2023 Modern Human Anatomy Program
Capstone Poster Presentations

April 25th, 2023

Education 2 Bridge
University of Colorado Anschutz Medical Campus

8:45 – 9:00 AM	Breakfast
9:00 AM – 10:30 AM	Presentations for Session I Posters
10:00 – 10:30 AM	Overlap between Session I and Session II
10:00 – 11:30 AM	Presentations for Session II Posters
11:30 AM	Lunch

Session I Poster Presenters
9:00 AM – 10:30 AM

Capstone Poster Presenter	Poster #	Abstract Page #	Poster Title	Category
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Michael Corigliano	**2**	6	Metabolic Dysfunction of Spinal Astrocytes Following Alphaherpesvirus Infection	Bench
Michael Ha	**3**	7	Using Patient Stem Cell-Derived Retinal Organoids to Investigate the Mechanisms of Retina Development and Degeneration in Down Syndrome	Bench
Rourke Haas	**4**	8	Smells Like Trouble: Antibody Verification in the Olfactory Bulb	Bench
Erika Alor	**5**	9	The Use of a 3D-Printed Model for the Interpretation of Chest CT Scans	Education
Caitlynn Hudlow	**6**	10	"This Atlas is the Reason I Passed My Lab Practical!": Evaluating the Use of Course-Tailored Review Resources in the Medical Gross Anatomy Flipped Classroom	Education
Marie-France Izere	**7**	12	It Takes Guts to Be Innovative! The G-Tube Health Literacy Project	Education
Maria Porpio	**8**	14	Vessels Less Traveled: Learning Upper Limb Arterial Anastomoses Through Gamification in Graduate Gross Anatomy	Education
Tiajah Valerio	**9**	16	Putting the A.R. in Heart: Utilizing Augmented Reality in the Cardiac Catheterization Lab	Education
Elizabeth Wigdahl	**10**	17	Cadaveric Donor Care: Establishing a Protocol for Longitudinal Integrated Curricula in Anatomy Labs	Education

Session II Poster Presenters
10:00 AM – 11:30 AM

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Quinlan Cuddy	**12**	20	Examining the Association Between Brain Connectivity and Satiety Responsiveness in Adolescents	
Joseph Gilmore	**13**	21	Design Informed by Anatomy – An Overhead Arm Support Apparatus for Use in Cardiac Catheterization Procedures	
Ashlee Harry	**14**	22	Perivascular Macrophage and Macphatic Roles in Metastatic Migration of Breast Cancer	
Aimee Kim	**15**	23	Liver Long and Prosper: How a 3D Liver Library Can Optimize MRI Imagining to Improve 3D Printed Models for Hepatic Pre-Surgical Planning	
Ryan LaGreca	**16**	25	Translating Concussion Gait Evaluations to a Mobile Approach: Reliability and Test Environment Differences	
Justin Schweigert	**17**	27	Generation of Z-values of Pediatric Cardiopulmonary Structures	
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Kara Tripp	**19**	29	"Face Fixin'": Developing an Algorithm for Complex Zygoma Surgical Reconstruction Following Trauma	
Maxwell Walker	**20**	30	3-D Printing for Vessel Location in Anterolateral Thigh (ALT) Grafts During Phalloplasty Procedures	
Gabriel Yuen	**21**	31	An Examination of Physical Parameters Across Transcatheter Pulmonary Valve Systems and Potential Correlation with Post-Placement Arrhythmia in Congenital Heart Disease Patients	

Thank you to faculty serving on capstone committees, as these projects would not be possible without your commitment to the success of our students.

MSMHA Student	Capstone Committee Chair	Capstone Mentor/s	Committee Member
Katherine Colon-Reyes	Ernesto Salcedo, PhD	Christy Niemeyer PhD	Maria Nagel, MD
Michael Corigliano	Ernesto Salcedo, PhD	Niemeyer, Christy, PhD	Andrew Bubak, PhD
Michael Ha	Maureen Stabio, PhD	Natalia Vergara, PhD	Karen Cusato, PhD, PA-C
Rourke Haas	John Thompson, PhD	Diego Restrepo, PhD	John Caldwell, PhD
Erika Alor	Danielle Royer, PhD	Emily DeBoer, MD	Emily Mastej, MS
Caitlynn Hudlow	Lisa Lee, PhD	Chelsea Lohman Bonfiglio, PhD, Danielle Royer, PhD	Zachary Throckmorton, PhD
Marie-France Izere	John Caldwell, PhD	Jill Kaar, PhD	Shannon Acker, MD
Maria Porpio	Ernesto Salcedo, PhD	Chelsea Lohman Bonfiglio, PhD	Kimi Kondo, DO
Tiajah Valerio	Danielle Royer, PhD	Jenny Zablah, MD	Natalie Soszyn, MD
Elizabeth Wigdahl	Caley Orr, PhD	Chelsea Lohman Bonfiglio, PhD	Debra Szuster, MS
Melissa Barella	Ernesto Salcedo, PhD	John Thompson, PhD	Alex Kaiser, PhD
Quinlan Cuddy	John Thompson, PhD	Allison Shapiro, PhD	Susan Johnson, PhD
Joseph Gilmore	Chelsea Lohman Bonfiglio, PhD	Gareth Morgan, MD	Nicholas Jacobson, MDesS
Ashlee Harry	Maureen Stabio, PhD	Traci Lyons, PhD	Lisa Lee, PhD
Aimee Kim	Caley Orr, PhD	Nicholas Jacobson, MDesS	Lorna Browne, MD
Ryan LaGreca	Chelsea Lohman Bonfiglio, PhD	David Howell, PhD	Maureen Stabio, PhD
Justin Schweigert	John Caldwell, PhD	Jenny Zablah, MD	Natalie Soszyn, MD
Katherine Spencer	Ernesto Salcedo, PhD	Allison Shapiro, PhD	Kristin Nadeau, MD
Kara Tripp	Caley Orr, PhD	Nicholas Jacobson, MDesS	Jason Yu, MD
Maxwell Walker	Ernesto Salcedo, PhD	Nicholas Jacobson, MDesS	Christodoulos Kaoutzanis, MD
Gabriel Yuen	Danielle Royer, PhD	Jenny Zablah, MD	Natalie Soszyn, MD

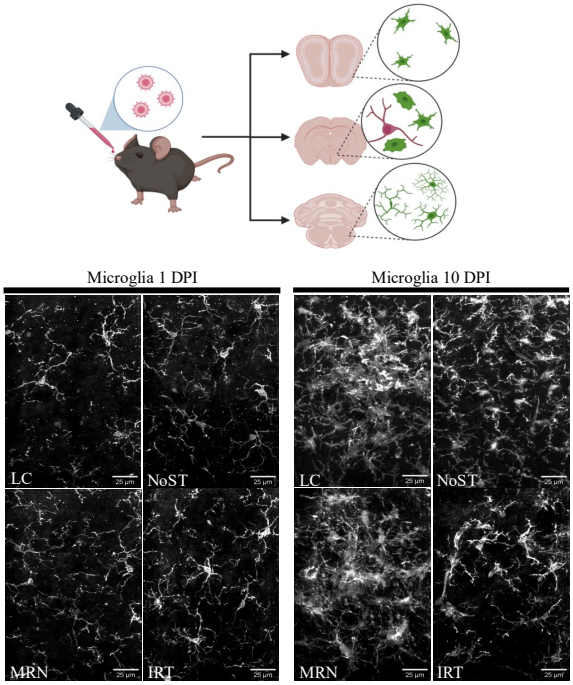
Session I: 9:00 AM – 10:30 AM

Poster #1 Katherine Colon-Reyes

Microglia Infiltration Within Distinct Brain Regions Across Acute HSV-1 Infection

Capstone Committee: Ernesto Salcedo, PhD (Chair), Christy Niemeyer PhD (Mentor), Maria Nagel, MD

ABSTRACT:



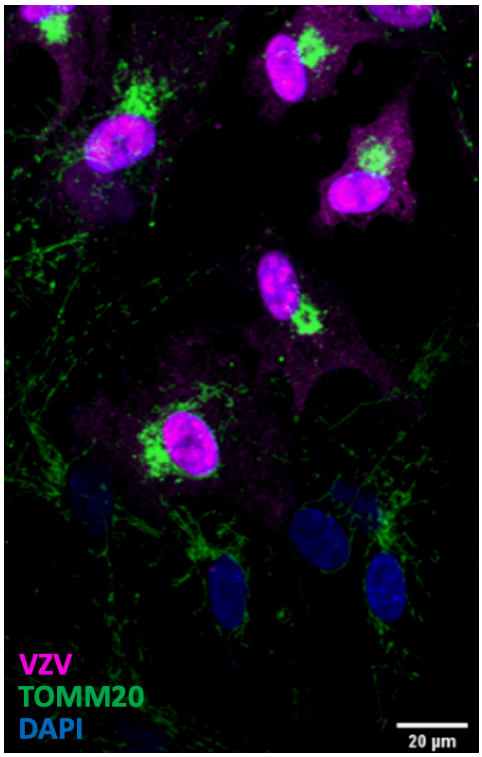
Herpes Simplex Virus type-1 (HSV-1) is a neurotropic alphaherpesvirus that has been shown to infiltrate the central nervous system and has been implicated in pathology associated with neurodegenerative diseases such as Alzheimer's Disease. Microglia, the primary immune cells within the brain, are important in the early antiviral response and clearance of HSV-1 infection. However, it is unclear how long neuroinflammation initiated by microglia remains in the brain throughout acute HSV-1 infection. Herein, we examine microglial infiltration and activation following intranasal HSV-1 infection using non-encephalitic mice models (C57/Bl6). We hypothesize that specific brain regions would be more vulnerable to HSV-1-induced neuroinflammation. We examined HSV-1 and microglia expression (IBA-1) in the coronal brain sections of mice at 1, 3, 7, 10, and 30 days post-infection (DPI). We found pronounced HSV-1 infections at 7 DPI in specific brain regions, including the subnuclei in the brainstem (i.e. locus coeruleus, raphe magnus, spinal trigeminal nucleus, etc.) and the hypothalamus (i.e. paraventricular nucleus, dorsomedial hypothalamus, lateral hypothalamus). We next assessed microglia morphological changes and found most regions infected with HSV-1 had a pronounced increase in activated microglia. We also found specific regions had sustained microglial activation even at 30 DPI. Together these data suggest certain brain regions may be more susceptible to HSV-1 infections and have prolonged neuroinflammation even after the virus has been cleared.

