Modern Human Anatomy Program

UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS

Capstone Project Poster Presentations

Tuesday, April 26, 2016

2016 Modern Human Anatomy Program
Capstone Poster Presentations
Agenda

8:30 AM – 9:00 AM	Breakfast available, students arrive
9:00 AM	Welcome and overview, Dr. Mike Pascoe
9:00 AM – 10:00 AM	Presentation for even-numbered posters
10:00 AM – 11:00 AM	Presentations for odd-numbered posters
11:00 AM – 12:30 PM	Lunch
12:30 PM	Presentation of Outstanding Poster Award & Outstanding MSMHA Student Award

9:00 AM – 10:00 AM Poster Presenters

Capstone Poster Presenter	Poster #	Abstract Page #	Poster Title
Betts, Kourtney	2	5	Development of a modern, program specific dissection guide for the lower extremity
Brown, Timothy	4	7	Statistical Shape Modeling of Healthy Adult Human Lungs and Analysis of Shape Variation
Dolata, Jonathan	6	8	The Segmentation of Muscular Structures in the Forearm in 3D Ultrasound
Gaona, Lindsay	8	9	Quantitative Analysis of Sexual Dimorphism in the Human Nuchal Crest and Mastoid Process Using 3D Surface Scans
Hlavac, Becky	10	13	Building a Plastinated Brain Library for Neuroanatomy Education
Masawi, Fadzai	12	15	Changes in muscle quality and attenuation in HIV patients on randomized antiretroviral treatments
Richardson, Alisa	14	18	Development of a Silicone Laryngeal Prominence Cosmetic Enhancement for us in Female to Male Gender Reassignment
Simon, Violette	16	19	Standardized Sections, Autofluorescence, and Immunohistochemical Protocols to Differentiate the Globus Pallidus Interna in Post-mortem Human Brains From Surrounding Neural Tissue
Willbanks, Halie	18	21	Creating a teaching module for yoga instructors using cross-sections to describe ‘core muscle’ anatomy

10:00 AM – 11:00 AM Poster Presenters

Capstone Poster Presenter	Poster #	Abstract Page #	Poster Title
Blough, Kiara	1	6	Right-sided congenital diaphragmatic hernia: Pilot study to predict severity and survival through 3D visualization and novel prognostic indicators
Goldberg, Chelsea	5	10	Using Current Attitudes Towards Integration of Anatomical Variations in Medical Curriculum to Create an Interactive Self-Study Module
Haghgou, Sean	7	11	Retinal Orientation Determination via Internal and External Eye Structures
Hayes, Bethany	9	12	Reliability of grading radiographic knee osteoarthritis can be improved through use of a novel online training tutorial.
Johnson, Erika	11	14	MR Imaging Visualization of Brain Anatomy: Protocol Development for Scanning a Cadaver to Achieve an "in-Vivo" Appearance
Mastej, Emily	13	16	Automated airway scores of lung CT
Ramirez, Grisela	15	17	Degeneration of Retinal Ganglion Cells in a Mouse Model of Familial Dysautonomia
Todd, Kaitlyn	17	20	Developing a Protocol for Creating Anatomical Models from Visible Light Photographs of a Cryosectioned Cadaveric Specimen: Modeling the Bifurcate Ligament and its Attachments
Winter, McKenzie	19	22	Electrophysiological Topography of Subthalamic Nucleus in Parkinson’s Disease

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	Committee Member	Committee Member
Betts, Kourtney	**John Caldwell**	**Mike Pascoe**	**Nancey Johnson Bookstein**
Blough, Kiara	**John Caldwell**	**Norma Wagoner**	**Marianna Meyers**
Brown, Timothy	**John Caldwell**	**Stephen Humphries**	**Emily DeBoer**
Dolata, Jonathan	**Danielle Royer**	**Ernie Salcedo**	**Richard Weir**
Gaona, Lindsay	**Danielle Royer**	**Caley Orr**	**Laura Saba**
Goldberg, Chelsea	**Danielle Royer**	**Jennifer Stratford**	**Mike Carry**
Haghgou, Sean	**Maureen Stabio**	**Ernie Salcedo**	**Joe Brzezinski**
Hayes, Bethany	**Vic Spitzer**	**Ernie Salcedo**	**Jennifer Stevens-Lapsley**
Hlavac, Becky	**Maureen Stabio**	**Ernie Salcedo**	**Nancey Johnson Bookstein**
Johnson, Erika	**Norma Wagoner**	**Ann Scherzinger**	**Mark Brown**
Masawi, Fadzai	**Ernie Salcedo**	**Ann Scherzinger**	**Kristine Erlandson**
Mastej, Emily	**Claude Selitrennikoff**	**Stephen Humphries**	**Emily DeBoer**
Ramirez, Grisela	**Maureen Stabio**	**Vic Spitzer**	**Steve Britt**
Richardson, Alisa	**Ernie Salcedo**	**Norma Wagoner**	**Matthew Clary**
Simon, Violette	**Norma Wagoner**	**John Thompson**	**Diego Restrepo**
Todd, Kaitlyn	**Vic Spitzer**	**Caley Orr**	**J. John Cohen**
Willbanks, Halie	**Norma Wagoner**	**Vic Spitzer**	**Nancey Johnson Bookstein**
Winter, McKenzie	**John Caldwell**	**John Thompson**	**Aviva Abosch**

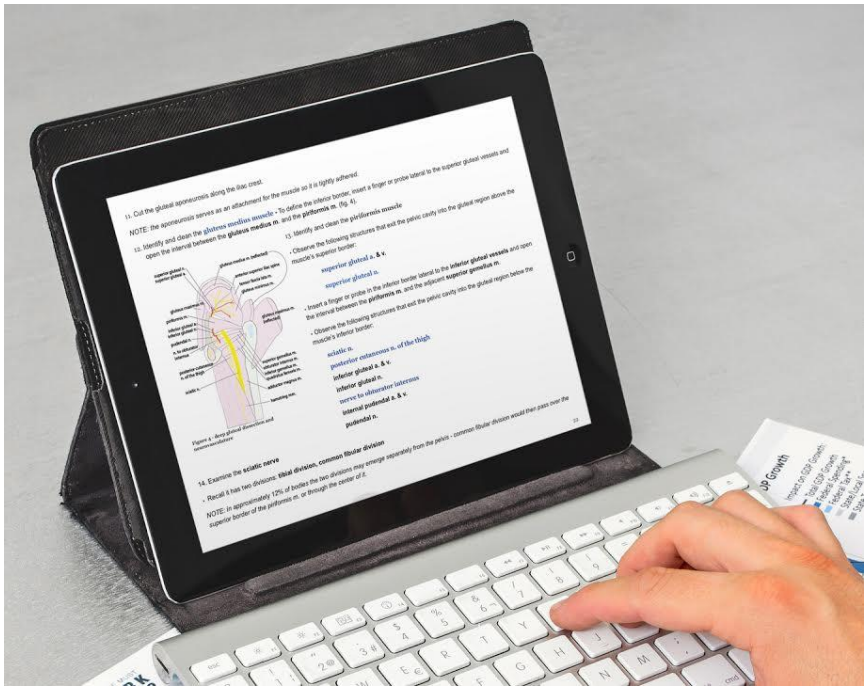
**Capstone mentors noted in red*

Kourtney Betts **Poster #2**

Development of a modern, program specific dissection guide for the lower extremity

Capstone Committee: John Caldwell (chair), Mike Pascoe (mentor), Nancey Johnson Bookstein

