The average concern score was reduced post-operatively from 28.75 to 13.56. Rating of head and forehead shape on a likert scale demonstrated 96% improved or greatly improved. Additionally, an objective measure of outcome by statistical method CUSUM, measuring deviation from established surgical error rates, was introduced in 2015. This measure prospectively calculates error rates for the unit across multiple complications and poor outcomes. This enables a pictographic tracking and early intervention and change of practice. These tools have benefited our unit directing pre-operative counselling and consent process, modification of surgical techniques, and early intervention to complications. These tools have potential for international utilization and standardization of outcome.

**e-poster 83**
Aesthetic Refinements in Patients with Hemi-facial Asymmetry
Presenter: Juan Martin Chavanne
Authors: Juan Martin Chavanne, Diego Steinberg, Cristian Schauvínhold
Institution: WCF Bs.As Craniofacial Center Austral University Hospital

Abstract:
Background: Hemifacial asymmetry is a condition often present in patients seeking facial plastic surgery. Known causes include muscular torticollis, previous subcondylar or condylar fracture, condylar hyperplasia, juvenile condylar arthritis, hemifacial microsomia, deformational posterior plagiocephaly, and unilateral coronal craniosynostosis. Most of these patients have laterally deviated mandible with or without occlusal changes. Very often, however, there is not a clear cause of asymmetry and malocclusion is not present. Although recent studies showed the association between this condition with isolated several environmental factors, the cause is not very well elucidated.

Material and Method: This paper presents surgical outcome in a series of 10 patients with different degrees of partial hemifacial asymmetries, treated between 2008 and 2016. Six patients were female and 4 males. All had normal occlusion or just minimal dental problems. Clinical features, cephalometric and CT were recorded to assess the deformity and to design the surgical plan. Additionally, pre and post photographic measurements were performed to evaluate the results. A combination of various procedures including muscular reduction, malarplasty, mandibular angleplasty, genioplasty, rhinoplasty, isolated or in conjunction with fat graft transfer were used to achieve an armonic and better facial contour.

Results: Most of the patients improved their facial appearance and the ratio between both hemifaces, looking symmetrical in the photographic control after 8 years of follow up.

Conclusions: Several procedures can be used to change and balance the facial skeleton. Reduction malarplasty and mandibular angleplasty are common facial contouring operations. The addition of procedures like rhinoplasty and fat graft transfer can help to compensate the asymmetry and improve the quality of aesthetic refinements. Decisions should be made according to the patient’s need.
e-poster 84
Platelet Rich Plasma Enhance the Angiogenesis of Adipose-Derived Stem Cells in Ischemic Hind Limb Model
Presenter: Chia-Fang, Chen
Authors: Chia-Fang, Chen, Han-Tsang, Liao
Institution: Dept of Plastic Reconstructive Surgery, Chang Gung Memorial Hospital

Abstract:
Objectives: Platelet rich plasma (PRP), with high content of growth factors, has been proposed to promote angiogenesis both in vitro and in vivo. However, the enhancement of angiogenesis of adipose derived stem cells (ADSCs) was not studied in details. Our study was aimed to evaluate the effectiveness of PRP-contained medium on ADSCs in both in-vitro angiogenic effect and neovascularization ability in ischemic limb model.

Materials and Methods: The ADSCs were cultured in different concentration of PRP (2.5%, 5%, 7.5% or 10%), fetal bovine serum (FBS) as negative control. The ability to promote cell proliferation was measured by MTS assay. The angiogenesis related gene expression including CD31(PECAM), VEGF-A, Hypoxia-inducible factors (HIFs) and endothelial cell nitric oxide synthase (eNOS) among groups were analyzed by q-PCR. The phenotype of angiogenic differentiation of ADSCs was assessed by immunofluorescence stain of CD 31 marker and by endothelium tube formation assay. In vivo, nude mice were divided into 5 groups: negative control, 5%PRP cultured ADSC, 7.5% PRP cultured ADSC, Fetal bovine serum cultured ADSC and HUVEC as positive control. Circulation of the ischemic limb was evaluated by laser Doppler perfusion scan at day 18.

Results: ADSCs cultured in 2.5%, 5% and 7.5%PRP groups revealed a significant higher ADSC proliferation rate (p<0.05). By immunofluorescence stain of CD31, we saw CD31 expression is significantly elevated of all PRP groups (p<0.05). 5%, 7.5% and 10% PRP have potential to form the vessel-like structure in Matrigel plug. Based on in vitro studies, ADSCs cultured in 5%PRP and 7.5% PRP showed better performance to acquire endothelial cell properties and in the end to promote angiogenesis, thus we chose above 2 concentrations as experimental groups. According to the data from LDPI, the perfusion unit is 0.42±0.17, 0.88±0.08, 0.85±0.07, 0.54±0.14, 0.81±0.06 (negative control), 5%PRP cultured ADSC, 7.5% PRP cultured ADSC, FBS cultured ADS

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e-poster 85
3D Printed Bioactive Ceramic Scaffold Osteoconduction Across Critical-Sized Mandibular Defects
Presenter: Christopher D. Lopez
Authors: Christopher D. Lopez, Lukasz Witek, MSci, PhD, J. Rodrigo Díaz-Siso, MD, Roberto L. Flores, MD, Eduardo D. Rodriguez, MD DDS, Paulo G. Coelho, DDS PhD
Institution: Icahn School of Medicine at Mount Sinai, New York NY

Purpose: The osteogenicity of 3D-printed bioactive ceramic (3DBC) scaffolds has been demonstrated in several translational models. Scaffolds can be designed to fit and fill defect sites while directing osseosynthesis by utilizing the micro-environmental cues of violated bone primed for healing. However, preoperative access to large segments of accessory bone replacement could be of significant benefit, particularly in settings of planned oncologic resection or congenital correction. Despite this, the osseoconductivity of biomaterials synthesized with 3D-printed geometric design to optimize bone growth has not been explored in an intact bone model. This study used a sheep model to evaluate the innate ability of 3DBC scaffolds to induce bone growth supplementary to the undisturbed calvarium.

Methods: Cylindrical 3DBC scaffolds, measuring ~5-mm in diameter and ~1.5-mm in height, were composed of 100% tricalcium phosphate and designed with an inner lattice network and solid outer wall. Dorset-Finn sheep (n=5) underwent surgical placement of four 3DBC scaffolds subperiosteally on top of the calvarial bone, which were stabilized by peristeal closure. Two scaffolds were placed on each side of the calvarium, with the right-left distinction corresponding to the treatment period length (3- vs. 6-weeks). Samples were evaluated through histologic quantification of bone, scaffold, and soft tissue as a function of time in vivo. For between-group comparisons, statistical analysis was conducted using a Student’s t-test with 95% confidence intervals and significance was set at an =0.05.

Results: On histologic analysis, there was no evidence of inflammation around the scaffold site. Gross examination revealed a trend of bone growth from the calvarium into the interior lattice network and up the outer walls of the scaffold in an inferior-superior directionality. At the 6-week timepoint, samples demonstrated a significantly greater mean of available space occupied by bone (23.33±3.4% vs 14.35±3.72%; p<0.01). When bone and scaffold were considered together, there was no significant difference in mean space occupancy (6-Week: 56.86±5.88%, 3-Week: 63.27±12.98%; p=0.43), suggesting a stable rate of scaffold degradation/osseous remodeling over time.
Conclusions: 3DBC scaffolds composed of β-TCP are capable of inducing bone growth in an undisturbed osseous environment. This osteogenic influence is continually exerted over time, necessitating longer-term follow-up to determine the temporality of the bone-forming capacity of this tissue engineering construct.

e-poster 86
Uncertainties in modelling soft tissue prediction in orthognathic surgery
Presenter: Paul Knoops
Authors: Paul Knoops, Alessandro Borghi, Federica Ruggerio, Alberto Bianchi, Silvia Schievano, David Dunaway
Institution: UCL GOS Institute of Child Health and Great Ormond Street Hospital for Children

Abstract: Computer modelling has the potential to become an important tool in craniomaxillofacial surgery as it allows for patient-specific surgical planning, and design of cutting guides and personalised implants. However, this method to date has shown limited reliability mainly because it does not account for variability of tissue characteristics. Furthermore, the deterministic nature of predictive computer models does not allow for discrepancies between planning and surgery. Finite element analysis (FEA) is used hereby to investigate how these uncertainties in input parameters relate to soft tissue prediction. 8 patients (age: 23±7 years, range 17-35 years, 3 female) who underwent orthognathic surgery by means of Le Fort I osteotomy were included in this study. Pre- and post-op cone beam CT images were post-processed (ScanIP, Synopsis, USA) to carry out probabilistic FEA (Ansys Inc, USA) on patient specific pre-op anatomies in order to assess the effects of each parameter on face displacement results. Input parameters included bone, nasal cartilage and soft tissue material properties, soft tissue viscoelasticity, as well as Le Fort I displacement vector. The soft tissue prediction was evaluated and compared to postop CT. Soft tissue properties and viscoelasticity, cartilage properties, and Le Fort I displacement vector were significantly correlated to the soft tissue movement. A wide range of soft tissue predictions was recorded (e.g. nose tip range 0.1-5.1mm vs. postop CT: 0.3mm), mainly caused by uncertainties in displacement vector and soft tissue stiffness. These results show how probabilistic variation in the input, i.e. bone position and material properties, relate to the uncertainties in soft tissue prediction. Thus, when discussing outcomes with patients preoperatively, a range of soft tissue predictions should be considered.
e-poster 87
Temporoparietal fascial flap for infected temporooccipital cerebrospinal fluid fistulae reconstruction
Presenter: Enrique Olivares
Authors: Enrique Olivares, Jorge Bonastre, Carlos Corrales, Beatriz Gonzalez-Meli, Javier Enríquez-de-Salamanca
Institution: Universidad Europea and Hospital Universitario Nino Jesus

Abstract:
Background: Skull base and posterior fossa surgeries are sometimes complicated by cerebrospinal fluid (CSF) fistulae, which may be challenging to treat. They can lead to meningitis, increasing morbidity and mortality. In case of failed medical treatment, revision surgery may be required. Cerebrospinal fluid fistulae at the level of posterior skull base are best reconstructed with vascularized tissue. The temporoparietal fascial flap (TPFF) is based on superficial temporal vessels that can well tolerate rotation to the temporooccipital region

Methods: A review of two cases of infected temporooccipital CSF fistulae whose reconstruction was performed using temporoparietal fascial flap. Case A is a 3 years old child with dural and bone retromastoid defect secondary to neurosurgical approach of pontocerebellar angle tumor. Case B is a 76 years old patient with a retrosigmoideal CSF leak secondary to neurosurgical approach of microvascular decompression for trigeminal neuralgia.

