

Abstracts accepted for the 37th Annual Meeting of the American Association of Clinical Anatomists, June 15–19, 2020

2020 AACA Abstracts for *Clinical Anatomy*

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Incidence of vertebral artery injury in cervical spine fractures

INTRODUCTION. The risk of vertebral artery injury (VAI) secondary to cervical spine fracture is becoming increasingly recognized in the literature. The aim of this study was to determine the incidence of VAI in patients admitted to the Royal Victoria Hospital (RVH) with cervical spine fractures. The RVH is Northern Ireland's Regional Trauma Centre with emergency surgical spinal services. Identification of the types of cervical spine fractures associated with the highest risk of VAI will then provide recommendations for when to screen patients so that cases of VAI are not missed. **METHODS.** A retrospective review of 1,894 computed tomography (CT) reports of patients who underwent imaging of their cervical spine and/or vertebral arteries over a 12-month period, from June 2018 to June 2019, was conducted. This yielded 68 patients (3.59%) with a confirmed cervical spine fracture. These patients had an age range of 18–97 and included 39 males (57.4%) and 29 females (42.6%). The fractures were then classified according to the AOSpine cervical spine fracture classification. **SUMMARY.** Out of 68 patients with a confirmed cervical spine fracture, five (7.35%) were diagnosed with VAI, all involving fractures of their upper cervical spine. Two involved fractures extending into the transverse foramen, two involved subluxation of the vertebrae and one involved both. **CONCLUSIONS.** CT angiography of the vertebral arteries is therefore recommended following radiological findings of fractures involving the transverse foramen or fractures classified as Type C/subluxation. The most common mechanism of injury for VAI was a road traffic collision. Regarding management, the patients with VAI in this study were either monitored and given no specific treatment or treated medically with antiplatelet therapy, none required surgical intervention.

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Theories of gluteus maximus involvement in low back pain causation

INTRODUCTION. There is a small but growing amount of research which supports a link between low back pain (LBP) and gluteus maximus (GM) weakness. Studies have found GM muscle atrophy, as well as EMG and strength changes, in the presence of LBP. We have, however, been unable to find any evidence demonstrating a specific mechanism explaining the connection between GM and LBP. **RESOURCES.** Skeletal models, cables and digital force gauges were used to create basic biomechanical models of the forces potentially involved in GM and LBP interactions. **DESCRIPTION.** Our strategy involved reviewing the anatomical relationships that exist in the gluteal/lumbar region, and then assessing potential, clinically relevant, biomechanical mechanisms deriving from these relationships. Four hypotheses were developed: Hypothesis 1: The protective effects of a strong GM during lifting may decrease the risk of intervertebral disc (IVD) herniation by moving the trunk into extension through a danger zone when IVDs are most susceptible to posterolateral herniation. Hypothesis 2: Hip extensor strengthening activities may indirectly exert a stabilization effect on the lumbar spine, via activation of deep muscles of the back such as multifidus during these exercises. Hypothesis 3: Attachments of the GM to the thoracolumbar fascia (TLF) may impart protective effects on the spine through multiple mechanisms including: facilitation of postural changes, increased paraspinal muscle force production, and motor control potentiation via GM's stimulation of afferent TLF receptors. Hypothesis 4: Incidental LBP-related disuse atrophy of GM may give the appearance of a relationship that does not exist. **SIGNIFICANCE.** LBP is a significant health problem worldwide. The theories proposed here can be used as a framework for future biomechanical studies that could support or refute the existence of a relationship between LBP and GM, and aid in the development of new exercise interventions for LBP.

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Persistent left superior vena cava with aberrant course of right common carotid artery

INTRODUCTION. Persistent left superior vena cava (PLSVC) is a relatively rare congenital anomaly that has no adverse effects on daily life. The incidence of PLSVC in the normal population was reported to be 0.2–0.7%. Precise knowledge for the topology and variation of the superior vena cava is important for catheter-based therapy. Present case shows a rare anomaly of the PLSVC with aberrant course of the right common carotid artery. **RESOURCES.** An 89-year-old Japanese male donor whose cause of death was angiocholitis with common bile duct stone. **DESCRIPTION.** In this case, PLSVC passed anterior to the left pulmonary veins and drained into the right atrium via the coronary sinus. In addition, this PLSVC received a vein that coursed longitudinally along the vertebra. This left longitudinal vein gathered the third to sixth right intercostal veins. Though the brachiocephalic trunk normally divided into the right subclavian and common carotid arteries, only the right common carotid artery passed anterior to the left brachiocephalic vein. **SIGNIFICANCE.** The PLSVC is the persistence of the left anterior cardiac vein in development. Left brachiocephalic vein derives from the anastomotic vein between bilateral anterior cardiac veins. In this case, this anastomotic vein drained into relatively posterior near the posterior cardiac vein, and therefore, the right common carotid artery could lie anterior to the left brachiocephalic vein. The internal jugular veins and subclavian veins have been used for a catheter in intravenous hyperalimentation and implantation of a wire for the pacemaker, etc. It is essential to evaluate the position surround the superior vena cava prior to catheter-based therapy to avoid complications.

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Popliteal artery: Its variants and clinical implications. A pictorial essay

INTRODUCTION. Knowledge of popliteal artery and infapopliteal branching patterns are important in reduction of iatrogenic vascular complications as these are recipient sites for above and below knee

by-pass grafts, popliteal entrapment, in arthroscopic knee surgery and in treating femoral artery blockade helping in minimizing severe symptoms needed to regain daily tasks completion such as peripheral arterial disease. **METHODS.** The popliteal artery has three main branches, anterior tibial (ATA), peroneal artery (PA) and posterior tibial (PTA) and their infapopliteal branches concerned with vascularization of anatomical structures in the leg and foot regions. **SUMMARY.** Eight major variants of popliteal artery and branches were encountered on review of about 100 dissected limbs. High arising ATA coursing, (a) anterior, (b) posterior to the popliteus muscle, (c) segmental hypoplasia of the ATA, (d) dorsalis pedis replaced by an hypertrophied PA, (e) ATA- PAT, (f) hypoplastic PTA, (g) trifurcation of the popliteal artery, (h) peroneal arterial magna (PAM). A high arising ATA coursing anterior to popliteus muscle stands a high risk of inadvertent ligation during a total knee replacement surgery. The dorsalis pedis pulsation will be absent in hypoplastic or aplastic ATA. Inadvertent ligation of the PAM may lead to gangrene and possible limb loss. **CONCLUSIONS.** Knowledge of variants of the popliteal and branches are important to vascular, orthopedic, and plastic surgeons in the selection of appropriate surgical interventions and to interventional radiologists in the interpretation of images. PAM plays a dominant role for lower leg perfusion and should be precluded for a fibular flap harvest.

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Case report: A unique ipsilateral branching variation of the axillary artery

INTRODUCTION. An unusual arterial branching pattern of the third part of the left axillary artery (AA) was observed in an 87-year-old male cadaver. **RESOURCES.** The cadaver was received through the Gift Body Program of the Center for Anatomical Science and Education, Department of Surgery at Saint Louis University School of Medicine. **DESCRIPTION.** A common arterial trunk arose from the third part of the left AA just inferior to the lower border of the pectoralis minor muscle. It quickly divided into the subscapular artery (SA) and a common stem for the deep brachial artery (DBA), the anterior humeral circumflex artery (AHCA), and the posterior humeral circumflex artery (PHCA). Both the SA and AHCA appeared normal regarding their course through the axilla. The PHCA traveled with the axillary nerve passing through the quadrangular space and gave off the radial collateral artery (RCA) in the posterior compartment of the arm. Superior to the elbow joint, the radial recurrent artery crossed anterior to the lateral epicondyle to anastomose with the RCA. The DBA traveled with

the radial nerve through the triangular interval and continued as the middle collateral artery (MCA) in the posterior compartment of the arm. Distally, the MCA anastomosed with the interosseous recurrent artery deep to the anconeus muscle. Another unusual finding was the medial cord and lateral cord contributions to the median nerve formed posteriorly to the axillary artery. **SIGNIFICANCE.** Knowing anatomical variation of the axillary artery is clinically important. These anomalies should be considered during vascular and reconstructive surgeries of the arm and interventional radiology procedures.

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Variable levels of bifurcation of the sciatic nerve in relation to the piriformis muscle

INTRODUCTION. The ventral rami of the Lumbosacral plexus formed by L4-S3 make up the Sciatic nerve (SN). The SN exits the pelvis through the Greater Sciatic Foramen (GSF) & enters the gluteal region inferior to the Piriformis muscle (PM), leaves the gluteal region coursing down the posterior thigh where it divides into the CPN & TN at the apex of popliteal fossa. Radiating lower back pain is a prevalent clinical issue proven to be treated effectively with OMM, including treatment of the piriformis. **RESOURCES.** Dissection of 52 lower limbs (LL) in the gluteal region & posterior thigh was done to expose the SN bifurcation. **DESCRIPTION.** Based on the Grewal classification, we found in 8 LL the SN division occurred in the pelvis; of these specimens in 5 LL both the CFN & the TN emerged infra-piriformis & in 3 LL, the CPN exits through the piriformis & the TN infra-piriformis. In 44 LL of the specimens showed division of the SN after its exit from the GSF, specifically 10 LL divided in the gluteal region, 2 LL the SN divided between the junction of the gluteal region & the upper 1/3rd of the thigh, 2 LL the SN divided in the upper 1/3rd of the thigh, 6 LL SN divided at the junction of upper & middle 1/3rd of the thigh, 4 LL the SN divided in the middle 1/3rd of the thigh, 17 LL, the highest incidents, SN divided at the junction of the middle & lower 1/3rd (apex of the popliteal fossa) & 3 LL the SN divided at the lower 1/3rd of the thigh. **SIGNIFICANCE.** The study of the SN variations is important when conducting surgical, diagnostic & therapeutic treatment such as osteopathic manipulative medicine. As the SN exits the pelvis, piriformis syndrome has been known to cause compression of the nerve causing pain and pathology. This understanding increases the clinical effectiveness in treatment, while decreasing the risks of lower extremity disability.

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Bilateral anomalous origin of radial artery from axillary artery—A case report

INTRODUCTION. The axillary artery is the continuation of the subclavian artery at the outer border of the first rib and is the main source of arterial blood supply of the upper limb. The axillary artery lies between the lateral border of the first rib and lower border of the teres major muscle. Throughout its course in the axillary region, it is in close relation with the cords and branches of the brachial plexus. The axillary artery continues as brachial artery at the distal / lower border of the teres major muscle. The brachial artery ends at the level of the neck of the radius by terminating into radial and ulnar artery. There is a lot of variation in these arteries. High origin of radial artery from axillary artery is very rare. **RESOURCES.** During routine dissection for medical students, skin, superficial fascia, deep fascia was removed. Axillary artery and its branches were traced from the axilla to the cubital fossa. The axillary artery is the main artery supplying the upper limb and is clinically important. **DESCRIPTION.** In the present case, we report a bilateral arterial variation in a 95-year-old male cadaver in which radial artery was taking origin from axillary artery. **SIGNIFICANCE.** The incidence of such an anomaly is low and there have been few previous reports. Being aware of vascular variations is important for both radiologists and surgeons, and may prevent diagnostic errors. Radial artery being commonly used for inserting coronary artery stents, the anomalies associated with it serve as important factors for procedural failures.

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Anomalous origin of flexor carpi radialis muscle from bicipital tendon—A case report

INTRODUCTION. In the flexor compartment of the forearm there are four superficial, one intermediate and three deep muscles. The superficial flexor muscles include the pronator teres, flexor carpi radialis, palmaris longus and the flexor carpi ulnaris, the muscle in the intermediate layer is the flexor digitorum superficialis. Deep group of flexor muscle include flexor pollicis longus, flexor digitorum profundus and

pronator quadratus. Flexor carpi radialis usually takes origin from the medial epicondyle of the humerus as common flexor origin of superficial flexors as well as from antebrachial fascia. It passes deep to flexor retinaculum and inserts on the base of the second and third metacarpal bones. **RESOURCES.** During routine dissection of forearm for medical students, we reflected the superficial and deep fasciae. Flexor muscles of forearm including flexor carpi radialis muscles were identified. **DESCRIPTION.** Several authors have reported the morphological variations of the flexor muscles in the forearm. Flexor carpi radialis is a superficial flexor muscle of the forearm. In addition to the medial epicondyle of the humerus, it was also seen taking origin from biceps brachii tendon. **SIGNIFICANCE.** The incidence of such an anomaly is low and there have been few previous reports. This kind of anomaly is important for clinical and radiological diagnosis of neurovascular compression affecting the upper limb distal to the cubital fossa and also to surgeons undertaking reconstructive surgery.

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Thoracodorsal nerve location variability on the thoracic wall and potential surgical complications

INTRODUCTION. Damage to the thoracodorsal nerve can potentially produce profound functional deficits involving back and shoulder pain as well as reduced shoulder mobility. Investigations into the variation of this nerve have focused on its origin on the brachial plexus and its spinal nerve contributions. The present study aims to quantify the variation in the pathway of the thoracodorsal nerve relative to thoracic cage landmarks and is the first to investigate morphological variation relevant to surgical procedures involving the axillary region and the lateral thoracic wall. **METHODS.** A MicroScribe™ G2X digitizer was used to register 14, 3D landmarks from 44 thoracodorsal nerves in 32 fully embalmed, whole-body donors (20 males and 12 females, aged 50–97 years). After exposure via dissection, the nerve was examined from its origin on the brachial plexus to its entry in the latissimus dorsi muscle at points perpendicular to the anterior and mid-axillary lines along the ribs. Distances between the axillary lines and the nerve were computed from the raw coordinates. Geometric morphometric analyses of the landmarks were performed to visualize areas of greatest shape variation in the nerve and axillary lines. **SUMMARY.** Along the anterior axillary line at ribs 1–3, the nerve has an average distance of 98 mm (range 15–160 mm). Along the mid-axillary

line at ribs 1–4, the nerve has an average distance of 58 mm (range 10–133 mm). The distance of the nerve from the axillary line increases in variation as the nerve descends along the thoracic wall. The terminus of the nerve is the most variable point, entering the muscle between costal levels four and seven. **CONCLUSIONS.** Surgeons can use these data to locate safe areas on the thoracic cage and avoid damage to the thoracodorsal nerve; thus, decreasing adverse outcomes in procedures such as chest tubes, video/robotic-assisted thoracoscopic lobectomies, and mastectomies.

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Multiple osteochondromas comorbid with enlarged parietal foramina: A case report

INTRODUCTION. Multiple osteochondromas (MO) is a condition that affects about 1 in 50,000 live births. Patients present with accessory bone growths, usually stemming from the epiphyseal plate of long bones. Furthermore, the presentation of MO comorbid with an underdeveloped skull is an extremely rare condition known as Potocki-Shaffer syndrome, with fewer than 100 documented cases. The present study investigates a unique case of MO and is reported in order to provide a deeper understanding of this anatomical variation for physicians in the clinical setting. **RESOURCES.** A 66-year-old Caucasian male donor was examined during a routine cadaveric dissection performed by medical students. Detailed exploration of the skeleton and organs was performed, and photographs were taken. Tissue samples were obtained from multiple outgrowths, and histopathological examination was done. **DESCRIPTION.** Bilateral bony growths were noted to arise from the long bones of the upper and lower extremities (femur, tibia, fibula and radius). An accessory muscle was found associated with the left radial bony growth. Histopathological examination was positive for osteochondroma. Inspection of the skull revealed enlarged parietal foramina. Other findings include tibio-fibular synostosis, abnormally shaped vertebral bodies and ribs, and elongated styloid processes of the skull. **SIGNIFICANCE.** Insight into the rare variation found in this case can be of use in a clinical setting. Individuals affected with MO have reported joint disorders, difficulty with movement, loss of circulation, and denervation. In some cases, malignancy of the bony overgrowths has been reported. The enlarged parietal foramina are associated with underdeveloped intellectual abilities, social skills, motor skills, and speech. This unique combination of bone pathologies provides a better clinical understanding of its presentation and necessitates further investigation on its pathogenesis.

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**Student perception and self-reported outcomes using
student-created questions for exam preparation**

INTRODUCTION. One of the initial obstacles of medical and graduate school is adjusting to the rigorous coursework and difficulty of exams. To assist with this transition, students at the Arkansas College of Osteopathic Medicine created Mockdocs.org, a question bank website designed to help students prepare specifically for first-year exams. Research has been conducted that demonstrated how practice tests help prepare students for exams, but none of these resources have been over questions created by students for students without faculty involvement. This study was conducted to determine the primary use, gauge how well-prepared students felt, and analyze self-reported outcomes after utilizing the student-made exam bank known as Mockdocs. **METHODS.** A multi-question survey with likert-rating, multiple-select, and open-ended questions was sent out to first-year students of the Arkansas Colleges of Osteopathic Medicine and to the students in the Master of Biomedical Sciences program at the Arkansas Colleges of Health Education. Results were analyzed by tallying students' responses to survey items and reported as percentages. **SUMMARY.** Of the students that completed the survey, a majority reported having used Mockdocs for exam preparation. Those who used Mockdocs reported higher exam averages when they used Mockdocs versus when they did not regardless of course. Students reported that Mockdocs was primarily used for content review and to gauge understanding of concepts presented in lecture material. **CONCLUSIONS.** Students believe that student-created exam banks are useful in preparing for exams. Mockdocs practice exams were viewed as an accurate depiction of what to expect on faculty-written exams and they perform better when utilizing them. According to the results, Mockdocs is a useful tool in preparing students for first-year medical and graduate school exams.

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**Unilateral absence of the musculocutaneous nerve and
associated median nerve compensation**

INTRODUCTION. The brachial plexus is an ordered network of large nerves in which anatomical variations are not uncommon. The

musculocutaneous nerve (MCN), one of the terminal branches of the brachial plexus, originates from the lateral cord and contains fibers from spinal cord levels of C5-7. It provides motor innervation to the anterior compartment of the arm and sensory innervation to the lateral forearm. On routine dissection of an embalmed 76-year-old female, the MCN was found missing on the right side. **RESOURCES.** The cadaver was obtained through the Gift Body Program of the Center for Anatomical Science and Education, Department of Surgery at Saint Louis University School of Medicine. **DESCRIPTION.** The right MCN was not observed during the dissection, rather, four branches arose from the median nerve at different levels. In proximal to distal order, the first three muscular branches supplied the coracobrachialis muscle, biceps brachii muscle, and the brachialis muscle. The fourth, most distal branch of the median nerve passed deep to the biceps brachii muscle and superficial to the brachialis and brachioradialis muscles. It continued to the lateral side of the forearm as the lateral antebrachial cutaneous nerve. The remainder of the brachial plexus, as well as the plexus on the contralateral side, appeared consistent with the typical pattern found in literature. Measurements at the convergence of the medial and lateral cord contributions showed the size of the median nerve was greater on the right side compared to the left side. **SIGNIFICANCE.** There have been reports of unilateral and bilateral absence of the MCN. An absent MCN that has been compensated for may not affect the daily life of the individual, but is still of surgical and anatomical interest. Specifically, it can be important in the settings of trauma, brachial plexus block, neurophysiological diagnostics, and nerve transplantation.