ABSTRACT:
Gross anatomy and its associated lab are a key foundation of Physical Therapy (PT) curricula. The primary form of instruction in cadaver lab is a dissection guide. Therefore, it is important for the guide to be clear and user friendly. There is a greater movement in dissection labs to adopt digital dissection guides. Currently, the PT program at the University of Colorado Anschutz Medical Campus uses a printed dissection guide, Grant's Dissector. Both PT faculty and students have expressed dissatisfaction with Grant's Dissector. The objective of this project was to create a modern dissection guide tailored to the specific content of the PT gross anatomy course. Notes on how to improve lab instructions were taken during the PT anatomy course in the summer of 2015. From those notes, dissection instructions were written for two regions of the lower extremity. The new guide was created using iBooks Author, with the addition of multimedia components created using various technologies. Due to time constraints of the project, the new guide was not systematically tested by PT during the gross anatomy course (summer 2016). However, a survey on PT student opinions demonstrated strong agreement on the high quality of the guide (= 4.62 across seven items, 5-point Likert scale; 5, strongly agree). These results demonstrate that incorporation of digital, multimedia content combined with program specific anatomy content yielded a guide favorably viewed by PT students. Further study is warranted comparing the effectiveness of this innovative guide on PT student performance in cadaver lab.



Kiara Blough **Poster #1**

Right-sided congenital diaphragmatic hernia: Pilot study to predict severity and survival through 3D visualization and novel prognostic indicators

Capstone Committee: John Caldwell (chair), Marianna Meyers (mentor), Norma Wagoner

ABSTRACT:
Right-sided congenital diaphragmatic hernia (CDH) is a muscular defect that is often diagnosed in utero. CDH has low incidence but high morbidity and mortality for fetuses and infants. One purpose of this pilot project was to improve the ability to predict survival and severity of cases in order to decrease morbidity and mortality. We did this in two ways: first by scoring a comprehensive prognostic index (CPI) and comparing it with survival, and second by developing two novel prognostic indicators and assessing their ability to predict survival. The second purpose was to create 3D models from 2D fetal MRI datasets. These 3D models will guide patient education and counseling, helping the mother to make more informed decisions regarding their care. This pilot study suggests that a CPI score of ≥5 may correlate with survival and that reduced herniated liver volume may be associated with increased survival. Furthermore, we successfully created 3D models from the 2D MRI datasets. These models provide an effective way to visualize the fetal anatomy and demonstrate the severity of individual cases. They are useful tools that can aid patient counseling.

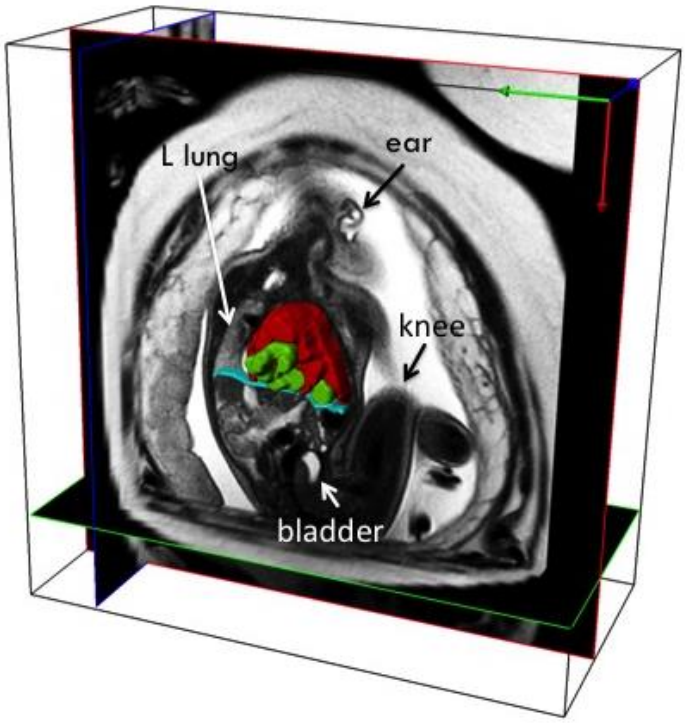


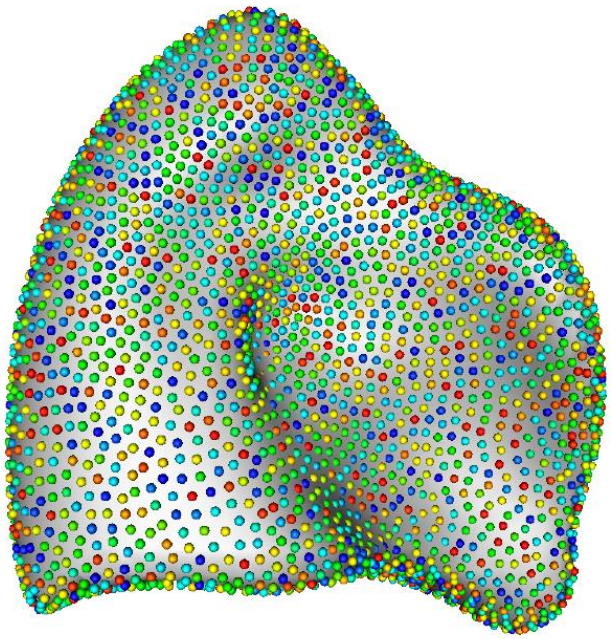
Figure:
T2 SSH (single shot echo) MRI (oblique view) of a 33-week fetus with right-sided congenital diaphragmatic hernia with an overlaid 3D model. The 3D model represents the herniated liver (red) and small intestine (green) located in the thoracic cavity, superior to the herniated diaphragm (blue). This model was constructed in the ScanIP software environment (Simpleware Ltd. Exeter, UK).

Timothy Browne **Poster #4**

Statistical Shape Modeling of Healthy Adult Human Lungs and Analysis of Shape Variation

Capstone Committee: John Caldwell (chair), Emily DeBoer (co-mentor), Stephen Humphries (co-mentor)

ABSTRACT:
Purpose: Prior studies suggest significant variability in lung shape, but identifying the shape variation quantitatively is challenging due to their complex three-dimensional shape. Statistical shape modeling (SSM) makes it possible to convert complex 3D models into a manageable number of shape parameters. The purpose of this study is to identify the shape themes of healthy adult lungs and compare the variation in those themes to body size and lung function measures. **Methods:** 442 lung models were used from inspiratory (INSP) and expiratory (EXP) CT segmentation from 221 healthy individuals. Point to point correspondence, a critical part of SSM, was determined using automated processes of particle splitting and optimization. The point distribution models were used in principal components analysis (PCA) to elucidate the modes of variation most common in a population. Univariate regression of lung shape parameters with pulmonary function test outcomes and patient biometrics were also examined. **Results:** Principal components (PCs) that captured a large percent of the overall variation correlated with measures of body size and PCs that correlated with lung function captured a smaller amount of the overall variation. PCs that captured a large percent of overall variation also showed statistically significant categorical difference depending on if they were INSP or EXP scans. **Conclusions:** SSM can be used effectively for quantitative analysis of lung shape within a population. This study may provide a comparison of the PCs for healthy lungs to those of a disease population in future studies. An average lung model may also be useful for improving automatic lung segmentation on CT.



