morbidity (p<0.0001), transfusion requirement (p<0.0001), and unexpected reoperations (p<0.0001) and readmissions (p=0.037) in the first thirty days by chi-square testing.

Patients younger than four months had lower risks of tracheostomy (p<0.0001), better sterility (p=0.0048), and a greater percentage of patients in ASA classes I and II (p<0.0001) compared to patients older than four months. As expected, the patients younger than four months of age also had shorter operation times (p<0.0001) and shorter lengths of stay (p=0.0008). Postoperatively, patients younger than four months had fewer unexpected reoperations (p=0.0008), readmissions (p=0.0377), and complications (p<0.0001), including fewer bleeding complications (p<0.0001).

CONCLUSION: Patients receiving surgery at younger than four months of age tended to have lower ASA class, with shorter procedures, less post-operative morbidity, and shorter lengths of stay. Patients older than twelve months had significantly higher ASA class, more comorbidities, longer operations and lengths of stay, and higher thirty-day reoperation and readmission rates. After a multivariate analysis, age was the single most important factor for craniosynostosis complications, increased length of stay, and readmission. Parents of patients greater than 12 months of age should be counseled about the increased risk profile in this population.

Does Autologous vs. Alloplastic Cranioplasty Affect Cranial Growth Patterns?

Presenter: Robert Thomas Nevitt, MD

Co-Authors: Greg Heuer, MD, PhD; Philip B. Storm, MD; Jesse A. Taylor, MD; Scott P. Bartlett, MD; Phuong Nguyen, MD

Affiliation: Mercy Catholic Medical Center, Darby, PA

BACKGROUND: While cranioplasty reconstructive strategies in adults include autologous bone grafts, bone substitutes, and alloplastic materials, there remains a hesitation to reconstruct pediatric cranial defects with synthetic material when paucity of autologous bone graft exists. Pediatric cranioplasty incurs challenges of increased bone resorption, timing, cranial growth, limited donor allograft, and longer exposure to foreign materials as a nidus for infection. Effect on cranial growth after cranioplasty in children is not fully elucidated. Herein, we review the cranial growth of pediatric patients who underwent cranioplasty at our institution.

METHODS: After IRB approval, a retrospective single institution review was conducted from a database of pediatric patients who underwent cranioplasty from 2000 to 2017. Patients without pre-operative, short-term (< 3 months) post-operative, and long-term (>11 months) post-operative imaging were excluded. Patients were divided into alloplastic vs. autologous reconstruction cohorts. Demographics, co-morbidities, age at surgery, etiology and size of cranial defect, type of reconstruction, time of initial surgery to reconstruction, and complications were assessed. 3D surface models were created from CT data and set to the Frankfort horizontal line, which allowed for calculation of cephalometrics pre and post-operatively including cranial growth. These cohorts were then compared to an age-specific database of 3D cranial imaging in normal subjects for assessment of growth patterns. Statistical analysis was performed using SPSS version 22.0.

RESULTS: Thirty-two patients met inclusion criteria for reconstructive cranioplasty (8 mos – 18 years, mean 9.6 years). Cephalic length, width, and 3D measurements were obtained to calculate the cephalic index at varying time points. Etiology of cranial defects included trauma (50%), neoplasm (12.5%), cerebral vascular accident (12.5%), epilepsy (9%), congenital cranial defect (9%), and herniation (4%). Twenty-three patients underwent autologous bone flap reconstruction, 7 underwent alloplastic reconstruction, and 2 underwent a combination of both. In long-term follow up, 3 alloplastic implants were lost to infection. Five autologous bone flaps were lost to infection and replaced with alloplastic materials. An additional 3 autologous bone flaps were revised due to nonunion or resorption. A total of 8 autologous and 3 alloplastic cranioplasties failed respectively. Cranial index at pre-operative, post-operative, and long-term follow up did not significantly differ between autologous vs. alloplastic cranioplasties at each age group (p=0.05 – 0.89). When compared to normative CI means, there was also no significant difference at each age group (p=0.08–0.99).