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**Reliability of 3D freehand ultrasound—triceps surae
muscle volume in typically developing infants**

INTRODUCTION. The muscles of the triceps surae (gastrocnemius and soleus) are responsible for generating power to allow vital functions such as walking and maintenance of posture. While studies have extensively investigated these muscles in adults and children, there is a lack of research looking into the architecture of these muscles in infants who have not started weight-bearing. Understanding the architectural changes that occur during muscle growth in typically developing infants will allow more accurate assessment and treatment

of neurodevelopmental conditions that cause alterations in said architecture (such as cerebral palsy). This study aimed to assess the reliability of freehand 3D ultrasound in measuring the muscle volume of the medial gastrocnemius (MG), lateral gastrocnemius (LG) and soleus in infants in vivo. **METHODS.** MG, LG and soleus from both limbs of 15 term-born infants aged 3 months were scanned using freehand 3D ultrasound, of those 10 were scanned again at 6 months of age. For intra-acquirer reliability, the right leg was scanned twice by the same investigator, with an interval of 10 minutes between acquisitions. For inter-processor reliability, two investigators manually segmented the images obtained to generate muscle volume measurements. Intra-acquirer reliability and inter-processor reliability was assessed using the intraclass correlation coefficient (ICC). **SUMMARY.** The intra-acquirer reliability for MG, LG, and soleus was 0.869, 0.896, and 0.972 respectively. Inter-processor reliability for the right MG, LG and soleus was 0.898, 0.708, and 0.911 respectively, while the corresponding results for the left-sided muscles were 0.977, 0.868, and 0.863. **CONCLUSIONS.** Freehand 3D ultrasound is a reliable method for measuring muscle volume in vivo for infants. The reliability of repeated scans and the segmentation process is good (ICC > 0.7), however further research is needed in this age group.

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An anatomy donor with a left cervical aortic arch has cardiac, skeletal & reproductive anomalies

INTRODUCTION. A cervical aortic arch (CAA) is a rare congenital anomaly that is usually oriented like a thoracic arch, but has anomalies of the aortic branches. The sidedness of the arch & pattern of branching are the basis for their classification into A, B, C, D and E subtypes. **RESOURCES.** The anatomical donor was used in the Clinical Gross Anatomy course & CT scanned prior to dissection. **DESCRIPTION.** The anatomical donor was a 65-year-old female. Dissection of the thorax & CT scanning revealed that the aortic arch was present at the level of the jugular notch, posterior to the trachea & esophagus. The first branch of the proximal ascending aorta was the left common carotid artery. There was no brachiocephalic artery; the right common carotid &

subclavian arteries were separate branches from the arch. An anomalous vertebral artery branched just distal to the right common carotid artery, followed by the left subclavian artery & ligamentum arteriosum. These characteristics are consistent with a Type B CAA. Exposure of the heart revealed the presence of clotted blood in the pericardial cavity suggesting cardiac tamponade as a possible cause of death; however, no obvious aneurysm was seen. Examination of the left ventricle revealed a 1-cm wide diverticulum in the interventricular septum just inferior to the aortic valve; this diverticulum projected into the right ventricle adjacent to the tricuspid valve. CT scanning & dissection of the back revealed the presence of scoliosis with rods placed in the thoracic spine. In addition to cardiovascular & skeletal defects, the right uterine tube was extremely long extending superiorly to the posterior abdominal wall anterior to the diaphragm, although the right ovary was located in the pelvis. **SIGNIFICANCE.** The presence of a cardiac anomaly, CAA & scoliosis, is consistent with deletions of the 22q11.2 chromosome. It is possible that this deletion may also be responsible for the reproductive anomaly seen in this patient.

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Quantitative analysis of cadaveric pelvic lymph nodes

INTRODUCTION. Lymphedema commonly develops as a result of cancer treatments, including surgical removal of lymph nodes (LN). Research suggests there are 500–800 (LN) throughout the body. Deciding how many LN to remove and predicting possible severity of damage can become problematic when the range of LN in one area can vary by 30 LN. The purpose of this study was to investigate more precise ranges of pelvic LN within cadaver samples. **RESOURCES.** Quantification of LN for number occurred on cadavers simultaneous with DO, PT, and PA students' dissections. Demographics of the cadavers were 27 female, 16 male, 39 Caucasian, 3 African American, 1 Asian, with an age range of 42–102 and a mean of 70. The study utilized anatomical landmarks to identify and label the LN. Cadavers ($N = 43$) inspected for lumbar LN and cadavers ($N = 86$ sides) inspected for sacral, common, deep and superficial inguinal, and internal and external iliac LN. **DESCRIPTION.** Quantitative analysis of the pelvic region LN revealed a power analysis value of 0.733 with 43 cadaver sample size (unpaired LN regions) and a value of 0.954 with a 86 cadaver sample size (paired LN regions). Analysis of LN in unpaired lumbar region revealed the true mean of the LN lies between 20 and 28 [CI = 95] while previous data shows LN quantity ranging

from 20 to 50. The true mean of LN in paired regions lies between [CI = 95] from 6–10 (numerical range 5–30) for the common iliac, 2–3 (numerical range 2–3) for the sacral, 5–7 (numerical range 4–18) for the internal iliac, 10–13 (numerical range 5–25) for the external iliac, 2–4 (numerical range 1–3) for the deep inguinal, and 9–12 (numerical range 4–25) for the superficial inguinal. **SIGNIFICANCE.** This study found reduced numbers of LN per 5 of the 7 regions from previous estimates. The common iliac and deep inguinal ranges did not change. These results could improve a surgeon's informed decision on the number of LN to remove with staging and treating cancer.

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Relational anatomy of the medial intermuscular septum redefining understanding of the plantar foot

INTRODUCTION. Obesity and diabetes are increasing globally, which may lead to an increase in tarsal tunnel and plantar compartment syndromes. Their etiology is not always clear, however. This may be due to a limited understanding of the spatial relationships of the posterior tibial neurovasculature. There is no consensus on the number of plantar compartments, with some even doubting their consistent presence. The aim of the present study was therefore to map the neurovasculature of the plantar foot and, in doing so, move towards anatomical evidence for the plantar compartments and their boundaries. **METHODS.** A total of 20 specimens were analyzed. Fifteen feet were dissected from which models were constructed within a 3D virtual space for each neurovascular structure and related soft tissues. The mean thickness of any fibrous tissue was also recorded. To validate these findings, 3 mm sections were taken from five -800C frozen feet, from the hindfoot to the midfoot. **SUMMARY.** Neurovascular bifurcation occurred in the tunnel at varied levels. The vessels were closely related to the flexor retinaculum, abductor hallucis muscle and the septae which formed the flexor tendon sheaths. The medial walls of these sheaths were further identified to continue distally into the plantar foot, forming the medial plantar intermuscular septum (MPIS), the only longitudinal extent from the tunnel contributing to the compartmentalization of the plantar foot. **CONCLUSIONS.** A distinct medial compartment is formed by the MPIS. This fibrous tissue band was much thicker than previously understood. Its relationship to the neighboring neurovasculature is therefore of particular importance. Compression of these nerves and vessels may be associated with a range of structures in close proximity, especially in cases of tendonitis, abductor hallucis muscle hypertrophy, obesity and diabetes, contributing to tarsal tunnel and plantar compartment syndromes.

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Relationship between age and pathological stage of colorectal cancer in a large cohort of subjects

INTRODUCTION. The American Cancer Society recommends colonoscopy screening for colorectal cancer (CRC) begin at age 45 despite a recent increase in CRC in those <45 years. The purpose of this prospective study was to explore the frequency of delayed CRC diagnosis (stages III-IV) in symptomatic subjects <45 compared to those >45 with symptoms who received prompt testing and early diagnosis (stages I-II). **METHODS.** IRB approval was granted. An a priori power analysis revealed that the minimum sample size needed to achieve significance was 220 subjects (G-power Version 3.1.9.6, Germany). An electronic survey was distributed to CRC support groups. Total sample size was $N = 255$. Inclusion criteria: 18–75 years, CRC diagnosis stages II-IV currently in treatment or remission, and a US resident. Exclusion criteria: <18 and >75 years, family history of CRC, and inherited CRC symptoms. Data were analyzed with IBM SPSS Version 24 (Armonk, NY), alpha level set at 0.05. **SUMMARY.** Respondent gender was F:80.78%, M:18.43%, and Other:0.78%. Over 90% of respondents were white and over 70% were 45 years or older. A total of 39.22% of subjects were <45 years at time of diagnosis and 69.81% were diagnosed at stages III-IV. 45.5% of subjects did not seek care within the first 3 months of symptoms and 43.48% were not referred to a gastroenterologist. There was a significant inverse relationship between age category (ordinal data) and stage at diagnosis (ordinal data): Spearman's rho -0.123 ($p = .049$). **CONCLUSIONS.** There is no standard of care guidelines for patients <45 years who have CRC symptoms. Because we found that younger people are more likely to be diagnosed with CRC advanced stages (III-IV), any delay in diagnosis could result in poorer outcomes. In contrast, people over 45 with CRC symptoms are often diagnosed faster and possibly at an earlier stage. Our data may help develop guidelines that recommend colonoscopies at an earlier age.

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Anatomy lab safety: When good isn't good enough

INTRODUCTION. For cadaver-based anatomy labs, OSHA defines limits for acceptable occupational exposure to preservation chemicals

and require careful environmental monitoring to prevent injury. But, even when monitoring results show exposure levels within acceptable limits, they may not tell the whole story as discovered at UMMS in October 2019, when a faculty member dissecting, was exposed to a waft of vapor which caused acute symptoms and long-term injury. **RESOURCES.** Injury response resulted in an analysis of historical and subsequent monitoring results, which determined that the formaldehyde and phenol levels in the anatomy labs were within acceptable limits. The proprietary nature of the embalming chemical blend hampered investigation as specific chemical information was unavailable. Facility-based factors that may impact exposure include embalming techniques, vapor reduction efforts, and facility controls such as temperature and ventilation systems. Individual characteristics also impact exposure, including donor characteristics and dissection techniques. **DESCRIPTION.** OSHA limits do not accurately represent the risks of exposure, leaving faculty, staff, and students at risk of injury. Further, these regulations do not consider the differences in exposure between faculty and students. Some research has been done on outcomes of long-term exposure in the anatomy lab outside of the USA. While best practices related to chemicals may change, regulations do not and it is the onus of each individual facility to maintain a working knowledge of potential exposure risks to prevent adverse long-term health outcomes. **SIGNIFICANCE.** There is little current research available on long-term chemical exposure in anatomy labs in the USA and how faculty and students are affected differently. The lessons learned from this accident and subsequent research have encouraged the creation of a larger multi-site analysis of faculty health concerns and possible chemical exposure.

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“Boning up”: Self-directed osteology lab stations support learning in time-crunched labs

INTRODUCTION. Human osteology is foundational for student understanding of gross anatomy, yet dedicated time for its study is often the first reduced along with decreased dissection hours. **RESOURCES.** Here we present the development and implementation of independent learning osteology stations with the goal of offering guided self-study of bones, whilst highlighting the clinical importance of osteological knowledge. **DESCRIPTION.** For each in-lab experience, specific bones, landmarks, and clinical relevancies were chosen to

accompany the dissection and planned in concert with the course objectives. Interactive PowerPoints were created and installed on individual computers in the anatomy lab. Each guide began with an overview of the region and the key skeletal elements involved for each dissection session, then proceeded with specific landmarks, key facts, and tips and tricks for recall. Osteological specimens were provided next to the computer, with access to pre-created screens in the “Complete Anatomy” atlas application. For rare specimens and models, students were directed to a secondary singular station. Key to the success of these stations was collaboration with course leaders while they set the learning objectives, timing, and planning of the dissection to allow an atypical regional approach to teaching osteological materials. **SIGNIFICANCE.** The self-directed nature of the station allows students to interact with the materials any time. This also allows the stations to be scalable depending on space, computers, and bones and support a high total class-size with limited osteological specimens, as not each student or group requires a specimen. Whilst it is always preferable for material to be taught concurrently, this set up provides a flexible educational opportunity, whilst continuing to highlight the clinical and anatomical importance of osteology in the anatomy lab.

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Injury reporting in the anatomy lab

INTRODUCTION. Institutional injury protocols for University of Massachusetts Medical School (UMMS) put the onus on individual departments to record, report, and direct students to Student Health Services for care. Historically, injuries occurring in the anatomy lab were treated without recording. In 2017 the lab moved from disposable scalpels to a permanent handle with replaceable blades. This requires students to place the blades themselves, with safety training falling to individual faculty. An increase in sharps injuries was noted after this change, prompting the creation of robust lab injury protocols and procedures for the academic year 2018/19 (AY18). **METHODS.** The creation and implementation of an incident report allowed for tracking. At the end of the academic year 2019/20 (AY19), reports were analyzed for total number and type of injury. Data were obtained from UMass Memorial Health Care (UMHC) system for comparison. **SUMMARY.** The UMMS first-year curriculum includes a

5-month lab dissection experience. There were 11 injuries reported in AY18 for 163 students and 14 injuries in AY19 for 165 students. Of the 11 injuries reported in AY18, all were scalpel injuries to the hands and fingers. Of the 14 AY19 injuries, 13 were scalpel injuries, one was cut by a bone. These data suggest ~7.5% of UMMS students will experience a sharps injury. Over 2019 UMHC reported 11 scalpel sharps injuries among the 600 total residents (1.83%), suggesting that scalpel injuries occur at higher rates among medical students in the anatomy labs. **CONCLUSIONS.** This study highlights the need for more robust sharps training and incident reporting systems. Minor injuries tend to be underreported by students unless they require immediate care. Guidance is required for complete reporting in all areas of safety extending to all injury types which may occur related to the lab experience. Preliminary data suggest both introductory training and a later “refresher” could reduce sharps injuries.

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Duplicated inferior vena cava with transverse interiliac vein and renal vessels abnormalities

INTRODUCTION. The inferior vena cava (IVC) is formed by the joining of the right and left common iliac veins. It is located in the posterior abdominal wall and runs on the right side of the abdominal aorta (AA). On each side, a renal vein and artery are found draining and supplying the kidney, respectively. **RESOURCES.** During dissection of the abdominal region, a 77-year-old Caucasian male donor presented with a case of duplicated IVC (DIVC) with renal vessel abnormalities. **DESCRIPTION.** Abnormal DIVC was found running on each side of the AA. The right and left IVC joined at the level of L1 and measured 35.6 and 36.2 cm in length, respectively. The DIVC was observed with a transverse interiliac vein connecting the right and left IVC at the level of S2. During further dissection, an aberrant left accessory renal vein (LARV) was found draining into the left IVC from an atrophic left kidney. The LARV, measuring 4.4 cm in length, ran inferior to the main left renal vein and posterior to the left renal artery and ureter. Meanwhile, an atypical right accessory renal artery (RARA) was found arising from the AA and supplying the superior pole of a normal-sized right kidney. The RARA, measuring 6.9 cm in length, ran superior to the main right renal artery and posterior to the right renal vein. The embryonic venous system is developed by subcardinal, posterior cardinal, and supracardinal primitive veins. Failure of the supracardinal and posterior cardinal veins to degenerate explains the DIVC with an

interiliac vein. Persistence between subcardinal and supracardinal anastomosis leads to double renal veins while persistence in the lateral segmental arteries from a primitive dorsal aorta results in double renal arteries. **SIGNIFICANCE.** Understanding variations associated with DIVC are relevant during abdominal surgery, aortic aneurysm repair, and kidney transplant to avoid vascular injury. In patients requiring an IVC filter, DIVC must be ruled out to avoid pulmonary embolism.

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Abnormal branching of the celiac trunk with atypical origin of the middle colic artery

INTRODUCTION. The abdominal aorta (AA), a continuation of the thoracic aorta, begins in the diaphragm and ends by dividing into right and left common iliac arteries. The AA gives off unpaired visceral branches: celiac trunk (CT), superior mesenteric (SMA), and inferior mesenteric (IMA) arteries; paired visceral branches: middle suprarenal (MSA), renal and gonadal arteries; paired parietal branches: inferior phrenic (IPA) and four lumbar arteries; and an unpaired parietal branch: median sacral artery. The CT, first ventral branch of the AA, trifurcates into left gastric, splenic and common hepatic arteries. **RESOURCES.** Dissection of a 94-year-old Caucasian female donor was performed during the study of the abdominal region. **DESCRIPTION.** A common trunk (CoT) was noticed as the first branch of the CT at a distance of 0.6 cm from its origin, and branched into a left MSA and IPA that measured 2.3 cm and 8.3 cm in length, respectively. The right IPA was observed as the second branch arising at a distance of 1.3 cm from the origin of the CT and measured 1.3 cm in length. Also, a middle colic artery (MCA) was found branching off the AA at the level of L3, 7.6 cm distal to the SMA and 2 cm proximal to the IMA. The MCA measured 0.8 cm in diameter by 11 cm in length and supplied the transverse colon. Embryologically, the paired dorsal aortae fuse to give rise to the descending aorta. Reshaping of the vitelline vessels then give rise to the CT, SMA, and IMA. Variations in the branching and fusion of lateral branches may explain the atypical origin of the MSA and IPA, while failure of ventral branches to regress could account for the presence of the MCA as an aberrant ventral branch of the AA. **SIGNIFICANCE.** This study aims to describe variations of the CT and MCA which may be involved in the treatment plan of unresectable hepatocellular carcinoma, source of gastrointestinal hemorrhage during surgical interventions, and risk of ischemia in the case of bowel obstruction.

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A rare trifurcation of the common hepatic artery with additional vascular variations

INTRODUCTION. The celiac trunk (CT) is the first unpaired anterior branch of the abdominal aorta (AA) and divides into left gastric artery (LGA), splenic artery (SA), and common hepatic artery (CHA). The CHA gives rise to the gastroduodenal artery (GDA), and right gastric artery (RGA), after which continues as the proper hepatic artery (PHA). Right hepatic artery (RHA) and left hepatic artery (LHA) are arising from PHA to supply the liver and gallbladder. **RESOURCES.** During routine dissection of an 88-year-old Caucasian male donor, aberrations in the branching pattern of the CT and CHA within the abdominal region were studied and documented. **DESCRIPTION.** There is an unusual trifurcation of the CHA into LHA, RHA and GDA. LHA and RHA measures 1.9 and 3.8 cm in length, respectively. LHA is coursing anterior and medial to the hepatic portal vein (HPV), and is found giving off the RGA. RHA runs lateral to the HPV, medial to the bile duct (BD), and anterior to the common hepatic duct. RHA ascends towards the porta hepatis along with the BD and HPV. The cystic artery, a branch of the RHA, is situated medial to the cystic duct. The right inferior phrenic artery (RIPA) has an unilateral origin from the CT. RIPA is the first branch of the CT at a distance of 1.27 cm from its origin and measures 5.1 cm in length. An additional finding on further dissection is a partially duplicated left testicular vein draining into the left renal vein (LRV). The left testicular artery originating from the AA just posterior the LRV courses between the left medial and lateral testicular veins. **SIGNIFICANCE.** This case study is clinically significant for surgeons during laparoscopic hepatobiliary surgeries, diagnostic angiography for gastrointestinal bleeding, and transcatheter therapy in cases of unresectable hepatic malignancies. The left medial and lateral testicular veins pose an increased risk for varicocele and infertility in patients.

