placement, presence of tube feeding at discharge, and days to full oral feeds.

RESULTS: Forty patients met the inclusion criteria. Eighteen (45.0%) patients carried a syndromic diagnosis. Thirty-one (77.5%) patients had cleft palate (CP). Thirteen (32.5%) patients had associated cardiac pathology. Nine (22.5%) patients were preterm. Preoperative laryngoscopy identified 8 (20.0%) patients with concomitant abnormal lower airway findings. Three (7.5%) patients required tracheostomy after MDO. Fourteen patients (35%) had a GT; 3 placed preoperatively and 11 placed postoperatively. Preoperative oral feeding ranged from those with no oral feeds (all feeds via NG/OG/GT) in 15 (37.5%), some oral feeds (combination of PO and NG/OG/GT) in 10 (25.0%), or full oral feeds in 15 (37.5%). At hospital discharge (mean 23.8 days after MDO), 20 (50%) patients were on full oral feeds. By 3 months postoperative, 27 (67.5%) were on full oral feeds. Mean weight percentile decreased from birth to the perioperative period but subsequently increased by 2-year follow-up ($P = 0.002$). Patients with CP had higher birth weight, pre-op weight, and 2-year follow-up weight percentiles compared with patients without ($P = 0.040, 0.017,$ and 0.006). Patients with cardiac pathology had a lower weight percentile at 2-year follow-up ($P = 0.035$). Preterm infants had lower weight percentiles at all time points including at 2-year follow-up ($P = 0.016$), with a 1.7 times increased risk of g-tube placement ($P = 0.032$). Compared with patient without preoperative oral feeding, patients with some preoperative oral feeds had higher weight percentiles preoperative, at discharge, and at hardware removal surgery ($P = 0.001, 0.001,$ and 0.018). Compared with some preoperative oral feeds, the full oral feed group had lower weight percentile at preoperative and discharge ($P = 0.001$) but not at hardware removal or 2-year follow-up. Neither preoperative feeding status ($P = 0.16$) or days to extubation ($P = 0.23$) were significant predictors of days to full oral feeding. Age at distraction, distance distracted, and use of reflux medication did not influence weight percentiles or feeding outcomes.

CONCLUSIONS: After MDO, 67.5% of PRS patients are on full oral feeds by 3 months compared with 37.5% preoperatively. Thirty-five percent of patients underwent GT placement, with an increased risk in preterm patients or those who required tracheostomy. Predictors of improved weight percentile at 2 years included presence of CP and absence of cardiac pathology. A combination of oral feeds and enteral feeds via NG/OG/GT during the preoperative period correlated with higher weight percentiles in the perioperative period; however, no weight differences were seen long term.

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Accelerating the Degradation Profile of β-Tricalcium Phosphate Bone Replacement through Three-dimensional Printing

Presenter: Chen Shen, BS

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INTRODUCTION: β-tricalcium phosphate (β-TCP), one of the most common synthetic bone replacement products, is frequently used in pediatric craniofacial reconstruction. Although solid β-TCP can be absorbed over time, a relatively slow degradation rate predisposes this product to exposure, infection, and fracture. Our tissue engineering laboratory has successfully leveraged three-dimensional (3D) printers to manufacture 3D-printed bioactive ceramic scaffolds composed of β-TCP in an architecture that optimizes the needs of rigidity with efficient vascular ingrowth, osteogenesis, and degradation kinetics, which are further optimized when using the osteogenic agent dipyridamole. This long-term animal study of immature rabbits through the time of facial maturity reports on the new degradation kinetics profile achievable through this novel manufacturing and tissue engineering protocol.

METHODS: Twenty-two 1-month-old (immature) New Zealand White rabbits underwent creation of unilateral 10-mm calvarial defects with ipsilateral 3.5 × 3.5 mm alveolar defects. Each defect was repaired with 3D-printed bioactive ceramic scaffolds composed of 100% β-TCP and coated with 1,000 µM dipyridamole. Rabbits were sacrificed at 2 months (n = 6), 6 months (n = 8), and 18 months (n = 8). Bone regeneration and scaffold degradation were calculated using micro-CT images reconstructed in Amira software. Bone density and mechanical properties at 18 months was compared with native uninjured bone using Amira software and nanoindentation, respectively. Cranial and maxillary suture patency and bone growth were qualitatively analyzed using histology.