Results: Two patients with cerebrospinal fluid fistulas at the level of posterior skull base were reconstructed transposing the TPFF. The flap provided complete coverage of the skull base defect. Both CSF leaks were resolved without any additional morbidity.

Conclusion: The TPFF is a reliable and versatile method for the reconstruction of retromastoid bone and dural defects. It is also recommended for patients with infected cerebrospinal leak in the temporooccipital region. The TPFF can be raised with minimal associated morbidity.

e-poster 88
Mixed Dentition Cleft/Craniofacial Patients: Incidental Head and Neck Findings on Cone Beam CT
Presenter: Wendy Chen
Authors: Giancarlos Santos, Wendy Chen, Joici Job, Joseph E Losee, Barton Branstetter, Lindsay A Schuster
Institution: Childrens Hospital of Pittsburgh

Abstract:
Background: Since its development, three-dimensional (3D) cone beam computed tomography (CBCT) has been used in dental medicine to assess the oral and maxillofacial region, especially in treatment of cleft/craniofacial patients. The increased field of view and detail of CBCT changes the scope of interpretation. The ordering clinician is legally and ethically obligated to comprehensively review the scan for incidental findings (IFs) or refer to a radiologist. Current literature for 2D images reports an IF rate of 6-43%, but these studies reference a wide age range and have inconsistent reporting practices. CBCT use is likely to increase the frequency of IFs. Our goal is to report the incidence of IFs in pre-ABG cleft/craniofacial patients during the period of mixed dentition.

Methods: This is a retrospective study at our institution (2012-2016) examining CBCTs of non-syndromic cleft lip/palate patients preparing for alveolar bone graft (n=111). CBCTs and 3D reconstruction images were reviewed systematically and independently by two orthodontists and a neuroradiologist. IFs were recorded. Descriptive statistics were applied.

Results: Overall, 95.5% of patients had some incidental finding; 37.7% had dental findings. IFs were most common in the paranasal sinuses (46.8%, i.e. sinusitis) and the middle and inner ear cavities (18.9%, i.e. otitis). The maxilla was the most common anatomic location for IFs (87.4%, e.g. ectopic dental eruption, missing teeth). The majority of patients had more than one anatomic area affected (68.9%). No IF was deemed medically significant.

Discussion/Conclusion: CBCT has become an increasingly accessible and prevalent technology. With increased diagnostic information, the clinician has a greater responsibility to assess for incidental findings. Unsurprisingly, the cleft population has a high incidence of IFs, especially surrounding the maxilla, paranasal sinusitis, and inner ear.
**E-Posters**

**e-poster 89**  
Spring use in Craniofacial Surgery - Indications and Contraindications  
Presenter: Noor Jeelani  
Authors: Noor Jeelani, R Hayward, G James, I Rather, J O'Hara, J Ong, D Dunaway  
Institution: GOSH UCL  

Abstract:  
**Aim:** To review which Craniofacial pathologies are best served with the use of spring assisted distraction and where this tool should be avoided.  
**Background:** Spring use in Craniofacial surgery was popularised by the Swedish Group led by Lauritzen, starting in 1997. We started using springs as an adjunct in our Craniofacial surgery programme in January 2008 and have since undertaken over 300 cases utilising some 800 springs; to our knowledge, this constitutes the largest global experience of spring usage in Craniofacial surgery. As with all new techniques, spring use has been employed across a whole breadth of pathologies, some with limited success.  

**Method:** We review our clinical experience of spring use across the spectrum of craniofacial pathologies ranging from correction of scaphocephaly caused by isolated sagittal synostosis, to correction of more complex calvarial deformities caused by other single suture and multi-suture pathologies.  

**Results:** In our experience, the use of springs in calvarial remodelling surgery offers a distinct advantage in the correction of scaphocephaly and for posterior vault expansion techniques including cases requiring asymmetric expansions. The technique also offers good aesthetic results for cases of lambdoid synostosis resulting in posterior plagiocephaly. Results for correction of frontal plagiocephaly caused by coronal synostosis are modest and for trigonocephaly poor. In subcategory analysis, for scaphocephaly correction, the results are most promising for the treatment of the occipital bullet and to a lesser degree improvement in the biparietal width and treatment of frontal bossing. Cases that present with severe frontal bossing at a young age will achieve an incomplete correction.  

**Conclusion:** Spring assisted calvarial remodelling is a useful addition to the surgical armamentarium of a Craniofacial Team but stringent pathology and patient selection are necessary to achieve acceptable results.

**e-poster 90**  
Segmental box osteotomy with internal orbital reconstruction for sphenoid wing absence associated globe malposition  
Presenter: Edward H Davidson MA (Cantab) MBBS  
Authors: Edward H Davidson MA (Cantab) MBBS, Michael P Grant MD PhD, Anand R Kumar MD  
Institution: Montefiore Medical Center/Albert Einstein College of Medicine  

Abstract:  
**Background:** Correction of sphenoidal wing absence associated globe malposition from neurofibromatosis presents a significant clinical challenge. Attempts to reposition the zygoma, bone grafting, or placement of orbital implants do not adequately address aberrant anatomy, undercorrect the deformity, and are prone to relapse. To restore native anatomy and address all elements of the deformity we have developed the segmental box osteotomy to reduce vertical orbital height and translocate the orbit in conjunction with bone grafts to reconstruct to sphenoidal wing and patient specific custom titanium implants to close the cranio-orbital communication and define the internal orbital volume.  

**Methods:** Virtual surgical planning (VSP) with contralateral mirror imaging was used to design symmetrical repositioning of the orbit and determine segmentation required to reduce the vertical excess as well as for manufacturing of patient specific titanium implants. Orbital volume was measured from preoperative, virtual surgical simulation and postoperative imaging using stereotactic software. Globe position was assessed using pre- and post-operative 3D photography software.  

**Results:** All patients (n=3, mean age 12 years) demonstrated improved globe position and orbital contour with resolution of globe pulsatility. VSP predicted postoperative volumes within 0.8cm³±0.5. Mean volume orbital change was 4.5cm³, change in conformational shape and distribution of orbital volume was more impactful than gross change for 2 patients. Vertical globe position improved from 11.5mm preoperatively to within 1mm of the unaffected side postoperatively. One patient had surgical site infection, one patient required secondary eyelid surgery, no evidence of relapse at mean 6 months follow up.  

**Conclusions:** The segmental box osteotomy with internal orbital reconstruction is a safe definitive surgical treatment for sphenoid wing absence associated globe malposition from neurofibromatosis.
e-poster 91
Virtual Custom Helmet Design for Sagittal Strip Craniectomy
Presenter: Christopher Derderian
Authors: Christopher Derderian, Pang-Yun Chou, Christopher Warne, Suyue M Zang, Alex A Kane, Rami Hallac
Institution: UT Southwestern Medical Center

Abstract:
Background: Postoperative helmet therapy is commonly used after sagittal strip craniectomy. Effective communication with the orthotist in the design and modification of the helmet is critical to ensure quality outcomes. This study examines the efficacy of a novel protocol to design the postoperative helmet using 3D imaging.

Methods: This is an IRB approved retrospective review of 23 consecutive patients treated with sagittal strip craniectomy with wedge ostectomies by a single surgeon and postoperative helmet by a single orthotist. 11 patients underwent traditional helmet design. 12 patients underwent custom helmet design. All patients had the helmet scan 7 days postop and the helmet applied 11 days postop. Traditional helmet design was based upon periodic conversations regarding the desired treatment goals. For custom helmet design a low radiation protocol CT and 3D photos (3dMD Vultus 3dMD LLC, USA) were captured on the day of the helmet scan. The 3D photos and CT were overlaid to allow the relationship of soft tissue landmarks and bone cuts to be visualized. Standardized lateral, top down and posterior views were generated with comments on the desired design goals and sent to the orthotist. This interface was used to finalize the helmet plan. The rate and magnitude of change in the cephalic index (CI) were evaluated until the CI stabilized.

Results: The mean baseline CI was 72.2 for the traditional helmet and 73.2 for the custom helmet. The CI stabilized at 49 days for traditional helmet and at 54 days for the custom helmet. The mean peak CI was 80.8 (±4.0) for the traditional helmet and 85.2 (± 2.4) for the custom helmet. The mean change in CI was 39.7% greater for the custom helmet.