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Comparison of volume models of real color cadaver images and grayscale patient images

INTRODUCTION. Volume models made from magnetic resonance images and computed tomographs are used widely in clinics.

However, since the medical images are in grayscale and have low resolution, detailed anatomical structures are difficult to be identified. On the other hand, volume model made from real color cadaver images can show minute structures. Purpose of this study is to help learning the interpretation of medical images by comparing the volume models of cadaver images and medical images. **RESOURCES.** From serially sectioned images of cadaver, real color volume models of cadavers were produced. From magnetic resonance images and computed tomographs of patients, grayscale volume models were manufactured. Dicom Browser and MRICroGL were utilized for the volume reconstruction. **DESCRIPTION.** The cadaver models and the patient models were sectioned in the same planes to be compared. The cadaver model with the voxel size of 0.5 mm × 0.5 mm × 0.5 mm showed more minute structures than the patient model with lower resolution. Referring to the cadaver models, locations of small structures could be estimated on the patient models. **SIGNIFICANCE.** The real color cadaver models can function as a bridge between the grayscale medical images and actual cadaver dissection. Medical students and doctors can download the cadaver volume models of this study from anatomy.co.kr for free. The cadaver sectioned images and volume reconstructing method can be provided to other researchers without commercial return.

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A simple and consistent rule for easy learning of neuroanatomy—Three neurons of afferent nerves

INTRODUCTION. In general, medical students regard neuroanatomy as a terrifying subject because of the vast amount and difficulty of neuronal connections. Such neurophobia can be relieved by the simple and consistent rules rather than the exhaustive details. **RESOURCES.** The authors propose a rule, named “three neurons of afferent nerves.” The core of the rule is the second neuron that decussates and synapses with the third neuron at the thalamus. **DESCRIPTION.** The rule is applicable not only to the spinothalamic tract, medial lemniscus pathway, sensory cranial nerves (visual pathway, trigeminothalamic tract, taste pathway, auditory pathway), but also to the ascending reticular activating system, pontocerebellum (afferent to cerebrum), basal nuclei (direct pathway), and limbic system. As a small exception of the rule, some few pathways' second neurons do not decussate. After grasping the big picture of neuroanatomy with the rule, detailed neuroanatomy knowledge should be added. In addition, the three neurons of afferent nerves are drawn in simple and consistent pattern by the authors. Students are expected to redraw the illustrations, which is helpful for memorization. **SIGNIFICANCE.** The proposed rule can help novice students learn neuroanatomy easily, which eventually contributes to the clinical anatomy.

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Skull thickness across sutures and grooves: Mapping areas of weakness

INTRODUCTION. An epidural hematoma (EDH) is a bleed that occurs between the inside of the skull and the brain's Dural covering. Although EDH occurs in approximately 2% of head injuries, it results in 5–15% mortality. Epidural hematomas are frequently associated with a fracture along the temporal suture yet little research has assessed the temporal bone thickness and the surrounding region. Our study investigates skull thickness along the temporal suture and the middle meningeal arterial groove as we hypothesize these are areas of weakness. **METHODS.** Twenty cadaver skulls from the Joplin and Kansas City Anatomy Labs (Kansas City University of Medicine and Biosciences) were measured along the temporal suture and middle meningeal arterial groove at 2 mm intervals using iGaging 8" Digital Outside Calipers. The artery's branching pattern was photographed and transcribed to compare individual skull laterality. **SUMMARY.** The average point values were transcribed to Excel to create a heat map. This map displayed the thickness of the skull along the temporal suture and the middle meningeal arterial groove providing visual information on relative thinness. **CONCLUSIONS.** As these temporal areas are thought to be weaker, finding a general fragile location may aid clinical assessment of head injuries. Our study could provide information on determining a greater relative risk of injury for one side of the skull or the other.

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Veteran body donation trends at UMASS medical school

INTRODUCTION. With the recent expansion of US Veterans Affairs (VA) health care at UMASS Medical School (UMMS) and its associated Memorial Medical Center we were prompted to examine veteran anatomical donations to the UMMS Anatomical Gift Program (AGP).

METHODS. Data on UMMS donations, including—age at death, sex, and veteran status were collated over a 10-year period. AGP data were retrieved from our RedCap database containing both the original donor registration and death certificate information. Most recent data (FY 2017) from the VA was collected on the percentage of veterans in the Massachusetts population and aggregated by sex for comparison. Statistical analysis was conducted utilizing STATA 16 (Stata Corporation; College Station, TX). **SUMMARY.** In 2017 the total veteran population of Massachusetts was 323,253, representing 6.70% of the state population (6.6% nationally; 19,998,799). Of these veterans, 6.93% (22,391) were female (9.41% nationally; 1,882,848). In the years 2010 to 2019 UMMS AGP received a total of 928 body donations. Of these, 512 (55%) were female and 416 were male (45%). During this period 207 donors were veterans, with 197 males (21% of overall donation; ~95% of veteran donor population) and 10 females (1% of overall donation; ~5% of veteran donor population). These data demonstrate veterans have a high rate of donation, comprising 22.7% of our donor population. When accounting for sex, male veterans are more likely to be a part of the donor population (47.4% of the male donor population) than female veterans (1.9% of the female donor population). **CONCLUSIONS.** These findings highlight the importance of veterans in our anatomical education environment. AGP outreach efforts could benefit from this knowledge, as the data suggest veterans have a legacy of serving their communities. Considering this donation trend, AGPs may consider adapting or expanding their remembrance activities and events.

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Multiple muscle variations altering femoral nerve course and distal attachment of iliopsoas

INTRODUCTION. Typically, the psoas major muscle originates via slips from the transverse processes of lumbar vertebrae and the iliacus muscle originates from the iliac fossa. Fusion of psoas and iliacus muscles occurs inferior to the inguinal ligament before attaching to the lesser trochanter. In the present case, a variant psoas muscle belly and an unusual iliacus minimus muscle compressing the femoral nerve were discovered. **RESOURCES.** The variant muscles were found during routine dissection of an 83-year-old female cadaver during the Physical Therapy anatomy course. Typical dissection techniques were utilized to expose the inguinal and pelvic regions. **DESCRIPTION.** Iliacus minimus (length 151.01 mm, widest width 92.73 mm) coursed across the iliac fossa in a manner overlaying the femoral nerve. Iliacus minimus tapered in its course and was 31.92 mm wide at the point where the femoral nerve emerged from beneath it. The variant psoas

muscle (length 49.27 mm), found medially at the distal third of the psoas major muscle belly, fused with the psoas major muscle at a point 71.4 mm lateral to the ipsilateral pubic tubercle. Distally, iliacus and iliacus minimus tendons fused and remained separate from the combined tendon of psoas major and the accessory psoas muscle. Thus, preventing the formation of an iliopsoas tendon of attachment. **SIGNIFICANCE.** An iliacus minimus muscle the size of the current finding has not been reported especially in combination with a previously unreported psoas muscle. The location of the femoral nerve, deep to iliacus minimus, invites speculation of possible femoral nerve entrapment leading to altered sensation along the femoral nerve cutaneous pathways and altered function of the quadriceps muscles. Further, the variant muscles preventing the conjoining of the iliopsoas muscle also invite speculation regarding altered hip flexor function and possible pain generating sources of two separate tendons attaching to the lesser trochanter.

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Thermal ultrasound induction of an abdominal heat-shock response prevents postoperative ileus

INTRODUCTION. Postoperative ileus (POI) is caused by the iatrogenic induction of an intestinal muscularis inflammatory molecular response that leads to the recruitment of leukocytes into the intestinal muscularis externa, which collectively causes POI. Currently, there is no therapeutic intervention to avert POI. The literature suggests that a preconditioning heat shock response is extremely protective via its modulation of the immune response to a subsequent injury, such as ischemia-reperfusion injury. To our knowledge, a focal, organ specific induction of a heat shock response has not been previously investigated in any experimental model. **METHODS.** We utilized a preconditioning, focused hyperthermic ultrasound (HUS) treatment to induce an organ specific protective heat shock response. We hypothesized that the administration of a HUS intervention will prevent the development of POI, as measured utilizing the fluorescent gastrointestinal transit assay and immunohistochemistry. **SUMMARY.** Compared to controls, pretreatment with therapeutic ultrasound significantly ameliorated the development of the delayed gastrointestinal transit of POI. Immunohistochemical studies reveal activation of HSP72 and contractility studies reveal improvement in jejunal muscle contractility following therapeutic ultrasound pretreatment. Neutrophil extravasation was significantly reduced in the treatment group following myeloperoxidase staining. **CONCLUSIONS.** A significant component of the protective heat shock response is known to be mediated by the activation of specific heat shock proteins. Interestingly, HSP70 upregulates a number of anti-

inflammatory mediators, including HO-1 and IL-10. Moreover, previously published works have clearly demonstrated a significant role for both HO 1 and IL 10 in ameliorating postoperative ileus. However, no known study has ever explored the endogenous role of HSPs in the context of postoperative ileus.

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Cutaneous arterial supply of the leg and its importance to medical students

INTRODUCTION. The importance of perforating arteries to the skin are often over-looked by medical institutions which can put future doctors at a disadvantage during their clinical rotations. In the lab, most students are unaware of their existence since they are not shown in lab. Knowledge of these vessels is necessary in reconstructive surgeries for planning viable skin flaps preventing postoperative necrosis. **RESOURCES.** The available textbooks and atlases were reviewed, and a table was constructed identifying which mentioned or depicted superficial arteries. A total of eight legs from donated adult human cadavers (age range) were dissected. The average time taken to locate and completely expose one of the perforating arteries, either along bone or the intermuscular septa was recorded. This was done by following the larger superficial veins to identify their perforating branches through the deep fascia which are always accompanied by an artery. **DESCRIPTION.** Students are often only taught the large blood vessels supplying the tissues deep to the fascia. Our current textbooks focus primarily on the venous drainage of the skin, what they lack is the cutaneous arterial distributions of the skin. Some textbooks mention superficial arteries of the groin, hands, feet and networks around the elbow and knee joint but omit other areas. **SIGNIFICANCE.** Collaboration between clinicians and anatomists is necessary for introducing the importance of perforating arteries. Images and illustrations of these arteries should be included in all anatomy textbooks since dissection of these vessels is easy, only taking about 20 minutes to display.

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Clinical relevance of quantifying pelvic lymph nodes for predicting and treating genital lymphedema

INTRODUCTION. Anatomical research on the pelvic lymph nodes (LN) is inadequate. According to previous research there are between

41 and 154 LNs in the pelvic region (Inguinals-Lumbar) based on reported mean values across several studies. This range should be considered too large for a surgeon to decide how many LN to remove for diagnosing cancer without causing unnecessary harm or for a lymphedema therapist to explain expectations of involvement or improvement to a person with lymphedema. A more precise understanding of numbers and LN removed can help guide a therapist's treatment with genital lymphedema. Muscles can assist in pumping fluid from an involved region to an uninvolved region when LN are removed. The pelvic floor muscles are located in close proximity to 4 of pelvic LN groups (Iliacs and Sacral). **RESOURCES.** A study on 43 cadavers was completed to quantify the number of pelvic LN based on anatomical landmarks. Quantitative and qualitative research was conducted to assess volumetric reductions and quality of life (QOL) improvements with targeting portions of the pelvic LN via pelvic floor muscle contractions in treatment of 10 females with lower extremity lymphedema with and without genital involvement. **DESCRIPTION.** The cadaveric study found a true mean range [CI = 95] of 54–77 LN in the pelvic region. The treatment study found significant reduction [$p = .006$, $\alpha = 0.05$] in volume and significant improvement [$p = .035$, $\alpha = 0.05$] in QOL. **SIGNIFICANCE.** Reducing the mean range of LN in the pelvic region should positively impact the medical community and patients. This is particularly true for lymphedema therapists treating those post cancer treatments in the pelvic region. Improved expectations for outcomes can be provided if the therapists know the number and location of the LN removed during diagnosis and/or treatment by the physician. Therapists can incorporate muscles near the removed LN in treatment to help reduce edema and improve QOL for cancer survivors.

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The aging brain: An MRI study of volumetric change

INTRODUCTION. Neurodegeneration is considered a “normal” part of the aging process, but at what point does it become pathological? Whilst studies have shown that the brain volume decreases as age increases, the rate and pattern of degeneration has yet to be quantified. The use of automated methods to establish quantifiable results has the potential to reduce subjectivity in imaging analysis through the use of research derived reference standards. **METHODS.** Three-hundred and 30 cerebral MRIs consisting of 165 each for males and

females, aged 20–75 were collected retrospectively and processed through the fully automated segmentation pipeline FreeSurfer. Volumetric data were collected for the caudate, putamen, thalamus, amygdala, hippocampus, globus pallidus, corpus callosum, lateral ventricles and the total cerebrum. All data were normalized using a manually calculated intracranial volume. Data analysis was performed through general linear models, curve estimation and T-tests in SPSS. **SUMMARY.** Age related volumetric change was evident in the caudate, putamen, thalamus, amygdala, hippocampus, lateral ventricles and cerebrum. However, the pattern of volume change differed between structures with some showing a linear decrease from 20 years of age, whilst others were quadratic in nature. The globus pallidus and corpus callosum showed no significant age-related volume change. Significant sex differences were found in all structures investigated; therefore, the sample was split by sex to further investigate age. Once split by sex, no significant age-related volume change was found in the caudate nucleus or hippocampus of females. **CONCLUSIONS.** Cerebral structures atrophy at different ages and rates, with some subcortical volumes relatively conserved until middle age. Females typically produced larger normalized volumes and less pronounced rates of degeneration.

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Comparison of infant and adult pectoralis major musculotendinous architecture: A 3D modeling study

INTRODUCTION. Musculoskeletal pediatric anatomical knowledge is important in clinical practice, yet clinicians usually translate adult anatomy onto children. Pectoralis major (PM) is a prime mover of the shoulder girdle, but in an infant the muscle architecture, the arrangement of contractile and connective tissue elements, is unknown. The purpose was to: (a) document and model in 3D the PM of a 6-month old infant; (b) determine spatial arrangement of contractile and connective tissue elements; and (c) compare infant anatomy to published adult data. **METHODS.** Fiber bundles (FBs) and aponeuroses/tendons of PM of a 6-month old formalin embalmed specimen were serially dissected, digitized (Microscribe[®] MLXDigitizer), and modeled in 3D (Autodesk[®] Maya[®]). Data were used to determine infant PM musculotendinous morphology and quantify mean fiber bundle length

(FBL) and pennation angle (PA). The infant and adult PM were compared. **SUMMARY.** The infant PM tendon consisted of a single tendon of insertion with two aponeurotic sheaths. In the adult, there were two tendons with separate attachments to the humerus. In the infant, both the clavicular head (CH) and sternal head (SH) consisted of one belly without partitioning. In the adult, the CH remained a single belly, whereas the SH consisted of 6–7 segments, each having unique medial and lateral attachments. Mean FBL of infant PM was 38.5% of the adult (10 cm shorter). Mean lateral PA of the infant CH ($31.2^\circ \pm 7.0^\circ$) was similar to the adult ($29.4^\circ \pm 6.9^\circ$); mean lateral PA of infant SH ($13.4^\circ \pm 4.9^\circ$) was smaller than the adult ($20.6^\circ \pm 2.7^\circ$). **CONCLUSIONS.** The morphology and architecture of CH was similar between the infant and adult, however the SH and the tendinous morphology differed. This suggests the morphology of SH and PM tendon undergo greater change than CH as development proceeds. The results of this study can be used as a baseline to develop an in vivo ultrasound protocol for infants to assess the developmental changes in PM.

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Clinical applied anatomy impact students overall understanding, performance, interest in anatomy

INTRODUCTION. Anatomy is critical in medical education. The curricula were modified to increase knowledge beyond dissection labs & expose students to specialties prior to rotations. “Clinically Applied Anatomy” (CAA) was instituted within first-year “Human Gross Anatomy” course. CAA combines case-based didactics/cadaveric dissections, integrating new knowledge with pathophysiology & medical-surgical problem solving. We hypothesized that CAA would positively impact students' understanding, performance, interest, & critical thinking of clinical care. Our study assesses these hypotheses & outlines future directions. **METHODS.** CAA curriculum was given to first-year students taking Anatomy in 2014–2018. Students complete organ-based blocks that integrate anatomy. Before CAA, instruction (lectures & cadaver dissection) consisted of 158 hr. Thirteen CAA lessons integrated into the curriculum without changing anatomy-related hours. Specialists provided 39 hr of clinical case-based didactics. CAA followed traditional lectures and during each session, students are given correlational examples of anatomy & patient care. A case-based approach shows surgical & medical patient morbidity. Students are encouraged to propose solutions in an open forum about the mastery of anatomy. **SUMMARY.** Students from the four classes of the new curriculum were surveyed at the

end of their CAA work. Six questions related to efficacy of CAA implications were included. **CONCLUSIONS.** Through supplementing traditional teachings, CAA positively impacts anatomical mastery, exam performance, interest, & understanding of clinical care. This encourages students to apply knowledge to medical & surgical patient challenges. 96% of students appreciated the positive impact as future clinicians. CAA courses can be integrated into an existing framework without increasing students' demands & additional resources.

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Does motivation and test anxiety affect success in a physical therapy clinical anatomy course?

INTRODUCTION. Gauging the motivation of newly admitted Doctor of Physical Therapy (DPT) students, during their first foundational science course, Clinical Anatomy, may improve our understanding of academic success rates. Academic success has been shown to be impacted by motivation behaviors, self-regulated learning, and metacognition. The purpose of this study was to investigate how DPT student motivation behaviors and test anxiety impact academic success. **METHODS.** Thirty-two DPT students (15 M/17 F) participated in the study. The survey consisted of six motivation behaviors and test anxiety which are included in the Motivated Strategies for Learning Questionnaire (7-point Likert scale). The motivation behaviors were compared with course grade using Pearson r correlation [strong/moderate/weak]. Independent t-tests [$p < .05$] were used to assess the relationship between gender and course grade. **SUMMARY.** Only one of the six motivation behaviors, self-efficacy for learning and performance, was strongly correlated with academic success [$r(31) = 0.44$], where higher self-efficacy for learning and performance scores were associated with a higher course grade. Course grade had a weak correlation with all other motivation behaviors and test anxiety. No gender differences were found for the six motivation behaviors and test anxiety. **CONCLUSIONS.** The results of this study suggest that self-efficacy for learning and performance is an important factor in DPT students' success in Clinical Anatomy. The need for Faculty to address self-efficacy for learning and performance could promote student success. Implementing strategies aimed to improve students' self-efficacy, such as providing timely feedback, delineating clear expectations, and incremental goal setting, may enhance academic success.