CONCLUSION: Both autologous and alloplastic cranioplasty do not appear to affect cranial growth patterns in children as compared to normative data. There was a higher failure rate in autologous cranioplasty compared to alloplastic cranioplasty. There does not appear to be a significant difference in cranial growth between autologous and alloplastic cranioplasty.
REFERENCES:
1. Delye H, Clijmans T, Mommaerts MY, Sloten JV, Goffin J. Creating a normative database of age-specific 3D geometrical data, bone density, and bone thickness of the developing skull: a pilot study. J Neurosurg Pediatr 16:687–702, 2015

3D-Printed Bioactive Ceramic Scaffolds for Induction of Osteogenesis in the Immature Skeleton

Presenter: Samantha G. Maliha, BA

Co-Authors: Madison E. Cox, HSD; Juliana Gomez, BA; Sejndi Rusi, BA; Alan Meskin, BA; Jonathan M. Bekisz, BA; Christopher D. Lopez, BA; Lukasz Witek, MSci, PhD; Paulo G. Coelho, DDS, PhD; Roberto L. Flores, MD

Affiliation: New York University Langone Health, New York City, NY

BACKGROUND/PURPOSE: 3D-printed bioactive ceramic (3DPBC) scaffolds composed of beta-tricalcium phosphate (β-TCP) and coated in the osteogenic agent dipyridamole (DIPY) have been previously shown to heal critically sized calvarial defects in several adult animal models.1–3 This bone tissue engineering construct has yet to be applied in a pediatric craniofacial model where the pathologic effects of osteogenic agents on the growing sutures may be of concern. The purpose of this study is to apply the described bone tissue engineering construct in a pediatric growing animal model and 1) quantify osteogenic potential in a growing calvarium; 2) maximize the scaffold design and dipyridamole concentration for the growing calvarium; and 3) characterize the effects of this bone tissue engineering construct on the growing suture.

METHODS/DESCRIPTION: Bilateral calvarial defects (10mm) were created in 5-week-old New Zealand White rabbits (n = 14) 2mm posterior and lateral to the coronal suture and sagittal sutures, respectively. 3DPBC scaffolds were constructed in quadrant form composed varying pore dimensions (220μm, 330μm, 500μm). Each scaffold was collagen coated and soaked in varying concentrations of DIPY (100μM, 1000μM, 10,000μM). Controls comprised empty defects and collagen coated scaffolds. Scaffolds were then placed into the calvarial defects to fill the bone space. Animals were euthanized 8-weeks post-operatively. Calvaria were analyzed using micro-computed tomography and 3D reconstruction. Mixed model analyses were conducted considering pore size and dosage effects on bone growth (α=0.05).

RESULTS: 3DPBC scaffolds generated bone throughout the construct (defect marginal and central regions) while bone healing in empty sites was restricted to the defect margins confirming its critical size dimension at 8 weeks in vivo. When evaluating volume occupied by bone solely as factor of pore size (small, medium, and large), the small pores yielded the highest mean value (26.8% ± 3.4) when compared to medium and large. However, analysis indicated no statistical differences between the sizes (p>0.10). In assessing the effectiveness of coating the scaffold in either collagen or dipyridamole (DIPY), higher mean bone occupancy values were observed in the scaffolds coated in 1,000μM DIPY (27.9% ± 4.05), which was significantly greater in comparison to the collagen-coated scaffolds (20.9% ± 4.43, p=0.021). Growing cranial sutures remained patent across all concentrations of DIPY, including 10,000μM.

CONCLUSION: 3DPBC scaffolds effectively generates bone in a growing calvarial animal model. Pore size and dipyridamole dose has been optimized for the growing cranium. Cranial suture patency is preserved even at a 2 log increase over the effective osteogenic dose.

REFERENCES:
1. Ishack S, Mediero A, Wilder T, Ricci JL, Cronstein BN. Bone regeneration in critical bone defects using three-dimensionally printed beta-tricalcium phosphate/hydroxyapatite scaffolds is enhanced by coating scaffolds with either dipyridamole or BMP-2. J Biomed Mater Res B Appl Biomater 2017;105:366–75.
2. Simon JL, Michna S, Lewis JA, et al. In vivo bone response to 3D periodic hydroxyapatite scaffolds assembled by direct ink writing. J Biomed Mater Res A 2007;83:747–58.
3. Bekisz JM, Flores RL, Witek L, et al. Dipyridamole enhances osteogenesis of three-dimensionally printed bioactive ceramic scaffolds in calvarial defects. J Craniomaxillofac Surg 2017.

Osteoprotegerin-Mediated Osteoclast Inhibition Is Augmented on Nanoparticulate Mineralized Collagen Glycosaminoglycan Materials

Presenter: Justine C. Lee, MD, PhD