Conclusions: Custom helmet design using our novel 3D protocol resulted in a 39.7% increase in CI change achieved from treatment. Future studies will evaluate the 3D outcomes from both helmet design processes at the end of treatment and skeletal maturity.

e-poster 92
Analysis of prognostic and risk factors for mortality of facial bone fractures
Presenter: Pofang Wang
Authors: Pofang Wang, Hsin-Yi Wu, Han-Tsung Liao
Institution: Linkou Chang Gung Memorial Hospital

Abstract: The pattern of facial bone fracture in Taiwan is different from that in most countries due to the injury mechanism. The major cause is high-energy automobile crash and scooter accident. The incidence of mortality for facial bone fracture is much higher than previous reports. Hence, the purpose of this study is to analyze the risk and prognostic factors for mortality of facial bone fractures. Patients with craniofacial injury treated in Linkou Chang Gung Memorial Hospital (level I trauma center in Taiwan) since May 2008 till April 2009 were reviewed. ICD 9th code number from 800 to 804 were collected. The information about age, gender, triage, injury severity score (ISS) score, mechanism, associated injuries and complications was reported. The facial bone fractures were classified to upper, middle, lower part and either combination two or three parts were compared between survival and mortality group. Then the univariate and multivariate analysis were used. 337 patients who had facial bone fracture were included. The average age was 34.19. The ratio of male to female is 2.87:1. 85% of injury mechanism was scooter accidents. There were 18 patients suffered from death (5.34%). The risk factors associated with mortality by univariate analysis were triage, ISS, GCS of severe and moderate scale, shock index, traumatic ICH, skull bone fracture, abdominal injury, intubation at ER and blood transfusion at ER. The pattern of facial bone fracture revealed no significant difference. Only traumatic ICH and blood transfusion at ER are risk factors of mortality in the multivariate analysis. The mortality rate related to craniofacial injury in our cases was higher than other countries may be attributed to high-energy crash accidents which resulted in more severe associated injuries especially the intracranial injury. While traumatic ICH and blood transfusion at ER presented fatal risk, the different pattern of facial bone fractures was not a determinant factor for mortality.
e-poster 93
Validating Outcome Metrics: Accuracy of the VECTRA H1 Portable 3D Photo System for Facial Imaging Applications
Presenter: Seth M. Weinberg
Authors: Liliana Camison Coauthors: Michael R. Bykowski, Wei Wei Lee, Jesse A. Goldstein, Seth M. Weinberg, Joseph E. Losee
Institution: University of Pittsburgh Medical Center

Abstract:
Background: 3D imaging using stereophotogrammetry has become increasingly popular, offering advantages for surgical planning and outcome evaluation. Compared to stationary counterparts, the handheld VECTRA H1 is a 3D facial imaging system that is low cost and highly portable, comparable to a common digital camera. However, the H1 has not been scientifically validated in independent studies, raising questions for accuracy, reliability of surface registration, and comparability to other systems. The purpose of this study was to validate the VECTRA H1 by comparing it to a validated stationary system, the 3DMdFace.

Methods: 25 adults (21-62 years) had 3D facial images obtained with both systems, carefully following manufacturer's guidelines. Resulting facial surfaces for each participant were registered to each other and heat maps generated to visualize the magnitude and direction of the differences in geometry between the two models, resulting in approximately 23,032 point-to-point comparisons per face. Root mean square (RMS) error was calculated to assess the magnitude of the deviation in mm over the entire face.

Results: Average RMS of all comparisons was 0.43mm (0.33-0.59mm). Facial surface differences between H1 and 3dMD were within a 1mm threshold. Areas exceeding +/- 1mm were limited to regions containing hair or subject to microexpressions. There was no evidence of systemic directionally to the error.

Conclusions: The validation of tools used to measure surgical outcomes is fundamental for high-quality practice and outcomes research. This study shows that 3D facial surface images acquired with the H1 system are accurate and comparable to the validated standard 3dMDFace system. H1 system results can be compared to other 3D systems for clinical or research purposes.

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e-poster 94
Le Fort 1 Distraction Osteogenesis in Cleft Patients Using an Adaptable Device and Virtual Planning
Presenter: Sean M. Hill, MD
Authors: Sarah A. Frommer, MD/PhD, Raymond J Harshbarger, MD, Patrick K. Kelley, Adriana C. Da Silveira, DDS, MS, PhD, Sean M. Hill, MD
Institution: Dell Childrens Medical Center

Abstract:
Introduction: A subset of orofacial cleft patients suffers from maxillary hypoplasia at skeletal maturity. These patients with tight soft tissue envelopes and a significant negative overjet can benefit from distraction osteogenesis (DO). Challenges of Le Fort I DO include accurate vector planning/execution and occlusal management. To account for patient differences, facilitate accuracy, and improve outcomes, we instituted the use of an adaptable partially orthodontic borne distractor (POBD) coupled with virtual surgical planning (VSP). The hypothesis was that using a POBD and VSP would create accuracy in execution and stable long term results.

Methods: Fourteen cleft patients with maxillary hypoplasia (average age 12.6 years) scheduled for Le Fort I DO, underwent VSP to plan vectors, and operative guides were generated. Devices were fashioned preoperatively using the guides. At the time of Le Fort I osteotomy, the pre- fashioned POBDs were applied using positioning templates.

Results: The preoperative virtual plan was compared to the POD2 CT scan to assess accuracy of execution of the VSP, as measured by setup angle and distraction vectors. Distraction was performed an average length of 12.38mm (range 8-18mm). Long term results were assessed by comparing simulated postop SNA derived from VSP with the SNA calculated from a 6-12 month postop cephalogram or CT. In addition, long-term bite relationship was assessed (after 1 year postop). The SNA preop was 71.54-74.78°, simulated postop SNA was 79.62-91.1°, and actual SNA was 77-77.87°. SNA difference between simulated postop SNA and actual SNA was 2.62-14.1° (AVG 7.99; STD 5.76). Additional findings were shortened operative time and a shorter treatment period with post- surgical orthodontics.

Conclusion: The use of VSP, operative guides, and a POBD for Le Fort I DO allows for reasonably accurate execution of a preoperative plan, and stable long term results.
**Abstract:**

**Purpose:** There are no accepted guidelines for inpatient vs ambulatory cleft lip surgery. The aim of this study is to review the safety of outpatient cleft lip surgery and develop outcome-driven guidelines for post op management.

**Methods:** Retrospective review of patients <2 years undergoing primary cleft lip repair from 2008 to 2015 at 5 medical centers was performed. The patients’ demographics, cleft type, concurrent syndromes, comorbidities, post-op admission status, and reason for admissions were recorded. Patients were divided into 2 groups: predominantly ambulatory (either discharged or admitted for a specific concern) and inpatient (consistently admitted due to surgeon’s preference/historical tendency). ED visits and readmissions within 1 month were compared between groups. SPSS 19 was used for predictive logistic regression analysis.

**Results:** Of 546 patients, 372 (68.1%) were males, 416 (76.2%) had unilateral clefts, 24 (4.4%) had syndromes and 129 (23.6%) had co-morbidities. Mean age at surgery was 141 days with a mean surgical time of 2.3 hours. A total of 404 patients (76%) were discharged after surgery and 142 (26%) were admitted. Of those admitted, 46 were due to surgeon’s preference. After excluding this subset, our ambulatory surgery rate was 80%. There was no difference in ED visits (3% vs 2.2%, p=0.6) and readmissions (0% vs 1.45%, p=0.5) between the groups. Of the 404 ambulatory surgeries, none were readmitted within 24 hours, for a successful ambulatory surgery rate of 100%. Logistic regression analysis showed that presence of comorbidities had the highest predictive probability 96% (p<0.001, 95% C.1, 92.5%-98%) of being admitted.

**Conclusion:** Ambulatory cleft lip repair can be done safely in the majority of patients with no difference in ED visits and hospital readmission. Patients with co-morbidities are admitted for observation in most cases. Adopting an 80% discharge rate for cleft lip surgery in the U.S. would save $19.7 million annually.

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**Abstract:**

**Background:** Although rare, pseudoaneurysms (PA) can develop following Le Fort I osteotomy and lead to life-threatening hemorrhage. However, the typical presentation of a PA in this patient population is not well characterized. Evidence-based guidelines are not currently available for evaluation of PA following Le Fort I osteotomy.

**Methods:** A case report is presented of a 27 year-old male who underwent Le Fort I advancement and subsequently developed a bleeding PA. A comprehensive search of journal articles was performed using the MEDLINE/PubMed database between 1964 and April 2016. Keywords used were “(osteotomy OR craniofacial OR orthognathic) AND (pseudoaneurysm OR aneurysm OR epistaxis)”.

**Results:** The case report and literature search yielded 13 reports of 20 patients. All 20 patients were born with a cleft palate who underwent Le Fort I advancement who developed a delayed postoperative bleeding PA. All studies were Level IV or V evidence. 25% (n=5) of the cases documented excessive intraoperative bleeding or >500cc of estimated blood loss. The average time for the first bleeding episode and time until final bleed was 16.3 +/- 15.0 days (range: 0 – 62 days) and 27.1 +/- 20.8 days following surgery, respectively. 60% (n=12) had multiple episodes of bleeding. The duration between the bleeding events averaged 10.6 (+/- 7.9 days) with a range of 1 – 35 days. Bleeding PA’s were treated with image-guided embolization (16/20 patients; 80%), ligation or clamping (3/20 patients; 15%), or dense packing only (1/20 patients; 5%).

**Conclusions:** In the setting of recurrent and/or delayed postoperative epistaxis following Le Fort I osteotomy, surgeons should maintain a high clinical suspicion for PA. Ruptured PA’s are often preceded by multiple episodes of progressively worsening epistaxis. Angiography is recommended to evaluate for PA in the setting of recurrent epistaxis following Le Fort I osteotomy, especially within four weeks following surgery.
Abstract:
Introduction: There is little objective data for severity of Pierre Robin Sequence and management. All current algorithms use physical exam, O2 saturation and polysomnography to determine the severity of respiratory obstruction and need for surgery. We propose that PSG severity scales are not very accurate in neonates and can be hard to obtain. We propose that capillary blood gas (CBG) can be used to determine severity and need for further studies in PRS management.

Methods: Retrospective review of patients < 1 year with micrognathia causing upper airway obstruction from 2008 to 2015 at 2 centers was performed. Patients were either managed conservatively or with mandibular distraction osteogenesis. Patient demographics, diagnosis, initial CBG and PSG results were analyzed. Using the successful treatment outcome as the reference standard the ROC curve was used to determine the accuracy of an evaluative test and cutoff values for AHI and CBG at which the test has the best sensitivity and specificity for evaluating the need for surgical intervention in these patients.

Results: Of 72 patients, 37 were female, 48 had sporadic PRS, 22 had syndromes, 43 had comorbidities, and 2 had micrognathia, not otherwise specified. Total of 61 patients required MDO at mean age of 37 days. The mean initial AHI in non-surgical vs surgical groups was 11 vs 29 (p=0.09), pH 7.41 vs 7.34 (p=0.04), pCO2 44 vs 55 (p<0.001) and HCO3 27 vs 30 (p=0.02). All these values improved significantly in the surgical group after surgery. ROC curve showed that the pCO2 is more accurate (curve-0.91, p<0.001, 95% C.I, =0.82-0.99) and has better specificity and sensitivity (91% and 72% at pCO2 of 49.5) compared to others.