Jonathan Dolata **Poster #6**

The Segmentation of Muscular Structures in the Forearm in 3D Ultrasound

Capstone Committee: Danielle Royer (chair), Richard Weir (mentor), Ernesto Salcedo

ABSTRACT:
Recent advancements in ultrasound technology have resulted in the capability to capture three-dimensional (3D) datasets. 3D Ultrasound images are increasingly available, but their full potential in imaging and modeling internal anatomical structures remains to be fully explored. The objective of this project was to determine the feasibility of creating three-dimensional (3D) models of muscles in the forearm using 3D ultrasound imaging. As current ultrasound scanning technology only allows for scanning and recording of small anatomical areas, multiple 3D models were developed, aligned, and combined post-hoc into a single larger model. The results of this study indicate that the generation of a scanning protocol to generate 3D models from ultrasound is feasible for individual scans, but that the alignment of multiple models into a larger unified model of muscular structures proved to be difficult and required software and equipment that may not be readily available on the clinical floor. Thus, while current ultrasound technology may have high enough resolution to visualize and segment small sections of muscular structures, the utility of this method is limited by the difficulty in merging smaller models into larger renderings of anatomical structures.

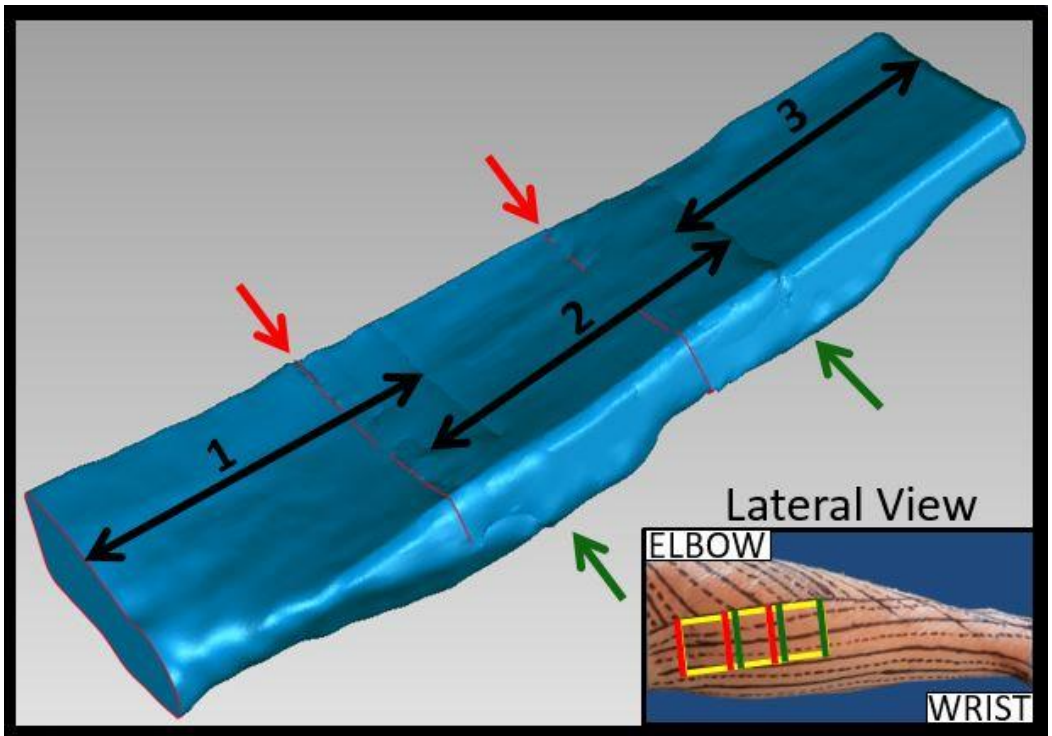


Figure 1: Three combined model segments. Lateral portion of brachioradialis distal to elbow. (Red - Proximal scan border. Green-Distal scan border)

Lindsay Gaona **Poster #8**

Quantitative Analysis of Sexual Dimorphism in the Human Nuchal Crest and Mastoid Process Using 3D Surface Scans

Capstone Committee: Danielle Royer (mentor & chair), Caley Orr, Laura Saba

ABSTRACT:
Established qualitative scoring guidelines identify the mastoid process, supraorbital margin, brow ridge, and the nuchal crest as standard features of human crania that exhibit differences between sexes. Currently, these sexually dimorphic traits are visually assessed due to a lack of quantitative methods. The overall goal is to establish a quantitative, reliable approach for sex determination of human crania using 3D models generated from laser surface scans. This study focuses on two well defined sexually dimorphic cranial features, the mastoid process and nuchal crest. Volumetric analysis of the mastoid process will follow the methods used in Wilkinson's analysis of Medieval Nubian individuals (Wilkinson, 2015). Analysis of the nuchal crest will utilize a similar volumetric ratio methodology. There are three specific aims of this project: 1) validate the Wilkinson method for determining sex from mastoid process, 2) develop similar method using the nuchal crest, and 3) combine information from mastoid process and nuchal crest to develop a multivariate approach to determine sex.

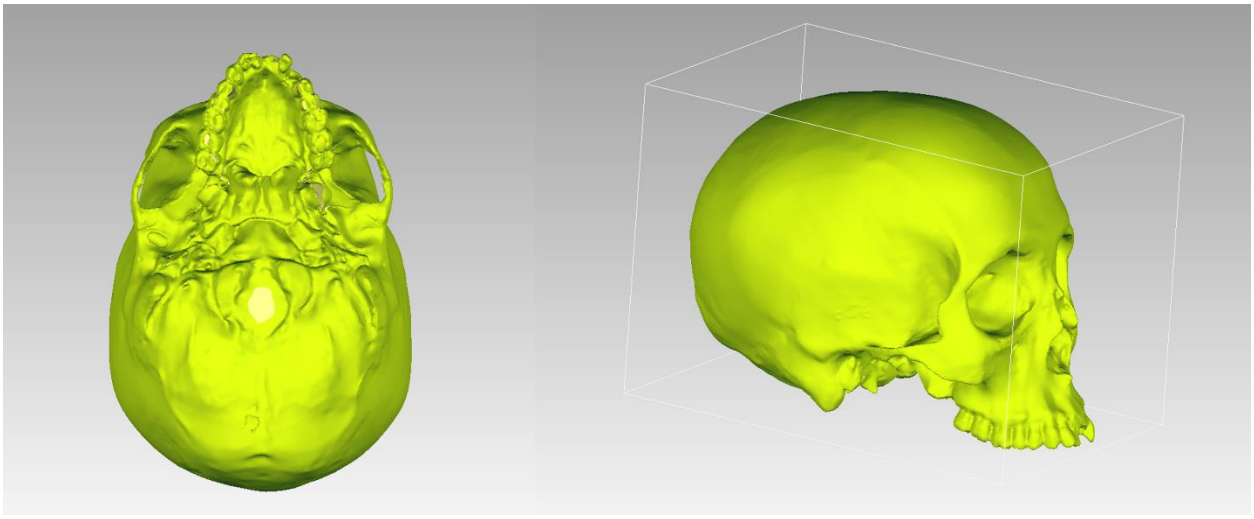


Figure: This fully rendered 3D model is a digital copy of the scanned cranium and is used for quantitative analysis of sexually dimorphic cranial features, posteroinferior and anterolateral views shown here.