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Towards an anatomical analysis of dart thrower's motion at the wrist

INTRODUCTION. Carpal mechanics are complex and poorly understood. Clinically, dart thrower's motion (DTM) is considered the benchmark of complete functional range in a single pattern of movement. Yet most bio-mechanical analyses still favor radial and ulnar deviation to best explain intercarpal motion; those that explore DTM are limited to bone or surface observations. This is partly driven by the complexity of simulating DTM. The result is a complete lack of understanding of the functional anatomy of DTM, and especially for intercarpal motion. This study aims to represent DTM in different wrist types in order to provide the first detailed analysis of the anatomy underlying DTM. **METHODS.** Unembalmed ($n = 5$) and Genelyn embalmed ($n = 10$) cadaveric hands were CT scanned, dissected under 6x magnification and modeled in a 3D virtual space. Stop-motion animation, puppetry and robotics were used in varied combinations to develop a DTM model for the cadaveric hand. Digital still and video analysis was used to quantify change in ligament dimensions throughout DTM. **SUMMARY.** Simulation of DTM in a cadaveric hand was a challenge that required multiple solutions. Stop-motion animation, aided by extensive intra-osseous wires allowed detailed postural analysis but lacked the dynamic influence on tissue strain. Robotics and puppetry provided avenues for more fluid movements, but these inhibited more detailed analysis. Further work is needed to advance the quality, realism and efficiency of the model. The initial data revealed the importance of the ulnar ligament complex and the sling-like function of the radiocarpal ligaments in ways not previously visualized. **CONCLUSIONS.** The differences in ligament loading patterns between DTM and classical, planar motion patterns are clear. The unique visualization of this essential motion pattern will inform the more refined management of wrist dysfunction and may enhance post-operative and post-rehabilitative outcomes.

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An investigation of learning features in anatomy videos

INTRODUCTION. Digital videos can be useful adjuncts for learning anatomy. This project evaluates student preferences for video-based

learning tools and the effects on student exam performance. **METHODS.** Two videos addressing different topics were distributed to dental students in their Head and Neck Anatomy course. The first video topic was the Carotid Triangle. It incorporated moving images, narration, implemented quiz questions, and background music. The second video was the Infratemporal Fossa. It incorporated still images, narration, digital highlighting, and implemented quiz questions. In both videos, the didactic information focused on the boundaries of each space, contents (muscles, vasculature, and nerves), and important relationships. Lab practical and lecture exam scores were compared between students that viewed and did not view the videos. A 2-sample T-Test was used to evaluate results between students that viewed and did not view the videos ($N = 100$). Participants were given a survey to provide additional qualitative data. **SUMMARY.** The Carotid Triangle video showed a difference in mean exam scores, but there was not a significant difference for the lecture questions ($p = .351$) and practical questions ($p = .179$). The Infratemporal Fossa video showed a difference in mean exam scores. While there was not a significant difference for the lecture questions ($p = .56$), there was a significant difference for the practical exam questions ($p = .02$). Survey results had common themes: both videos were ranked very helpful/useful (4.42/5 for the Carotid Triangle and 4.30/5 for the Infratemporal Fossa), engaging (4.20/5 for the Carotid Triangle and 4.18/5 for the Infratemporal Fossa), and 97.6% of the students that responded would like to have more videos. **CONCLUSIONS.** Using the most effective learning tools in an anatomy video can help students learn more efficiently. These results will help guide future production of anatomy videos intended for supplemental learning.

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Clinical significance of bedside ultrasonography in identifying variations of the radial artery

INTRODUCTION. The radial artery originates from the bifurcation of the brachial artery in the antecubital fossa. It courses down the medial aspect of the neck of the radius before subsequently crossing the floor of the anatomic snuff box deep to the tendons to form the deep palmar arch. Variations in the origin or proximal tortuosity of the radial artery are found in 15% of cases. Cadaveric studies describe a superficial radial artery in 0.5–1.0% of wrists, in which the distal radial artery passes superficially to the tendons of the anatomical snuff box. Arteriovenous fistulas can follow transradial procedure that damage the radial artery. This study aims to determine the clinical significance of

using bedside ultrasonography in identifying anatomical variations in the radial artery. **METHODS.** Doppler ultrasonography was employed to investigate the anatomy of the radial artery and surrounding vessels in the forearms of 6 medical students. Measurements and ultrasonography images were taken at 3 key areas: A = ½ length between lateral epicondyle to styloid process of radius (SPR), B = ½ length between A and SPR and C at SPR. At these positions, the diameter of vessels, the distance between vessels, and the distance to skin (all in centimeters) were collected. In two patients the radial artery bifurcated between Points B and C creating the superficial radial artery. **SUMMARY.** In two patients the radial artery bifurcated between Points B and C creating the superficial radial artery. **CONCLUSIONS.** Palpating for the presence of a radial pulse and the use of bedside ultrasound guidance can function as a valuable adjunct for all healthcare professionals in minimizing the risk for iatrogenic injuries.

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Incorporating ultrasound in an integrated medical curriculum—Student perspectives and performance

INTRODUCTION. Ultrasound is increasingly being used as a point-of-care tool as obstacles such as cost and portability are overcome. However, a user's lack of confidence with this tool may still present a barrier. This study investigates whether hands-on ultrasound sessions delivered as part of the anatomy curriculum can increase student confidence and performance in using ultrasound. **METHODS.** Students across the University of Washington SOM WWAMI region—which comprises six universities in Washington, Wyoming, Alaska, Montana, and Idaho—completed surveys to report their self-confidence at the beginning and end of an ultrasound session. Students also completed pre- and post-session content quizzes to assess learning. Data were analyzed using ANOVA. **SUMMARY.** Student responses differed

between sites that had previously held an introductory ultrasound session as part of orientation—Wyoming, Alaska, and Montana—and those that had not—Seattle, Spokane, and Idaho. In pre-session surveys, students at sites with orientation ultrasound sessions reported higher confidence in their ability to orient and identify/locate structures using ultrasound; these students also reported more favorable views on their future use of ultrasound and on the importance of including it in the classroom phase of medical school. After the session, the confidence of all students was significantly increased and there was no longer a statistical difference between students with and without prior ultrasound experience. Post-session content quiz performance improved relative to pre-session performance for all students; however, those students with an orientation session performed better on both quizzes. **CONCLUSIONS.** Prior use correlates with higher student confidence and more positive perspectives on the utility of ultrasound. Prior use also correlates with improved performance on both pre- and post-session quizzes, highlighting the importance of repeated exposure for improved efficacy.

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Not your average flashcards: “Images of the day” for practice testing of head and neck anatomy

INTRODUCTION. Active recall and practice testing activities promote learning and knowledge retention. Health professions students are introduced to a vast amount of anatomical information during foundational coursework. Anatomical knowledge must be learned and retained for theory and lab practical exams in the short-term and applied in clinical settings in the long-term. **RESOURCES.** A series of digital image flashcards of head and neck anatomy dubbed “Images of the Day” (IODs) were designed with varying levels of questions to test knowledge, comprehension and application (Bloom's levels 1–3). The goal of the IODs was to provide students with visually engaging, active recall and practice testing resources to prepare for the anatomy components of theory and lab practical exams in a first-year medical school course. **DESCRIPTION.** One to two representative images from each head and neck region were selected from photographs of prosected specimens, medical images, or illustrations capturing key views and relationships. Digital images were converted into formative assessment resources in PowerPoint by annotating with colorful arrows, outlines or symbols to ask questions related to identification of structures, functions, neurovascular supply, and clinical significance. Each IOD included 8–12 questions ranging from low to higher order difficulty and utilized active recall and practice testing methods.

Immediate feedback was provided for formative assessment. IODs were posted to the online course learning management system in PDF format. **SIGNIFICANCE.** The IODs are low-cost, high-yield, and visually appealing resources which provide learners with multiple levels of questioning to promote learning and retention of anatomical information. The IODs are an interactive and engaging approach to practice testing of course material. Students have given positive feedback, rating them 3.66 out of 4 on a Likert scale for helpfulness in learning and understanding the course material.

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Anatomical consideration of latissimus dorsi myocutaneous breast reconstructive surgery for patients

INTRODUCTION. Increased interest in breast cancer survivors to seek reconstructive surgery exists due to the amplified number of diagnoses and public awareness of breast cancer. Numerous surgical techniques to perform breast reconstruction exist, each indicated for a specific patient presentation. The latissimus dorsi myocutaneous (LD) flap is one of several viable options for breast reconstruction that can tolerate surgical transition with minimal post-operative complications; these options grant the additional benefits of a natural appearance and sensation recovery. However, patient education materials with detailed anatomical illustrations are lacking. **RESOURCES.** An extensive review of literature was conducted to obtain a detailed anatomical description of the LD flap. **DESCRIPTION.** The LD flap is a useful graft for women with low BMI who wish to have a scar easily covered by undergarments. The LD flap is a skin, muscle, and fat flap supplied by the thoracodorsal artery and the thoracodorsal nerve. Variability exists but does not pose an issue to relocation of the flap through the tunnel created subcutaneously. The skin island is reattached in the area of the defect and can be cutaneously reinnervated via neurotomy between the prominent intercostal nerves of the breast region. Women can have satisfactory results of the LD flap reconstruction, immediately or delayed. **SIGNIFICANCE.** Patients capable of immediate reconstruction have shown decreased satisfaction, potentially because of expectation for the breast to look exactly the same as the original breast. The recovery of sensation is vast, but will never return to the level before reconstruction. With increasing demands for surgeons to make a perfect breast, numerous techniques

presented to the patient can be overwhelming. It is important to supply adequate information concerning the LD flap operation for the patient to be informed and to have realistic expectations of the reconstruction outcome.

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Characterization of HILPDA-dependent lipid droplet abundance in a mouse model of pancreatic cancer

INTRODUCTION. Due to their microenvironment, pancreatic cancers are under different stresses, such as oxidative stress, hypoxia and nutrient deprivation. Accumulation of lipid droplets (LDs), which are storage organelles for neutral lipids, has been observed in a variety of tumors. Hypoxic conditions have been shown to increase LD formation through induction of the hypoxia-inducible and lipid droplet associated protein (HILPDA). One of the mechanistic functions of HILPDA is inhibition of adipose triglyceride lipase (ATGL). **METHODS.** A cell line derived from LSL-KrasG12D/+;LSL-Trp53R172H/+;Pdx-1-Cre (KPC), a genetically engineered pancreatic cancer mouse model, was used to test the hypothesis that HILPDA regulates LD abundance and tumor growth. HILPDA knockout (KO) cells were created by CRISPR-Cas9 technology to characterize HILPDA's function in KPC cells. Triglycerides (TGs) were biochemically quantified under basal and fatty acid loaded conditions. Wild type (WT) and KO cells were injected subcutaneously into nu/nu mice to compare tumor growth rates and TG levels in tumors of different HILPDA status. **SUMMARY.** Fatty acid supplementation increased TG storage and LD formation in KPC cells in a HILPDA-dependent manner. Inhibition of ATGL with a specific small molecule inhibitor did not ameliorate TG abundance differences between HILPDA WT and KO cells, suggesting that deregulated ATGL is not responsible for the absence of LDs in KO cells. The growth rate of the tumors in the nu/nu mice was decreased by HILPDA deletion. The WT tumors had almost double the TGs compared to the KO tumors. **CONCLUSIONS.** HILPDA positively regulated model tumor growth of KPC cells. In vitro, HILPDA regulated LD abundance independently of ATGL activity. This suggests additional novel biological roles for HILPDA in LD turnover in pancreatic cancer (e.g., through the stimulation of TG synthesis rather than TG hydrolysis).

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Gross and histological analysis of metastatic uterine leiomyosarcoma involving the liver

INTRODUCTION. Uterine leiomyosarcomas are malignant gynecological mesenchymal tumors known to metastasize to other organs, primarily the lungs. The present study concerns a 57-year-old human female cadaver known to have uterine leiomyosarcoma. Upon dissection, we observed an enlarged uterus and tumor-ridden liver. The lungs appeared normal except for a single nodule. The objective of this study is to determine whether the liver and lung pathologies resulted from uterine leiomyosarcoma metastasis. **METHODS.** Photographs were taken of the uterus, lung, and liver gross dissections. Histological sections from each organ were stained with hematoxylin & eosin (H&E) to examine tissue and cell structures. Immunohistochemical stains for nuclear protein Ki67, smooth muscle myosin (SMM), and smooth muscle actin (SMA) were performed to determine cell proliferation and uterine leiomyosarcoma metastasis. **SUMMARY.** The uterus presented as a 10.5 cm spherical mass. Physical appearance of the liver tumors varied but were notably vascular, contained by the liver capsule, and primarily localized to segments II, III, IVb, and V. The left lung presented with a 2 cm nodule on the anterior periphery of the superior lobe. H&E staining exposed tissue structures, invasion borders, hypoxic regions, cell nuclei shapes and sizes, and mitotic figures. Ki67 staining showed active states of proliferation for 19.2, 16.6, and 36.6% of uterus, lung, and liver cells, respectively. SMM and SMA staining was positive in the uterus and liver tumors only. **CONCLUSIONS.** The histological analyses confirmed uterine leiomyosarcoma metastasis as cause of the liver tumors but not the lung nodule. Since the lung is generally the primary location for metastasis, more thorough analyses of the lung parenchyma will be performed. Illustrating gross presentation and histological analyses of these pathologies may help physicians diagnose uterine leiomyosarcomas and choose most-effective patient treatment options.

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Anatomical landmarking of cervical nerves: 3D modeling study

INTRODUCTION. Chronic headache/neck pain are usually managed with pharmacologic and interventional measures, including nerve

block (NB)/radiofrequency ablation (RFA). NB/RFA require precise knowledge of the course of the greater (GON), lesser (LON), and third occipital nerves (3ON) and sensory innervation to cervical zygapophysial (ZP) joints relative to soft and bony tissue landmarks. No 3D studies investigating the relationships of these nerves were found. The purpose of the study was to capture and model in 3D the course of GON, LON, 3ON and sensory innervation to ZP joints to identify soft and bony tissue landmarks that could be used to locate the nerves with image-guidance systems. **METHODS.** In this pilot study, 1 formalin embalmed specimen (M/61) was used. GON, LON, and 3ON were identified, traced and digitized (Microscribe® G2X Digitizer). Articular branches of the posterior rami of C2-C7 were digitized to ZP joints, along with the skull and cervical vertebrae. The data were modeled in 3D (Autodesk® Maya®) and analyzed to determine the course of the nerves relative to soft and bony tissue landmarks. **SUMMARY.** The 3D models provided comprehensive visualization of the nerves. Anatomical landmarks that were identified included: (a) GON where it pierces semispinalis capitis just lateral to the nuchal ligament at level of posterior tubercle (C1); (b) LON just medial to the posterior border of the superior musculotendinous junction of sternocleidomastoid; and (c) two articular branches of 3ON and C4-C7 posterior rami where they pierce the medial part of the posterior cervical intertransversarius and coursed on the articular pillar. **CONCLUSIONS.** This proof of concept study demonstrated that the experimental protocol could provide novel 3D data of GON, LON, 3ON and the cervical sensory ZP innervation relative to soft and bony tissue landmarks. This methodology will be pursued, and the sample size increased to enable comparison of innervation patterns.

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The osseous anatomy of palatal tori observed utilizing cone beam computed tomography

INTRODUCTION. Edentulism is a common feature found in the elderly. As a means of regaining function, many patients utilize dentures which are a common prosthodontic device used to restore function to edentulous patients. Dental clinicians must observe the osseous anatomy of a patient's oral cavity and understand any potential anomalies that might complicate treatment planning. **RESOURCES.** Cone beam computed tomography (CBCT) was performed on a patient for dental evaluation. **DESCRIPTION.** CBCT was performed to evaluate recent dental implants. However, secondarily CBCT revealed a palatal torus in the midline of the patient's hard palate. **SIGNIFICANCE.** Dentures are held in place by seals created by close association of the denture to the mucosa. Palatal tori are bony protuberances of the palate that may have undercuts or other

irregularities that prevent dentures from maintaining their tight seal to the oral mucosa. In rare instances, excess growth of the vomer bone can pierce the median palatine suture to form a palatal torus. Palatal tori may also restrict full movement of the tongue which may lead to speaking difficulties. Issues with breathing may also occur depending on the size and location of the torus. Palatal tori must be removed for a proper seal in denture treatment. CBCT help clinicians visualize the extent of the osseous anatomy of palatal tori as well as anomalous anatomical features which might cause complications during removal.

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Aberrant right subclavian artery: Embryologic development and clinical implications

INTRODUCTION. Aberrant right subclavian artery is a rare anatomical variation of the origin of the right subclavian artery. Aberrant right subclavian artery is the most common aortic arch abnormality found in 0.5–2% of the population. The right subclavian artery typically arises from the brachiocephalic artery off of the arch of the aorta. During embryological development the right subclavian artery is typically derived from the proximal fourth aortic arch, the dorsal portion of the aorta, and the seventh intersegmental artery. In an individual with aberrant right subclavian artery the regression of the dorsal aorta is abnormally positioned and occurs between the seventh intersegmental artery and the right common carotid artery causing the right subclavian artery to be connected to the left dorsal aorta. As the artery develops, it will migrate until it is just distal to the left subclavian artery. During a dissection laboratory an aberrant right subclavian artery was discovered. **RESOURCES.** One cadaveric specimen donated to the Ohio State University's Body Donor Program was utilized using standard dissection procedures. **DESCRIPTION.** The right common carotid artery was dissected from the neck and cleaned distally towards the brachiocephalic trunk. The brachiocephalic trunk did not give rise to the right subclavian artery, which was found to be deep to the brachiocephalic trunk as an aberrant right subclavian artery. The artery was dissected and was found to course behind the trachea and esophagus to its origin on the aortic arch just distal to the left subclavian artery. The right recurrent laryngeal nerve was discovered to be a non-recurrent laryngeal nerve as it did not loop underneath the right subclavian artery due to the artery malformation and entered the larynx directly. **SIGNIFICANCE.** Providing familiarity with anatomical anomalies, such as the aberrant right subclavian artery, is essential for clinicians and anatomists for educational and medical purposes.