Poster #2 Michael Corigliano

Metabolic Dysfunction of Spinal Astrocytes Following Alphaherpesvirus Infection

Capstone Committee: Ernesto Salcedo, PhD (Chair), Niemeyer, Christy, PhD (Mentor), Andrew Bubak, PhD

ABSTRACT:



Alphaherpesviruses, like herpes simplex virus type 1 (HSV-1) and varicella-zoster virus (VZV), are ubiquitous, with large portions of the population having been infected and latent with one or both viruses. Beyond dermatomal lesions, alphaherpesvirus infection is associated with neurodegenerative diseases like Alzheimer's disease and Amyotrophic Lateral Sclerosis. Recent evidence suggests metabolic dysregulation plays a role in the progression of many neurodegenerative diseases. Interestingly, infection may be a catalyst for immunometabolic alteration, and alphaherpesviruses have been associated with cellular metabolic changes like mitochondrial aggregation and fragmentation. While the effects of alphaherpesvirus infection have been characterized in a variety of cell types, less is known about how primary human spinal astrocyte (qHA-sps) mitochondrial network structure is affected during acute HSV-1 or VZV infection. Given that astrocytes are preferentially infected during HSV-1 and VZV reactivation and are known to become dysfunctional in neurodegenerative disorders, we hypothesized mitochondrial network morphology would be altered in qHA-sps infected with either HSV-1 or VZV. To examine morphological changes in mitochondria, we infected qHA-sps with either HSV-1 (McKrae strain; 0.001 Multiplicity of infection) or VZV (DG strain, 50-70 PFU/cm^2) and harvested cells for immunofluorescence at 1 and 3 days post-infection, respectively. We co-immunolabeled mitochondria (TOMM20) and HSV-1/VZV antigen and assessed morphology in cells positive and negative for infection; we assessed mitochondrial network area and mitochondrial network branching complexity. We found that HSV-1 and VZV infections are associated with significant reductions in the mitochondrial network area and alterations in branching complexity in qHA-sps. Additionally, our results indicate a bystander effect, whereby cells negative for HSV-1 or VZV antigen but adjacent to positive cells exhibit reductions in mitochondrial network branching complexity. Taken together, mitochondrial network changes in qHA-sps during alphaherpesvirus infection may suggest long-term metabolic shifts in astrocytes reminiscent of neurodegenerative states.

Poster #3 Michael Ha

Using Patient Stem Cell-Derived Retinal Organoids to Investigate the Mechanisms of Retina Development and Degeneration in Down Syndrome

Capstone Committee: Maureen Stabio, PhD (Chair), Natalia Vergara, PhD (Mentor), Karen Cusato, PhD, PA-C

ABSTRACT:

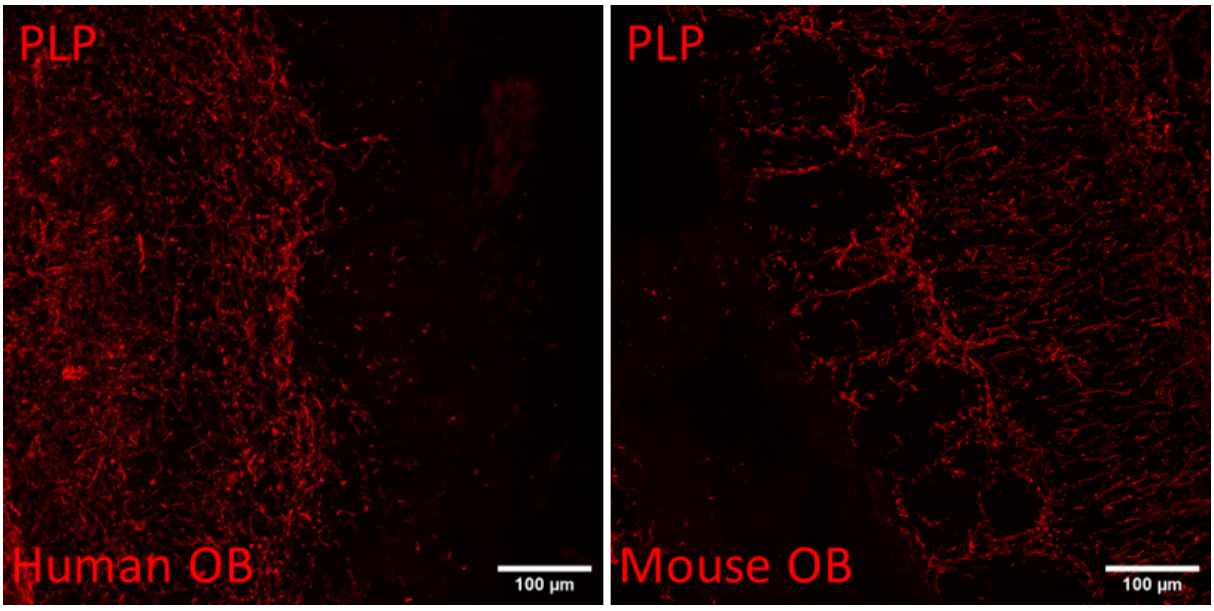
Down Syndrome (DS) is the most common genetic disorder, caused by a triplication of chromosome 21. DS is associated with numerous developmental problems, including several ophthalmic disorders. There is an increased retinal thickness observed in people with DS, largely attributed to the increased number of retinal ganglion cells. The developmental mechanisms behind this phenomenon remain unclear. Additionally, all individuals with DS develop Alzheimer's disease (AD) histopathology, including deposition of amyloid-β (Aβ) plaques and neurofibrillary tangles of abnormally phosphorylated Tau (pTau) proteins in the brain and retina, which could further exacerbate visual dysfunction in these patients. Unfortunately, current animal models are limited in their ability to recapitulate human pathophysiology. Here, we present the first human stem cell-derived model of the Down syndrome retina using patient-derived induced pluripotent stem cells. Our findings show that DS retinal organoids recapitulate key features of the native retina, including increased ganglion cell numbers and AD histopathology. We also used this model to investigate the developmental mechanisms underlying the increase in RGC numbers in DS. Our findings demonstrate the potential utility of this DS retinal organoid model for further developmental studies and drug screening applications.

Poster #4 Rourke Haas

Smells Like Trouble: Antibody Verification in the Olfactory Bulb

Capstone Committee: John Thompson, PhD (Chair), Diego Restrepo, PhD (Mentor), John Caldwell, PhD

ABSTRACT: The processing of olfactory information in the brain begins where olfactory sensory neurons (OSNs) synapse onto the glomeruli of the olfactory bulb (OB). Each individual OSN will express one out of many possible olfactory receptors (ORs). Mice express ~1,200 ORs and have roughly 2,400 glomeruli in their OB. Humans only express ~400 ORs but have ~5,500 glomeruli in their OB. This creates a 1:2 ratio of OR:Glomeruli in mice and a 1:10 ratio in humans. That stark difference raises the question of whether humans and mice process odor information in fundamentally different ways. The Restrepo Lab is working to establish the mapping between OSNs expressing specific ORs in the olfactory epithelium (OE) and glomeruli in the OB. This endeavor will require the generation of morphological and spatial transcriptomic data of the proximal olfactory system. This capstone project details the initial stages of this larger research project in the Restrepo Lab. Here, I report our ability to utilize a number of different antibodies to identify various structures and layers of the OB. An antibody specific to Myelin Proteolipid Protein (PLP) was used to identify the myelinated axons of mitral and tufted cells of the OB. TUJ1 was the antibody used to identify the axons of immature OSNs projecting to the OB. We attempted to use various antibodies to identify glomeruli in the human OB to mixed success. We were able to finally achieve glomerular staining in the human OB with antibodies specific to Synapsin2, a protein associated with synaptic vesicle release. The antibody troubleshooting performed in this project will be used to assist the mapping of the human olfactory connectome.