Chelsea Goldberg **Poster #5**

Using Current Attitudes Towards Integration of Anatomical Variations in Medical Curriculum to Create an Interactive Self-Study Module

Capstone Committee: Danielle Royer (chair & mentor), Mike Carry, Jennifer Stratford

ABSTRACT:
The goal was to determine the current inclusion and attitudes of anatomical variations in USA medical education, and use these findings to create a new teaching tool. Using Qualtrics, we surveyed and received responses from 22% of allopathic medical anatomy course directors. Respondents agreed that variations in curricula are valuable and they ranked the relationship variation category as the most important to teach. Highest rated specific variations in categories diverge from what is being included in medical curricula. An interactive brachial plexus variation self-study module was created to supplement anatomy education and we surveyed current anatomy students with a pre-test before any classroom exposure to brachial plexus content both in the course and module. After exposure, students took a post-test where we split respondents into module users and non-module users. In the survey, Likert scale statements reflected 3 themes: confidence to recognize variations, variations' place in education, and opinions towards variations. Overall, students saw high value in variations for medical education and there was a trend toward higher mean ratings for module users, although the differences were generally not statistically significant. Next, students were asked 20 multiple-choice questions in 2 categories: general variation knowledge and specific variations in the brachial plexus. The percentage of correct responses mostly improved from pre to post-test, and in select questions students who used the module had higher percent correct responses in the post-test. This study showed that both faculty and students value the inclusion of variations in gross anatomy, and that it is feasible and effective to teach targeted variations through an interactive module.

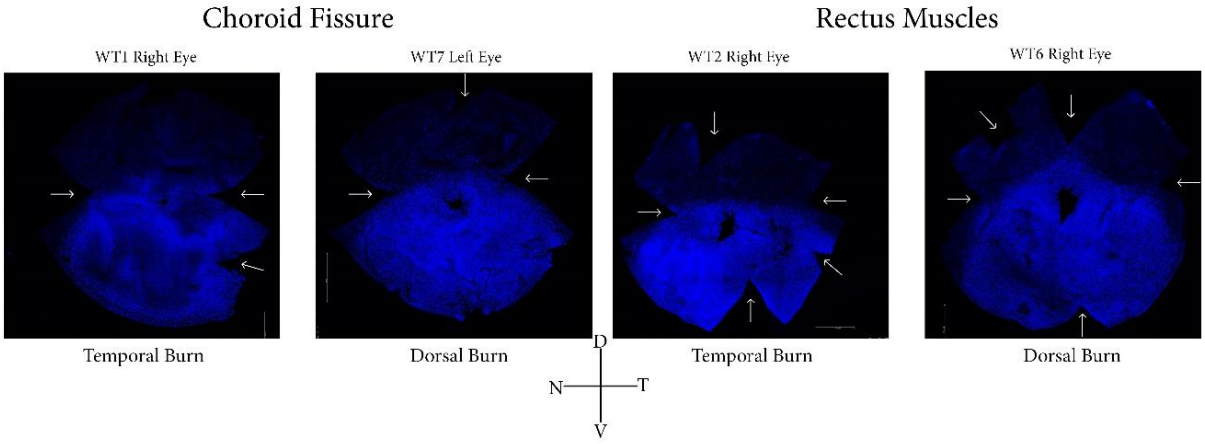
Figure: Various scenes from an interactive self-study module that focuses on relationships within the brachial plexus for students to use as a supplemental educational tool in a gross anatomy course.

Sean Haghgou **Poster #7**

Retinal Orientation Determination via Internal and External Eye Structures

Capstone Committee: Maureen Stabio (chair & mentor), Joe Brzezinski, Ernesto Salcedo

ABSTRACT:
There are currently multiple ways of orienting the eye by using external and internal landmarks pertaining to the retina. Because of the variability in giving orientation, labs studying similar cell types and trying to show where these populations can be found have come to find differing results. A better way of relating landmarks giving orientation to the retina needs to be established to populate areas of the retina with specific cells. By making cuts at various structures in the retina and using immunohistochemistry and confocal microscopy, conclusive relations can be drawn. The Retistruct software can reconstruct the retinas that were flat-mounted and put them in a polar plot for angle measurements. It was found that the choroid fissure, medial and lateral rectus, and opsin gradient all lie in a similar fashion on the retina and can be used to give orientation in a medial and lateral manner. It was also shown that the superior and inferior rectus muscles split the eye down the vertical plane. A polar plot showing the average angles of the external landmarks give a map of the retina and show how these individual features relate to one another. This plot may be used by other studies to help place populations of cells identified in specific areas while maintaining relations to other landmarks not taken into account.

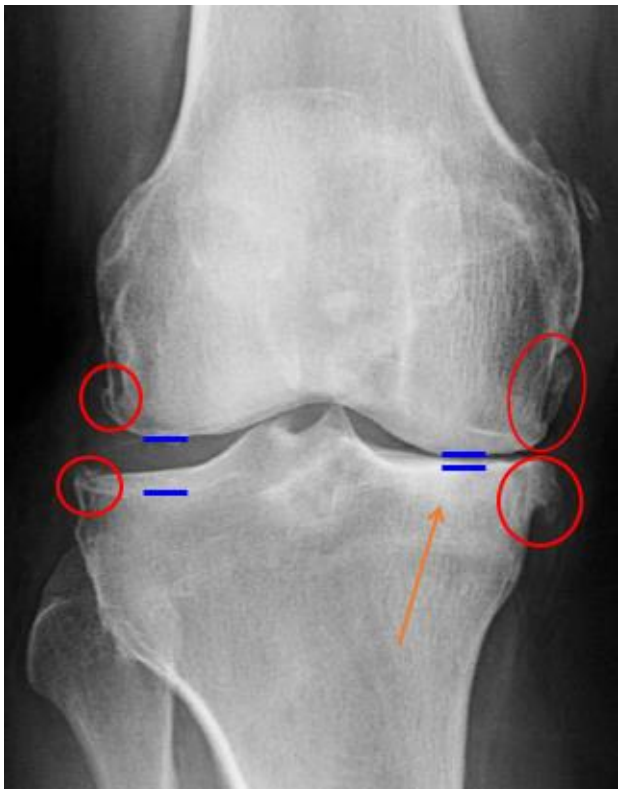


Bethany Hayes **Poster #9**

Reliability of grading radiographic knee osteoarthritis can be improved through use of a novel online training tutorial.

Capstone Committee: Vic Spitzer (chair), Jennifer Stevens-Lapsley (mentor), Ernesto Salcedo

ABSTRACT:
Knee osteoarthritis (OA) is a degenerative form of arthritis typically seen in older adults. It is typified by pain and impaired function associated with cartilage degeneration and skeletal changes. Using radiography, these changes can be examined by the semi-quantitative grading scale known as the Kellgren-Lawrence (KL) scale. Currently, no standard training exists for KL grading, which may explain the poor reliability of this tool in research. Therefore, the objectives of this project were to 1) develop a training tutorial for KL grading of knee OA in an e-learning authoring tool, Articulate Presenter, and 2) test reliability of KL grading. Forty-seven graduate students were randomized into an experimental group and a control group, each taking the same assessment upon completion of the training tutorial. Five experts participated in the assessment to obtain baseline reliability as the industry standard. Weighted kappa statistics (κw) for inter- and intra-rater reliability were calculated for each group. Results show that intra-rater reliability of KL grading in the experimental group was almost perfect (κw =0.85), compared to substantial intra-rater reliability (κw =0.69) in the control group. Experts had almost perfect intra-rater reliability (κw = 0.90). Inter-rater reliability was substantial in the experimental group (κw =0.82), compared to substantial in the control group (κw =0.70). Inter-rater reliability for expert group was almost perfect (κw = 0.81). This study suggests that utilization of a training tutorial for the KL grading scale may improve reliability among graders, and therefore, may improve the consistency of OA severity assessments in research settings.