Conclusion: pCO2, pH and HCO3 from a CBG heel stick predict the physiologic effects of obstructive apnea better than a PSG. CBG should be added to the algorithm of PRS work-up to determine the need for surgical intervention and post-operatively to determine the success/end point of distr

Abstract:
Background: The maxillary division of the trigeminal nerve is directed along the floor of the orbital through a bony canal and exits through the infraorbital foramen (IOF). As the nerve exits it becomes the infraorbital nerve and supplies sensory innervation to the ipsilateral lower eyelid, cheek, nasal sidewall, upper lip, and oral mucosa. Knowledge of the presence and position of the infraorbital nerve is relevant for regional anesthesia of the face and surgical interventions on the face, jaw, and orbit. Children with cleft lip/palate have intrinsic maxillary differences on the cleft side that could potentially alter the anticipated location of the IOF. There is minimal research describing these differences in children with cleft lip and palate.

Methods: A retrospective chart review identified a cohort of patients with unilateral complete cleft lip and palate who have undergone pre-operative work-up for alveolar bone grafting with 3D maxillofacial CT scans used for digital measurements.

Results: 17 patients were identified with adequate preoperative 3D maxillofacial CT scans. Vertical and horizontal position measurements of the infraorbital foramina on the cleft and non-cleft side for each patient. Paired student t-test was used for statistical analysis. Mean value of the vertical height from the infraorbital rim to the IOF in the sagittal plane was 8.34±1.49mm on the cleft side and 9.28±1.62mm on the non-cleft side (p=.0001). An orthogonal horizontal measurement between the IOF and the vertical midline in the coronal plane revealed mean values of 24.3±1.53mm on the cleft side versus 26.13±1.48mm on the non-cleft side (p=.001). An orthogonal horizontal measurement between the IOF and the vertical midline in the coronal plane revealed mean values of 24.3±1.53mm on the cleft side versus 26.13±1.48mm on the non-cleft side (p=.001). Differences in vertical maxillary height were seen with mean height of 35.30±4.19mm on the cleft side versus 36.00±4.27mm on the non-cleft side (p=.008).

Conclusion: Statistically significant differences were seen between the vertical and horizontal position of the IOF and overall maxillary height between cleft and non-cleft sides.
Spring-assisted cranioplasty for sagittal craniosynostosis: a subtype analysis
Presenter: Jungwon Genevieve Park
Authors: Christopher Runyan, Jungwon Genevieve Park, Christopher Michael Runyan, Kyle Gabrick, Edreca Allison Thompson, Daniel Couture, Lisa Renee David
Institution: Wake Forest

Abstract: The most common type of craniosynostosis is sagittal craniosynostosis, which affects about 1 in 4000 children, and is associated with frontal bossing, sagittal ridging, bitemporal narrowing, and a prominent occiput. We have previously proposed a classification of sagittal craniosynostosis, based on CT imaging, into 4 types: anterior, central, posterior, and complex. Surgical intervention is performed in infancy, when brain growth is rapid, and methods include open cranial vault remodeling (CVR), endoscopic strip craniectomy, and spring-assisted cranioplasty (SAC). We performed a retrospective chart review of patients who underwent SAC, in order to determine if the type of sagittal craniosynostosis or age at surgery were associated with improved outcomes. SAC was performed according to a published treatment algorithm based on type of sagittal craniosynostosis. In this study, 139 children with sagittal craniosynostosis (104 males, 35 females), who underwent SAS during a 16-year period (2000-2016), had pre-operative head CT scans available for review. There were 25 children with anterior-type (18%), 41 with central (29%), 45 with posterior (32%), and 28 with complex (20%) sagittal craniosynostosis. The mean age at spring placement and removal were 4.6 months (range: 2.8 months to 8.3 months) and 9.6 months, respectively. Patients with the anterior type were significantly older than those with posterior or complex type (2.3 months old vs. 2.7 or 2.5 months old, respectively). All types had significant improvement in cephalic index (CI) and correction of CI to an overall mean of 74.5. There were no significant differences in preoperative CI or change in CI of patients with different types of sagittal craniosynostosis. There was a weak negative correlation of correction of CI with increased age at the time of surgery. This study supports the hypothesis that SAC is an effective treatment for infants diagnosed with all types of isolated sagittal craniosynostosis.

Craniofacial Surgical Planning with Augmentation Reality: Accuracy of Linear 3D Cephalometric Measurements on 3D Holograms
Presenter: Kihyun Cho, MD, MSc
Authors: Kihyun Cho, MD, MSc, Jeff Yanof, PhD, Graham S Schwarz, MD, FACS, Karl West, MS, Jennifer McBride, PhD, Francis A. Papay, MD
Institution: Plastic Surgery, Cleveland Clinic, Cleveland, Ohio, USA

Abstract: Conventional craniofacial surgical planning software lacks intuitive operator interaction and 3D navigation. Recently available augmented reality (AR) headsets have the potential for detailed 3D holographic projections of virtual 3D models, intuitive interaction and navigation, and accurate measurements. Objective: To evaluate the accuracy of linear measurements performed on HoloLens (Microsoft, Seattle, Wash.) in comparison with caliper and a 3D cephalometric analysis program (Dolphin Imaging, Chatsworth, Calif.) toward assessing potential use for surgical planning.

Methods: Seven adult dry human skulls were selected based on stable occlusion. Stereolithography files were generated from CT imaging data acquired with a default imaging protocol, loaded onto HoloLens. Two researchers performed three repeated linear measurements on 1) skulls with calipers as an anatomic physical measurement (gold standard), 2) Dolphin Imaging, and 3) holograms by selecting two surface points. A subset of measurements that could be measured with calipers was used. The analysis of variance (P<=.05) and the intraclass correlation coefficient was determined as an index of intraobserver and interobserver reliability. The agreement between the calipers versus HoloLens and the Dolphin versus HoloLens were also evaluated using the Bland and Altman analysis.

Results: All HoloLens measurements were completed by easily gazing and navigating through complex 3D structures augmented to the virtual operating room. There was no significant difference between the three methods used.

Conclusions: Our results indicate that HoloLens has significant potential for surgical planning including sufficient accuracy for linear measurements. Future studies will include formal usability evaluation and augmentation of 3D holographic planning results for intraoperative use.
e-poster 101
Strategies for Immediate Reconstruction of Disfiguring High-flow Vascular Malformations of the Lips
Presenter: Dov Charles Goldenberg
Authors: Dov Charles Goldenberg, Esther Choi, Vania Kharmanyan, Tatiana Moura, Rolf Gemperli
Institution: Division of Plastic Surgery - Hospital das Clínicas, University of São Paulo Medical School

Abstract:
Introduction: High-flow vascular malformations of the lips present a challenge to the craniofacial surgeon. Involvement usually exceeds anatomical limits and planning is necessary to restore anatomical landmarks. Expansion of adjacent non-affected tissues may potentially simplify primary reconstruction even in large defects. The purpose of this study was to analyze the results of primary reconstruction after extensive lip resections, hypothesizing that expansion of normal tissues simplifies reconstruction.

Methods: From 2006-2016, 13 patients with AVMs affecting more than 25% of the lip were included (7 females, mean age 24.7 ± 9.7 years). Upper lip was affected in 10 patients. Resection design was planned to ensure complete lesion removal, correction of lip height and lining of skin, muscles and oral mucosa. The correlation between defect size and type of reconstruction was analyzed and compared to the classical principles of lip reconstruction. Type of repair was classified as direct closure, advancement-rotation flaps, opposite lip flaps or distant flaps.

Results: Post-resection defects affected up to 50% of the lip in 5 patients, 50-75% in 4 and were larger than 75% in 4 patients. In 7 patients, involvement exceeded lip boundaries, affecting nose, cheeks or chin. When compared to the conventional principles of lip reconstruction, a reduction in additional tissue needs was observed. For defects up to 75% of the lip, closure was obtained by direct approach (6 cases) or rotation-advancement flaps (4 cases) without tissue interposition. Only in 3 patients (with defects larger than 75%) opposite lip flaps (2) or reconstruction with microsurgical flap (1 case) were needed.

Conclusions: The low incidence of lip transposition flaps or distant flaps, even in large defects, was a consequence of the expansive effect of normal tissues and surgical planning. The combination of these factors ensured a more satisfying result and reduced the morbidity of the procedure.

e-poster 102
Median and oblique facial clefts: a series of 13 cases
Presenter: Takanori Miyajima
Authors: Takanori Miyajima, Takayuki Okumoto, Yoshikazu Inoue
Institution: Fujita Health University

Abstract: Facial clefts are rarer than cleft lip and palate. Its anatomical dysplasia ranges widely from face to skull and is very complex, so its diagnosis, surgery and management is difficult. Thus the timing and strategy of operation have not ever established yet. We will report 13 cases of median and oblique clefts which we experienced from 2006 to 2016. And we will introduce the surgery and strategies of facial clefts in our institution.

The Tessier classification of 13 cases is as follows:

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e-poster 103
Image Guided Navigation in Craniofacial Surgery: A Systematic Review and Grading of the Literature
Presenter: Brad Gandolfi  
Authors: Brad Gandolfi, Coauthors: Meaghan L. Barr, Michael R. Delong, MD, Neha Datta, MD, Thomas D. Willson, MD, Reza Jarrahy, MD  
Institution: UCLA Division of Craniofacial Surgery

Abstract:
Introduction: Intraoperative image guided navigation, although universally adopted in neurosurgery, has slowly and sporadically been applied in craniofacial surgery. A systematic review of intraoperative image-guided navigation in craniofacial surgery was designed to assess its adoption and outcomes in craniofacial surgery.