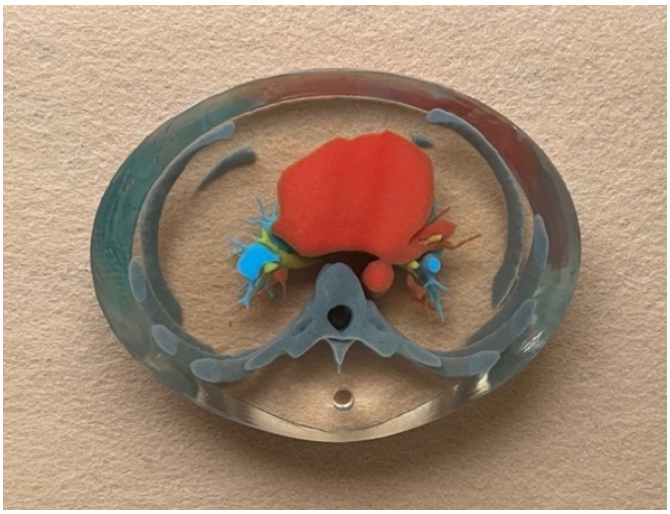


Poster #5 Erika Alor

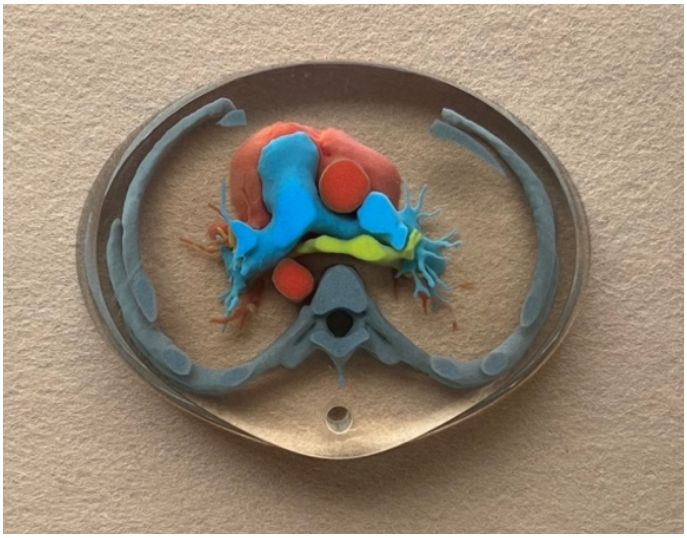
The Use of a 3D-Printed Model for the Interpretation of Chest CT Scans

Capstone Committee: Danielle Royer, PhD (Chair), Emily DeBoer, MD (Mentor), Emily Mastej, MS

ABSTRACT:



Three-dimensional (3D) printed models have served multiple purposes in many areas, such as academia and medicine. Its application has increased the performance of healthcare providers and students during medical simulations and procedures. Moreover, it has facilitated the visualization and comprehension of human anatomy compared to other tools available in two-dimensional (2D) or 3D virtual modalities. Therefore, a 3D-printed model of the thorax was created to determine its reliability in helping students and medical providers interpret the relationships between airways and blood vessels in chest CT scans. Physician Assistant (PA) students and pulmonary fellows participated in this study with an approved IRB protocol. A pre-test was provided to the participants a day before the scheduled meeting. On the day of the meeting, the participants used the 3D printed model along with a list of spatial relationships of the thorax, followed by a post-test. The average scores of five pulmonary fellows for the pre-test and post-test were 88% and 91%, respectively. Moreover, participants expressed feeling confident in identifying structures that surround the main bronchi after working with the 3D-printed model. Collecting and analyzing data from more participants will provide more insights to determine whether this 3D-printed model is useful when interpreting anatomical structures in cross-sectional views.

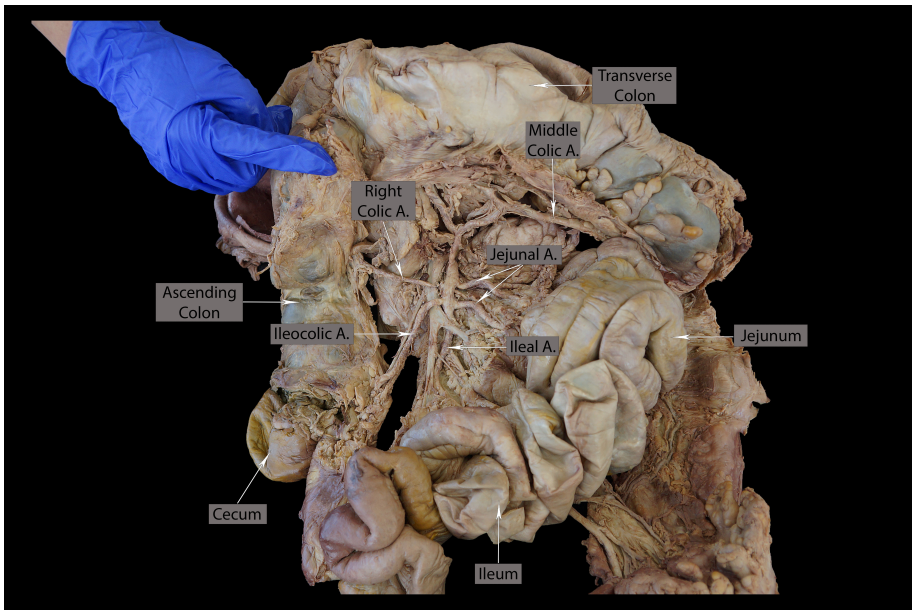


Poster #6 Caitlynn Hudlow

"This Atlas is the Reason I Passed My Lab Practical!": Evaluating the Use of Course-Tailored Review Resources in the Medical Gross Anatomy Flipped Classroom

Capstone Committee: Lisa Lee, PhD (Chair), Danielle Royer, PhD, Chelsea Lohman Bonfiglio, PhD (Co-Mentors), Zachary Throckmorton, PhD

ABSTRACT:



A trend in medical gross anatomy curricula revision is the purposeful shift to student-centered learning. Flipped classroom is one such pedagogy where foundation learning occurs prior to class in preparation for concept practice during class. However, the effects of using course-tailored review resources (CTRR) to supplement flipped classroom curricula is unknown. Currently, students are expected to continue concept review after class, but are often not supplied with additional course materials, leading to some students using external resources as course supplementation. These external resources are often not tailored directly to any specific medical gross anatomy course and the misalignment could be detrimental to medical students who struggle to self-identify anatomy knowledge gaps. This project aims to investigate how medical student learning outcomes and perceived self-confidence are impacted when CTRR are used as a supplement for a flipped classroom medical gross anatomy course. It is hypothesized that the addition of CTRR will increase the academic performance and perceived self-confidence of medical gross anatomy students. A convenience sample of 333 first year medical students in the university's medical school were recruited for participation. Subjects included 167 medical students from the 2022 medical school cohort, and 166 from the 2021 medical school cohort for the purpose of historical comparison. The 2022 medical school cohort was provided two types of CTRR during their gastrointestinal (GI) course: a GI Autopsy Cadaver Atlas and weekly activity modules. An external cohort analysis between the 2021 and 2022 GI lab practical scores

confirmed a significant improvement in GI anatomy academic performance. The median score for the 2021 cohort who completed the GI course without CTRR was 81 ± 13%, while the median score for the 2022 cohort was 87.5 ± 11.1%. However, an internal cohort analysis between the 2022 GI lab practical and the subsequent pulmonary cardiovascular (PCV) lab practical resulted in an insignificant improvement in GI anatomy academic performance. The median score of the PCV lab practical was 85 ± 10.2%. Of the 2022 cohort, 57 students completed a GI anatomy content quiz to investigate any effects on academic performance between the two types of CTRR. There was a significant improvement in performance when concepts were addressed in both CTRR types (median score of 85.7 ± 10.1%) as compared to when concepts were addressed only in the weekly activity modules (median score of 66.7 ± 9.96%). The 2022 cohort completed a student perception survey for the purpose of assessing self-perceived student confidence. In the survey, medical students reflected on how the CTRR provided students with clearer assessment expectations, assisted in anatomy knowledge gap identification, and connected GI anatomy with other courses. Results of this study suggest the benefit of CTRR should be considered when designing a flipped classroom medical gross anatomy curriculum as academic performance significantly increased historically and medical student reflections communicated an increased perceived sense of self-confidence. The insignificant academic performance increase between the 2022 lab practicals encourages future research determining if student academic skills are improving after using CTRR. Multiple types of CTRR are also more beneficial than a single CTRR as increased exposure to anatomical concepts leads to improved academic performance.

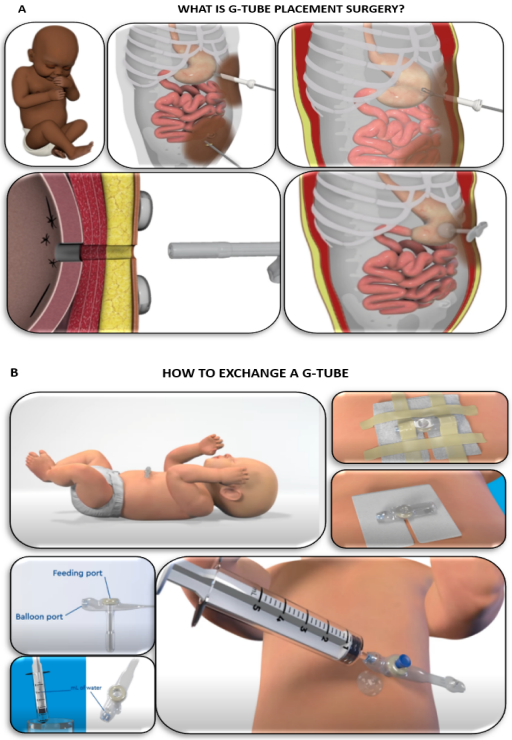
Poster #7 Marie-France Izere

It Takes Guts to Be Innovative! The G-Tube Health Literacy Project

Capstone Committee: John Caldwell, PhD (Chair), Jill Kaar, PhD (Mentor), Shannon Acker, MD

ABSTRACT:
The COVID-19 pandemic has increased the burden of staffing shortages, rising costs, physical and mental decline of healthcare providers and the communities they serve, and widened gaps in care for racially and culturally minoritized and low-income patient families. To enable access to quality, patient-driven healthcare for all communities, we are partnering with Inside Out Medicine (IOM) to create a digital, self-service health app to provide patient families a clinical task list, streamline flow of care to prepare them for surgery, and make educational content and resources more easily accessible. Implementation of this individualized "boarding pass" is being piloted for families of pediatric patients undergoing gastrostomy (g-)tube placement. Through our collaboration, we have created three educational videos about 1) how g-tube placement surgery is performed, 2) how to perform a g-tube exchange, and 3) complications associated with g-tubes, all of which accommodate varying levels of reading and health literacy. Next, we are creating a modular patient care workflow within the app that can be assigned to families by clinical staff as indicated. Parent preoperative anxiety and satisfaction, provider burden, and volume of unplanned ED visits and calls to report g-tube concerns will be compared between families receiving standard of care and families receiving additional education through the IOM app. We hypothesize that implementing a digital workflow of clinical and educational tasks will increase throughput for patients, including minoritized, low-income, and low health literacy patients, and reduce administrative burdens on providers. A current assessment of provider burden within g-tube care processes at baseline indicates a need for patient care streamlining. App piloting and pre-post analyses to test workflow and educational content effectiveness are ongoing. We believe that providing families access to an individualized (based on medical and socio-economic needs) patient boarding pass experience and insight across all steps of care (clinic, preoperative, postoperative, at home care) allows clinicians to see where families struggle or succeed to result in more effective and equitable care, and empowers parents to take charge of their child's healthcare.

