(dual-radiofrequency pulse, dual-echo, 3D ultrashort echo time) and the utility of a segmentation pipeline.

OBJECTIVES:
Part 1. Evaluate the concordance between MR-based and CT-based 3D skull renderings
Part 2. Describe and evaluate a novel multiatlas segmentation pipeline

DESIGN/METHODS:
Part 1: A cadaver skull and the skulls of 5 healthy adult volunteers were scanned with bone-selective MR and thin-slice CT. Semi-automatic bone segmentation (1.5 hours/scan) was performed creating 3D renderings of the skulls. Mimics software was used to measure 8 anatomic distances from the 3D renderings. Lin’s Concordance Correlation test was applied to assess agreement between MR and CT-based 3D renderings.

Part 2. CT and bone-selective MR images were acquired from 16 additional healthy adult volunteers, yielding 21 MR/CT pairs. The CT images were segmented using a semi-automated method to generate “ground truth” labels for the MR images. An automated multiatlas segmentation pipeline was then used to segment the 3D MR images using a 2-step process consisting of a training and segmentation. The training step develops an “atlas package,” which represents the varying anatomy from different subjects. The segmentation step uses the atlas package to generate segmentations for new subjects using several image registration steps.

RESULTS: MR-based measurements differed from CT-based measurements by mean percent difference ranging from 2.3% to 5.0%. Lin’s Concordance Correlation ranged from 0.998 to 1.000. The segmentation pipeline took 10 minutes per segmentation with an average symmetric surface distance of 0.96 ± 0.15 mm between the manual reference segmentation and the corresponding automated segmentations.

CONCLUSIONS: This study demonstrates high concordance between the gold standard (thin-slice CT) and our novel imaging modality as well as an 89% reduction in segmentation time. This technique is highly applicable to craniofacial surgery as well as cases involving extremity surgery, musculoskeletal trauma, and bone tumors. It additionally allows acquisition of data of both soft and hard tissue structures from a single imaging modality with no radiation exposure. The demonstrated reduced segmentation time would allow bone-selective MRI to be used in clinical practice without a delay in treatment. We plan to investigate the accuracy of this technique as a tool for craniosynostosis diagnosis as well as in craniofacial virtual surgical planning.

Silicone Implant Shells Increase the Rate of Proliferation of Alk- but Not Alk+ Lymphoma Cells in an Engineered Biomimetic Breast Microenvironment

Presenter: Ishani D. Premaratne, BA

Co-Authors: Matthew A. Wright, BA; Mariam Gadjiko, BA; Xue Dong, MD, PhD; Arash Samadi, BS; Daniel O. Lara, BS; Nabil Berri, MD; Paula S. Ginter, MD; Giorgio Inghirami, MD; Kristy A. Brown, PhD; Jason A. Spector, MD

Affiliation: Weill Cornell Medicine, New York, NY

PURPOSE: The pathogenesis of breast implant-associated anaplastic large cell lymphoma (BIA-ALCL), an Alk-pathology, remains poorly understood. Our lab has demonstrated the power of studying BIA-ALCL behavior in a high-fidelity tissue engineered ex vivo biomimetic, 3-dimensional model. Herein we use this model to study the behavior of Alk+ Lymphoma cells, which characterize the most common type of ALCL, within an engineered breast microenvironment, to serve as an important comparator to the behavior of BIA-ALCL cells, which are Alk-.

METHODS: Patient-derived breast tissue was processed for its component adipocytes, ductal organoids, and stromal vascular fraction. These were suspended within 50 µl of 0.3% Type I collagen matrix to which was added 200,000 Alk+ Lymphoma cells. These were then plated into 6 mm wells. As a control, Alk+ Lymphoma cells were also suspended within Type I collagen alone at the same seeding density without breast components (“collagen only”). Before plating, wells were lined circumferentially with 1 cm by 2 cm pieces of either textured, smooth, or no implant shell (dissected from the intact implant). Wells were imaged using confocal microscopy over 8 days.

RESULTS: There was a significant difference in cell counts over 8 days between the 6 different groups ($P = 0.002; R^2 = 0.625$). Cell proliferation over time in the biomimetic groups, regardless of the presence or absence of implant shell, was significantly greater than cell proliferation in the collagen only groups over the same time period.
(P < 0.001). Overall, cell counts trended downward in the collagen only groups over 8 days with a significant decrease in count starting at day 6. There was no difference in the rate of proliferation of Alk+ cells in the presence of silicone shells. This is similar to the proliferation seen in Alk-BIA-ALCL cells, which was significantly more robust in the biomimetic platform compared to collagen-only groups, regardless of implant shell type (P < 0.01). Unlike Alk+ cells, Alk- BIA-ALCL cells grew nearly 30% faster in textured and smooth shell biomimetic groups compared with biomimetic wells lacking an implant shell.