Methods: A systematic review of the literature was performed using search terms related to image-guided navigation and craniofacial surgery, adhering to the PRISMA guidelines for systematic reviews. Medline and Web of Knowledge databases were queried. Titles were filtered for relevance and abstracts were reviewed for content. Case studies were excluded as were animal, cadaver, and virtual data. Studies were categorized based on the type of study performed and graded using the Jadad scale and the Newcastle-Ottawa scales when appropriate.

Results: A total of 2030 titles were returned by our search criteria. Of these, 518 abstracts were reviewed, 207 of which met criteria for paper review. A single randomized controlled trial was identified (Jadad score 3), and thirteen studies were identified as being case control or case cohort studies (Average Newcastle-Ottawa Score 6.5). The most common application of intraoperative surgical navigation cited was orbital surgery (n=39), followed by surgery of mandible (n=28). Other craniofacial topics reviewed were midface (n=20), fibrous dysplasia (n=7), tumor reconstruction (n=3), zygoma reconstruction (n=4), foreign body removal (n=3), cleft care (n=2), and vascularized composite allotransplant (n=1). Higher quality studies more commonly pertained to the orbit (7/13), and consistently show improved results in case control and cohort studies.

Conclusions: Image guided surgical navigation improves outcomes in orbital reconstruction. Although image guided navigation has promise in many aspects of craniofacial surgery, current literature is either lacking or too poor in quality to recommend widespread adoption.

e-poster 104
Peptide Amphiphile Nanofibers with BMP-2 Promote Bone Regeneration with Attenuated Inflammation
Presenter: Reena Bakshi  
Authors: Reena Bakshi, Akishige Hokugo, Mark McClendon, Samuel Stupp, Reza Jarrahy  
Institution: University of California, Los Angeles

Abstract:
Background: Bone morphogenetic proteins (BMPs) play a central role in regenerative bone therapy. Broad use of this growth factor is limited secondary to severe side effects thought to be the result of significant local inflammation, likely due to the ‘burst release’ nature of delivery. Our previous work has demonstrated the ability of peptide amphiphile (PA) nanofibers to function as a controlled release carrier of BMP-2 and support robust bone regeneration in animal models. Here we investigate the local and systemic inflammatory response in a rat alveolar cleft model.

Methods: A critical sized alveolar cleft defect was created in Sprague Dawley rats and treated as follows: collagen alone (control), collagen with PA incorporating low and high doses of BMP-2. Animals were sacrificed 4 days after surgery and the maxilla surrounding the defect harvested. Total RNAs were isolated from the gingiva surrounding the defect and gene expression of inflammatory markers (TNF, IL-6, and COX2) were evaluated by qPCR. Immunohistochemistry with COX2 was performed to evaluate the local tissue. Additionally, blood was collected for serum analysis of systemic markers of inflammation.

Results: Animals treated with high dose BMP-2 demonstrated significantly increased gene expression of all inflammatory markers while animals treated with collagen or with PA and low dose BMP-2 had low expression of these genes. Immunohistochemistry demonstrated high inflammatory markers in only the high dose BMP-2 group. No increase in systemic markers of inflammation was noted in any of the groups.

Conclusion: PA with low dose BMP-2 elicits a robust osteogenic response in animal models. Here we show that this regenerative response is induced without significant local or systemic inflammation. Based on these results we expect that clinical usage of PA with low dose BMP-2 will provide a significantly less morbid adverse event profile while still providing the advantageous osteogenic effects of BMP-2.
e-poster 105
The Importance of Using a Comprehensive Multidisciplinary Cleft Registry to Record a Complete and Detail Patient Characteristics
Presenter: Gadia Ayundya
Authors: Prasetyanugraheni Kreshanti, Gadia Ayundya
Institution: Plastic Surgery Div, Cleft Craniofacial Center, Cipto Mangunkusumo Hospital -

Abstract:
Background: Cleft lip and palate patients need a comprehensive treatment from multidisciplinary team throughout their life. In order to have an appropriate long term follow up, especially for the surgical outcome and their speech and maxillary growth, a complete and detail database is needed. Before September 2015 the database in Cleft and Craniofacial Center (CCC) Cipto Mangunkusumo Hospital, Jakarta, Indonesia was input in a Microsoft Excel® spreadsheet taken from the written medical record by non- medical resources. Afterward, the database was input in the comprehensive Multidisciplinary Cleft Registry which was developed by the Gothenburg Cleft Team, Sahlgrenska University Hospital, Sweden, by an operator with medical background. Objective: To assess whether using a comprehensive multidisciplinary cleft registry can improve the recordings of patients’ database and characteristics compared to conventional spreadsheet.

Method: We compare the completeness of patients’ diagnosis data from January 2012 to August 2015 with the data from September 2015 to December 2016.

Result: A total of 978 patients had undergone various cleft related procedures in CCC since January 2012 to December 2016. The conventional spreadsheet database revealed a total of 813 cleft patients up to August 2015. Only 523 (64.3%) patients have the diagnosis clearly mentioned (the affected site and the extent). Meanwhile, the database from the multidisciplinary cleft registry revealed 170 patients from September 2015 to December 2016, with 95.2% completeness of patients’ diagnosis. It showed a statistically significant difference that it is more beneficial using the cleft registry than the conventional spreadsheet (p<.001).

Conclusion: There are significant improvement in recording patients’ database and characteristics using a comprehensive multidisciplinary cleft registry. However, both methods are operator dependent and it is preferred to have an operator with medical background.

e-poster 106
Posterior Cranial Distraction Osteogenesis Including the Foramen Magnum: A Comparative Analysis
Presenter: Sean M. Hill, MD
Authors: Sarah Frommer Coauthors, Raymond J Harshbarger, MD, Sean M. Hill, MD, Patrick K. Kelley, MD, Timothy M. George, MD
Institution: Dell Childrens Medical Center

Abstract:
Intro: Posterior cranial vault distraction osteogenesis (PCVDO) in cephalocranial disproportion patients can be used to overcome a tight skin envelope and allow for adequate bone formation. When there is abnormal cerebellar positioning, a suboccipital decompression can be performed. Here, we evaluate our technique to include the foramen magnum with the PCVDO osteotomy for tonsillar decompression.

Methods: Cephalocranial disproportion patients with or without tonsillar herniation (age range 7-188 months) underwent PCV osteotomies with placement of cranial distractors; PCV osteotomies were extended to the foramen magnum in patients with tonsillar herniation. Distraction latency was 7-10 days, with a rate/rhythm of 0.6-0.9mm/day; range 15-30mm total distraction. Patients consolidated for two months. We compared the POD2 and consolidation phase imaging.

Results: 12 patients who underwent PCVDO were analyzed; six included extension to the foramen magnum, and six did not extend to include the foramen magnum. Analysis was carried out to compare changes in intracranial volume, tonsillar herniation height, cerebellar height, cerebellar width, cerebellar height/width ratio, cerebellar angle, and area of foramen magnum. Neurologic symptomatology including headache, nausea/vomiting, balance problems, and behavior, was also evaluated. Both groups showed improvement in intracranial volume, cerebellar width, cerebellar angle, and neurologic symptomatology, as well as less sulcal effacement. Patients with extension to include the foramen magnum, additionally had a >30% decrease in tonsillar herniation height and increase in foramen magnum area.

Conclusion: PCVDO is a valid technique to expand the posterior cranial vault in cephalocranial disproportion patients. When tonsillar herniation is present, extension of osteotomies to the foramen magnum can be performed to successfully achieve tonsillar decompression.
e-poster 107
Safety Outcomes after Endoscopic versus Open Repair of Metopic Craniosynostosis
Presenter: Laura A. Monson, MD
Authors: Tara L. Braun, BS, Bradley S. Eisemann, MD, Shola Olorunniwa, MD, Edward P. Buchanan, MD, David Y. Khechoyan, MD, Robert C. Dauser, MD, Sandi K. Lam, MD, Laura A. Monson, MD
Institution: Baylor College of Medicine

Abstract:
Background: Premature fusion of the metopic suture leads to a range of clinical presentations, with more severe cases presenting characteristically with trigonocephaly. Endoscopic-assisted correction of craniosynostosis is emerging as an alternative to the gold-standard open cranial vault remodeling. While there are several documented benefits of endoscopic correction, the management of craniosynostosis varies widely in the literature with little consensus as to the preferred timing and surgical technique for repair. The purpose of this study was to investigate the safety outcomes of endoscopic versus open surgery at our institution.

Methods: This retrospective cohort study included all patients diagnosed with metopic craniosynostosis who underwent open or closed surgical management and received at least 6 months of follow-up. Data extraction was performed via chart review and included demographic information and safety outcome variables.

Results: From January 2013 to December 2016, 17 patients who met our inclusion criteria were treated by the multidisciplinary craniofacial team at our institution. Eight patients underwent endoscopic surgery and nine underwent open surgery. The mean age at surgery was significantly higher in the open surgery group than the endoscopic surgery group (13.7 months versus 2.3 months, respectively). Estimated blood loss, percent estimated blood volume lost, transfusion volume, procedure length, hospital length of stay, and ICU length of stay were all significantly higher in the open surgery group compared to the endoscopic group.

Conclusions: In our patient population, endoscopic surgery for metopic craniosynostosis had an improved safety profile versus open surgery based on reduced procedure length, estimated blood loss, volume of blood transfusion, and length of stay in the ICU and hospital.

e-poster 108
Outcomes in Furlow Palatoplasty for Secondary Speech Surgery
Presenter: Laura A. Monson, MD
Authors: Tara L. Braun, BS, Tara L. Braun, BS, Edward P. Buchanan, MD, David Y. Khechoyan, MD, Kristina D. Wilson, PhD, SLP, Ellen E. Moore, MA, SLP, Cristina Hernandez, RN, Laura A. Monson, MD
Institution: Baylor College of Medicine

Abstract:
Background: Velopharyngeal insufficiency (VPI) occurs frequently after primary palatoplasty, with many patients requiring management via secondary speech surgery. Furlow palatoplasty, while first described as a technique for primary palate repair, is increasingly advocated for secondary correction of VPI in certain patients. Furlow palatoplasty works well for management of VPI because it reconstructs the levator sling, lengthens the palate, and constricts the velopharyngeal port. The purpose of the current study was to assess speech outcomes after Furlow palatoplasty as secondary surgical management of VPI.