EDUCATIONAL INTERVENTION



Poster #8 Maria Porpio

Vessels Less Traveled: Learning Upper Limb Arterial Anastomoses Through Gamification in Graduate Gross Anatomy

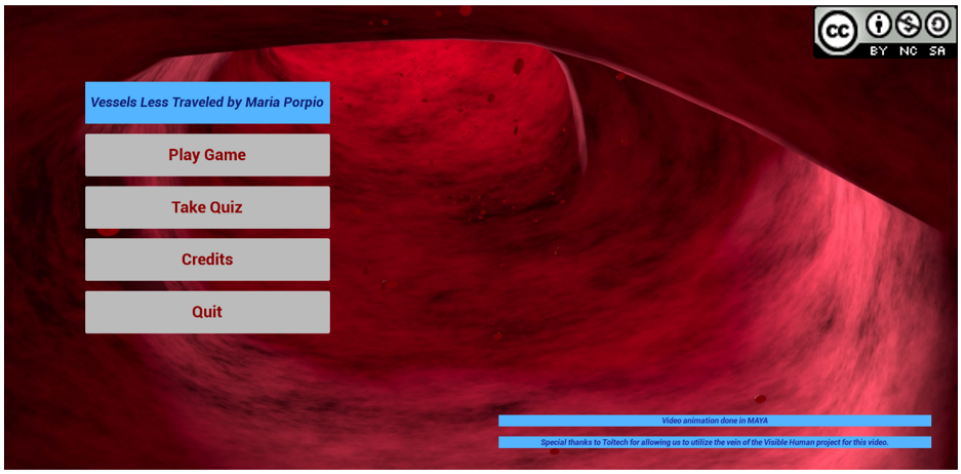
Capstone Committee: Ernesto Salcedo, PhD (Chair), Chelsea Lohman Bonfiglio, PhD (Mentor), Kimi Kondo, DO

ABSTRACT: The purpose of this study was to create a video game tool that helps graduate anatomy students learn anastomoses of the upper limb. Anastomoses can be difficult to learn due to the complex 3D anatomy involved. Gamification can benefit learning because of its capacity to motivate and engage learners. Although gamifying the circulatory system has been established for at high school and undergraduate level, learning blood flow with arterial anastomoses at a graduate level has not been investigated. This study was designed to assess the hypothesis that gamification will help graduate students retain information by learning through interaction and self-mastery. Moreover, this project sought to ascertain anatomy graduate students' perception on engagement and motivation while using gamification in learning the circulatory blood flow. We tested this hypothesis by creating the video game "Vessels Less Traveled." The game design includes an environment that consolidates the anatomical representation of the human heart and branching arteries. Gamification elements, such as achievement and rewards, storyline, time element, personalization, micro-interaction, and feedback, were incorporated as interactive strategies. Graduate students from the University of Colorado Modern Human Anatomy program participated in our study (n=17). Students were first given a pre-quiz, then used the video game to supplement their learning, and then took a post-quiz. Test scores significantly increased from pre- (M = 17.8, SD = 5.08) to post-quiz (M = 21.5, SD = 3.62), based on the paired T-test calculation ($t(16) = 3.52$, $p = .003$). On average, test scores increased 3.71 points after gamification, (95% CI: 1.47 to 5.94). Students were also given a survey with a combination of Likert scale, semantic, and open-ended questions to measure overall perceptions of the tool and a thematic analysis was performed. The post-game likert scale survey results indicate that there is a positive perception towards gamification. More than 60% of the participant population strongly agreed that playing the game led them to believe that video games are useful tools in learning. Furthermore, more than 60% claimed to be strong advocates for gamification in the learning environment. Sentiment analysis of the comments indicated 5 out of the 17 participants expressed positive sentiments in the comments section. 8 out of 17 had comments that were categorized as negative. The rest of the 4 participants were neutral. Further analysis was performed on the negative responses to extract valuable feedback and suggestions. Limitations of this study include small sample size, lack of a control group, and constraints in game content due to course sequencing and timing. Future studies should be conducted to increase sample size to achieve desired effect size, attempt to eliminate confounding variables, and further investigate direct benefits to

gamification by adding a control group. Suggestions for improving the game included expanding anastomoses pathways and building a map that could zoom in and out. Some participants who don't have access to Windows indicated a desire for the game to be played on Apple Mac computers.

Play on itch.io

Scan to visit game site.

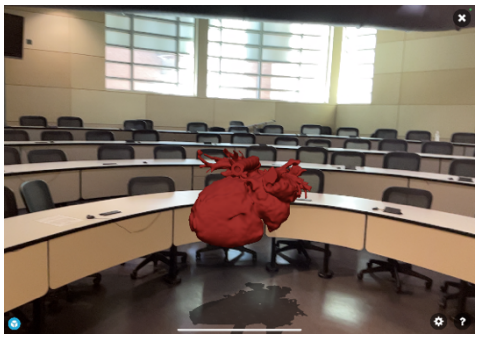


Poster #9 Tiajah Valerio

Putting the A.R. in Heart: Utilizing Augmented Reality in the Cardiac Catheterization Lab

Capstone Committee: Danielle Royer, PhD (Chair), Jenny Zablah, MD (Mentor), Natalie Soszyn, MD

ABSTRACT:



Patient education within medicine is critical for patient understanding and management of overall health. As medicine continues to evolve with the incorporation of technology, so should methods of delivery for patient education. 3D models have been utilized to effectively deliver education related to a patient's specific cardiac anatomy and has been proven to increase patient comprehension. Resources to produce 3D models for patient education may be costly and not feasible for all hospitals. Augmented reality (A.R.) applies virtual anatomy to the external environment and is a less costly option that integrates new uses of technology within the medical field. Limited studies have explored the effectiveness of A.R, however it is suggested A.R can increase retention and overall satisfaction with patient care. This study was designed to test the hypothesis that AR can be an effective method of delivery for patient education compared to other modeling techniques such as printed 3D models and 2D segmentations. Patients/caregivers (N=19) were provided surveys that assessed their preference for different imaging modalities used to deliver patient specific education. Each survey assessed general demographics, comfortability with technology, and current understanding of the patient's cardiac anatomy and clinical pathway. Following physician led explanations of the patient's cardiac anatomy using an imaging modality, the participants were asked to complete the related questions on the survey. 50% of participants reported feeling very comfortable, while 17% of participants felt extremely comfortable following explanations with 2D segmentations and A.R. 3D models provided a higher percentage, 28%, of patients who felt extremely comfortable with their patient education. Of the participants, 83% preferred the use of the 3D models for patient education. The other 17% of participants preferred 2D segmentations. 3D models appear to be the better method to deliver patient education, most participants preferred the ability to utilize tactile sensation while learning. Although A.R may not have been the preferred imaging modality, it is suggested to be useful to deliver patient education. A.R's free use would benefit many hospitals who do not have access to print costly 3D materials.

Poster #10 Elizabeth Wigdahl

Cadaveric Donor Care: Establishing a Protocol for Longitudinal Integrated Curricula in Anatomy Labs

Capstone Committee: Caley Orr, PhD (Chair), Chelsea Lohman Bonfiglio, PhD (Mentor), Debra Szuster, MS

ABSTRACT:
Cadaveric donor care protocols are valuable and critical to ensure the success of a gross anatomy laboratory environment. Many professional healthcare programs are transitioning to an integrated longitudinal curriculum and using prosected (pre-dissected) donors. With this change, new challenges have arisen with the need for prolonged use of donors throughout the academic year, which can compromise the physical integrity of the tissues. Scientific studies have explored embalming preservation methods, but limited research has been conducted on how to effectively manage the donor after it has been preserved. To help with the longevity and viability of the prosected donors, it is essential that an evidence-based approach to long-term donor care is employed. The goal of this project was to test different external covering materials to determine which combination would best prevent the prosected donors from drying out during their extended use. A pilot study was first conducted to identify two protocol groups for the primary study. A convenience sample of 16 donors in a medical school gross anatomy lab were randomly assigned into the two groups. Donors in Group A were regionally wrapped in five wet bath towels (100% cotton) and a clear plastic sheeting (4 mil), while donors in Group B were wrapped in one full-body size blanket (100% cotton) and white plastic sheeting (2 mil). Trained raters evaluated the dryness of anatomic structures including muscular, neural, and vascular tissue, in four regions (cubital fossa, thorax, face, thigh) using a weekly survey over an 11-week period. Donor care and maintenance was conducted consistently twice per week across both groups. Results revealed a significant difference ($p<0.001$) in dryness rating between different body regions. Post-hoc comparisons revealed the thoracic region was the driest region which is likely due to constant removal and poor coverage of the chest plate during lab. The cubital fossa was the least dry region which is likely due to retention of skin flaps with this particular dissection approach. There was no significant difference between protocol groups ($p=0.115$). Thus, donors are recommended to be covered with either a blanket or towel as the first covering layer (depending on lab preference and availability) and plastic as the second covering layer. Disseminating this knowledge of post-mortem donor care in anatomy education facilities will not only increase the viability of the donors but will also ultimately improve the future and success of gross anatomy education.