Rebecca Hlavac Poster #10

Building a Plastinated Brain Library for Neuroanatomy Education

Capstone Committee: Maureen Stabio (chair & mentor), Nancey Johnson Bookstein, Ernesto Salcedo

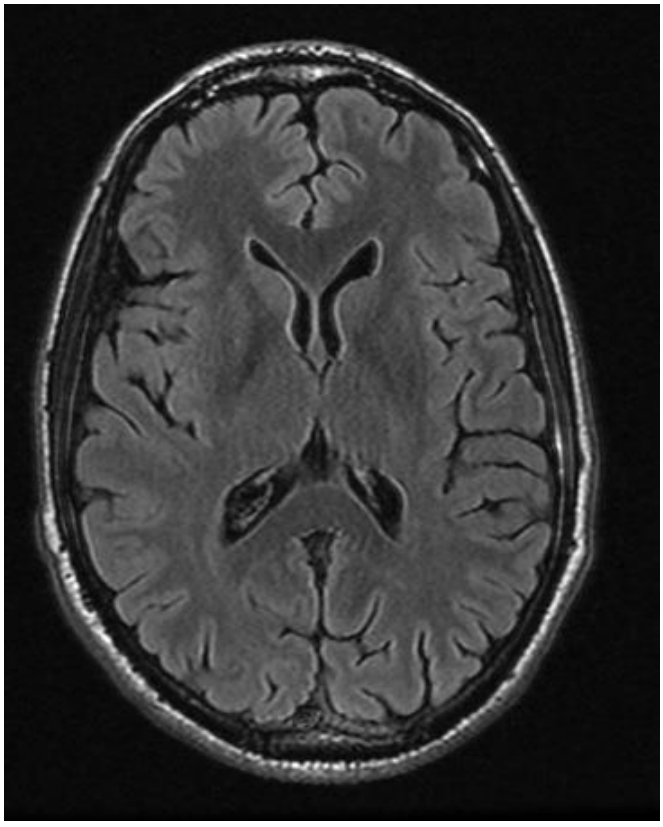
ABSTRACT:
Due to time limitations and lack of available tissue, neuroanatomy courses typically do not offer students the opportunity to perform advanced nervous system dissections. This often results in limited hands-on classroom/laboratory resources to explore the human brain. Brains preserved by plastination provide an alternative solution. Plastinated brains are dehydrated and impregnated with polymers; thus, they are dry, durable, safe, easy to manipulate and anatomically precise. However, few studies demonstrate their use in neuroanatomy education. Furthermore, instructional resources for how to perform and plastinate such dissections are scarce. In particular, there are no instructions in the anatomical literature for performing a full central nervous system (CNS) extraction. The goal of this project was to develop, and to determine the best approaches for development of, a collection of plastinated brain dissections. Cadavers and brain tissue were acquired from the Colorado State Anatomical Board and the pathology department of the University of Colorado Hospital. Three CNS extractions were performed; various tools and approaches were compared and dissection techniques refined, which resulted in a 50% reduction in the total dissection time required. Plastination methods were determined at training workshops at the University of Toledo Plastination Center. A dissection manual, instructional video and keyed CNS atlas were crafted. Two CNS dissections, one whole brain, three sliced brains, one brain with a basilar aneurysm, and one spinal cord were plastinated. Future work will evaluate students' views of the usefulness of plastinated tissue in the classroom, as well as its impact on student learning of neuroanatomy.

Erika Johnson Poster #11

MR Imaging Visualization of Brain Anatomy: Protocol Development for Scanning a Cadaver to Achieve an "in-Vivo" Appearance

Capstone Committee: Norma Wagoner (chair), Ann Scherzinger (mentor), Mark Brown

ABSTRACT:
The use of radiologic imaging to assist with cadaver dissection has a great deal to offer contemporary gross anatomy students. MRI is the optimal imaging technique to display brain anatomy, where many imaging protocols are available to selectively enhance the image contrast between structures. Anatomical tissues exhibit different imaging signal intensities in MRI scans, based on the density, mobility and chemical environment of the protons they contain as water or fat. In cadavers, these properties are affected by temperature and fixation state. Thus the contrast between, or visibility of, anatomic structures is significantly modified when cadavers are imaged with "in-vivo" protocols. The goal is to determine the optimal acquisition parameters to provide an "in-vivo" contrast appearance of fresh and embalmed cadaver brains using three standard brain imaging MRI sequences. Initial images were obtained on three cadavers (two fresh, one fixed), using "in vivo" acquisition parameters to determine the modifications in contrast for five brain structures: CSF, cortical white matter, cortical grey matter, thalamus and basal ganglia. Equations describing MRI contrast, coupled with expected tissue property changes with temperature and fixation were used to predict modified imaging parameters. Three cadavers (two fresh, one fixed) were then imaged with modified protocols and contrast once again compared to the "in vivo" case. Modifications were successful in establishing "in vivo" like contrast for structures, although not necessarily for all structures in the same image.



Fadzai Masawi Poster #12

Changes in muscle quality and attenuation in HIV patients on randomized antiretroviral treatments

Capstone Committee: Ernesto Salcedo (chair), Kristine Erlandson (mentor), Ann Scherzinger

ABSTRACT:
Physical function impairment and metabolic dysfunction occur commonly among HIV-infected compared to HIV-uninfected adults (Ali, et al.). Antiretroviral therapy (ART) initiation is associated with gain in both total body fat and lean body mass among HIV-infected adults, but little is known about the effects of ART and weight gain on the quality of the muscle (i.e., fat infiltration). We hypothesized that antiretroviral therapy (ART) initiation would be associated with greater fatty infiltration (lower attenuation measured by CT Hounsfield units, HU) after 96 weeks of therapy, in HIV+ patients and thus may be a mechanism underlying physical function impairment and metabolic dysfunction. L4-L5 single-slice CT scans at baseline and week 96 among HIV-infected participants initiating ART were analyzed for psoas muscle attenuation ; Differences in CT density (by HU) between adipose tissue and muscle estimated the amount of fat present in muscle, with lower HU indicating fat and higher HU indicating muscle. Regression models used to determine associations between baseline psoas measures and covariates of interest. Our results showed older age, female sex, and Hispanic ethnicity, but not HIV disease severity (CD4 count), to be significant predictors of psoas muscle area and intramuscular/intermuscular density prior to ART initiation. Although not statistically significant, ART initiation was associated with a trend towards increased psoas muscle mass. Greater fatty infiltration among the White race with ART suggests that this population may be at increased risk of metabolic and physical function impairment compared to the Black race. Physical function measures in future research could confirm these findings.

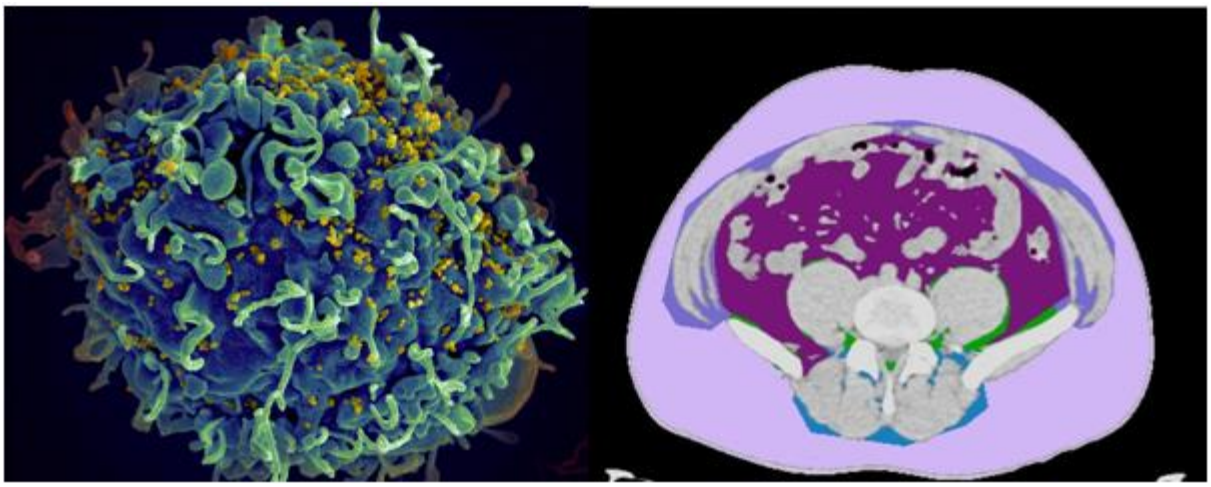


Figure: (Left) Human CD4+ T cell under attack by HIV. (Right) CT scan observing muscle quality over time after antiretroviral therapy (ART)