Methods: Between 2012 and 2016, 165 patients were identified with VPI and treated with Furlow palatoplasty at a single institution. Patients underwent preoperative speech evaluations with a licensed speech pathologist, and then had postoperative speech evaluations at their three-month follow-up appointments. Primary outcome measures of velopharyngeal function and hypernasality were measured perceptually by the speech pathologist. Postoperative ratings were compared to baseline to detect changes that occurred after surgery.

Results: Following surgery, velopharyngeal functioning was competent in 61.9% of patients and was improved from baseline in 67.9%. Additionally, VP functioning was unchanged in 22.4% of patients, worsened in 0.7%, and was unable to be assessed in 9.0%. Hypernasality ratings improved in 70.9% of patients, were unchanged in 16.4%, were unable to be assessed in 9.0%, and worsened in 3.7%.

Conclusions: Furlow palatoplasty was an effective means to improve velopharyngeal function in our study population.
**e-poster 109**

**Impaired EEG-SEP finding in the affected hemisphere in patients with posterior plagiocephaly**

**Presenter:** Maiju Härmä  
**Authors:** Maiju Härmä, Leena Lauronen, Junnu Leikola, Jyri Hukki, Anne Saarikko  
**Institution:** Department of plastic surgery, Helsinki University Hospital and University of Helsinki

**Abstract:**

**Objective:** To determine the effectiveness of cranioplasty for nonsynostotic posterior plagiocephaly compared with the natural course of the condition.

**Design:** Retrospective study of posterior plagiocephaly patients treated in Helsinki Cleft Palate and Craniofacial Center.

**Participants:** Between the years 2012 and 2014 407 infants with posterior deformational plagiocephaly where sent for consultation in our outpatient clinic. 22 infants with severe posterior skull deformation but no synostosis where sent for further investigations. EEG somatosensory evoked potential (SEP, median nerve) were monitored in these patients first in age of 14-42 months, and if impaired controlled 12-18 months later. In our center neither helmet therapy nor distraction osteogenesis are in use, however, cranioplasty (full remodelling operation) is considered in severe cases with neurological symptoms. Participants were assigned to two groups depending on the symptoms and the severity of the deformation: While one group has been treated with cranioplasty (n=11), the control group (n=11) did not receive medical treatment.

**Results:** 8 of the 11 patients in the operation arm had impaired SEP (7/8 on the affected cerebral hemisphere), and all SEPs were recorded normal when controlled postoperatively. In follow-up arm 6/11 patients (5/6 on the affected cerebral hemisphere) had impaired SEP in age of about 18 months, and all were normalized when controlled. The difference was not statistically significant.

**Conclusion:** The natural course of posterior plagiocephaly has not been investigated in depth. In our material impaired SEP EEGs were seen in 13/22 patients with posterior plagiocephaly. SEPs became normal equally in both groups (operated and not operated) when controlled 12-18 months later.

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**e-poster 110**

**Molecular Mechanisms of Craniosynostosis**

**Presenter:** Derek Steinbacher  
**Authors:** V. P. Eswarakumar, Miles Pfaff, Derek Steinbacher  
**Institution:** Yale School of Medicine

**Abstract:** Craniofacial anomalies are the fourth most common congenital birth defects that occur in new born. Dominant gain-of-function mutations in the fibroblast growth factor receptor 2 (FGFR2) account for the majority of the human craniosynostosis syndromes including Crouzon, Pfeiffer, Jackson-Weiss, Seathre Chotzen and Apert syndrome which are characterized by the premature fusion of cranial sutures before the completion of brain growth. The cranial sutures are specialized joints that contain rapidly dividing osteoprogenitors and mesenchymal cells. The balance between proliferating and differentiating osteoprogenitors is finely regulated by quantitative signals from growth factor receptors including FGFR2, which is expressed by proliferating osteoprogenitors and down-regulated in differentiating osteoblasts. FGFR2 signaling is mediated via the docking protein FRS2, which interacts with SHP2, a tyrosine phosphatase, and GRB2, an adapter protein, to induce ERK-MAPK activation. Using a gain-of-function FGFR2 mouse model of Crouzon syndrome (Fgfr2cC342Y), we demonstrate that genetic uncoupling of FRS2 and SHP2 prevents craniosynostosis and restores normal craniofacial growth while uncoupling FRS2 and GRB2 only partially prevents craniosynostosis. Fluorescence Resonance Energy Transfer-Fluorescence Lifetime Imaging Microscopy (FRET-FLIM) experiments revealed a robust interaction between GRB2 and FRS2 in cells expressing wild-type (WT) or Fgfr2cC342Y receptors whereas SHP2 interacted only with FRS2 in cells expressing Fgfr2cC342Y receptors, suggesting that SHP2 is the primary mediator of dysregulated FGFR2c signaling.
**e-poster 111**

**Dipyridamole-Coated 3D-Printed Bioactive Ceramic Scaffolds Regenerate Alveolar Cleft Defects: A Pilot Study**

Presenter: Christopher D. Lopez BA  
Authors: Christopher D. Lopez BA, Jonathan M. Bekisz BA, Lukasz Witek, MSci PhD, Roberto L. Flores MD, Andrea Torroni MD PhD, Paulo G. Coelho DDS PhD  
Institution: Icahn School of Medicine at Mount Sinai, New York NY

**Abstract:**

**Purpose:** The standard of care for alveolar bone clefts is autologous grafting, which has limitations (e.g., bone resorption, infection, poor local blood supply) that have driven progress in tissue engineering as an alternative approach. This pilot study had two objectives: first, to establish a critical-sized alveolar cleft defect in a translational, skeletally immature rabbit model for future investigation. Second, to assess the regenerative capacity of 3D-printed bioactive ceramic (3DBC) scaffolds coated with adenosine A2A receptor indirect agonist dipyridamole (DIPY), which is known to shift osteoblast/osteoclast function in favor of bone formation.

**Methods:** Eight skeletally immature New Zealand White rabbits underwent unilateral, ~3.5 mm x ~3.5 mm alveolar cleft defect creation by means of an oral surgery burr. Four rabbits had defects replaced by a custom, 3D printed scaffold made of tricalcium phosphate with geometric design known to facilitate osseoconduction, that was also coated with 1000 m DIPY, while 4 remained untreated as negative controls. After 8 weeks, animals were euthanized and samples were evaluated for bone formation within scaffold porosity. This was performed via microCT and quantitative analysis of scaffold reconstructions using Amira 3D software, and new bone was compared to non-operated cleft segments. Mean bone regeneration was calculated with 95% confidence intervals.

**Results:** Gross examination demonstrated scaffold-bone integration, and microCT imaging revealed that all controls had alveolar cleft defects that were fully unhealed at ~3.5mm x 3.5mm. Mean experimental group had 41.61% ±16.17% bone occupancy of free space. Sutures were fully patent.

**Conclusion:** DIPY-coated 3DBC scaffolds demonstrated bone regeneration at 8 weeks while maintaining suture patency. Critical-sized defects of the alveolar cleft can be created and investigated in a skeletally immature rabbit model.

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**e-poster 112**

**Long Term follow-up of the Surgical Hypercorrection Technique for Trigonocephaly**

Presenter: Katelyn Bennett  
Authors: Katelyn Bennett, Fan Liang, Kavitha Ranganathan, Karin Murasko, Christian Vercler, Steven Buchman  
Institution: University of Michigan

**Abstract:**

**Aims:** Lasting correction of trigonocephaly is exceedingly difficult to attain, as a durable correction requires significant expansion to overcome the galeal restriction and soft tissue recoil of the scalp. High rates of relapse have been reported due to recurrence of bitemporal constriction (54%) and loss of lateral orbital projection (47%). The specific aim of this study was to determine if the senior author’s (SB) method of hypercorrection would decrease relapse and the need for later revision surgery.

**Methods:** A retrospective review of all patients undergoing operative correction of metopic craniosynostosis between 1996 and 2017 with at least five years follow-up was performed. All patients underwent hypercorrection performed by the senior author, which consisted of a frontal-orbital advancement of 2.5-3.5 cm and a concomitant overcorrection of bitemporal projection. Split cranial bone ensured adequate coverage of the significantly expanded cranial vault. Relapse was defined as a recurrence of bitemporal constriction or lateral orbital retrusion requiring surgical correction.

**Results:** Sixty-one patients met inclusion criteria. Mean age at surgery was 10.9 months with mean follow-up of 9.0 years. No patients required repeat craniotomy for relapse. Cranial bone defects were found in 4 (6.6%) patients, 3 of which underwent cranial bone grafting, while 1 underwent methylmethacrylate placement at an outside institution. 1 (1.6%) patient underwent fat grafting for areas of soft tissue irregularity. 7 (11.5%) patients demonstrated mild to moderate temporal constriction. No patients exhibited persistent sequela of hypercorrection.

**Conclusions:** Surgical hypercorrection of metopic craniosynostosis functions to provide reproducible and stable correction of trigonocephaly with significantly lower rates of relapse compared to historic standards.
e-poster 113
Quantification of Aesthetic Changes to the Temporal Region Through Three-dimensional Volumetric Photo Analysis
Presenter: Christian Vercler
Authors: Christian Vercler, Russell Ettinger, Riaz Nabi, Fan Liang, Aditya Pandey, Steven Buchman
Institution: University of Michigan

Abstract:
Objective: Hollowing of the temporal region is a disfiguring condition seen in a wide range of diseases and as a result of iatrogenic injury to the temporalis muscle during surgery. Despite the well-known changes that can occur in the temporal region, few studies have quantified how volumetric changes in the temporal region impact the degree of external deformity of patients.