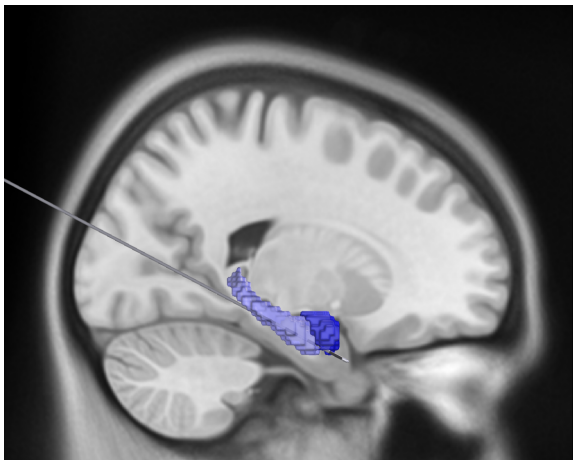
Session II: 10:00 AM –11:30 AM

Poster #11 Melissa Barella

Responsive Neurostimulation Implants Improved Outcomes in Patients with Drug- Resistant Mesial Temporal Lobe Epilepsy Regardless of Probe Proximity to Hippocampus or Amygdala

Capstone Committee: Ernesto Salcedo, PhD (Chair), John Thompson, PhD (Mentor), Alex Kaiser, PhD

ABSTRACT:



Objective: Evaluate the seizure-reduction response in patients with drug-resistant temporal epilepsy with respect to the anatomical placement of the brain-responsive neurostimulator (RNS System, NeuroPace) and its proximity to the hippocampus and amygdala.

Methods: Subjects with drug-resistant temporal epilepsy were treated with responsive neurostimulation (RNS) using a NeuroPace® system with 10mm spaced electrodes. Pre-operative T1-weighted MRI and post-operative CT data were coregistered and normalized in the program LeadDBS to map the probe to the anatomy. The hippocampus was then mapped using the Melbourne Subcortex Atlas 2020. Contact location and association to outcome were analyzed using a Fisher's Exact Test in R for four locations: right hippocampus, left hippocampus, right amygdala, left amygdala or outside all regions. Additionally, a Fisher's Exact Test was used to test the association between patient outcome and bilateral or unilateral probes. A test of equal or given proportions was used to generate an 80% confidence interval for patient outcome.

Results: Ten subjects with drug-resistant temporal epilepsy were included in this study: 10% had right sided probes, 40% had left sided probes, and 50% had both. No statistical significance was found (a=0.200) between patient outcome and contacts present or absent in any location tested. Additionally, there was no statistical significance in the association of

unilateral or bilateral probes in respect to patient outcome. Of all the patients in this study, 80% saw improvement (80% CI: [54.8,94.4]).

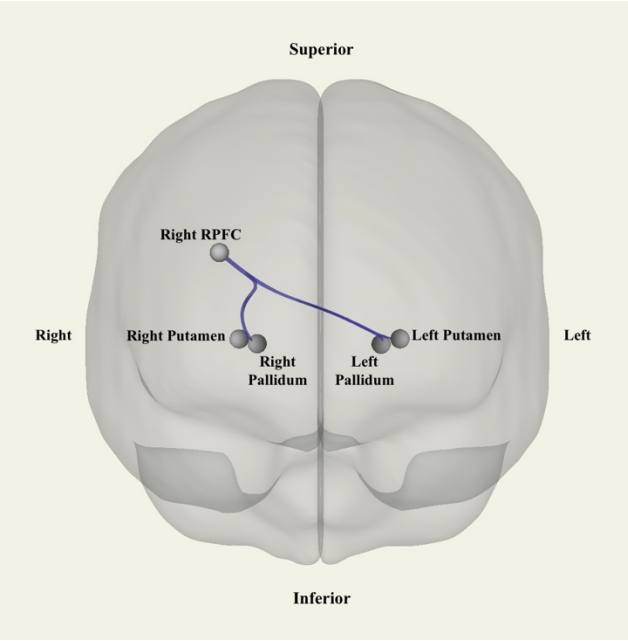
Discussion: Since there was no association between anatomic location and patient outcome, NeuroPace® probes can continue to have a variety of placement with no detriment to the improvement of patients with drug-resistant mesial temporal lobe epilepsy (MTLE). These procedures, therefore, will require less time consuming and expensive planning than Deep Brain Stimulation (DBS), while also having the luxury of recording brain frequencies to enhance our understanding of this condition. Future direction should be to look at the proximity of the probe contacts to the seizure focus (pathology) rather than the anatomy.

Poster #12 Quinlan Cuddy

Examining the Association Between Brain Connectivity and Satiety Responsiveness in Adolescents

Capstone Committee: John Thompson, PhD (Chair), Allison Shapiro, PhD (Mentor), Susan Johnson, PhD

ABSTRACT:



Dysregulated satiety responsiveness of key brain regions involved in appetite control is a likely contributor to disinhibited eating behavior (DEB), which can contribute to obesity development. However, in adolescence, when DEB is common and obesity prevalence is increasing, the brain mechanisms underlying satiety responsiveness are incompletely understood. As such, we examined the relationship of brain functional connectivity and satiety responsiveness in adolescents participating in the Food and Adolescent Brain Study. Adolescents (n=26; mean age [SD]=14.92 [1.46]; 46% female; 56% with obesity) completed fasting and immediately post-ingestion of 75 grams of glucose (Glucola) resting-state functional magnetic resonance imaging to derive measures of functional brain connectivity during fasting-induced hunger and glucose-stimulated satiety. At a separate visit, 4 constructs were used to quantify satiety responsiveness before (fasted; t0) and after a lunch meal (t1). Participants self-reported ratings of fullness, hunger, desire to eat, and the amount of food they felt they could eat at t0 and t1 using visual analog scales (0-100 mm). Percent change was derived as the difference between t1 and t0 ratings, divided by the t0 rating. A linear model was applied to examine the association between brain connectivity and percent change in ratings of satiety, adjusting for age, sex, and BMI. Family-wise error (FWE) correction was applied for multiple comparisons. Change in fullness, hunger, desire to eat, and the amount of food ratings from a hunger state to a satiated state was 65.8%, 76.2%, 85.4%, and 74.9%. Change in fullness ratings was significantly associated with weaker connectivity between the right rostral prefrontal cortex and bilateral pallidum and putamen (FWE $p<0.01$, for all respectively). The results suggest that as satiety increases, functional connectivity between the salience and reward networks decreases.

Poster #13 Joseph Gilmore

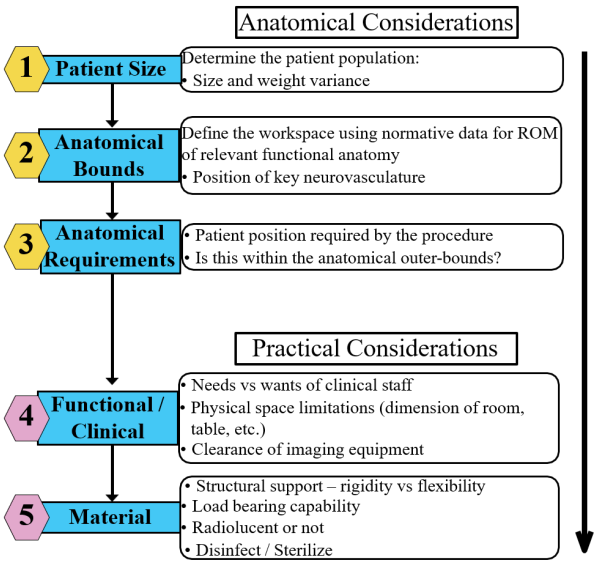
Clinical

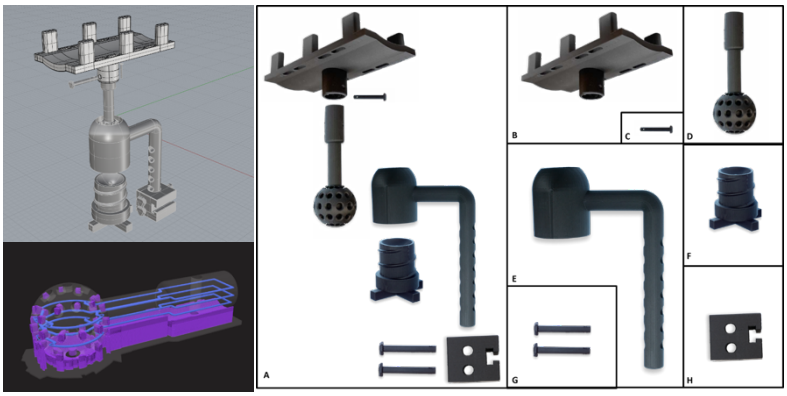
Design Informed by Anatomy – An Overhead Arm Support Apparatus for Use in Cardiac Catheterization Procedures

Capstone Committee: Chelsea Lohman Bonfiglio, PhD (Chair), Gareth Morgan, MD (Mentor), Nicholas Jacobson, MDesS

ABSTRACT:

An overhead position of the arm is needed for cardiac catheterizations; however, patients are subjected to possible perioperative nerve stretch injuries throughout the procedure. Further, no formal standardized overhead arm stabilization method exists. The purpose of this study is to create a template for optimizing device design by using anatomy to direct the creation of a patient positioning device – an arm support apparatus for future use in cardiac catheterizations. A design template *serially* considering the patient population, functional anatomical outer bounds, anatomical requirements of the clinical position, functional/clinical needs, and material requirements was created. This template was used to create an overhead arm support apparatus by using normative range of motion data of shoulder flexion and abduction; considering forearm pronation/supination; and discussing with medical personnel. A 3D model was created in a CAD software, exported into a slicing software, and printed on an FDM printer with a carbon-based filament. The final apparatus consists of five core pieces. 1. A curved arm board with lateral support posts and holes for straps. 2. A locking ball-and-socket post on which the arm board mounts and is secured. 3. A locking ball joint cap and vertical post with variable holes for height adjustment of the entire apparatus. 4. A threaded piece with a peg that locks the ball joint post in place. 5. A piece that affixes directly to the siderails of the procedure table through which the vertical post slides and locks. This workflow can be applied to design other patient positioning devices.