RESULTS: Results of 3D reconstruction are reported as a percentage of volumetric space occupied by either scaffold or bone. When comparing time points 2, 6, and 18 months, scaffolds showed significantly decreased in vivo defect...
occupancy in calvaria (23.6% ± 2.5%, 15.2% ± 2.2%, and 5.1% ± 2.2%; \( P < 0.001 \)) and in alveoli (21.5% ± 2.2%, 6.7% ± 1.9%, and 0.2% ± 1.9%; \( P < 0.001 \)), with annual degradation rates 54.6% and 90.3%, respectively. Between 2 and 18 months, significantly more bone regenerated in calvarial defects (25.8% ± 7.9% versus 55.7% ± 6.9%; \( P < 0.001 \)) but was similar to native bone density (46.7% ± 6.8%; \( P = 0.06 \)), and no difference was found in alveolar defects over time (28.4% ± 8.2% versus 31.4% ± 7.1%; \( P = 0.57 \)) and compared to native bone (33.8% ± 3.7%; \( P = 0.34 \)). Regenerated elastic modulus (E) and hardness (H) were similar to native bone in calvaria (E: 12.6 ± 1.8 GPa versus 13.2 ± 1.8 GPa, \( P = 0.62 \); H: 0.54 ± 0.06 GPa versus 0.53 ± 0.06 GPa, \( P = 0.81 \)) and alveoli (E: 11.7 ± 1.5 GPa versus 11.3 ± 1.5 GPa, \( P = 0.71 \); H: 0.64 ± 0.05 GPa versus 0.66 ± 0.05 GPa, \( P = 0.70 \)). Histology revealed vascularized and organized bone without suture fusion.

DISCUSSION: The degradation kinetics of \( \beta \)-TCP can be altered through 3D printing and addition of an osteogenic agent. Our study demonstrates an acceleration of \( \beta \)-TCP degradation from 1% to 3% a year to 55% to 90% a year. Absorbed \( \beta \)-TCP is replaced by vascularized, organized bone, with histologic and mechanical properties similar to native bone and without damage noted to the growing suture. This additive manufacturing and tissue engineering protocol has implication to future reconstruction of the craniofacial skeleton, especially as a safe and efficacious method in pediatric bone tissue engineering.

Early Alveolar Bone Grafting Decreases Regraft Rates and Improves Long-Term Psychosocial Outcomes

**Presenter: Allison C. Hu, BA**

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**BACKGROUND:** Late childhood (8–10 years of age) has emerged as a vulnerable period in children with cleft and craniofacial anomalies such that increased interventions during this period is associated with worse long-term patient-reported anxiety and depressive symptoms. These findings suggest that one possible practice change may be to consider changes in timing for surgical treatment algorithms. In this work, we investigated outcomes in altering the timing of the most common surgery in late childhood for cleft lip and palate (CLP) patients, alveolar bone grafting (ABG).

**METHODS:** A 2-part, multi-institutional cohort study was conducted. To understand the feasibility of changing ABG timing with respect to the surgical success, reoperation rates were retrospectively compared among patients grafted at different age groups (4–7, 8–10, and 11–13 years of age). To understand the long-term effect of changing ABG timing on psychosocial outcomes, the psychosocial suite of the Patient-Reported Outcomes Measurement Information System was prospectively administered to CLP teenagers and adults.

**RESULTS:** Among the three age groups, early grafting (4–7 years of age) demonstrated the lowest regraft rates compared with the other groups. As these results suggested that early grafting is a viable alternative to standard timing, we next compared the differences in long-term psychosocial outcomes. Patients who were grafted early reported lower levels of anxiety and depressive symptoms as teenagers and adults.

**CONCLUSIONS:** Altering timing of 1 stage in CLP reconstruction to an earlier age decreases regraft rates and improves long-term patient-reported anxiety and depressive symptoms.

**Standardized Schematics for Facial Trauma Planning: A Clinical Education Tool**

**Presenter: Brandon J. De Ruiter, MD**

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**PURPOSE:** Learning facial fracture management principles can be challenging for surgical trainees. Targeted educational efforts in the posttraumatic setting are