Methods: Patients demonstrating temporal hollowing were selected from the senior authors (AP) Neurosurgery practice (n=20). All patients had undergone unilateral pterional craniotomy and mobilization of the temporal muscle during surgical exposure. Patients were selected based on evidence of unilateral temporal hollowing following a neurosurgical procedure. Patients underwent 3D image capture using Vultus 3dMD; their photographs were then analyzed with volumetric windowing of the temporal region of both the affected side and the contralateral unoperated control side. Normal control patients also underwent 3D measurements to compare the affected individuals against natural deviations in volume of the temporal region. Statistical comparison was conducted with Students T-test (p<0.05).

Results: Patients with moderate to severe temporal hollowing (n=12) demonstrated an average volumetric difference of 1.069 cm3 between the ipsilateral (average volume = 0.976 cm3) and the contralateral side (average volume = 2.048 cm3). The average volume difference in the control group (n=20) for the right side (average volume= 1.455 cm3 ) and left side (average volume = 1.319 cm3) was 0.136 cm3, which was significantly less than the difference seen in the affected group (p < 0.05).

Conclusion: This analysis demonstrates that a small but significant volumetric change (1.069 cm3 difference) in the temporal region can manifest as a significant degree of aesthetic deformity for patients. The results of this study serve to quantify the degree of correction required to eliminate deformities in temporal hollowing.

e-poster 114
Neonatal Mandibular Distraction Osteogenesis Reduces Cleft Palate Width and Lengthens Soft Palate, Influencing Palatoplasty in Patients With Pierre Robin Sequence
Presenter: Marcus Collares
Authors: Marcus Collares, Daniele W Duarte, Davi S Sobral, Ciro P Portinho, Gustavo J Faller, Mariana M Fraga
Institution: University of Rio Grande do Sul - Brazil

Abstract: The aim of this study was to evaluate the influence of neonatal mandibular distraction osteogenesis (MDO) on cleft dimensions and on early palatoplasty outcomes in patients with Pierre Robin Sequence (PRS). In a prospective cohort study that enrolled 24 nonsyndromic patients with PRS, 12 submitted to the MDO group and 12 patients not treated (non-MDO group), the authors compared patients for cleft palate dimensions through 7 morphometric measurements at the moment of palatoplasty and/or for early palatoplasty outcomes. At palatoplasty, the MDO group presented a significant shorter distance between the posterior nasalspines (PNS-PNS, P<0.001) and between uvular bases (UB-UB, P<0.001), representing a reduction in cleft palate width. They also had significant soft palate lengthening represented by a larger distance between UB and retromolar space (UB-RM, P<0.001) and UB and PNS (UB-PNS, P<0.001). Their UB moved away from the posterior wall of the nasopharynx (UB-NPH, P<0.001). The MDO group had a length of operative time significantly shorter (P<0.001) and no early palatoplasty complications compared with the non-MDO group. In conclusion, MDO acted as an orthopedic procedure that reduced cleft palate width and elongated the soft palate in patients with PRS. These modifications enabled a reduction of around 11% in the length of operative time of palatoplasty (P<0.001).
E-Posters

**e-poster 115**
**Median Cleft Lip - Surgical Management Protocol Based on 18 Operated Cases**
Presenter: Jorge Morán
Authors: Marcus Collares, Jorge Morán, Mariana M Fraga, Ciro P Portinho, João Maximiliano Martins, Jorge Hoyos
Institution: University of Rio Grande do Sul - Brazil

**Abstract:** The median cleft lip are rare anomalies, usually associated with other craniofacial and systemic malformations that compromise survival or at least social life. The genesis of the median cleft lip may be distinct, true and false terminology are used to qualify it. In the true form, a separation between the medial globular processes occurs, while in the false form there is a congenital absence of globular processes. The so-called false form is associated to a wide range of cerebral anomalies (holoprosencephaly). Their treatment is controversial. We discuss the therapeutic management more suitable for each group of patients, based on their embryological, anatomical and clinical aspects. Forty-six patients with median cleft lip were followed and 18 were operated. Four patients had true or hyperteloric form and 14 false or hypoteloric form. Postoperative follow-up ranged from 6 to 244 months with an average of 96 months. The Abbé flap was the technique presenting better results for the lip closure. This procedure is normally associated with the reconstruction of the columella with skin flaps from the medial margin of the cleft segments and the nasal structure with Max Pereira’s cartilage graft and calvarial bone graft to the dorsum. Treatment of patients with true median cleft lip (TMCL) and false (FMCL) with De Myers type V should follow the same timing of unilateral CLP. Cases of FMCL, Fascies IV of De Myers, can benefit from the nasolabial correction for better social interaction after passing the critical period of first year of life.

**e-poster 116**
**Scaphocephaly Part III: Cranial Perimeter and Intracranial Hypertension in Sagittal Synostosis with and without Secondary Coronal Synostosis**
Presenter: Joseph Michienzi
Authors: Joseph Michienzi, Joseph Michienzi, Eric Arnaud, Federico Di Rocco, Dominique Renier, Daniel Marchac, Alexandre Marchac
Institution: Hopital Necker-Enfants Malades Paris, France

**Abstract:**
**Purpose:** Saphocephaly and secondary coronal synostosis (SCS) with its functional consequences were retrospectively analyzed. 10% incidence of secondary coronal synostosis after craniectomies not involving the removal of the coronal suture. 1% requiring surgical decompression due to increased intracranial pressure. In a secondary retrospective review, there were 2 groups studied. The first group, a decreased cranial perimeter in scaphocephaly with secondary coronal synostosis was correlated with increased intracranial pressure and approximately 1% required surgical decompression. In the second group, a decreased cranial perimeter in scaphocephaly without secondary coronal synostosis appeared to be associated with headaches, thumb printing, abnormal coronal suture, psychomotor delay, and abnormal wave slowing on EEG.

**Method:** Observation of SCS, and clinical signs of raised intracranial pressure in scaphocephaly. Division into 4 groups according to surgical intervention. Group 1: ‘H’ craniectomy [193]; Group 2: craniectomies with removal of the coronal suture [24]; Group 3: ‘H’ craniectomies without removal of the coronal suture [36]; and Group 4: nonsurgical [253]. Group I, 20 patients or 10.4% where found to have SCS, group II and III, 6 patients or 10% were found to have SCS. Also observed in Group I, 47 patients without secondary coronal synostosis. Both these sets of scaphocephaly patients in Group 1,2 and 3, with and without SCS after craniectomy were evaluated for cephalic circumferential perimeter.

**Results:** In group I, 4 had a decrease in PC (circumferential head perimeter), 2 of the 193 had a decrease in PC and had increased ICP which
e-poster 117
Diagnosis And Early Intervention Of Velofaring Insufficiency After Primary Palatoplasty In Patients Interdisciplinary Treated In Fisulab (Rehabilitation Center for children with cleft lip and palate, Bogotá Colombia)
Presenter: Diana Marcela Diaz Lopez
Authors: Diana Marcela Diaz Lopez, Rolando Prada, Juan Carlos Zambrano, Pilar Echeverry
Institution: Fundación Universitaria de Ciencias de la Salud

Abstract:
Objectives: A comprehensive and interdisciplinary treatment of patients with cleft palate is essential to ensure satisfactory long-term results. Adequate speech is one of the main goals in treatment because it allows each patient a proper adjustment to their educational and social environment. Velopharyngeal insufficiency (VPI) occurs due to anatomic changes of the velopharyngeal sphincter. Early and appropriate management of patients with cleft palate is crucial to prevent Velopharyngeal insufficiency. The aim of this study is to determine the incidence of patients with VPI that were detected and received treatment during their first 5 years of age at FISULAB center. (Rehabilitation Center for children with cleft lip and palate, Bogota Colombia) and to evaluate the effectiveness early treatment.

Materials and Methods: This is a descriptive study of case series. Patients included were diagnosed with cleft palate and treated exclusively in FISULAB, following the treatment protocol of this institution. A total of 972 patients were treated in FISULAB, 118 patients met the inclusion criteria.

Results: A total of 118 patients with cleft palate, with or without associated cleft lip, were treated in FISULAB following the institutional protocol. Of these 118 patients, 17 patients (14.4%) had VPI (8 male and 9 female). Of the patients who had VPI, 4 (23.5%) had a syndromic diagnosis. The incidence of VPI in our patient population was 13% with a resolution of 100% of VPI after surgical treatment.

Conclusions: Early diagnosis and interdisciplinary management of VPI are essential to ensure the success in speech rehabilitation in patients with cleft palate. A conservative and stepwise treatment of VPI has shown good results, minimizing complications.

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e-poster 118
Approaching Transfusion Free Surgery for Posterior Vault Reconstruction for Sagittal Synostosis
Presenter: Jane Kugler
Authors: Jane Kugler, Amy Beethe, MD, Jason Miller, MD, Rachel Spitznagel, MD
Institution: Children’s Hospital and Medical Center, and the University of Nebraska Medical

Abstract:
Background: Posterior vault reconstruction for sagittal synostosis is associated with significant bleeding requiring transfusion in greater than 95% of patients. Stricker, et al. with the Pediatric Craniofacial Collaborative Group postulated that institutions with low volume transfusion of packed red blood cells [PRBCs] may increase the number of transfusion free patients with the use of antifibrinolytics.

Methods: Forty-one children, ages 4-24 months underwent posterior vault reconstruction for sagittal synostosis at Children's Hospital and Medical Center from March, 2013-December, 2016. The same cranial facial plastic surgeon, neurosurgeon, and anesthesia team provided care. Care included intra-operative warming, arterial line, and 2 IV access sites. All patients received meticulous surgical care of blood conservation and intra-operative salvage of red cells. Tranexemic acid [TXA] 12.5 mg/kg IV was utilized at the discretion of the anesthesiologist beginning mid-2015. The authors analyzed transfusion rates before and after the team initiated the use of TXA using an exact Fischer test.

Results: The TXA patient group had a significantly lower exposure to transfused packed red blood cells P<0.0001. Without TXA, 19 of the 28 patients received packed red cells [range 10-125 ml/kg] [median 15 ml/kg]. In the group that received TXA, only one of 13 patients received PRBCs [10 ml/ kg].