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Bilateral persistent median artery and its implications for carpal tunnel syndrome

INTRODUCTION. The median artery is a major supply of blood to the forearm and hand during early embryonic development. During the eighth week of intrauterine life, the median artery usually regresses due to the development of the ulnar and radial arteries. In some individuals, the median artery remains as a vessel accompanying the median nerve through the carpal tunnel called the persistent median artery. The persistent median artery commonly originates from the ulnar artery, common interosseous artery or the anterior interosseous artery. The persistent median artery is found in about 8% of the population and is typically unilateral. During anatomical dissection of the forearm, a bilateral persistent median artery was discovered. **RESOURCES.** One cadaveric specimen donated to the Ohio State University's Body Donor Program was utilized using standard dissection procedures. **DESCRIPTION.** During routine laboratory dissection, the persistent median artery was discovered as a bilateral structure arising from the ulnar artery. In both forearms, the artery was found to course with the median nerve through the anterior compartment of the forearm and into the carpal tunnel. **SIGNIFICANCE.** Carpal tunnel syndrome is the most common nerve entrapment in the upper extremity. Carpal tunnel syndrome involves the compression of the median nerve as it passes through the carpal tunnel. The persistent median artery can contribute to carpal tunnel syndrome due its close proximity to the median nerve. Identification and knowledge of the persistent median artery is crucial for potential clinical treatment of carpal tunnel syndrome.

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A case of multiple simultaneous brachial plexus anomalies in one specimen

INTRODUCTION. In a typical brachial plexus, upper, middle, and lower trunks subdivide into anterior and posterior divisions reflecting flexor and extensor compartment innervation, respectively. Posterior

divisions combine to form the posterior cord, anterior divisions combine to form medial and lateral cords, which give rise to terminal branches. In the present case, several reported and unreported variations were found within the same plexus of one cadaver. These configurations which have not been reported together in previous studies are clinically significant. **RESOURCES.** The variations of the brachial plexus were found during routine dissection of a 77-year-old female cadaver at PCOM GA Anatomy lab. Typical dissection techniques were utilized to expose the brachial plexus. **DESCRIPTION.** The following variations were found: (a) Posterior division coming from C8, instead of typical position from lower trunk. (b) Axillary nerve arising from posterior division of upper trunk without contributions from C7, C8, T1. (c) Contribution from C7 abnormally piercing pectoralis major. (d) Medial pectoral nerve absent. (e) Anterior division of middle trunk contributing to lateral cord absent. (f) Absent contribution from C7 to musculocutaneous nerve. (g) Anterior division of middle trunk directly contributing to lateral contribution of median nerve. (h) Posterior division of upper trunk contributing to posterior cord distal to emergence of thoracodorsal nerve. (i) Long thoracic nerve is missing a contribution from C7. **SIGNIFICANCE.** Although variations have been well documented, there have been few discoveries of multiple variations occurring in one extremity. Clinically, the present case would have exhibited atypical myotome and dermatome patterns on assessment. Knowledge of these variations of the brachial plexus are clinically crucial not only to physical therapists but to other medical professionals, especially in cases of thoracic outlet syndrome and brachial plexus nerve blocks.

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Intra and extramuscular innervation of tibialis anterior: Implication for botulinum toxin injection

INTRODUCTION. Lower limb post stroke spasticity can be treated using botulinum toxin (BTX-a) injections to improve function by chemodenervation. To optimize BTX-a injections, nerve entry-points and intramuscular innervation pattern must be defined. Tibialis anterior (TA) is commonly affected, resulting in impaired gait. Currently, a single TA injection site into the proximal third of the muscle belly is recommended. TA innervation patterns have not been studied volumetrically. The purpose is to determine the intramuscular innervation of TA in 3D to characterize potential sites to optimize BTX-a injection. **METHODS.** In 8 embalmed specimens (mean age 84 ± 10.6 years), the nerve entry points of

the deep fibular nerve (DFN) were exposed, and each branch was traced in short segments and digitized (Microscribe® G2X Digitizer). The muscle volume, tibia and fibula were scanned (FARO ScanArm). Data were modeled in 3D (Autodesk® Maya®) to document and compare the innervation patterns of TA. A frequency map was used to propose potential BTX-a injection sites. **SUMMARY.** The DFN close to its bifurcation from the common fibular nerve gave off 2 main branches, superior (SB) and inferior (IB), and then coursed along the lateral margin of the TA giving off 5–13 motor branches. Both the SB and IB supplied the proximal and middle thirds of the muscle belly. SB supplied the region anterior to the central aponeurosis and IB the region posterior to it. Branches from the DFN entered the middle and distal thirds of TA. The location where both DFN and IB could be captured was in the middle third of TA deep to the aponeurosis. SB and IB could be captured in the central part of the proximal muscle belly. **CONCLUSIONS.** Intramuscular innervation of TA was from the SB, IB and DFN, each having a distinct area of innervation. These distinct areas could be targeted by BTX-a injection at two levels. Further study of injectate spread will be carried out to determine the extent of potential nerve capture.

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Anatomical injection model strengthens clinical skills in dental and emergency medicine trainees

INTRODUCTION. Failure rates for local oral anesthesia are reported as high as 15–20% and are attributed to a variety of factors including abnormal anatomy, poor technique, and psychological factors. These factors are likely to have the greatest impact when injections are performed by dental medicine trainees or within specialties, such as emergency medicine, where little to no training of local oral anesthesia exists. The aim of this study was to develop an anatomical model for mandibular and maxillary oral injections with realistic tissue feedback and real-time visualization of anatomical landmarks and needle placement. **METHODS.** Lightly embalmed anatomical donors were prepared to provide intact oral landmarks with minimal loss of relevant anatomy of the injection placement sites. Real-time

visual feedback regarding injection placement was provided via a camera for the inferior alveolar nerve block along with the anterior, middle, and posterior superior alveolar nerve blocks. To investigate the effectiveness of the model, dental students and residents along with emergency medicine (EM) residents and EM-interested medical students performed injections with the model. A pre and post survey was administered to determine self-efficacy for dental injections and general knowledge of anatomical landmarks for local oral anesthesia. Following the session with the anatomical models, attendees also participated in a focus group. **SUMMARY.** Marked improvement with self-efficacy was demonstrated after performing oral injections with the anatomical donor model. Thematic analysis from the focus group highlighted the model's ability to decrease anxiety and increase confidence, visualize/feel landmarks and technique approaches, and experience injections with anatomical variations and with edentulous patients. **CONCLUSIONS.** The anatomical model provided significant feedback and improved self-efficacy even for attendees with previous experience with local oral anesthesia.

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Introduction of morphological stroke risk factors of PFO (MorPFO) score

INTRODUCTION. Determining which specific patent foramen ovale (PFO) features are conducive to stroke may significantly improve prognoses, medical therapies, and the likelihood of reducing stroke recurrence. Therefore, the aim of this study was to evaluate the differences in the morphometric and functional features of the PFO channel in cryptogenic stroke and non-stroke patients. **METHODS.** A total of 106 consecutive patients with cryptogenic stroke and 93 non-stroke control patients with diagnosed PFO (by transesophageal echocardiography) were analyzed. **SUMMARY.** Multivariate regression logistic analyses indicated PFO channel length change (OR: 2.50 [95%CI:1.75–3.55], $p < .001$), the PFO length/height ratio during the Valsalva maneuver (OR: 0.75 [95%CI:0.60–0.95], $p = .015$), septum primum thickness (OR: 0.34 [95%CI:0.14–0.80], $p = .013$), septum secundum height (OR: 0.91 [95%CI:0.84–0.98], $p = .013$), the presence of an atrial septal aneurysm (OR: 3.38 [95%CI:1.27–8.97], $p = .014$), and large shunt (OR: 2.49 [95%CI:1.13–5.46], $p = .022$) as PFO-related risk factors for stroke. The MorPFO score was developed (AUC = 0.816, SD = 0.031), where six factors were included: PFO

channel length reduction (= 23%) (3 pts), low length/height ratio during the Valsalva maneuver (= 2.1) (1 pt), thin septum primum (= 1.5 mm) (1 pt), short septum secundum (< 5.6 mm) (1 pt), presence of an atrial septal aneurysm (1 pt), and large right-to-left shunt (1 pt). Patients with scores of 0–2 pts had low-risk PFO channels, 3–4 pts intermediate-risk PFO channels, and 5–8 points high-risk PFO channels. **CONCLUSIONS.** The MorPFO score developed in this study may be used to indicate high-stroke-risk PFO channels.

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Depth of muscular components of midface by ultrasonographic analysis

INTRODUCTION. Midface is the middle third of the face. The first signs of face aging appear in this zone. That's why several facial rejuvenation procedures are performed here. However, no clinical anatomy guidelines in terms of depth have been published. The aim of this research was to describe depth of midface muscles using Ultrasonographic (US) imaging in order to provide a critical clinical anatomical guideline to improve clinical procedures. **METHODS.** Ninety-five volunteers (53 males and 42 females; Age: 19–36 years). Twelve facial landmarks (P) were assessed. US analysis by axial and sagittal plane was carried out. NIH'S imageJ was used for depth measurement. Student's T-test for statistical difference by sex. $p < .05$ was considered significant. **SUMMARY.** Orbicularis oculi was found in P1, P2, P3, and P4, Levator labii superioris alaeque nasi (LLSAN) in P1, P5, and P9; Levator labii superioris in P2, P5 P6, P9, P10; Zygomatic minor in P4, P7, and P11; Zygomaticus major in P8, P12 (in both planes). LLSAN's depth was significantly different between sexes in sagittal plane [P5 ($p = .017$), P9 ($p = .026$)] meanwhile depth of zygomaticus major [sagittal plane P8 ($p = .001$), P12 ($p = .009$); axial plane P8 ($p = .000$), P12 ($p = .001$)] and zygomaticus minor [sagittal plane P4 ($p = .018$), P7 ($p = .000$), P11 ($p = .010$); axial plane P4 ($p = .000$), P7 ($p = .000$), P11 ($p = .010$)] were significantly different in both planes, being deeper located in female sample. **CONCLUSIONS.** The current research provides a deeper knowledge about midface and its muscular component in term of depth, using

ultrasonographic imaging and living human beings as sample. Suggesting that depth of midface muscles vary by sex mainly in zygomaticus muscles and levator labii superioris which tend to be deeper located in females. This could be helpful to develop anatomical guidelines for procedures in this zone. [Sponsored by Grant No. NRF-2020R1A2B5B01002238 from the National Research Foundation of Korea (NRF) Association.]

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Anatomical donor luncheon: A transformational experience for medical students

INTRODUCTION. The University of Oklahoma Health Sciences Center hosts an annual Anatomical Donor Luncheon during student orientation week. The purpose of the luncheon is to provide an opportunity for families to share the life story of the anatomical donors with medical students assigned to their deceased family member prior to the start of the anatomy course. Students are advised to keep the conversation focused on the life stories of the deceased, and active listening strategies are demonstrated to facilitate this process. Upon completion of the anatomy course, students conduct a service of appreciation and submit a brief reflection paper regarding the impact of meeting the donor's family on their gross anatomy experience. The purpose of this qualitative study is to determine medical students' perceptions of donor family-student interaction on their anatomy learning experience. **METHODS.** Student reflection papers were retrieved via learner management system and were coded using the constant comparative method to saturation. Data was triangulated and themes developed by faculty investigators and doctoral students in an iterative review process. (IRB #10624). **SUMMARY.** A meta-theme of Positive Transformational Experiences was identified. Subthemes included Student Gratitude Regarding Experience, Donors as Student Motivators, and Contextual Influences Alter Student Attitudes. Anecdotally, faculty reported cessation of inappropriate student comments and behavior regarding the anatomical donors since the luncheon's inauguration. **CONCLUSIONS.** Though some initially expressed reservations about meeting donor families, upon reflection students recognized the value of learning the life stories of their "first patients." The overwhelmingly positive effects of donor family-student interaction on medical students may contribute to professional identity development and need to be considered when debating the ethics of the use of protected health information (PHI) of donors.

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Longitudinal muscle fibers in the pyloric sphincter and their possible function

INTRODUCTION. The present study was conducted to investigate the existence and function of the longitudinal fibers in the pyloric sphincter. **METHODS.** Stomach and duodenum were obtained from 42 Korean adult cadavers. Pyloric sphincters and their adjacent stomach and duodenum of 30 specimens, were dissected under a surgical microscope. Six specimens were histologically analyzed using the staining of hematoxylin and eosin, and Masson's trichrome. Another six specimens were scanned using micro-computed tomography (micro-CT). **SUMMARY.** Some longitudinal fibers of the stomach were found to enter the pyloric sphincter and divide into several bundles to intermingle with the sphincteric circular fibers in all specimens by microdissection and micro-CT. Histologic observation showed that these longitudinal fibers terminated at the muscle fascia of the circular fibers of the pyloric sphincter or blended with the sphincteric circular fibers. A thin and loose muscular coat was found inside the internal thick circular fibers of the sphincter, and some longitudinal fibers from the muscular coat divided to blend with the circular fibers of the duodenum at the adjacent region. The possible role of the longitudinal muscle fibers in the function of pyloric sphincter was simulated using a mathematical model, which may strengthen antroduodenal motility during tonic and phasic pyloric contractions. **CONCLUSIONS.** These results are expected to provide helpful information for advancing the current knowledge on the physiology of the pyloric sphincter.

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An anatomic study of the anterior muscle fibers of the transverse part of the nasalis

INTRODUCTION. The aim of this study was to clarify the arrangement of the anterior muscle fibers of the transverse part of the nasalis

(Nasalis-t) and its relationships with the surrounding muscles. **METHODS.** Facial muscles were investigated in 20 specimens obtained from formalin-fixed Korean adult cadavers. **SUMMARY.** Some anterior fibers of the Nasalis-t were branched from the arising fibers of the Nasalis-t that originated from the incisive fossa of the maxilla. These anterior fibers of the Nasalis-t ascended superiorly or superolaterally to intermingle or blend with the deep fibers of the levator labii superioris muscle (LLS) in all specimens and sometimes also with the zygomaticus minor muscle (Zmi). The intermingled fibers of the Nasalis-t with the LLS and Zmi were attached to the skin lateral to the nasal ala. In the cases that the anterior fibers of the Nasalis-t were distinctive, these muscle fibers were arranged in a fan shape in front of the Nasalis-t and between the Nasalis-t and incisivus labii superioris muscle, located deep to the LLS and Zmi. The quantity and extension of these fibers varied among the specimens. The possible actions of the anterior muscle fibers of the Nasalis-t with the surrounding muscles were simulated using a mathematical model for their analysis. **CONCLUSIONS.** When the Nasalis-t compresses the nostrils, the anterior muscle fibers of the Nasalis-t are likely to pull the skin lateral to the nasal ala inferomedially toward the incisive fossa of the maxilla (origin of the Nasalis-t). These results might contribute to understanding of the detailed movements of the face and will be helpful for when botulinum toxin type A therapies and electromyographic analyses in this area. (Sponsored by Grant No. 2020R1C1C1003237 from National Research Foundation of Korea [NRF] by the Korea government [MSIT].)

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Chordae within the transverse sinus: Application to understanding transverse sinus thrombosis

INTRODUCTION. It has been suggested that trabeculae within the transverse sinuses (chordae Willisii) might restrict venous blood flow, contribute to idiopathic intracranial hypertension, and result in thrombus organization. To investigate this potential cause of transverse sinus thrombosis, the anatomy of the trabeculae of the transverse sinus needs to be investigated in detail. Therefore, the current study aimed to better elucidate these structures within the transverse sinus via a morphological study in fresh cadavers. **METHODS.** Thirty fresh-frozen cadaveric transverse sinuses were dissected and their detailed intraluminal morphology recorded. Classification schemes were applied based on the anatomy and orientation of each chordae. The morphology of the chordae was documented. **SUMMARY.** Out of 30 sides,

34 chordae were identified; one chorda was found in 36.7%, two chordae in 23.3%, three chordae in 10.0%, and 30.0% had no chordae. Overall, chordae were found in 86.6% of right sides and 53.3% of left sides. There was a statistically significant difference between the number of chordae in left and right sides ($p < .01$). Chordae were classified into three different types based on their shape and size; Type I: Thin string-like (29.4%), Type II: Narrow sheet-like (41.2%), Type III: Wide plate-like (29.4%). **CONCLUSIONS.** To date, a comprehensive anatomical evaluation of the intraluminal chordae of the transverse sinuses has been lacking. This study furthers our understanding of the internal architecture of the transverse sinus. Knowledge of these bands is essential for those performing endovascular procedures of the dural venous sinuses and for those interpreting imaging of these structures.

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Anatomic variation of aortic arch branches: A rare case of Lusoria artery with a bicarotid trunk

INTRODUCTION. The right subclavian artery (RSA) is typically the first branch of the aortic arch; however, several variants have been described. One rare RSA variant emerges from the proximal descending aorta (Lusoria artery). **RESOURCES.** Lusoria artery was observed in an 84-year-old male cadaver who died of myocardial infarction. **DESCRIPTION.** The Lusoria artery emerged from the proximal descending aorta and coursed transversely across the posterior mediastinum deep to the esophagus. A bicarotid trunk was also observed originating from the aortic arch; these variations are rarely observed together. It is reported that 2/3 of the population having Lusoria artery are asymptomatic. The presence of symptoms likely depends on other variants (e.g., bicarotid trunk). Several hypotheses have been proposed to explain why some people are asymptomatic, but later become symptomatic. One is increasing esophageal rigidity with advancing age, leading to dysphagia caused by the retroesophageal course of the artery. Another is that the bicarotid trunk gives rise to right and left carotid arteries in close proximity, thus preventing the trachea and esophagus from bending forward where the Lusoria artery crosses. Calcification and aneurysm at the origin of Lusoria artery have been reported. We excised this region and found extensive calcification and a greatly thinned wall. This section of the artery appeared “folded upon itself”, possibly preventing noticeable blood loss. **SIGNIFICANCE.** Patients with Lusoria artery may present with mild respiratory distress, dysphagia, and other less frequently observed symptoms. This anomaly is adequately common to demand the attention of vascular surgeons confronted with a superior mediastinal mass accompanied by symptoms of Lusoria artery. Awareness of diminished vascular wall thickness at the Lusoria artery origin (which could lead to aneurysm) is an important consideration when proceeding with treatment.