CONCLUSIONS: Within a tissue-engineered 3-dimensional model of the breast microenvironment, Alk+ Lymphoma cells, which serve as an important comparator cell line to the study of Alk- BIA-ALCL, showed a significant increase in proliferation within the biomimetic groups only over 8 days, regardless of the presence or absence of implant shell. Comparatively, BIA-ALCL cells proliferated significantly more robustly within this platform in the presence of textured and smooth implant shell as well as biomimetic platform. These data suggest that there is thus something inherently unique to Alk- BIA-ALCL cells that drives proliferation in the presence of both biomimetic platform and silicone implant shell as the presence of a silicone implant shell does not drive increased proliferation of Alk+ Lymphoma cells. These data suggest that breast implant silicone shell in combination with the breast microenvironment may drive the growth of BIA-ALCL.

Prenatal Diagnosis of Craniofacial Anomalies: How Positive Are We About That Positive Result?

Presenter: Carrie E. Zimmerman, BS

Co-Authors: Laura S. Humphries, MD; Julia Bushold, BS; Christopher L. Kalmar, MD, MBA; Giap H. Vu, BA; Thomas Reynolds, MBA; Edward R. Oliver, MD, PhD; Lori J. Howell, DNP, MS, RN; Scott Paul P. Bartlett, MD; Jesse A. Taylor, MD; Jordan W. Swanson, MD, MSc

Affiliation: Children’s Hospital of Philadelphia, Philadelphia, PA

BACKGROUND: Due to advances in 3-dimensional and 4-dimensional ultrasonography, it is possible to detect CF anomalies at 10 weeks of gestation as the facial bones begin to ossify. Rates of prenatally diagnosed craniofacial anomalies vary by region and country partially due to varied screening policies and level of technician expertise. Isolated craniosynostosis is a particular diagnostic challenge due to difficulties visualizing cranial sutures on ultrasound. The purpose of this study was to identify the diagnostic accuracy of ultrasound and magnetic resonance imaging (MRI) for various craniofacial anomalies at our tertiary care center associated with a high volume fetal diagnostic unit.

METHODS: Our institutional fetal imaging database, Fetal Force, was queried to identify patients with suspected craniofacial conditions from January 2002 through August 2019. Parental and demographic data, prenatal imaging, fetal DNA sequencing, postnatal exam findings, and outcomes (delivery, termination, fetal demise, infant demise) were obtained. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of prenatal diagnosis were calculated using postnatal clinical examination as the gold standard. Fetal terminations, demises, and dyads lost to follow-up were excluded from calculations due to lack of gold standard comparison.

RESULTS: Of the 73 parent/fetus dyads identified, 43 fetuses met all inclusion criteria. Thirty dyads were excluded for noncraniofacial anomalies, common facial clefts, or scans obtained due to family history of craniofacial anomalies. The mean maternal age at consultation was 32.8 ± 5 years (range, 22.4–41.3), mean gestational age 26w ± 4w6d (range, 19w–36w5d). 70% (30) of patients were prenatally suspected to have craniosynostosis, 14% (6) micrognathia, 7.0% (3) Binder’s syndrome, and 9.3% (4) a variety of other conditions; microophthalmos, goldenhar, amniotic band syndrome, and Rubenstein-Taybi syndrome. 69.7% (30) of patients received fetal ultrasound and fetal MRI, 23.3% (10) received fetal US only, and 7.0% of patients (3) received fetal MRI alone. Seven fetuses were terminated (Craniosynostosis n = 6, microophthalmos n = 1) and 4 infants with multiple congenital anomalies passed away in infancy. For the diagnosis of any craniofacial anomaly, ultrasound: sensitivity 90%, specificity 43%, PPV 82%, NPV 60%; MRI: sensitivity 86%, specificity 50%, PPV 82%, NPV 50%. For craniosynostosis specifically, ultrasound: sensitivity 100%, specificity 43%, PPV 86%, NPV 71%, NPV 100%; MRI: sensitivity 100%; specificity 50%; PPV 82%, NPV 100%. Ultrasound had a sensitivity and PPV of 100% for both micrognathia and Binder’s syndrome. There were 4 false positive diagnoses of isolated craniosynostosis on prenatal ultrasound that were found to be overriding sutures without synostosis or normal head shape variants on postnatal examination. In the setting of syndromic craniosynostosis, careful attention was paid to associated anomalies (ie, hands and feet in Apert Syndrome) to support the diagnosis.