Emily Mastej **Poster #13**

Automated airway scores of lung CT

Capstone Committee: Claude Selitrennikoff (chair), Stephen Humphries (mentor), Emily DeBoer

ABSTRACT:
Background: Airway count, a quantitative measure scored by calculating the number of visible airways on each slice of a chest CT, correlates with the presence and magnitude of numerous lung diseases. Current methods for locating airways require an expert human reader to analyze the chest CT. While effective, manual scoring has shown to be time consuming and limited to expertise. This project addresses the need for an automated image analysis program to predict airway count of a patient.
Methods: An automated image analysis program was developed using the random forest classifier. This program created an automatic airway index (AAI) for a cohort of 20 cystic fibrosis patients and 20 disease control patients.
Results: The automated airway indexes were significantly higher in patients with cystic fibrosis than in disease control patients ($p < 0.00001$). Among patients with cystic fibrosis, there was a strong positive correlation between the AAI and the Brody bronchiectasis score by two expert human raters ($r = 0.71$, p-value = 0.0004; $r = 0.66$, p-value = 0.00007).
Conclusion: Automated airway index correlates positively with cystic fibrosis. Automated airway counting programs appear to be a useful alternative to manual scoring of airway count and could be beneficial in long-term clinical trials.

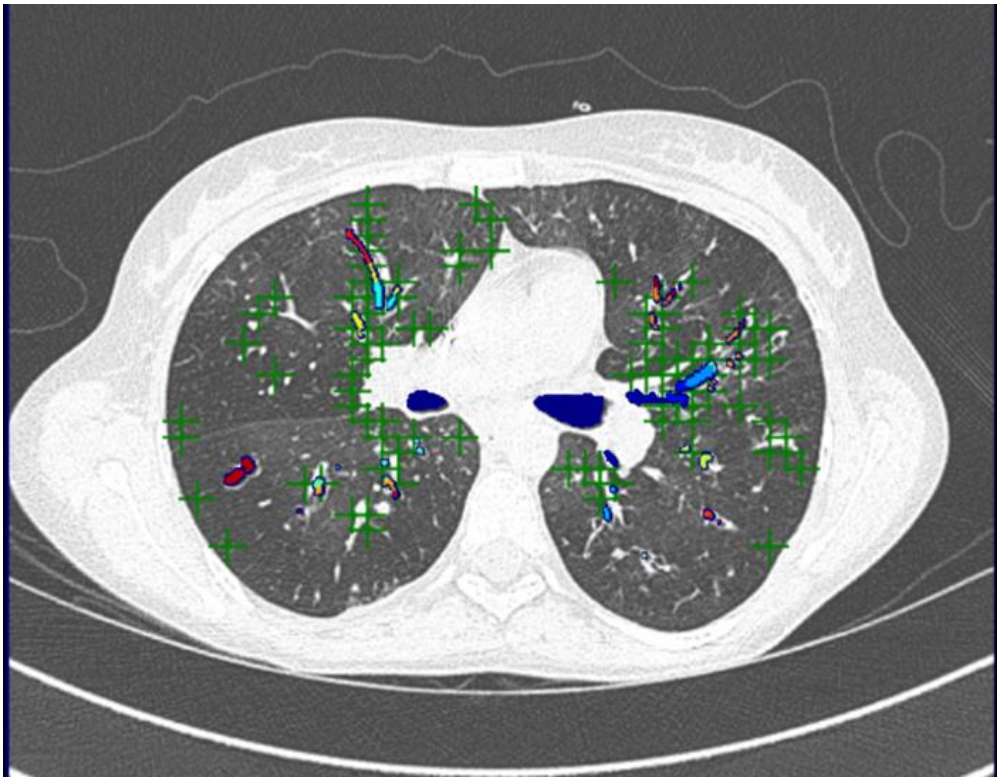


Figure: The colored segments within the lung tissue are airways that had been identified before this study. The green crosses are areas where the automated program created in this study predicted airways.

Grisela Ramirez **Poster #15**

Degeneration of Retinal Ganglion Cells in a Mouse Model of Familial Dysautonomia

Capstone Committee: Maureen Stabio (chair & mentor), Steve Britt, Vic Spitzer

ABSTRACT:
Familial Dysautonomia (FD) is a degenerative developmental neuropathy affecting the sensory and autonomic nervous system due to a mutation encoding for the gene inhibitor of kappa B kinase complex-associated protein (Ikbkap). FD has no cure and leads to major neuropathies, one of the most debilitating of which is progressive blindness. The neurobiology underlying FD blindness is not understood; however, degeneration of the retinal ganglion cell (RGC) layer has been suggested. The goal of this project was to determine the specific cell types that degenerate in a mouse model of FD in which the Ikbkap gene is deleted.

Tα1-Cre+ IKBKAP CKO mice and their healthy littermates were donated by Montana State University. Retinas were dissected and immunostained with markers for RGCs, intrinsically photosensitive melanopsin-containing retinal ganglion cells (ipRGCs) and alpha RGCs. Cell counts were compared in dorsal, ventral, nasal and temporal quadrants in mutant and wildtype retinas at both 6 and 9 months of age.

Significant reductions of RGCs were observed in the dorsal and temporal quadrants of 6-month mutant retinas and in large areas of the 9-month mutant retinas. Interestingly, IpRGCs at 6- and 9-month mice did not show significant reduction. Alpha RGCs increased in mutants at 6- but not 9-months of age.

In summary, our mouse model demonstrates a slow progressive reduction of RGCs similar to FD patients, and suggests that ipRGCs may be resistant to neuronal degeneration. This model may be useful to determine

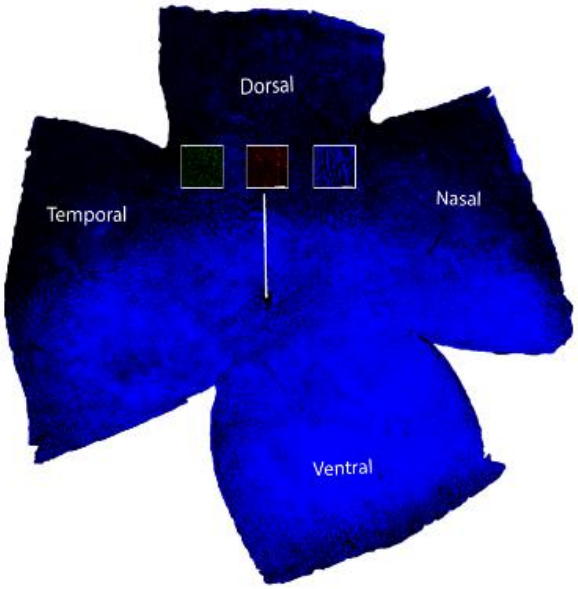


Figure: Retina of a 9 month FD mouse model assessed for all retinal ganglion cells (stained green with white outlined box) 1 millimeter away from the optic nerve head. Intrinsically photosensitive melanopsin containing retinal ganglion cells (stained red with white outline box) and alpha retinal ganglion cells (stained blue with white outline box) were examined as well in all four quadrants of the retina. Short wavelength sensitive opsin gradient (stained blue) was used to determine orientation of the retina. Scale bar 1mm.