JOHANSEN, KRISTA, VIVEK KUMAR, MICHAEL MASTROIANNI, AND YOUSAF FARUKHI**Tufts University School of Medicine, Boston, MA 02111, USA****Joint ventures: Glycerin fixation of human cadaveric joints to facilitate integrated learning**

INTRODUCTION. Joint complaints are in the top 5 reasons patients seek healthcare. Osteoarthritis (OA) is the leading cause of disability in older patients; CDC reports OA occurs in ~25% of the adult population with annual costs of \$150 billion. In addition, rotator cuff tears occur in ~20% of the population and incidence increases with age. These statistics underlie the importance of teaching functional joint anatomy in medical education so healthcare providers are confident in diagnosing and treating joint disorders. Students consistently prefer cadaveric lab dissection over non-cadaveric methods to facilitate an understanding of anatomy. Yet, coverage of joint anatomy through student dissection often lacks both timeliness and time. **RESOURCES.** Joint specimens were prepared using glycerin fixation methodology. Specimens were fixed in formalin, dehydrated in acetone, and treated with glycerin. The process is simple and inexpensive. Joint specimens can be prepared to highlight healthy tissue as well as pathologies and arthroplasties. Samples and an accompanying digital lesson plan are used in an integrated curriculum to boost students' knowledge, confidence, and clinical application. **DESCRIPTION.** To apply a methodology to facilitate efficient and effective learning of functional and clinical joint anatomy in an integrated curriculum. **SIGNIFICANCE.** Glycerin fixation allows for anatomical specimens to be stored for long duration in a dry environment. This simple, inexpensive methodology addresses issues of plastination as samples retain flexibility. Specimens can be integrated to cover subject material that fast-paced anatomy curricula would otherwise be rushed to dissect. Specimens can be coupled with digital technology, independent and collaborative learning and as a complement to student dissection. In addition, specimens can be used in multiple settings and levels of training.

JOHNSTON MAI-LAN¹, EMMA S. CAMPISI¹, CATHERINE AMARA², AND ANNE M. R. AGUR¹**¹Division of Anatomy, Department of Surgery, University of Toronto, Toronto, ON M5S 1A8, Canada;****²Faculty of Kinesiology and Physical Education, University of Toronto, Toronto, ON M5S 2W6, Canada****Median nerve innervation of flexor digitorum superficialis: Implications for botulinum toxin therapy**

INTRODUCTION. Post-stroke spasticity of flexor digitorum superficialis (FDS) limits functional capability. Botulinum toxin injections

into FDS can reduce spasticity by blocking the presynaptic release of acetylcholine. Clinically it is recommended that FDS be injected at the mid-forearm level. In order to develop more effective injection strategies to target single bellies of FDS the intramuscular innervation of each belly must be elucidated, as current studies are scarce and 2-dimensional. The purpose of this study is to: (a) document and model in 3D the intramuscular innervation pattern of FDS and (b) to use the 3D models to propose strategies that could target the entire muscle or each belly. **METHODS.** The median nerve entry points and intramuscular branching patterns were serially dissected and digitized (MicroScribe[®] Digitizer) in 8 embalmed specimens (mean age 87.3? 6.3 years). The data were reconstructed into 3D models (Autodesk[®] Maya[®]) that were used to visualize, document, and compare the innervation patterns of the median nerve within the bellies of FDS. Models were used to identify possible optimal injection sites. **SUMMARY.** The FDS was found to be innervated by two branches of the median nerve, proximal and distal. The entry points of both branches were located in the superior third of the muscle belly. The proximal branch was superficial and supplied the proximal FDS belly and then continued to branch intramuscularly into digital bellies 2, 4, and 5. The distal branch of the median nerve independently supplied the third digital belly. It should be noted that the third digital belly was located deep to the proximal head of FDS. **CONCLUSIONS.** The proximal and distal branch of the median nerve supply specific bellies of FDS. This suggests that botulinum toxin injection could be enhanced if each nerve territory was injected, including that of the third FDS belly. Injectate spread studies will be conducted to confirm nerve capture.

KABBASH, MICHEL S., AND JICKSSA GEMECHU**Foundational Medical Studies, Oakland University William Beaumont School of Medicine, Rochester, MI 48309, USA****The recurrent laryngeal nerve and its vulnerability in thyroid surgeries**

INTRODUCTION. Although thyroid procedures are very common, research has shown that post-operative complications may dramatically affect the patient's quality of life. In order to decrease the rate of these occurrences, researchers have studied the branching patterns of the recurrent laryngeal nerve (RLN) to avoid its iatrogenic injury. Awareness of variations in the RLN's relationship with the inferior thyroid artery (ITA) is clinically significant to preserve the nerve and minimize associated postoperative symptoms. The normal course of the nerve was described as superior to the ITA and posterolateral to the ligament of Berry; however, it has been noted that the RLN's course can be different, and the identification of its different branches

is important in thyroid surgeries. Failure to do so increases the possibility of iatrogenic injury, which can lead to hoarseness, loss of voice, or closure of the vocal cords during bilateral RLN damage. **METHODS.** In this study, 34 formalin-fixed cadavers were carefully dissected and examined, with the course of the RLN and ITA evaluated and documented bilaterally. Cadavers with anatomical variations were photographed and the data was analyzed quantitatively. **SUMMARY.** In our investigation, we found that out of 34 cadavers, 55.8% of the RLNs were related superiorly to the respective ITAs, and 44.11% were related inferiorly. Additionally, our findings indicate that 50% of the RLNs bifurcated, 41.17% trifurcated, and 8.82% had four branches. Altogether, the findings show a significant amount of variation in the relationship and branching pattern of the RLN and ITA. **CONCLUSIONS.** The different branching patterns of the RLN increases its vulnerability during ligation of the ITA in thyroid surgeries. Knowledge of these variable relationships is critical for identification and isolation of the neurovascular structures in order to preserve the nerve, prevent voice hoarseness, and minimize the risk of voice loss in thyroid surgeries.

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Morphometric analysis of psoas major muscle to lumbar vertebrae ratio: A cadaveric study

INTRODUCTION. The dimensions of the psoas major muscle (P) has been utilized to evaluate sarcopenia as an indicator of pre-surgical risk. The optimal anatomic location for the measurement of P has not been determined. The goal of this study was to select an optimal site for measurement of P and determine the utility of an anatomic ratio between P and skeletal dimensions as an index independent of body height (H). The size of P in these elderly cadaver donors was small and not anticipated to affect the results of this study. **METHODS.** Measurements were taken of the diameter (D) and circumference (C) of both P and lumbar vertebrae (L) on 34 adult cadavers ($N = 34$) at the level of L4 and L5. Cross sectional areas (A) of P and L were calculated. Ratios of psoas area (PA) to lumbar area (LA) were compared between the L4 (PA4:LA4) and L5 (PA5:LA5) levels. Correlation coefficient analysis was performed using the P:L ratios to assess the association with donor H. **SUMMARY.** P:L ratios were calculated in

25 female and 9 male cadavers ($N = 34$) at the L4 and L5 levels. The mean donor age was 79 ± 9.8 years, H was 1.63 ± 0.1 m and BMI was 22.6 ± 6.3 kg/m². The standard deviations (SD) for both PA and psoas circumference (PC) were less at the L4 level (PA4 \pm 1.56 cm and PC4 \pm 1.16 cm) than the SD at the L5 level (PA5 \pm 1.74 cm and PC5 \pm 1.38 cm). The PA demonstrated a moderate positive correlation (0.343) with donor H at the L4 level and a weak positive correlation (0.224) at the L5 level. In contrast, the PA:LA ratios demonstrated a weak negative relationship with donor H at both L4 (-0.094) and L5 (-0.162) levels. **CONCLUSIONS.** This study supports the measurement of P at the L4 level rather than the L5 level and confirms that the PA:LA ratio is independent of donor H. We recommend using the PA:LA ratio at the L4 level to evaluate for sarcopenia as an indicator of pre-surgical risk in future clinical studies.

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3D topographic distribution of the superficial temporal artery by MATLAB analysis

INTRODUCTION. Temporal region is the target area that frequently performed for the various aesthetic procedures such as thread lifting, filler and botulinum toxin injections. The frontal branch of the superficial temporal artery (FBrSTA) is the major vascular branch located at the superficial temporal area. The aim of this study is to analyze the distribution of the FBrSTA with the three-dimensional facial capturing technique to obtain the precise topographical data to provide safe and efficient procedures for the Asians. **METHODS.** Forty-four embalmed adult Korean and Thai hemifaces (29 Koreans and 15 Thais; 22 males and 22 females; mean age of 78 years) were used. Each hemiface was dissected carefully to trace the FBrSTA within the superficial temporal area and a structured-light 3D scanner (Morpheus3D) was used to scan. All the scanned images were aligned based on Frankfort horizontal line and overall scanned FBrSTA images were superimposed by MATLAB software, then analyzed the FBrSTA. **SUMMARY.** A 3 by 3 chart was established evenly inside the average sized rectangular shape and delineated. Where four angular points from the rectangular shape chart are lateral canthus, two lines intersecting perpendicularly from the lateral canthus and tragus, frontal eminence, and two lines intersecting perpendicularly from the frontal eminence and the tragus. The image data from the MATLAB was merged with the established standard chart. According to the

analyzed data, the distribution of the FBrSTA was classified into 3 types A, B, and C from one of the vertical columns in the middle of the standard chart. The distribution was made based on the three rows in the column. Type A is upper region (20.5%, 9/44); Type B is middle region (54.5%, 24/44); and Type C is lower region (25%, 11/44) respectively. **CONCLUSIONS.** Throughout this research, it is observed that there were mainly three morphological distribution types of FBrSTA, and this finding can be used for clinical guidance.

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Does the use of 3D images reformatted from an anatomage table enhance learning of anatomy?

INTRODUCTION. Biomechanical assessment and treatment skills taught in the musculoskeletal courses for physical therapy (PT) students require an in-depth understanding of human anatomy. Traditionally, instructors have used images from anatomy textbooks to review the relevant body region of focus. The Anatomage Table is a fully segmented, real human, anatomy teaching system that many programs use to teach anatomy. Individual anatomic structures can be reconstructed in 3D. To date, use of the Anatomage Table to review the relevant anatomy within our PT courses has not been explored. The purpose of this study was to explore an innovative use of the Anatomage Table outside of the anatomy course in the PT program and to investigate whether students' use of 2D anatomy images translated to both 2D and 3D anatomical knowledge. **METHODS.** Thirty-nine PT students participated. Four separate anatomy tests, focusing on different body regions, were given (shoulder, elbow, cervical spine, and wrist and hand). Prior to each test, images from an anatomy textbook relevant to the body region to be studied were posted. Each student was asked to take two versions of the test: traditional paper test with 10–12 labeled structures to be identified and a 3D video test where 10–12 short (20 sec) dynamic, labeled, video clips were presented to the class with students asked to identify labeled anatomy. The 3D test was always administered first. **SUMMARY.** Scores on the 3D tests were significantly lower than the traditional 2D test. For particular body region tests, statistically significant differences were found for the elbow and cervical spine. **CONCLUSIONS.** Findings suggests learning from static images may not carry over to being able to identify the same anatomic structures in 3D. Providing more

3D resources and integrating more 3D dynamic anatomy into courses where a strong appreciation for spatial relationships is needed may be an effective teaching practice.

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A story full of twists and turns: Investigating the causes of splenic artery tortuosity

INTRODUCTION. The splenic artery is well known for its conspicuously tortuous path, often having many loops, turns, and even elaborate coils. Previous hypotheses suggest that the coiled nature of the artery accommodates the expansion of the stomach, the movement of the diaphragm, is a result of higher blood pressure, or even the result of vascular disease. Pathologically tortuous vessels are more likely to experience aneurysm. The purpose of this study is to quantify splenic artery tortuosity and identify explanatory and confounding factors. **METHODS.** One hundred thirty-one formalin-fixed donors were dissected to expose the splenic artery from its origin on the celiac trunk to its branching prior to entering the spleen (63 females, 68 males, aged 50–101 years). Vessel tortuosity, vessel diameter, vessel wall thickness, and splenic volume were measured with spreading calipers. Presence, extent and calcification of atheroma was visually observed. Sex, age of death, and cause of death were abstracted from donor records. Correlations between variables were calculated to explore potential relationships. ANCOVA was used to examine variable effect magnitude on tortuosity. All analyses were performed with $\alpha = 0.05$ in SPSS v26. **SUMMARY.** The average tortuosity index is 1.80 (1.00–4.08) and 51.1% of the sample had atheromas. No significant associations exist between tortuosity and the other parameters. The general linear model shows that vessel thickness, splenic volume, and presence of atheroma influence tortuosity, explaining 0.5, 15.1, and 7.1% of the variation in tortuosity, respectively. All other variables

have no effect. **CONCLUSIONS.** Results suggest that vascular health and biomechanical factors influence tortuosity. Atherosclerotic plaques would alter blood flow dynamics, vessel dimensions, and vessel wall microstructure. An incidental finding of marked splenic artery tortuosity in a patient could indicate systemic vascular disease that warrants further investigation.

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Assessment of ultrasound-guided anteromedial and posterolateral rotator interval injections

INTRODUCTION. Ultrasound guided intra-articular rotator interval (RI) injections are commonly used to treat adhesive capsulitis pain. Pain reduction has been reported to vary depending on the injection approach, however the approaches have not been investigated anatomically. The purpose was to determine, using anteromedial and posterolateral RI injections, the: 1.area/extent of intra-articular injection spread, 2.extracapsular structures that would be captured, and 3.efficacy of both approaches. **METHODS.** Ten lightly embalmed cadaveric specimens (mean age 87 ± 11 years/8 M,2F) were injected ($n = 5$ anteromedial/ $n = 5$ posterolateral approach) with 5 ml of methylene blue. The specimens were serially dissected to identify extracapsular structures that were captured. To determine intracapsular dye spread, an incision was made into the anterior aspects of the joint capsule and retracted to reveal the extent and area of intra-articular dye spread. Dye spread was compared between approaches. All specimens were photographed throughout the dissections. **SUMMARY.** Extracapsular ligaments (coracoacromial, coracohumeral, and transverse humeral) were completely stained in both approaches. Intra-articular injections in all 5 specimens using the posterolateral approach and 3/5 specimens using the anteromedial approach resulted in complete capture of the humeral head, glenoid fossa/labrum, tendon of long head of biceps in the joint cavity/intertubercular groove, and superior, middle, and inferior glenohumeral ligaments. In 2 specimens using the anteromedial approach, the dye spread was limited to the superior third of the anterior capsule. **CONCLUSIONS.** The posterolateral approach consistently captured the entire joint, whereas the anteromedial approach was not consistent. Our initial data provides preliminary evidence that the two approaches may not have the same clinical outcome. This pilot data will be used to calculate an appropriate sample size for each group, based on observed differences.

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Anomalous origin of middle colic artery from celiac trunk—A case report

INTRODUCTION. Three main arteries supply gut: celiac trunk, superior mesenteric and inferior mesenteric arteries. Celiac trunk is the artery of the foregut, arising from the abdominal aorta at the T12 vertebral level. Normally it divides into three branches: left gastric, common hepatic, and splenic arteries. Superior mesenteric artery is the artery of the midgut, arising from the abdominal aorta at L1 vertebral level. It gives rise to the inferior pancreaticoduodenal, middle colic, right colic, ileocolic, jejunal, and ileal arteries. Inferior mesenteric artery originates from abdominal aorta at L3 vertebral level and gives rise to left colic, sigmoidal and superior rectal arteries. **RESOURCES.** During routine dissection for MD students, we found a rare variation in the origin of middle colic artery. After opening the abdominal cavity, celiac trunk was identified and its branches were traced. **DESCRIPTION.** In addition to the normal branches of the celiac trunk, we found the middle colic artery originating from the celiac trunk instead of the superior mesenteric artery. After originating from celiac trunk it courses posterior to the portal vein behind pancreas, then entered transverse mesocolon to supply transverse colon. **SIGNIFICANCE.** The incidence of such an anomaly is low and there have been very few previous reports. These arterial variations are of great importance while performing surgery on abdominal cavity.

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Role of Sihler's staining technique in teaching innervation of skeletal muscles to medical students

INTRODUCTION. Clinical anatomy teaching requires clinical experience and sound knowledge of anatomy. It may be challenging for a

year-1 medical student to distinguish small nerve branches from adjacent structures in a formalin embalmed cadaver. Our aim was to study the extra-muscular and intra-muscular innervation pattern of skeletal muscles. **METHODS.** We studied innervation of skeletal muscles of the hand from six upper limbs using the modified Sihler's staining technique. After staining, specimens were soaked in glycerol and sealed in airtight acrylic jars for extended preservation. The location of the intramuscular nerves in relation to the surfaces of the muscle belly was documented. Once the staining process was complete, the superficial and deep surfaces of the muscles were photographed, using a back-light technique. **SUMMARY.** During the process of Sihler's staining, the entire neurovascular bundle (artery, vein & nerve) gets stained; but the nerve takes up the stain most deeply, the contrast is striking and clear. The stain binds to DNA due to the electrostatic attraction. Using this method, the entire nerve supply can be mapped without interruption as the integrity of the nerve branches including dense nerve plexuses are preserved. The precise intramuscular nerve branching and distribution patterns can be documented with the peripheral course, extra muscular branching and the entry point of a given nerve is seen clearly. Furthermore, neural organization within the structurally complex organs can be demonstrated even if it is innervated by two or more nerves. This staining technique renders muscle translucent and stains the myelin in the nerve as dark blue. **CONCLUSIONS.** The details of intramuscular nerves could be demonstrated without the need for meticulous dissection of individual nerve branches. The student would be decisive before placing a surgical incision to prevent inadvertent nerve injury and possible injury to adjoining neurovascular structures.

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Hiring a research consultant to assist anatomy faculty members in expanding scholarly activities

INTRODUCTION. At West Virginia University (WVU) School of Medicine, the Anatomy Division of the Pathology, Anatomy, and Laboratory Medicine (PALM) Department sought to improve scholarship, educational endeavors, and intra/interdepartmental collaborations. **RESOURCES.** We incorporated a consultant with the responsibilities that include the engagement of faculty, residents, and students to: (a) submit abstracts detailing their scholarly activities to present at national meetings; (b) publish their findings in peer-reviewed journals; (c) expand collaborations between anatomy teaching faculty and pathology clinical faculty; (d) apply for internal and external funding for research, outreach, and educational

projects; (e) provide expertise in transitioning on-ground courses into online courses; and (f) help with implementation of novel educational methods. The consultant has also helps to further the research endeavors of the Director of the Anatomy Division when administrative duties are demanding attention. **DESCRIPTION.** Details of the two-year experience incorporating a consultant within the Department are provided. **SIGNIFICANCE.** Incorporating a consultant into a blended basic science/ clinical department can positively impact departmental scholarship, improve communication, and intra/interdepartmental relationships, as well as enrich the experiences of students and residents.