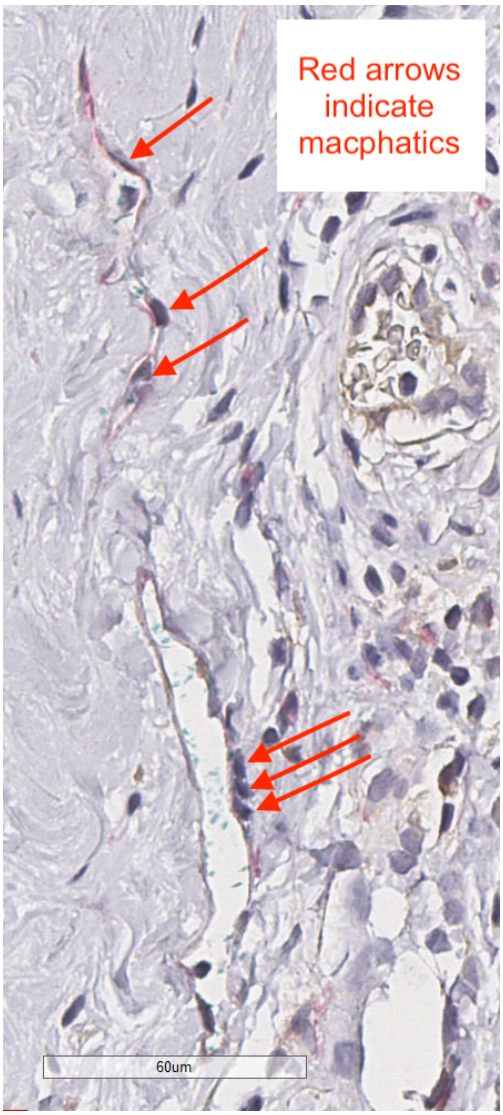


Poster #14 Ashlee Harry

Perivascular Macrophage and Macphatic Roles in Metastatic Migration of Breast Cancer

Capstone Committee: Maureen Stabio, PhD (Chair), Traci Lyons, PhD (Mentor), Lisa Lee, PhD

ABSTRACT:
Patients with postpartum breast cancer have the worst overall survival outcomes of young women's breast cancer due to metastatic disease. Mammary gland involution initiates the recruitment of macrophages and neo-lymphangiogenesis. Additionally, tumors positive for SEMA7A, a transmembrane protein, have been shown to have an increase in macrophage (POEMs) recruitment and lymphatic endothelial remodeling. These factors have been shown to be tumor promotional. It is thought that there are two mechanisms of macrophage mediated metastatic migration of tumor cells. Firstly, perivascular macrophages phagocytose and carry the tumor cells to the lymphatic vessel driving metastasis. Secondly, POEMs induce a remodeling of the lymphatic vessel wall allowing the macrophage to intravasate into the lymphatic epithelium thus becoming a macphatic. The macphatic renders the lymphatic epithelial wall vulnerable to the invasive tumor cells which will slip into the lymphatic lumen leading to metastasis (Fig 2). However, how these two mechanisms play a role in metastatic migration of tumor cells is not fully understood. Therefore, we hypothesize there will be a difference in nulliparous and postpartum lymphatic vessel density, perivascular macrophages (POEMs), and macphatics in the tumor microenvironment which allow tumor cells an opportunity for metastasis. Immunohistochemistry preparation of breast tissues comparing nulliparous and postpartum patient from the University of Colorado YWBC cohort will be used to test our hypothesis. We will analyze the histologic slides for lymphatic vessel density, perivascular macrophages (POEMs), and macphatics.



Poster #15 Aimee Kim

Liver Long and Prosper: How a 3D Liver Library Can Optimize MRI Imagining to Improve 3D Printed Models for Hepatic Pre-Surgical Planning

Capstone Committee: Caley Orr, PhD (Chair), Nicholas Jacobson, MDesS (Mentor), Lorna Browne, MD

ABSTRACT:

Introduction/Objective: Hepatic surgeries are complex due to extensive vascularization caused by intertwining of branches of the hepatic arteries, portal veins, and biliary tree throughout the organ. This can lead to complications such as excessive bleeding during surgery or hemorrhaging post-surgery, thus presurgical planning requires cross-sectional imaging from multidetector computed tomography (CT) or magnetic resonance imaging (MRI). However, 2D sectional images require surgeons to mentally reconstruct the organ, adding cognitive load. Tangible 3D printed models of livers decrease surgical time, inpatient costs, and minimizes risks for patients. We will create a 3D printed liver model which directly translates vasculature from an image for presurgical planning and intraoperative guidance. Creating a methodology to augment the 2D images can create better resolution 3D printed models which accurately show vascular branching. By increasing the efficiency of developing a 3D print liver model, the model can be regularly incorporated in surgical care plans for liver surgeries. Current methods of 3D printing use stereolithography (STL) file format requiring segmenting, editing, and co-registering structures prior to printing which is time-consuming and produces a crude representation of the structures. Bitmap printing, our novel method of printing, has been shown to produce more accurate models using less steps. However, bitmap printing requires a deeper understanding of source images, and few studies of 3D printed liver models are explicit in the settings of the source images used. Better imaging will improve voxel printing and provide a 3D model showing multigenerational branching that may give a better understanding of the patient-specific vasculature which will lead to reduced risk during surgery.

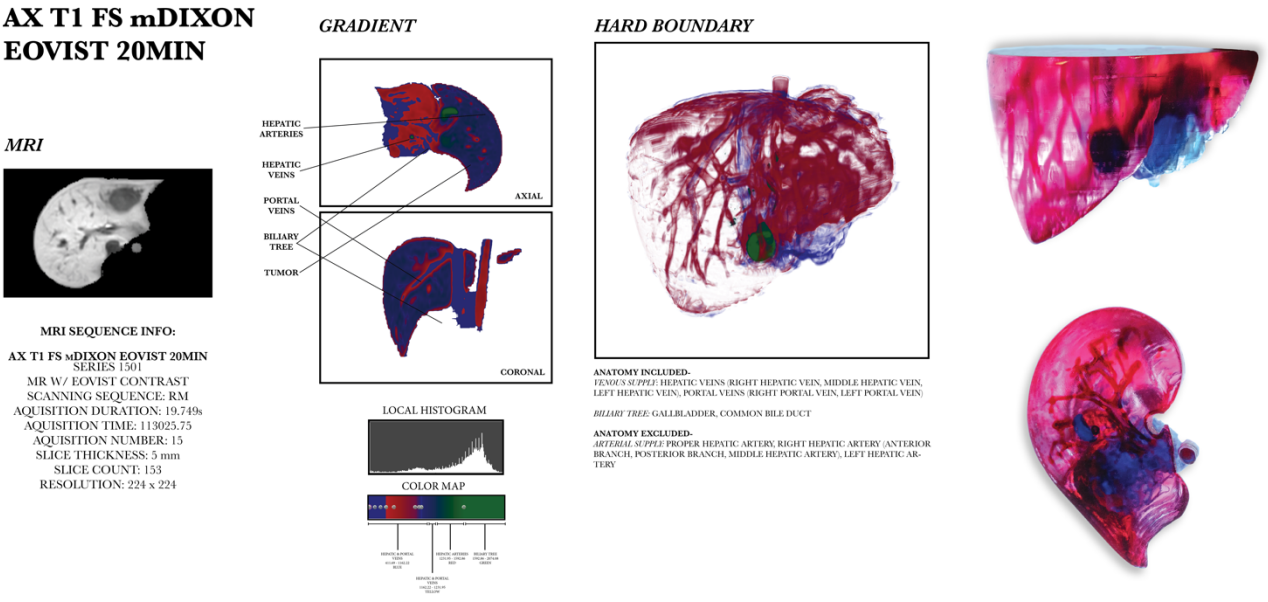
Methods: Anatomical structures are taken from several EOVIST triple-phase MRIs of the liver of a pediatric patient which will be edited individually and co-registered. Each scan varies in slice count, slice thickness, and resolution. Using the bitmap printing method, a colored histogram is applied directly to the voxelized volume created from the MRI image slices which will isolate the structures based on their intensity value. That stack of images will be fed to our patented software and printed on a multi-material polyjet printer.

Results: Using retrospective cases, several voxel-based liver models are printed using the methods above to understand differences in MRI image settings. All models will show

hepatic arteries in red, portal vein in blue, and biliary tree in green in clear parenchyma. These models will provide a visual comparison of results from different settings to determine the best representation of hepatic anatomy that can be produced via bitmap printing.

Conclusion: Optimizing the 2D images leads to a high resolution and anatomically accurate 3D model of a patient's liver via bitmap printing. This provides the ideal MRI settings to produce a 3D model for hepatic surgeries.