Alisa Richardson **Poster #14**

Development of a Silicone Laryngeal Prominence Cosmetic Enhancement for us in Female to Male Gender Reassignment

Capstone Committee: Ernesto Salcedo (chair & mentor), Matthew Clary, Norma Wagoner

ABSTRACT:
Masculinization surgeries are offered for the Female to Male (FTM) transgender community. While there are numerous cosmetic surgical options for masculinization, a surgical intervention to produce the appearance of an "Adam's Apple" is uncommon. The current procedure entails harvesting cartilage from the patient's ribs. Morphometric measurement data was collected from 52 computerized tomography (CT) scans, to evaluate the size and shape of female and male thyroid cartilages. Using the data collected, a numeric scale depicting a standardized range of sizes for a silicone implant was developed. The implant is molded using medical grade silicone, commonly used in cosmetic procedures. Implantation of a silicone laryngeal prominence enhancement will provide FTM persons with the exclusively male characteristic of an "Adam's Apple", allowing their physical appearance to agree with the gender phenotype with which they identify.

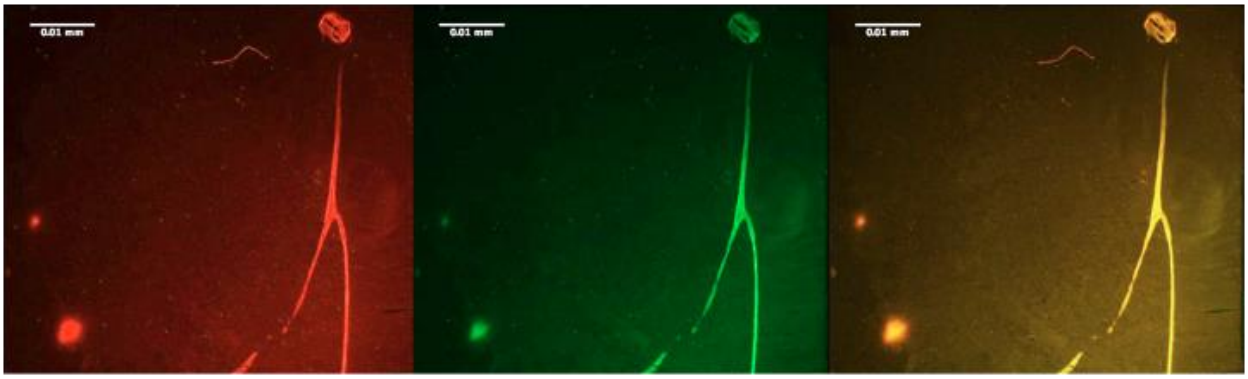
Laryngeal Prominence Enhancement Cosmetic Implant Scale				
Scale (size)	1	2	3	4
Laryngeal Angle (deg)	40°	50°	60°	70°
Superior View of Implant				
Anterior View of Implant				

Violette Simon **Poster #16**

Standardized Sections, Autofluorescence, and Immunohistochemical Protocols to Differentiate the Globus Pallidus Interna in Post-mortem Human Brains From Surrounding Neural Tissue

Capstone Committee: Norma Wagoner (chair), Diego Restrepo (mentor), John Thompson

ABSTRACT:
The objective of this study was threefold: (1) to standardize sections of fixed human cadaveric brains in order to isolate the globus pallidus (GP), (2) to use autofluorescence in order to differentiate the globus pallidus interna (GPi) from surrounding structures, and (3) to use immunohistochemistry to distinguish the cellular composition of the GPi. The GPi is targeted in the treatment of Parkinson's disease (PD) and the ability to visualize this structure and the cellular composition within it would aid neurosurgeons performing deep brain stimulation (DBS) procedures. Multiple centers across the University of Colorado are collaborating on this study and the objectives listed above are the specific goals targeted by the author. The GP was successfully isolated using standardized sections, the GPi was distinguished from surrounding structures using autofluorescence, and the immunohistochemistry was unable to identify the cellular composition of the GPi. Therefore, autofluorescent intraoperative imaging modalities may be developed to identify the GPi during DBS procedures.



Kaitlyn Todd **Poster #17**

Developing a Protocol for Creating Anatomical Models from Visible Light Photographs of a Cryosectioned Cadaveric Specimen: Modeling the Bifurcate Ligament and its Attachments

Capstone Committee: Vic Spitzer (chair & mentor), J. John Cohen, Caley Orr

ABSTRACT:
The human foot is made up of 28 bones, 30 joints, and more than 100 muscles, tendons and ligaments that are responsible for locomotion, and are susceptible to injury. Understanding the complex relationships of the structures in the foot and ankle is essential for correct physical diagnosis and treatment of injuries in this region. With an increasing amount of information to learn in the health professions, mastering anatomical knowledge has become more challenging as many students spend less time on anatomical dissection. The use of computer-assisted instruction has been successful in supplementing traditional teaching formats and offers an alternative method to master anatomy. The objective of this study is to create a protocol for generating computerized anatomical models from visible light photographs of a cryosectioned cadaveric specimen to enhance anatomical education resources. The bifurcate ligament and its attachments were chosen as pilot structures to develop the protocol because of the high incidence of injury misdiagnosis and ability to illustrate how modeling with volume rendering is advantageous compared to other methods currently in use. This study demonstrated that it is possible to create surface models from visible light photographs through hand-segmentation and that the segmentation protocol has a high reliability across raters with and without anatomical knowledge. The protocol developed for modeling anatomical structures from visible light photographs of cryosectioned cadaveric specimens has the potential to be expanded to include the physiological properties of tissues, applied to other regions of the body, and be used to create additional educational resources.

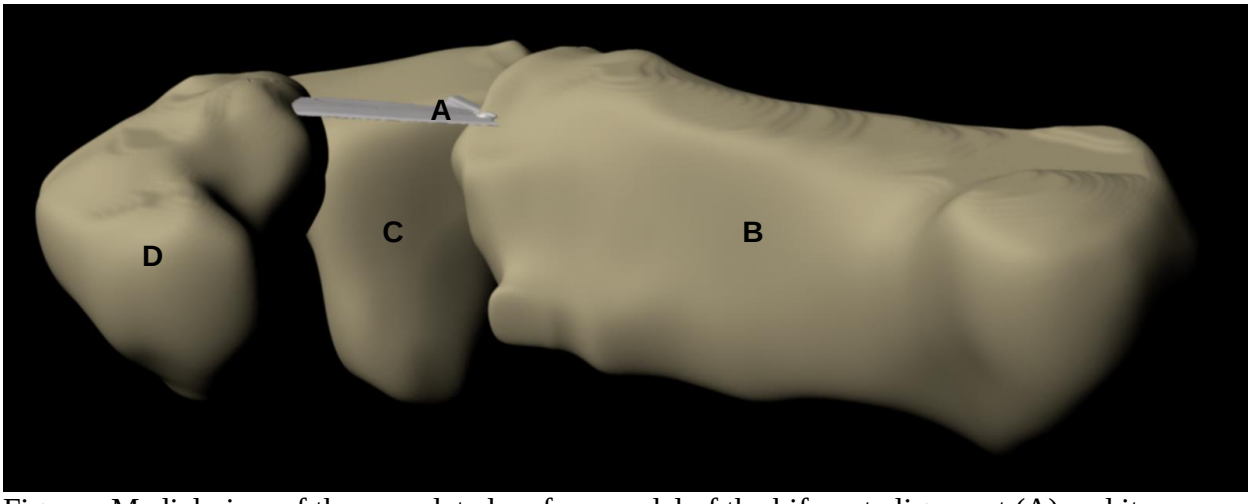


Figure: Medial view of the completed surface model of the bifurcate ligament (A) and its attachments to the calcaneus (B), cuboid (C), and navicular (D) bones.