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Brachial plexus anatomy in the costoclavicular space: Effective location for upper limb anesthesia

INTRODUCTION. The interscalene block (ISB) is the gold standard for pain management following shoulder surgery. However, phrenic nerve blockade and associated hemi-diaphragmatic paralysis presents a potentially serious complication in patients with respiratory insufficiency. The newly described costoclavicular brachial plexus block (CCB) may offer a phrenic nerve sparing alternative to the ISB with equivalent analgesic efficacy. The costoclavicular space (CCS) is deep to the clavicle midpoint, where the brachial plexus cords are clustered together lateral to the axillary artery. This study investigates the anatomic distribution of injectate with ultrasound-guided CCB. **METHODS.** Five injections were performed on supine unembalmed cadavers with the arm abducted to 90°. A 20-gauge echogenic needle was inserted in-plane from lateral to medial until the needle tip was in the CCS adjacent to the brachial plexus cords; 20 ml of 0.1% methylene blue dye was injected into the CCS. The region was dissected, and the phrenic nerve and brachial plexus were assessed for dye spread. **SUMMARY.** The injections showed a consistent pattern of supraclavicular dye spread. The C7, C8, and T1 nerve roots were dyed in all injections, but dye did not extend superiorly to the C5 and C6 roots. All trunks, cords, and divisions were dyed, as were nerves arising from these structures (e.g., medial and lateral pectoral nerves, upper and lower subscapular nerves, thoracodorsal nerve, proximal portions of the medial brachial and antebrachial cutaneous nerves, nerve to subclavius, and

suprascapular nerve). The phrenic nerve was spared in all injections.

CONCLUSIONS. The orientation of the brachial plexus cords in the CCS and the spatial separation of the phrenic nerve and brachial plexus at this location offer a safe anatomical site for upper limb regional anesthesia. The CCB may provide an alternative method of regional blockade for patients with significant pulmonary disease undergoing shoulder surgery.

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Severe skeletal dysplasia with Morquio IVA syndrome

INTRODUCTION. Morquio A syndrome (MPS IVA) is a mucopolysaccharidosis, or lysosomal storage disease, in which the body cannot break down glycosaminoglycans (GAGs) in connective tissues. MPS IVA causes a deficiency of galactosamine-6-sulfatase, resulting in accumulation of partially-degraded keratan sulfate and chondroitin-6-sulfate. Accumulation of these GAGs results in systemic skeletal dysplasia and distinctive phenotypic features caused by disrupted endochondral ossification and chondrogenesis. This report presents the life history and skeletal pathology of a MPS IVA patient who began to develop skeletal abnormalities at 4 months of age and died at age 23 of severe tracheal obstruction and hypoventilation due to respiratory muscle weakness from neurological cord myelopathy.

RESOURCES. The University of Tennessee Forensic Anthropology Center received a body donation from a 23-year-old white male with MPS IVA. Soft tissues were sampled for histology during autopsy. A detailed comparative analysis of the MPS IVA skeletal morphology was conducted, comparing the skeletal and dental features to healthy adult males and to a 5-year old skeleton.

DESCRIPTION. The dentition reflects developmental interruptions, evidenced by marked enamel hypoplasia. However, the postcranial skeleton was affected more severely by the disease. The size of the elements is more similar to the 5-year old skeleton than similar-aged adult skeletons, yet the morphology is markedly distinct, with some upper limb bones being difficult to recognize and classify due to the severe dysplasia (scapula, humerus, radius, ulna). **SIGNIFICANCE.** The opportunity to document the skeletal morphology of an individual affected by MPS IVA is unique. This study demonstrates the extent of severe skeletal dysplasia caused by MPS IVA. While soft

tissue analyses can explore the underlying pathogenesis of MPS IVA, skeletal analysis contributes to understanding the functional anatomy of this rare condition.

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The role of fascia and muscle morphology in erector spinae plane block injectate spread

INTRODUCTION. The erector spinae plane (ESP) block is an emerging interfascial block for postoperative pain control after thoracic and lumbar surgeries. Cadaveric studies on thoracic level ESP blocks have reported extensive cephalocaudal spread; however, little data exists for lumbar ESP blocks. This study evaluated the anatomical spread of dye in ultrasound-guided lumbar ESP blocks and compared it to spread reported in the thoracic region. **METHODS.** Nine 20-ml injections of methylene blue 0.166% were performed on 5 prone unembalmed cadavers under ultrasound guidance with a 22-gauge, 8 cm echogenic needle. The needle was inserted in a cranial-to-caudal direction deep to the ESP on the L4 transverse process. The skin, superficial and thoracolumbar fascia, and lumbar musculature were incised midline and reflected laterally. The extent of craniocaudal dye spread was documented relative to vertebral levels; lateral spread was documented relative to the erector spinae muscles. The intramuscular plane of the spread was also noted (i.e., if the dye was restricted to the ES muscles or penetrated deeper into multifidus). **SUMMARY.** Cephalocaudal spread from L3-L5 was observed all specimens with extension of spread to L2 in 44%. Longissimus and multifidus were dyed in all injections; iliocostalis was dyed in 67% of the specimens. The lateral extent of the dye spread was most extensive at the L4 and L5 levels. Dorsal primary rami were dye-stained in all injections. **CONCLUSIONS.** The cephalocaudal dye spread in lumbar ESP blocks was not as extensive as reported in thoracic ESP blocks. Musculofascial anatomy differences in the lumbar versus thoracic regions of the back may explain the more localized spread of the lumbar ESP block. The complex, multilayered thoracolumbar fascia forms fascial planes that likely influence injectate spread. Differences in muscle thickness and morphology may also account for the more limited spread observed in lumbar ESP blocks compared to the thorax.

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Instructional guide to intact central and medially oriented peripheral nervous system removal

INTRODUCTION. Learning human gross anatomy can be overwhelming and challenging for first year medical students. While common learning modes like textbooks and flashcards are helpful, students struggle to connect anatomical relationships with 2-D pictures. Plastinated models are powerful in their ability to provide a 3-D visualization of the body systems, yet these models cost thousands of dollars to acquire. We provide an inexpensive protocol for producing an intact human cadaver central nervous system and peripheral nervous system plexi model for study that will benefit both students and dissector. **RESOURCES.** A cadaver was used for the intact dissection of the brain and spinal cord using tools commonly found in a graduate cadaver laboratory. **DESCRIPTION.** We provide a step-by-step guide for intact dissection of the nervous system starting with a new cadaver and subsequently dissecting out each region taking about 50 hr completed in 11 steps. Final dissection produced the brain and spinal cord with intact cranial nerves, eyes, brachial plexi, sympathetic chains, lumbar and sacral plexi, and all spinal roots. **SIGNIFICANCE.** Current dissection manuals do not provide instruction for a complete removal of the brain and spinal cord, forcing educators to purchase plastinated models if they want their students to appreciate the anatomy of the intact nervous system. Our guide instructs students and teachers to expose the complete nervous system through a hands-on approach, with tools commonly available in graduate cadaver laboratories.

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Correlation analysis between the muscle architecture and anaerobic power of elite athletes

INTRODUCTION. The athletes grow highly developed muscles that work according to each sport events and create a body shape

that matches the characteristics of the sport. Various opinions on whether a muscle development is positively related to exercise ability, but the research conducted based on scientific evidence is insufficient. The aim of this study is to identify the characteristics of muscle development and to determine whether the results have a significant correlation with sport performance and each of events. **METHODS.** Fifty-five elite players were selected and the ultrasonography, Wingate test were conducted. Subjects were 10 boxers, 8 judo players, 10 taekwondo players, 10 soccer players, 7 wrestlers, and 10 traditional Korean wrestlers. Ultrasonography was performed on the lower extremity for measuring muscle characteristics, and the Wingate test were performed on ergometer to determine the anaerobic power. For multiple comparison between these results, one-way ANOVAs with Tukey's hoc test was used to muscle characteristics of each muscle with aerobic power of each sport events to confirm the significance. The statistical significance was accepted at 0.05 levels. **SUMMARY.** There was a significant difference between muscle characteristics and anaerobic strength for all muscles, especially the vastus medialis, vastus lateralis and medial head of gastrocnemius ($p < .05$). There was a significant correlation with the sport events were also observed. In particular, strong correlation between peak power, mean power torque% weight and muscle characteristics, while the soccer players showed a most of correlation. **CONCLUSIONS.** To date, various studies that measure muscle volume, area, and force have been conducted, and significant relationships have been reported. However, cross-sectional studies are not easy to understand and apply in the actual training environment. These results can be used directly to establish and utilize in actual sports field.

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Microanatomical characteristic of ventricular myocardial extensions to the pulmonary valve sinuses

INTRODUCTION. It is believed that ventricular myocardial extensions into the pulmonary valve sinuses are a substrate for certain ventricular

arrhythmias. Catheter ablation is the first-choice treatment for arrhythmias arising from the pulmonary valve region. Nevertheless, little attention has been paid to the microanatomical characteristic of the pulmonary valve, especially to the possible heterogeneity within the pulmonary valve sinuses. **METHODS.** Sixty-five randomly selected autopsied human hearts (24.5% females, age = 45.9 ± 15.8 years) were examined. Selected morphometric parameters of the corresponding sagittal sections of each pulmonary valve sinuses were analyzed in Masson's trichrome stained paraffin sections. **SUMMARY.** Ventricular myocardial extensions were found in all studied pulmonary valves. They were observed in 87.5% of left anterior, 89.0% of right anterior, and 90.5% of posterior pulmonary valve sinuses ($p > .05$) with a mean height of 4.1 ± 1.8, 3.7 ± 1.5, and 4.3 ± 1.7 mm, respectively ($p = .137$). The percentage coverage of the sinus with the ventricular myocardium was the highest for posterior sinus (79.7 ± 24.41%), followed by left anterior (73.8 ± 17.90%) and right anterior (72.4 ± 19.06%) sinuses, however the difference between groups was statistically insignificant ($p = .279$). Also, no significant difference was observed for leaflet length ($p = .877$), which was highest in the right anterior leaflet (13.8 ± 2.4 mm), followed by the left anterior (13.7 ± 2.6 mm) and posterior (13.5 ± 2.4 mm). Leaflet length and myocardial height correlated strongly in left anterior ($r = 0.52$; $p < .001$) and in posterior sinuses ($r = 0.51$; $p < .001$), but not in right anterior sinus ($r = 0.08$; $p = .53$). **CONCLUSIONS.** Ventricular myocardial extensions into the pulmonary valve are observed in all hearts. No significant inter-sinus heterogeneity in terms of myocardial extensions presence, their length, and coverage of the sinus was observed.

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Course of the greater palatine nerve and artery: Implications for palatal tissue graft harvesting

INTRODUCTION. Palatal soft tissue (PST) graft harvesting is a common procedure to treat gingival recession. To maximize dimensions of PST grafts, the 3D course of the branches of the greater palatine nerve (GPN) and artery (GPA) is essential. Previous studies are scarce and report results in 2D. The purpose of this pilot study was to document in 3D the distribution pattern of the GPN and GPA relative to landmarks used to harvest PST grafts. **METHODS.** Six embalmed specimens were used. The

palate was digitized (Microscribe® G2X Digitizer) and mucosa removed to expose the greater palatine neurovascular bundle. A transverse incision was made posterior to the greater palatine foramen (GPF) to enable serial dissection and digitization of the branches of the GPN and GPA (Synca® HD Loupes 2.8x). Digitized data was reconstructed into 3D models (Autodesk® Maya®) and used to determine the relationships, course, and extent of the branches of the GPN and GPA. **SUMMARY.** The GPN coursed superficial to the GPA with differing branching patterns. GPN had 4–6 medial branches coursing anteriorly and 1–2 lateral branches coursing to the premolar gingival margin. In all specimens, GPA split into superior, medial and lateral branches at the mesial of the first molar (mean 13 mm anterior to the center of the GPF). Superior and medial branches coursed anteriorly, but not in the same branching pattern as the GPN. In one specimen, the GPA had two accessory lateral branches coursing towards the gingival margin of the first molar, 5 mm and 15 mm from the GPF. 3D frequency maps enabled documentation of possible compromised palatal neurovascular supply. **CONCLUSIONS.** The GPN and GPA demonstrate significant branching over the course of the palate, with the GPN residing superomedial to the GPA. The GPN demonstrated less branching towards PST graft sites, with the majority of branching occurring medial to the GPA. The GPA demonstrated unique branching patterns laterally that may infringe upon PST grafts.

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What lies beneath: Ultrasound imaging brings clinical anatomy to life for physical therapy students

INTRODUCTION. Many students find anatomy challenging to learn. While most learn via cadaver dissection, knowledge does not readily translate to gaining a clinical perspective or understanding the effects of dynamic musculoskeletal tasks on function. Consequently, it can be difficult for students to determine the contributions of deep musculature to various tasks since they cannot be palpated nor their function readily observed. **METHODS.** Thirty-three 2nd year doctor of physical therapy (DPT) students received 2-hr didactic ultrasound imaging (US) instruction focused on US physics, nomenclature and applications prior to 4-hr of labs. Labs consisted of a brief orientation to the US units with illustrated lab manual instructions on how to acquire static and dynamic cineloops for a selection of superficial and deep structures that included upper extremity, trunk, and lumbopelvic regions. Students completed an online survey to

assess their experience. A 5-point Likert scale graded responses ranging from 5 (strongly agree) to 1 (strongly disagree) and 2 questions permitted free-text comments. **SUMMARY.** 100% of respondents (97% response rate) agreed that US was an innovative tool that allowed them to observe musculoskeletal components of dynamic movement. At least 94% agreed that US stimulated their interest, enhanced their assessment skills of all structures imaged and the US units were easy to use. Free text comments were extremely supportive of US with many sharing how US improved their understanding of clinical anatomy during dynamic tasks. Furthermore, students requested further integration of US throughout the curriculum with most interested in an elective course. **CONCLUSIONS.** US brings anatomy to life and underlines the clinical relevance of why students are learning it. Students embrace it, are actively engaged in the classroom and would like to integrate it into clinical practice. US is a powerful supplement to didactic and lab experiences for DPT students.

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Origin of the deep femoral and circumflex femoral arteries: A case report

INTRODUCTION. The femoral artery provides blood supply to most of the thigh through its branches. The femoral (FA), deep femoral (DFA), and the medial and lateral circumflex femoral arteries are commonly utilized in a wide range of clinical procedures including arterial catheterization, and coronary artery bypass grafting. Due to the variability in the branching pattern of these arteries, anatomical knowledge is crucial for clinicians to avoid iatrogenic injuries when performing these procedures. **RESOURCES.** In this case report, we describe a variant branching of the left femoral artery and its branches. This was found in a 63-years old Caucasian (female) body donor during routine dissection of the lower limbs. The cause of death was indicated as metastatic endometrial cancer. **DESCRIPTION.** During the exposure of the contents of the femoral triangle, the skin and the fascia of the thigh were incised and reflected. After the exposure of the FA and femoral vein, the DFA was found to originate at the beginning of the FA (deep to the midpoint of the inguinal ligament), on its anterior side. Its course could be traced inferomedially where it gave rise to three perforating branches. In

most individuals, the DFA arises from the posterolateral side of the FA, about 4 cm below the midpoint of the inguinal ligament. An anterior origin is a very rare finding. The lateral and medial circumflex femoral arteries were found to arise from the posterolateral and posteromedial sides of the FA respectively, about 4 cm below the inguinal ligament. In most individuals, the two circumflex femoral arteries are branches of the DFA. **SIGNIFICANCE.** The FA, DFA and the medial and lateral circumflex femoral arteries are used in a diverse number of clinical procedures giving their normal and variant anatomy a high degree of clinical significance. Radiographic assessment of the vessel's anatomy prior to surgical procedures highly recommended in order to decrease the risk of iatrogenic injuries.

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Teaching functional neuroanatomy using computer-aided learning at Weill Cornell Medicine-Qatar

INTRODUCTION. Neuroanatomy course is intimidating to most students because it involves learning of a complex spatial structure of the brain. Sectional anatomy, where anatomy of the brain and spinal cord is viewed in 2D planar sections, forms a key component of the neuroanatomy learning. **RESOURCES.** Neuroanatomy course at WCMQ is organized into system-based modules taught through lectures and small group tutorials. Tutorials are run using a computer-aided functional neuroanatomy resource (FNAR) developed by the functional neuroanatomy faculty at Weill Cornell Medicine in New York. Each module has a section on laboratory notes, interactive images, tutorial outline, clinical cases and a set of self-assessment questions. Interactive images include gross brain specimens, unstained and stained brain sections cut at different planes. A combined team of neuroanatomy faculty and neurologists facilitate the tutorials, with the neuroanatomist leading the structural and functional concepts discussion and the neurologist facilitating the clinical case discussion. **DESCRIPTION.** Course evaluation reports for the last two academic years, shows that 42 (47%) students out of 90 responded to the evaluation survey. The following components of the course were viewed to be more useful and helpful: Interactive nature of the tutorials (76%), clinical case discussion (85.4%) and tracing pathways (71%). One of the challenges encountered by students was the difficulty in the “mental construction” of 3D structures from 2D histological slides. Modification of the self-assessment questions to multiple

choice questions was one of the recommendations for improvement. **SIGNIFICANCE.** A combined team of neuroanatomy faculty and neurologist has been effective in the facilitation of the tutorials because each brings a different perspective and experience. Weill Cornell Medicine in New York, in collaboration with WCM-Q are currently reviewing the FNAR to address some of the suggestions and recommendations.

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Analysis of ambiguous terminology of anatomical “olfactory” spaces adjacent to the cribriform plate

INTRODUCTION. A precise nomenclature is the foundation of communication in anatomy and related biomedical subjects. The olfactory bulbs and nerves lie above and below the cribriform plate (CP). Numerous anatomic landmarks in this region have descriptive names using “olfactory” as a qualifier for structures serving olfaction. Inaccurate use of several of these anatomic “olfactory” terms is common. We performed a publication database analysis to determine the frequency of misuse of names for five anatomic spaces close to the CP and nasal cavity. We provide a pictorial review of these structures and examples of their mislabeling. **METHODS.** We searched publications in PubMed having the keyword “olfactory” in the title or abstract, plus one of 5 other keywords: “groove”, “fossa”, “recess”, “vestibule”, or “cleft”. We reviewed all abstracts for accuracy of these terms relative to accepted standards. **SUMMARY.** We found these keywords in 1162 articles. “Groove” (depression in the CP supporting each olfactory bulb)—of 397 articles, 374 were useful, and 3 (0.8%) used this term incorrectly. “Fossa” (depression in the anterior cranial fossa whose floor is the CP)—of 270 articles, 57 were useful, and 18 (31.6%) used this term incorrectly. “Recess” (space in the nasal cavity roof between the nasal septum and vertical lamella of the middle turbinate)—of 133 articles, 13 were useful, and 4 (34.6%) used this term incorrectly. “Vestibule” (lower subdivision of the “cleft” below the recess)—of 52 articles, all were spurious and related to the “nasal vestibule”. “Cleft” (olfactory nose is comprised of two medial clefts, each made of vestibule plus recess)—of 310 articles, 104 were useful, and 4 (3.8%) used this term incorrectly. **CONCLUSIONS.** Terms used to describe “olfactory” spaces are often ambiguous or inaccurate. The terms olfactory “fossa” and “recess” are particularly misused. We make a plea for uniform nomenclature leading to greater clarity in use of anatomic “olfactory” terms.