Significance/Implication: Bitmap printing reduces the barrier of incorporating 3D printing into surgical planning, thus potentially reducing surgical time, inpatient costs, and minimizing patient risk. By optimizing the 2D images, the benefits of bitmap printing can be amplified leading to higher resolution 3D printed models with more extensive branching. The completion of this study will allow for clinical trials using 3D printed models for hepatic surgeries.

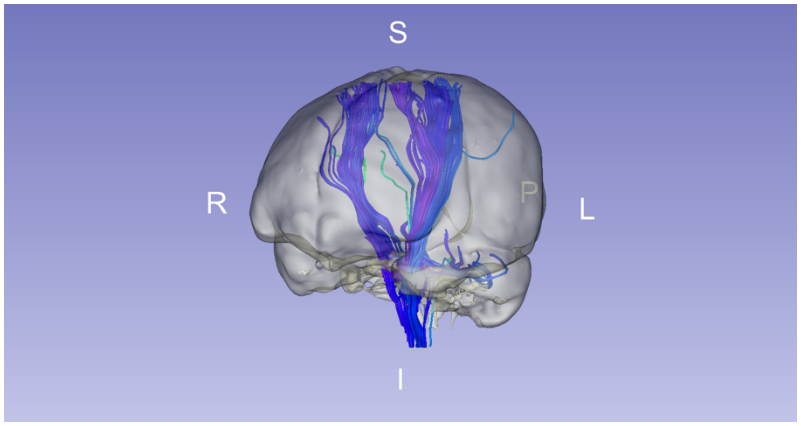


Poster #16 Ryan LaGreca

Translating Concussion Gait Evaluations to a Mobile Approach: Reliability and Test Environment Differences

Capstone Committee: Chelsea Lohman Bonfiglio, PhD (Chair), David Howell, PhD (Mentor), Maureen Stabio, PhD

ABSTRACT:



Purpose: To examine the reliability of an at-home gait assessment performed weekly via smartphone application, and to examine differences in gait performance compared to in-person assessment in a laboratory environment.

Methods: Participants underwent in-person gait assessment at two time points 8 weeks apart by completing a 20-meter self-paced walking task under single/dual-task conditions. Between visits, participants self-administered at-home gait assessments weekly (IMPROVE, Control One LLC). Gait assessment was conducted with a smartphone affixed to the lumbar spine (in-person) or placed in back pocket (at-home). The primary outcome for gait assessment was gait velocity (m/s). Reliability was evaluated using one-way ANOVA and intraclass correlation coefficient (ICC). Testing environments were compared using a paired samples t-test.

Results: Thirty-seven uninjured young adults (age=26.1±3.2 years; 70% female) were assessed in-person at two time points (mean: 55.3±2.7 days apart). Participants completed 82% and 75% of possible weekly single/dual-task gait assessments at-home, respectively. At-home single-task gait had good reliability (Figure 1A) and dual-task gait had excellent reliability (Figure 1B). Participants walked faster under in-person single-task (Figure 1C) and dual-task (Figure 1D) conditions compared to at-home assessments.

Conclusion: At-home gait assessments demonstrated high reliability across time during single/dual-task gait mobile testing in uninjured adults. Remote monitoring throughout recovery may be useful when patients do not have easy or regular access to medical care. Significantly faster laboratory gait velocity may be partially explained by the Hawthorne effect, as participants may have performed differently under observation. Clinicians should

consider these differences if comparing in-person and at-home performance during concussion recovery.

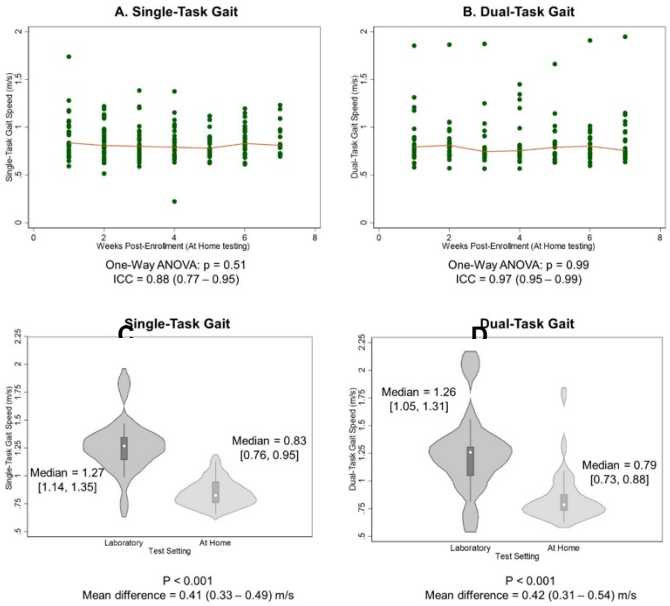


Figure 1. Reliability of (A) single-task and (B) dual-task gait velocity when completed by participants at-home across seven-weeks: individual dots represent measures obtained via the smartphone application, while the line represents the group median value at each weekly time point. Violin plots describing the performance on (C) single-task and (D) dual-task gait velocity when performed in the laboratory (averaged across both time points, administered by a trained member of the research team) versus when performed at home (averaged across all seven time points, self-administered). Data are presented as median (center dot) and interquartile range (box around the median, number in brackets), the shaded area represents the probability density of data at each level of the scale, smoothed using a kernel density estimator.

Poster #17 Justin Schweigert

Generation of Z-values of Pediatric Cardiopulmonary Structures

Capstone Committee: John Caldwell, PhD (Chair), Jenny Zablah, MD (Mentor), Natalie Soszyn, MD

ABSTRACT:

Due to the advancements in visual modalities it is becoming more commonplace to measure cardiopulmonary structures in vivo. Currently, there exists no normalized data derived from computerized tomography angiography (CTA) scans for right heart cardiac structures and accompanying pulmonary circulation for the normal pediatric population. In order to fill this deficiency, a pioneer study was conducted to find measurements for four cardiopulmonary measurements including: Apex of right ventricle (RV) to pulmonary valve (PV) (yellow line), PV to bifurcation of pulmonary trunk (PT) (orange line), PT bifurcation to the first branch of the right pulmonary artery (RPA) (red line), and PT to the first branch of the left pulmonary artery (LPA) (magenta line). To normalize the measurements two z-score calculations were carried out where method A used a derivation of the z-score as recommended by the world health organization (WHO) and method B used a formula that adjusted the z-score for BSA which is commonly done in echocardiography studies. Differences between the values produced via both methods suggested BSA may give unrealistic results for the length of the cardiopulmonary lengths. Thus, for applications of this study, values obtained via method A were suggested to be used to create a Z-table. Creation of this table would allow physicians to calculate the length of cardiopulmonary structures with just knowledge of the patient's BSA.

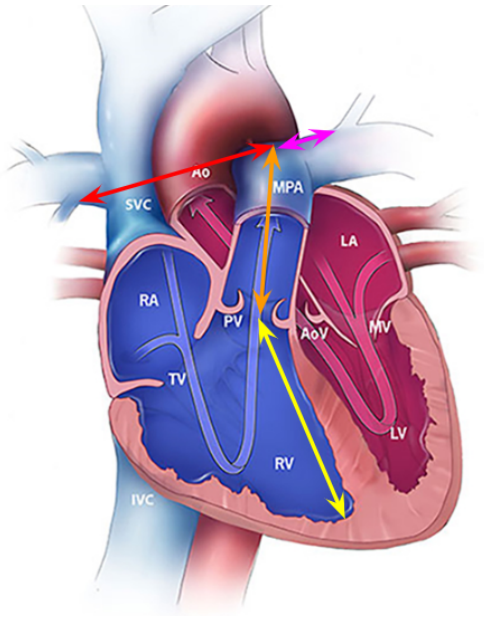


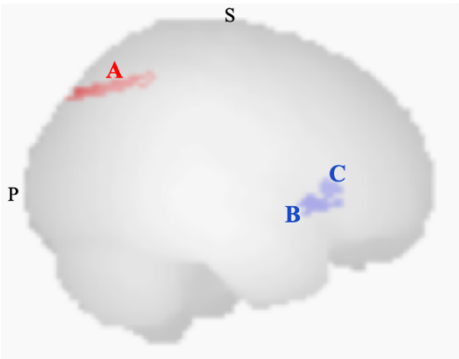
Image is open source and provided by Centers for Disease Control and Prevention, National Center on Birth Defects and Developmental Disabilities.

Poster #18 Katherine Spencer

A Little Something Sweet: Glucose-Stimulated GLP-1 Secretion and Functional Brain Connectivity in Adolescents

Capstone Committee: Ernesto Salcedo, PhD (Chair), Allison Shapiro, PhD (Mentor), Kristin Nadeau, MD

ABSTRACT:



Background Glucagon-like peptide 1 (GLP-1) is a critical hormone involved in brain satiety regulation via the hypothalamus. However, the relationship between GLP-1 secretion and hypothalamic functional connectivity with other brain satiety centers has not been fully investigated in adolescents. Thus, we examined these relationships in adolescents participating in the Food and the Adolescent Brain Study.

Methods Twenty-two adolescents ages 13-18 years (mean age [SD]=15[1.5] years) with normal weight (NW) or obesity, all with normoglycemia (HbA1c<5.7%), completed fasting and post-oral glucose (75 gram) resting-state functional magnetic resonance imaging scans to derive measures of functional brain connectivity. Blood samples were collected fasting (t0) and 30min after consumption of glucose (t30). Plasma GLP-1 was quantified via ELISA (Mercodia). A general linear model was used to test the association between change in GLP-1 secretion from t0 to t30 and functional connectivity in a seed-to-voxel analysis, setting the hypothalamus as the seed, and adjusting for age, sex, and BMI. Family wise error (FWE) correction was applied for multiple testing.

