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PURPOSE: Vascular and cellular depletion secondary to radiotherapy represents a major clinical challenge in mandibular reconstruction. Adipose-derived stem cells (ASCs) represent a promising component of regenerative medicine due to their multipotent potential and relative ease of harvest, yet remain under-investigated in the setting of radiotherapy. Furthermore, clinical translation of ASCs is currently impeded by arduous processing techniques and FDA regulations surrounding cell culture. This investigation examines the ability of minimally-processed ASCs (MPASCs) to enhance irradiated bone healing during fracture repair in the murine mandible to further delineate translatable methods of efficient ASC administration that ultimately expand the use of cell-based therapeutics in craniofacial reconstruction.

METHODS: Isogenic male Lewis rats were divided into the following groups: fracture (Fx, n =12), irradiated fracture (XFx, n =12), and irradiated fracture with MPASCs (XFxMP, n =11). Two weeks before surgery, irradiated groups received a fractioned dose of 35Gy over 5 days, equivalent to 70Gy administered to head and neck cancer patients clinically. All rats underwent osteotomy of the left hemi-mandible and external fixation. MPASCs were harvested from the inguinal fat of isogenic donors, centrifuged, and immediately placed intraoperatively into the osteotomy site. On post-operative day 40, all mandibles were perfused and evaluated for bony union upon dissection. Vascularity was evaluated at the fracture site through microcomputed tomography prior to histologic analysis of osteocyte proliferation and mature bone volume using Gomori Trichrome stain.

RESULTS: Bony union rates were significantly improved by MPASC implantation in the XFxMP group (82%) compared to XFx (25%) and were not statistically different from Fx (100%) (p = 0.01, 0.12). MPASC therapy significantly improved vessel volume, vessel volume fraction, vessel number, vessel thickness, and reduced vessel separation compared to the XFx group (p = 0.01, 0.01, 0.01, 0.01, 0.09, respectively). No significant differences in vascular metrics were observed between the Fx and XFxMP group. Histologic analysis revealed a significant reduction in both osteocyte proliferation and mature bone volume in the XFx group compared to Fx (p = 0.00, 0.00). Bone cellularity and mature bone formation were significantly increased in the XFxMP group compared to XFx and were restored to non-irradiated levels (p = 0.00, 0.04).

CONCLUSION: Impairment of angiogenesis and the destruction of osteocompetent cells secondary to radiotherapy are principal obstacles to irradiated bone healing. This study demonstrates the efficacy of MPASCs in remediating these damaging effects and provides a promising foundation for future studies aimed at developing minimally-processed cell-based therapeutics for clinical implementation. Facilitation of normal bone healing in the setting of radiotherapy through MPASCs may offer an effective strategy to address the sequelae of pathologic fractures and osteoradionecrosis that currently present significant challenges in the management of head and neck cancer.

QS8
Separating Craniopagus Twins: A 4 Stage Approach Using 3D Imaging Technology

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PURPOSE: Craniopagus twins are the rarest form of conjoined twins, and successful separation poses a significant challenge to both neurosurgical and plastic surgical teams. Total craniopagus twins share a unified calvarium that houses two fused brains with shared venous sinuses. One senior author has previously separated 11 sets of craniopagus twins, and the relative advantages of our most recent approach using 3D technology will be discussed.

METHODS: Two sets of total craniopagus twins were separated in 4 stages (n=4). 3D technology was used for pre-operative planning, intra-operative execution, and post-operative analysis of reconstructive outcomes. Virtual surgical planning with 3D printed jigs and guides, 3D surface analysis, and 3D printed models were used at each stage. A two-team approach with neurosurgery and plastic surgery was employed at each stage, and 3D-technology was used by each team.

RESULTS: Two sets of total craniopagus twins were successfully separated using a 4-stage, two-team approach supplemented by 3D technology. The neurosurgical team used 3D-printed models of the brains and vasculature to...
plan and perform dissection. Plastic surgery used VSP to select tissue expanders and design templates for incisions and osteotomies. 3D printed models offered intraoperative reference to safely separate the brain and its vasculature. 3D printed jigs and guides were fit on the calvarium to guide osteotomies for cranial vault reconstruction, and onto the scalp to guide soft tissue reconstruction.

CONCLUSIONS: Successful separation of total craniopagus twins relies on meticulous pre-operative planning and execution. 3D technology offers anatomic reference and surgical guidance in the multistage separation of total craniopagus twins. Separating the brain and its vasculature followed by calvarial reconstruction was improved with 3D technology.

QS9
Convolutional Neural Network Models for Automatic Pre-Operative Severity Assessment in Unilateral Cleft Lip

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PURPOSE: Despite the wide range of cleft lip morphology, consistent scales to categorize pre-operative severity do not exist. Machine learning has been used to increase accuracy and efficiency in detection and rating of multiple conditions, yet it has not been applied to cleft disease. We test a machine learning approach to automatically detect and measure facial landmarks and assign severity grades using pre-operative photographs.

METHODS: Pre-operative images were collected from 800 unilateral cleft lip patients, manually annotated for cleft-specific landmarks and rated using a previously validated severity scale by eight expert reviewers. Five convolutional neural network (CNN) models were trained for landmark detection and severity grade assignment. Mean squared error (MSE) loss and Pearson correlation coefficient for cleft-width-ratio (CWR), nostril-width-ratio (NWR) and severity grade assignment were calculated.

RESULTS: All five CNN models performed well in landmark detection and severity grade assignment with the largest and most complex model, ResNet, performing best (MSE = 24.41, CWR correlation = 0.943, NWR correlation = 0.879, severity correlation = 0.892). The mobile-device compatible network, MobileNet also showed a high degree of accuracy (MSE = 36.66, CWR correlation = 0.901, NWR correlation = 0.705, severity correlation = 0.860).

CONCLUSION: Machine learning models demonstrate the ability to accurately measure facial features and assign severity grades according to validated scales. Such models hold promise for the creation of a simple, automated approach to classifying cleft lip morphology. Further potential exists for a mobile-phone based application to provide real-time feedback to improve clinical decision making and patient counseling.

QS10
Cleft Surgery Knowledge and Skills Acquisition by Plastic Surgery Residents: A Simulation-Based Prospective Randomized Blinded Trial

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PURPOSE: Simulation is a standard component of residency training in many surgical subspecialties, yet its impact on knowledge and skills acquisition in cleft surgery training remains poorly defined. We evaluated cleft surgery knowledge and skills acquisition by plastic surgery residents through a simulation-based prospective, randomized, blinded trial.

METHODS: Thirteen plastic surgery residents were randomized to a digital simulator or textbook demonstrating