Halie Willbanks **Poster #18**

Creating a teaching module for yoga instructors using cross-sections to describe 'core muscle' anatomy

Capstone Committee: Norma Wagoner (chair & co-mentor), Vic Spitzer (co-mentor), Nancey Johnson Bookstein

ABSTRACT:
There is a clear link between decreased 'core muscle' stability and low back pain (LBP) (Standaert, 2008). With the prevalence of LBP, significant research has been done to determine specific exercises aimed to strengthen 'core muscles'. Electromyography (EMG) data has shown that yoga activates specific muscles involved in 'core muscle' stabilization. It is hypothesized that visualizing 'core muscle' anatomy through cross-sections will improve yoga instructors confidence when describing specific musculature used in various yoga postures while safely and effectively helping clients decrease the likelihood of developing low back pain (LBP). Prior to the creation of this module, cross-sections had not been paired with anatomical content for the purpose of teaching anatomy to yoga instructors. To uniquely visualize 'core muscle' anatomy, 3D renderings of musculoskeletal anatomy and cross-sections from the VH Dissector (VHD) were enhanced using Adobe Photoshop®. The educational content was collected from peer-reviewed articles, textbooks and consults with anatomists and physical therapists. The images and content were integrated into an online teaching module using Articulate Studio®. The Anatomy for Yoga Instructors teaching module was composed of 15 slides pairing cross sections and 3D images with text and voice narration. Future studies are implicated to test the efficacy of the teaching module.

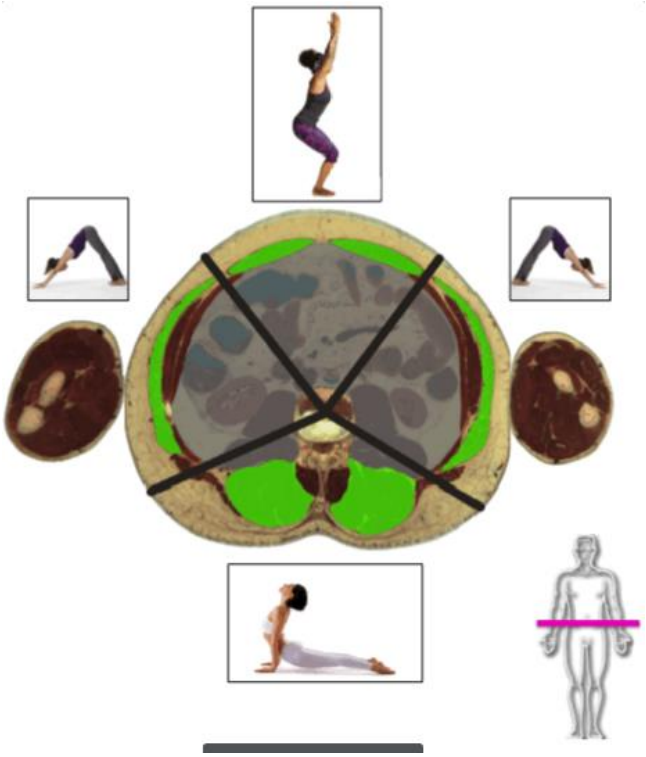


Figure: Three yoga postures (chair pose, downward-dog and upward-dog) shown with cross-section illustrating superficial 'core muscles' highlighted in green.

McKenzie Winter **Poster #19**

Electrophysiological Topography of Subthalamic Nucleus in Parkinson's Disease

Capstone Committee: John Caldwell (chair), John Thompson (mentor), Aviva Abosch

ABSTRACT:
Parkinson's disease (PD) is routinely treated with continuous stimulation from an indwelling electrode implanted into pathophysiological deep brain structures. In PD, neural disruption arises in the output nuclei of the basal ganglia controlling movement. To counteract this dysregulated activity one of the output nuclei, Subthalamic Nucleus (STN), is targeted in deep brain stimulation (DBS). STN is a complex structure with distinct functional compartments potentially contributing to varying stimulation effects. Therefore, in this study we sought to examine the physioanatomic topography of STN through analysis of individual neuron spike activity patterns. Single neuron electrophysiology from 15 PD subjects was analyzed in a twostep process, 1) visual inspection to exclude non-spike related recordings [Spike Sorter program (Matlab, Mathworks)], and 2) application of clustering and sorting algorithms to eliminate false positive spikes and identify isolated single neurons from multi-unit activity [Clusterizer program (Matlab, Mathworks)]. Visual inspection and rendering of electrode trajectories from postoperative MR imaging derived the 3D spatial orientation. Intraoperative MER positions were then back calculated relative to their respective cannula orientation, allowing us to remap STN electrophysiology topography. From the 514 single units analyzed, dorsal STN had a significantly higher firing rate than ventral STN ($p = 0.0034$). Ventral STN had significantly longer spike bursts (ms) ($p = 0.026$) and neural variability ($p = 2.59x10\text{-}5$), as measured by coefficient of variation for inter-spike interval, than dorsal STN. Dorsal and ventral STN did not have distinct representations of spikes per burst ($p = 0.43$).

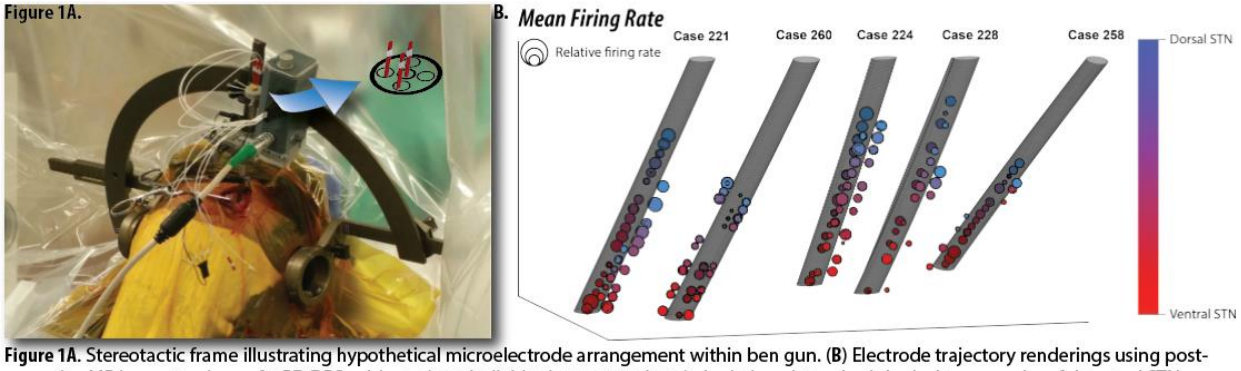


Figure 1A. Stereotactic frame illustrating hypothetical microelectrode arrangement within ben gun. (**B**) Electrode trajectory renderings using post-operative MR image tracings of 5 PD DBS subjects *(see individual case numbers)*, depicting eletrophysiological topography of detected STN single units. Physioanatomic differences in mean firing rate are indicated by a color gradient scale, transitioning dorsal *(blue)* to ventral *(red)*. Mean firing rate is directly proportional to bubble diameter. Relative to the plotted electrode trajectory position in 3D space, the remaining 2 MER cannulas were back calculated and overlaid for each subject.