Results Twelve adolescents were NW (BMI 21.3[2.1] kg/m^2, 71% female) and 10 had obesity (BMI 33.7[2.3]). t0 GLP-1 was significantly higher in NW (4.5[2.1] vs. 3.9[2.0] pg/mL, p=0.003) but not significantly different at t30 (9.4[3.5] vs. 4.9[1.9]). Higher glucose-stimulated GLP-1 rise was associated with weaker connectivity between the hypothalamus, bilateral subcallosal cortex and cingulate gyrus, and left frontal orbital cortex, insular cortex, and frontal operculum cortex, but stronger connectivity between the hypothalamus, precuneus cortex and lateral occipital cortex (FWE p<0.05 for all, respectively).

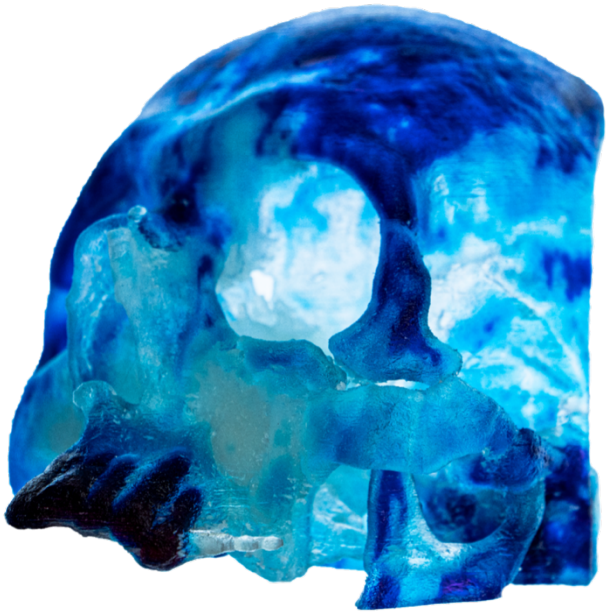
Conclusion Our results suggest that GLP-1 secretion is related to hypothalamic communication with brain regions involved with inhibition following food intake, reward related decision making, and food reward systems.

Poster #19 Kara Tripp

"Face Fixin'": Developing an Algorithm for Complex Zygoma Surgical Reconstruction Following Trauma

Capstone Committee: Caley Orr, PhD (Chair), Nicholas Jacobson, MDesS (Mentor), Jason Yu, MD

ABSTRACT:



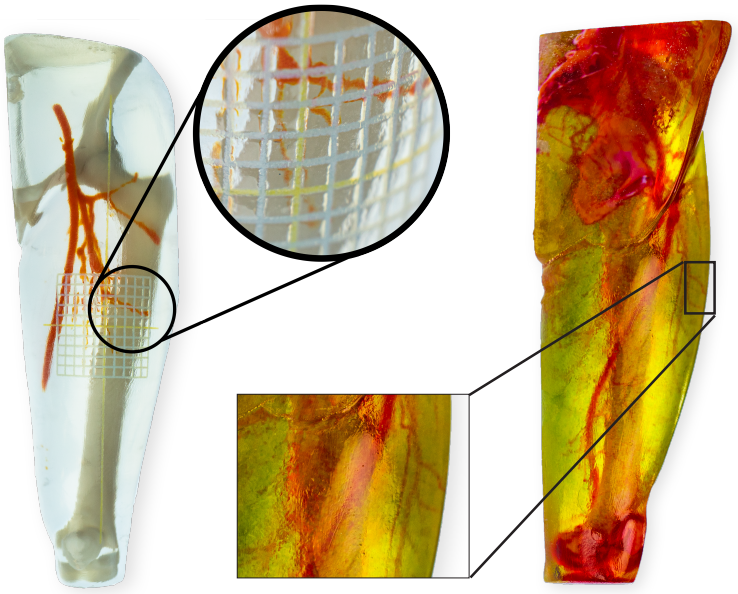
Technological advances can aid in the assessment, planning, and management of complex craniomaxillofacial injuries. At University of Colorado Hospital, the current approaches to planning zygoma fracture repair is limited to viewing virtual 3D models constructed from computed tomography (CT) scans. These only rotate in the x-plane and individual bones cannot be isolated from the full head CT. Viewing models without the ability to manipulate bone fragments to confirm proper repair sequences causes physicians to rely heavily on visuospatial abilities, which is individually variable. Errors in visuospatial planning can lead to errors in the proper sequence of fragment manipulation. These errors cause surgeons to re-manipulate fragments during the surgery, causing longer exposed patient surgical time, more anesthesia, and even wasted hardware. Further technological advances in pre-surgical planning using machine learning require rules to be set such as precise fragment labeling and manipulating fragments in the correct sequence based on current surgical approaches. The objective of this study is to develop and evaluate an algorithm for the proper sequence of fragment manipulation of the zygomatic bone in complex fractures following trauma.

Poster #20 Maxwell Walker

3-D Printing for Vessel Location in Anterolateral Thigh (ALT) Grafts During Phalloplasty Procedures

Capstone Committee: Ernesto Salcedo, PhD (Chair), Nicholas Jacobson, MDesS (Mentor), Christodoulos Kaoutzanis, MD

ABSTRACT:



Phalloplasty procedures are performed to construct a phallus in some gender affirming surgeries. In this study, we created a patient specific 3D printed model from segmented computed tomography (CT) scans to accurately represent the relevant vasculature necessary for anterolateral thigh (ALT) graft phalloplasty procedures. During this procedure, the most commonly sought-after vessels derive from the descending branch of the lateral circumflex femoral artery, typically found traveling within the intermuscular septum between the rectus femoris and vastus lateralis. Current methods attempt to locate the vasculature using 2D CT images and surface level landmarks to find a midpoint between the anterior superior iliac spine and the superolateral border of the patella. However, anatomical variation and the execution of a 2D Plan on a 3D structure can create obstacles for the surgical team. 3D printed anatomical models help improve spatial recognition and visualization of vasculature during procedures and can reduce surgical times and complications. Our method involved the creation of two types of 3D models. One model created from segmentations of the relevant anatomy and overlaid with a 1x1 cm grid placed at the currently used midpoint between the ASIS and Superolateral Patella, and another created by applying specific colors to the different intensity values on patient CT scans to highlight specific anatomical structures. The models were printed using a polyjet 3D printer and brought to the surgical team for evaluation of accuracy and potential use in surgical planning and execution.

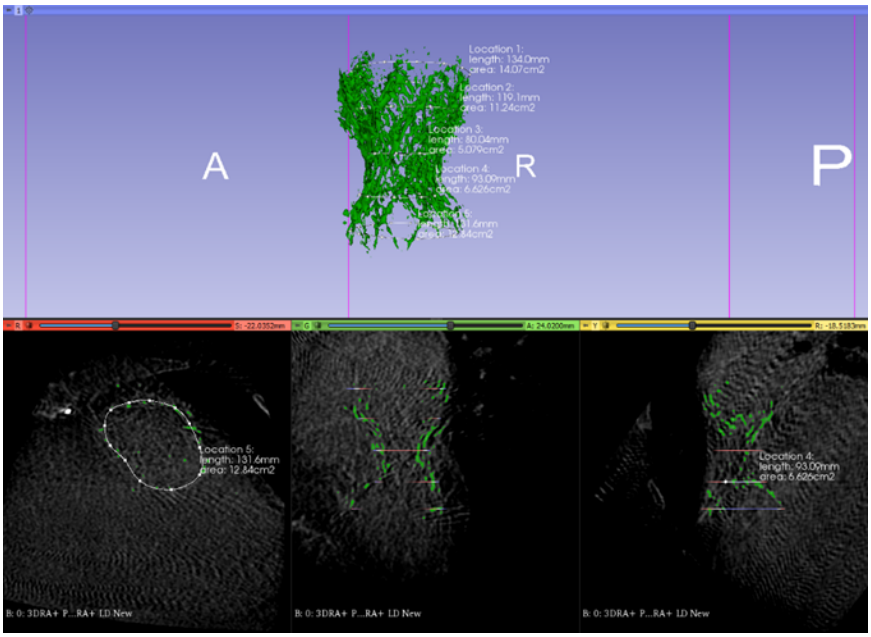
Poster #21 Gabriel Yuen

Clinical

An Examination of Physical Parameters Across Transcatheter Pulmonary Valve Systems and Potential Correlation with Post-Placement Arrhythmia in Congenital Heart Disease Patients

Capstone Committee: Danielle Royer, PhD (Chair), Jenny Zablah, MD (Mentor), Natalie Soszyn, MD

ABSTRACT:



Innovation in pulmonary valve replacement has resulted in a large impact on the variety of methods that interventional cardiologists have when addressing patients with right ventricular outflow tract (RVOT) defects. The Harmony Transcatheter Pulmonary Valve (TPV) was developed as a self-expanding device, requiring only one placement. Further innovation saw the development of the Alterra Adaptive Pre-stent, which was designed as a docking adaptor for the subsequent placement of an Edwards SAPIEN S3 valve. Both systems had received FDA approval, however following the placement of the Harmony TPV within the RVOT, cardiologists were finding significant numbers of patients had acquired arrhythmias that were not present prior to their procedure. The objective of this capstone project is to examine the post-placement physical characteristics (diameter between systole and diastole, perimeter, and cross-sectional area) of the Harmony TPV and Alterra-Sapien complex using 3DRA, fluoroscopy imaging, and CT to investigate potential correlations with greater arrhythmia risk. The comparison showed differences in several parameters at given locations that correlated with greater arrhythmia risk. The results also showed a greater arrhythmia risk for the Harmony TPV compared to the Alterra-Sapien Complex. Further results displayed significant differences in these characteristics between the two valve systems.