Conclusions: The use of tranexemic acid along with other multimodal surgical practices in a single institute with low volume transfusion rates can lead to an increase in transfusion free patients for posterior vault reconstruction for sagittal synostosis.

e-poster 119  
Distraction-induced TMJ Ankylosis: Comprehensive Management  
Presenter: Kevin Xiao  
Authors: Michael Lypka, Kevin Xiao  
Institution: Children’s Mercy Hospital  

Abstract:  
Background / Purpose: Mandibular distraction is popular at many craniofacial centers for the treatment of mandibular deficient patients with moderate to severe airway obstruction, from the neonatal years on into adolescence. While the procedure typically has a positive impact on the airway and facial profile, a potential negative sequelae of mandibular distraction is TMJ ankylosis. The purpose of this presentation is to illustrate the comprehensive management of distraction-induced TMJ ankylosis, consisting of wide gap arthroplasty with use of virtual planning and navigation, ramus- condylar unit reconstruction, aggressive physical therapy, with subsequent orthognathic surgery.  

Methods: Five patients, ages 6-12, with TMJ ankylosis iatrogenically-induced by mandibular distraction were reviewed. Three patients had bilateral ankylosis for a total of eight joints. All patients had undergone mandibular distraction via a vertical vector, in some cases more than one time. All patients were multiply operated before the definitive ankylosis release. Patients were treated with wide gap arthroplasty, lining of base of skull with temporalis muscle/fascial flap, RCU reconstruction with distraction osteogenesis, rib graft, or prosthetic, and aggressive postoperative physical therapy. Virtual planning with intraoperative navigation and ultrasonic bone cutting was used in all cases. Two patients have undergone orthognathic surgery with three in the pre-surgical orthodontic phase. Follow up ranged from one to three years.  

Results: All patients underwent successful base of skull resection for TMJ ankylosis. All achieved greater than 25 mm of mouth opening with functional RCU reconstruction. One patient had transient facial nerve weakness. Stable occlusion with acceptable esthetic outcome have been achieved in the two patients who have undergone orthognathic surgery.  

Conclusion: For patients with distraction-induced TMJ ankylosis, a protocol consisting of wide gap arthroplasty, aided by virtual planning and navigation.

e-poster 120  
Obstructive Sleep Apnea Treatment: Structural expansion of the upper airway  
Presenter: Romulo Guerrero  
Authors: Romulo Guerrero, Adriana Guerrero  
Institution: Hospital Metropolitano de Quito  

Abstract: Obstructive sleep apnea is a common disorder that involves the collapse of the upper airway during sleep. This condition can have potentially serious consequences. Continuous positive airway pressure ventilation is the standard treatment. Upper airway obstruction causes 90% of sleep apnea, positive airway pressure does not cure the patient in these cases. There are several surgical alternative treatments aiming to expand the upper airways such as increasing the pharyngeal space by removing structures. Multiple bone anomalies have shown a narrow upper airway such as short anterior cranial base, maxilar retraction, micrognathia, and elongated soft palate. Our objective in this study is to describe our treatment protocol in this type of patients and surgical technique. We have 60 patients with obstructive sleep apnea. Our average age is 34 years old, our oldest patient is 73 years and our youngest patient is 14. All of our patients have pre and post operatory 3D tomography scans to measure the upper airway volume, and polysomnography studies. Our surgical technique is based on the correction of 3 affected structures: maxilar bone, mandibular ramus and mandibular symphysis. Our treatment consists in performing a maxillomandibular surgery in which we vertical elongate and advance the maxilla, we vertical elongate the mandibular ramus and a symphysis osteotomy for AP advancement. After one month of the surgical procedure a 3D tomography scan is perform which measures the upper airway volume. Our average upper airway expansion is 70% of its volume. Our 3year follow up does not show any recurrence. All of our patients have postoperative polysomnography that showed improvement in sleeping patterns after surgery. With our protocol maxillomandibular surgical treatment a structural expansion can be achieved increasing the upper airway and providing a cure for obstructive sleep apnea.
Refined Concepts to Improve Aesthetic Outcomes in Microtia Ear Reconstruction: Personal experiences based on 100 cases

Presenter: Akihiko Oyama MD, PhD
Authors: Akihiko Oyama MD, PhD, Emi Funayama MD, PhD, Yuhei Yamamoto MD, PhD
Institution: Faculty of Medicine, Hokkaido University

Abstract:
As the ear has a 3-dimensional architecture with complex contours, ear reconstruction in microtia is considered to be a challenging operation. The goal of the ear reconstruction for microtia is to obtain three-dimensionally precise ear with a well-defined contours that is as closely as possible to normal ear.

We believe that in order to improve the quality of the reconstructed ear, we should pay attention to the following three important points:
1. draw the anatomically precise ear
2. estimate the ideal location of the reconstructed ear
3. understanding the three-dimensional architecture of the ear
4. practice of framework fabrication with training equipments

The author performed over 100 autologous ear reconstructions for microtia as an operator from 2003 at the division of plastic surgery, Hokkaido University hospital.

All reconstructions have been performed in two surgical stages basing of Nagata's technique with some modifications and refinements. The first stage consists in fabrication and grafting of a three-dimensional costal cartilage framework. The second stage is performed 6 months or more later: the reconstructed ear is raised up and an additional cartilaginous graft is used to increase its projection. A mastoid fascial flap together with a skin graft are then used to cover the supporting cartilage. In this presentation, we will report improvement in surgical techniques and short and long term results, and to introduce our present concept and key point in microtia ear reconstruction surgery.

Factors Associated with Unplanned Re-Operation in Pediatric Plastic Surgery

Presenter: Dra. Renata Maricevich
Authors: Kevin T Jubbal, Dmitry Zavlin, Edward P Buchanan, Larry H Hollier, Jr Dra. Renata Maricevich
Institution: Loma Linda University

Abstract:
Background: Unplanned re-operation (UR) is an outcome measure that can be used as a standardized tool to assess an institution’s quality and safety of medical care. The goal of our study was to identify parameters associated with an increased likelihood of UR following plastic surgery in pediatric patients in a large validated national multi-center database.

Methods: We performed a retrospective analysis of the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) Pediatric database between years 2012 and 2014 to identify pediatric patients undergoing primary plastic surgery procedures. Two cohorts were compared: patients who experienced UR and those who did not. Multiple logistic regression analysis was utilized to identify independent risk factors associated with UR.

Results: A total of 18,106 patients were identified in this analysis, with an overall UR rate of 0.8% (n = 137) within 30 days after surgery. Patients were on average 5.59 ± 5.27 years of age with 9,522 boys (52.6%) and 8,584 girls (47.4%). The procedures most commonly associated with UR were excision of skin and subcutaneous tissue for hidradenitis (UR = 10.3%), forehead and/or supraorbital rim reconstruction with grafts (allograft or prosthetic material, UR = 6.1%), use of multiplane external fixators (UR = 5.6%), and mastectomy for gynecomastia (UR = 4.4%). Independent risk factors for UR include inpatient procedure (p < 0.001), ASA class 3 or higher (p = 0.03), prolonged operative time (p < 0.001), and prior open wound or wound infection (p = 0.05). The most significant predictors of UR were postoperative medical and surgical complications (OR, 18.92 and 39.98, respectively, p < 0.001).

Conclusion: Factors independently associated with UR included inpatient procedures, ASA class of 3 or higher, prior open wound or wound infection, and prolonged operative time. Medical and surgical complications were the strongest predictors of UR.
**e-poster 123**

**A 42 year experience with autogenous cranioplasty.**

Presenter: S Anthony Wolfe  
Authors: S Anthony Wolfe  
Institution: Chief, Division of Plastic Surgery Miami Children’s Health System

**Abstract:**  
Dr. Tessier, and his teacher Harold Gillies, advised using only autogenous bone for the treatment of cranial defects. Over a 42 year period 176 cases have been treated, using exclusively autogenous bone, largely split calvarial. Several cases have required preliminary free flaps, and the indications for this will be discussed. In the entire series there have been no infections, nor complications related to bone graft harvest vindicating the advice of Tessier and Gillies.

**e-poster 124**

**Ex nihilo alicuid fit: Something is made where there is nothing**

Presenter: S Anthony Wolfe  
Authors: S Anthony Wolfe  
Institution: Chief, Division of Plastic Surgery Miami Children’s Health System

**Abstract:**  
A child with a severe hemifacial agenesis, microphthalmia, hemiarrhinia and hemimaxillary absence was treated with multiple autogenous fat injections starting in infancy. At age three, two tissue expanders were placed in the forehead and scalp, and a tube pedicle created for provision of further soft tissue at the time of vertical orbital dystopia correction. Autogenous fat injection can and should be done in infancy when indicated.
**Abstract:**

**Purpose:** Craniofacial center websites are an early and significant source of education for parents. The aims of this presentation are to analyze the answers given by these websites to selected questions about craniosynostosis, and to assess the variability and accuracy of these answers.

**Methods:** The internet search-phrases “craniosynostosis,” “craniofacial center,” and “craniosynostosis center” were employed. The first 30 teams for each search were chosen, leading to 53 center websites after accounting for duplications. The websites were reviewed. Answers to select questions were recorded and assessed.

**Results:** Answers to questions were highly variable between websites with disparate statements noted, including:

1. 10% of websites state that surgery is required for all craniosynostoses.
2. 9% of websites state that if untreated, craniosynostosis mostly or always leads to developmental delay.
3. 95% of websites state there’s a combined plastic surgical-neurosurgical team approach. 5% are neurosurgeons working alone.
4. 22% of websites only mention open surgical correction. No sites exclusively mention endoscopic techniques.
5. The maximum age for endoscopic surgery is less than 3 months for 50% of sites, 3-6 months by 44%, and 8 months by 6% of websites.
6. 51% of websites obtain CT-scans routinely. 4% of centers do not routinely scan. 44% do not mention CTs.
7. 76% of websites do not address if blood transfusion is required. 4% of centers claim transfusion is only required for an open approach.
8. Overall, American craniofacial center websites have more inaccuracies, but are more comprehensive.

**Conclusions:** The most search-engine-optimized craniofacial center websites often are not comprehensive and provide inaccurate and variable information to families.
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