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Anatomic basis for unconventional trans-sacral punctures to access the caudal subarachnoid cistern

INTRODUCTION. A standard lumbar puncture may be impossible for many technical reasons. By considering anatomy of the sacrum and its dural sac, we critically analyzed four alternative percutaneous intradural puncture techniques. Specifically, previous accounts of caudal epidural anesthesia via the sacral hiatus prompted us to test if image-guided percutaneous trans-sacral hiatus access to the caudal subarachnoid cistern would be anatomically feasible. **METHODS.** To study sacral canal morphometry and curvature, we analyzed midsagittal CT-myelogram images of 40 normal subjects and digitally measured sacral curvatures between S1 to S5 and S2 to S4 using two methods whereby a lower angle signifies a straighter sacrum. We measured midsagittal sacral canal area, hiatus width, dural sac termination levels, and distance from sacral hiatus to the dural sac tip (needle distance). **SUMMARY.** Subjects were F:M = 25:15, with a mean age of 44.9 years. The two S1-S5 full sacral curvature mean angles were 57.3° and 60.4°. Almost all sacral hiatuses were at S4, and dural sac terminations were at S1-S2. The mean S2-S4 sacral curvature was 25.1°, and the mean needle distance was 57.7 mm. Using two-way ANOVA, there were significant sex differences for needle distances ($p = .001$), and full and limited sacral curvatures ($p = .02$, and $p = .046$, respectively). There were no significant linear correlations between age and sacral curvature, needle distance, canal area, or hiatus width. **CONCLUSIONS.** Despite a frequently prominent full sacral curvature, the combination of S1-S2 dural sac termination plus a relatively straight trajectory of the lower sacral canal between S2 to S4 support the theoretical feasibility of percutaneous trans-sacral hiatus and sacral canal access to the lumbosacral cistern using a standard spinal needle. We also review three other puncture techniques, namely: via S1 or S2 foramina, dorsal trans-osseous at S1/S2, and through a sacral spina bifida occulta in <5% of subjects.

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Massa intermedia of the thalamus: MRI spatial topography relevant to hydrocephalus predisposition

INTRODUCTION. The thalamic massa intermedia (MI) differs in size and location between individuals. Computational fluid dynamic

models suggest that MI locations can affect patterns of CSF pressure distribution within the third ventricle (3rdV)—MIs closer to the posterior 3rdV cause higher resistance to flow toward the aqueduct, thus potentially contributing to development of hydrocephalus. We hypothesized that normal subjects with larger or posteriorly placed MIs may have higher values of ventricular Evans' index (EI), suggesting possibly a higher baseline predisposition to ventriculomegaly. **METHODS.** We analyzed midsagittal MR images of 35 normal subjects and measured dimensions of MIs and 3rdVs, and categorized MI locations by dividing the 3rdV into 4 quadrants relative to the bicommissural line. We then statistically correlated findings with EIs (ratios of maximal width of frontal horns of the lateral ventricles to maximal internal diameter of the skull on axial images). **SUMMARY.** Subjects were F:M = 19:16, mean age: 48.5 year, and with normal EIs (<0.3). MIs were present in 23 (66%) subjects. Three MIs were in one 3rdV quadrant, 17 were in 2 quadrants, and 3 were central in all 4 quadrants. Anterior and posterior halves of 3rdVs contained portions of 26 and 23 MIs, respectively. The mean MI and 3rdV areas were 15.2 and 497 mm², respectively (mean ratio 3.1%). The mean EI in presence or absence of MIs were 0.248 and 0.245, respectively ($p > .5$). The mean EI when MIs were in both superior quadrants, both anterior quadrants, and centrally were 0.246, 0.276, and 0.239, respectively ($p > .5$). The mean EI when MI/3rdV ratio was >3.1% or <3.1% were 0.247 and 0.245, respectively ($p > .5$). **CONCLUSIONS.** In normal subjects, there is no significant correlation between MI size/location and baseline normal ranges of lateral ventricle width. We will conduct future studies in hydrocephalic patients to ascertain if there is any role of MI morphology in development of CSF flow disorders.

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Essential digital anatomy table skills to enhance independent anatomy learning

INTRODUCTION. Digital Anatomy (Anatomege) Table (DAT) is available at many medical schools; however, its adaptation within classrooms has been a considerable challenge. Instructors and students face a steep learning curve familiarizing themselves with the basic functioning of the Table, making it challenging to incorporate such systems into the curriculum. **METHODS.** This study is to determine the confidence level, operational skills, and ability of participants to independently learn the foundational gross anatomy after completing a short, comprehensive, self-guided training on the Digital Anatomy Table. First-year medical students in two consecutive classes of fifty-three and fifty-one students (designated Group 1 and Group 2) respectively participated in the study. Students with minimum or no

experience on the DAT completed a self-guided training exercise on the DAT followed by a confidence level survey. They then took a formative assessment to demonstrate operational skills on the DAT and their ability to identify and explore from simple to complex anatomical structures not yet studied in the curriculum. **SUMMARY.** Using the DAT, students were able to complete the self-guided training in less than twenty minutes (mean 16.5 minutes). After the training, students ranked their confidence level of operating eighteen critical functions of the DAT on a scale of one to ten, where ten is very confident. Forty-six students (72%) of Group 1 and forty-nine students (96%) of Group 2 felt that they could operate the DAT with a confidence level of 7 or better. Upon assessment, students were able to demonstrate the critical skills to operate the DAT. Additionally, 89% of students independently uncovered challenging anatomical structures on the DAT, previously not studied in the curriculum. **CONCLUSIONS.** Our innovative approach would help medical schools confronted with the challenges of training faculty and students to use the Digital Anatomy Table efficiently to learn anatomy.

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Morphology of the lumbar plexus with application for lateral lumbar interbody fusion: A pilot study

INTRODUCTION. Lateral lumbar interbody fusion (LLIF) is an emerging technique utilized to treat diseases of the lumbar spine and is becoming a preferred treatment modality to meet the increasing demands for corrective procedures. LLIF procedures permit the use of wider interbody cages, which are associated with lower rates of subsidence and better clinical outcomes; however, iatrogenic injury to the lumbar plexus remains a concern. This pilot study aims to demonstrate the efficacy of using landmark morphometric techniques to characterize vulnerable components of the lumbar plexus encountered during a LLIF. **METHODS.** Dissection techniques were used to access the posterior abdominal wall on 29 formalin-fixed whole-body donors (mean age = 79 years). A Microscribe[®] G2X Digitizer was used to register the location of 34, 3D landmarks. Landmarks include points along intervertebral discs commonly targeted in the procedure, as well as the femoral nerve (FN), obturator nerve (ON), and genitofemoral nerve (GFN). Wireframe graphs were created to illustrate nerve trajectory parallel to the spine. Data were analyzed with geometric

morphometric techniques in MorphoJ v1.07a. **SUMMARY.** The FN and ON concomitantly take a modest ventral course with gradual divergence in the coronal plane; their proximity to surgical targets increasing caudally. The GFN emerged from the L1 and/or L2 ventral rami assuming a dramatic angle through the psoas major muscle before exiting through its ventral surface. The mean landmark configuration revealed significant intersection of the GFN with surgical targets at the level of the L3/L4 intervertebral disc. **CONCLUSIONS.** The trajectory of the FN and ON place them at the greatest risk of injury at lower intervertebral disc levels, specifically the L3/L4 and L4/L5 disc levels. The GFN is placed at very high risk when performing discectomy at the level of the L3/L4 disc. These results may influence preoperative planning, leading to improved clinical outcomes.

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Flipped classroom method: Medical students' perceptions of the learning experiences for embryology

INTRODUCTION. Medical students consider embryology to be a difficult subject to learn and apply in clinical practice. We developed a flipped classroom model for teaching embryology of the central nervous system (CNS) during the second year of medical school. The objective of the present study was to assess students' perceptions of the quality of resources provided by our model to learn the embryology of the CNS. **METHODS.** The flipped classroom model was comprised of out-of-class (OOC) and in-class (IC) activities. During the OOC activity, students watched four videos on the embryology of CNS, took online quizzes and read relevant clinical documents. In the faculty-guided IC activity, students participated in solving clinical vignettes using Poll Everywhere. Faculty then commented on both the correct and incorrect answer choices. Finally, students completed a voluntary online evaluation survey regarding their flipped-classroom experience. **SUMMARY.** The survey response rate for the academic years 2019 and 2018 were 23 and 20%, respectively. In 2019 and 2018, the students' responses to the content and quality of the videos (that included narration, annotations, animations etc.) averaged 3.9 and 4.45 (out of 5), respectively. 59% (2019) and 91.43% (2018) of students considered the videos to be just the right length; 75% (2019) and 68.57% (2018) of students

stated that the interactive quizzes reinforced the content learned in the videos. The four questions regarding the effectiveness of the OOC activity on the IC activity and the effectiveness of both activities on the overall learning experience averaged 3.4 (2019) and 4.23 (2018), respectively. **CONCLUSIONS.** Our flipped classroom model significantly enhanced students' learning experience; This positive feedback suggests that the model may be successfully applied to enhance students' learning of other topics covered in the second year of medical education.

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Establishment and cryopreservation of camel stem cells from Wharton's jelly of umbilical cord

INTRODUCTION. Stem cells are special cells that have the ability to develop into many different cell types and also have the ability to repair damaged tissues. Mesenchymal stem cells (MSCs) are currently considered as "Medicinal Signaling Cells" and a promising resource in regard to cell-based regenerative therapy. Umbilical cord is a term perinatal tissue which is easily attainable, and a promising source of stem cells with no associated ethical concerns. Wharton's jelly (WJ) is the gelatinous matrix that surrounds and provides protection to the umbilical cord blood vessels. Being more primitive, MSCs from umbilical cord exhibit greater proliferative capacity and immunosuppressive ability. Thus, as compared to adult stem cells it gives them a therapeutic advantage. **METHODS.** 25 camel umbilical cords were collected from Camel farms in U.A.E. Wharton's jelly was dissected from the umbilical cord by separating it from umbilical blood vessels. It was cultured by explant method using growth medium. It was then subjected to passaging the cell line to increase the confluency to more than 80%. They were then cryopreserved in liquid nitrogen (-120°) to be used again for future use. **SUMMARY.** The cultured Wharton's jelly showed fibroblast like cells spreading out after 4–5 days. These cells were then removed in to different culture plates and passaging of them was done to increase their confluency above 80%. The results were very encouraging. They were then cryopreserved in liquid nitrogen. **CONCLUSIONS.** Being a primitive stromal cell population, WJ-MSCs offer the advantage of faster proliferation rate and reduced immunogenicity as compared to adult tissue derived MSCs. Hence, successful isolation of robustly proliferating healthy MSCs from WJ of camel umbilical cord, which retain all the basic MSC properties, assumes importance in injuries occurring in racing animals and in any debilitating diseases of camels.

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Anatomical predictors for difficult airway and evaluation of cadavers in airway training

INTRODUCTION. A difficult airway is one in which the operator has a less than optimal view which can lead to hypoxia during intubation. Do external measurements predict a higher likelihood of encountering abnormally sized internal features during intubation? We measured cadaveric airways to correlate external and internal features that have previously been shown to make intubation or ventilation more challenging. Training for difficult intubation remains a challenge as manikins lack realism. Given limited reports of using formalin fixed cadavers for difficult airway training, we evaluated cadaver suitability as a training model. **METHODS.** Using 44 formalin fixed cadavers external measurements were taken of the neck and correlated to internal measurements by dissection and CT of the airway. We attempted to obtain glottic view with MAC and glidescope blades. **SUMMARY.** There is correlation between several external and internal measures notably between height and tracheal diameters as well as neck circumference and tongue length. Only 18% the cadavers could accept a glidescope blade. There were significant external measurements related to the ability to obtain a glottic view. **CONCLUSIONS.** There is value to obtaining external neck measurements to predict abnormal internal features. Small stature is correlated with narrowed trachea which could impede ventilation. Increased neck circumference is associated with increased tongue length which could create a difficult intubation. Data is limited by having been studied on cadavers and would need to be evaluated in live patients for more applicable clinical outcomes. Obtaining glottic view was challenging on cadavers, likely related to rigidity. Despite external measurements associated with ability to obtain glottic view, given low frequency with which cadavers are possible to intubate, we conclude they are not an appropriate resource for difficult airway training.

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Implementation and perceptions of a Thanksgiving Reflection activity in cadaveric anatomy courses

INTRODUCTION. In addition to invaluable educational experiences, human cadaveric dissection provides opportunities to improve teamwork

skills and opportunities for students to consider principles of death, donation, empathy and gratitude. To encourage students to explore these principles, a Thanksgiving Reflection activity was implemented in two human cadaveric gross anatomy courses at UT Health San Antonio. **METHODS.** 219 medical and 106 dental students were assigned a Thanksgiving Reflection exercise. Students were instructed to reflect on the privilege and gift of body donation. The Thanksgiving Reflection exercise was flexible; students could write a letter to their body donor or their family, a poem, an essay, or create an artistic piece. Upon completion of the courses, 208 medical students and 76 dental students completed a survey on their perceptions of the assignment. **SUMMARY.** In general, student submissions of the Thanksgiving Reflection demonstrated thoughtful and heartfelt feelings toward their donor and their family. Student submissions included letters, poems, drawings, paintings, sculptures, and the creation of jewelry and blankets. Results from the course evaluation show that 90.38% of medical and 84.21% of dental students “Strongly Agreed” or “Agreed” with the statement “The Reflection activity during the Thanksgiving break was useful to promote empathy, reflection, and professionalism”. Student-provided feedback of the activity was generally positive. Students felt the Thanksgiving Reflection: “pushed students to emotionally grasp the magnitude of the gift they have been given”, “was a good way to appreciate what an honor and privilege it was to dissect a cadaver”, and was a “sweet sentiment”. **CONCLUSIONS.** The meaningful submissions and positive feedback indicate the Thanksgiving Reflection activity served as a valuable assignment that enabled students to reflect on their experience and express their gratitude to their body donors.

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Analysis of the positional relationship of the long thoracic nerve considering clinical treatment

INTRODUCTION. The long thoracic nerve (LTN) is a structure that has a risk of damaging in chest surgery and should be considered to perform anesthesia such as serratus anterior plane block (SAPB). We aimed to reveal the relationship between landmarks, the fourth to ninth ICS at the midaxillary line (MAL), where the distal part of the LTN passes through, and the LTN. **METHODS.** Twenty-five specimens from 17 embalmed Korean cadavers were used in this study. The MAL, rib level and ICS, and regions 5 cm anteroposterior to the MAL (aMAL/pMAL) were established to measure the position of the LTN crossing the MAL, pathway of the LTN, and entering points of the LTN to the SA. **SUMMARY.** The LTN crossed the MAL by 76% or entered the SA in aMAL before reaching the MAL by 24% of the specimens. The LTN crossed the MAL by 70.8% within the fifth to sixth rib level. The LTN entered the SA by 74.5% in aMAL within the fourth to sixth ICS, but no branches were found in pMAL within these levels. The fifth ICS was the most frequent region in aMAL; in contrast, no branches

were found in pMAL. **CONCLUSIONS.** We settled the danger zone as the fourth to sixth ICS in aMAL for thoracotomy. In addition, we proposed the fifth ICS in aMAL at the superficial plane as the alternative injection point for SAPB when blocking the LTN, and the fifth ICS in pMAL at the deep plane to prevent blocking the LTN. (This study was supported by a faculty research grant of Yonsei University College of Medicine for 6-2019-0181.)

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Bilateral variation of superficial ulnar artery, common interosseous artery, and palmaris longus

INTRODUCTION. Through anatomical dissection, variations of the human body can be identified and categorized. Here, we report a rare case of a bilateral vascular variation in the upper limb and propose a potential connection to the absence of the palmaris longus muscle. **RESOURCES.** Dissection of the upper limb of a 99-year-old female donor revealed bilateral superficial ulnar artery with atypical branching of the common interosseous artery and absence of palmaris longus muscle. **DESCRIPTION.** All described anatomical variations were symmetric and bilateral in this individual. The superficial ulnar artery was found to branch from the brachial artery in the cubital fossa and replaced the typical ulnar artery. Further, the common interosseous artery was found to originate from the radial artery. Finally, the palmaris longus muscle was absent. **SIGNIFICANCE.** A present superficial ulnar artery is at risk for iatrogenic injury during surgical procedures or venipuncture. Currently, there is no clinical test to detect its presence. However, the clinical tests for palmaris longus muscle presence are largely reliable and are a possible avenue for aiding in identifying a superficial ulnar artery before procedures begin. Further studies are needed to determine the validity of this connection.

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Pre- and post-operative HARDI tractography of cerebellar pathways with posterior fossa tumors

INTRODUCTION. This study aimed to demonstrate the role of high angular resolution diffusion imaging (HARDI) tractography in mapping

of the cerebellar pathways associated with posterior fossa tumors and to determine whether it is useful for brain surgery planning and post-operative evaluation. **METHODS.** Data from 18 male and 12 female patients aged between 2 and 16 years who were diagnosed with posterior fossa tumor and 30 age- and sex-matched healthy controls were used. MRI was collected with a 3T MR system which included a diffusion-weighted sequence with 30 gradient directions at $b = 1,000$ and 5 b_0 values. Whole brain fiber pathways were reconstructed using Diffusion Toolkit software, Q-ball model, FACT propagation algorithm, and an angle threshold of 45°. Manually identified regions-of-interest (ROIs) were placed to identify reconstructed fiber pathways passing through the superior, medial and inferior cerebellar peduncles for the preoperative, postoperative, and the healthy control participant groups. Fractional anisotropy (FA), apparent diffusion coefficient (ADC), track volume, and fiber length measures were obtained and analyzed. **SUMMARY.** Statistically significant differences were found between the pre-op/post-op, pre-op/control and post-op/control comparisons for volume and length of the tracts. Displacement and disruption of the pathways were observed correlated to the grade of tumor. The loss of pathways after the operation was associated with selective resection during surgery due to tumor infiltration. Tumor infiltration was shown on the left middle cerebellar peduncle via a decreased FA and an increased ADC in that region. **CONCLUSIONS.** The effects of posterior fossa tumors on cerebellar peduncles and reconstructed pathways were successfully evaluated by HARDI tractography. The technique appears to be useful not only for preoperative but also for postoperative evaluation. (Sponsored by Grant No. 2018/14 from the Research Fund of Istanbul Medipol University.)

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Popliteal arcuate ligament—A meta-analysis of prevalence and morphometric properties

INTRODUCTION. The arcuate ligament (AL) is one of structures comprising posterolateral corner (PLC). It is a static stabilizer, restrains external tibial rotation, varus angulation, and posterior tibial translation. AL, is not properly described in literature. We aimed to conduct

a meta-analysis assessing the prevalence of AL to raise awareness about possibility of AL and PLC injuries. Moreover, we wanted to compare the prevalence of AL between patients of different ethnicities. **METHODS.** All major medical databases were searched to identify valid studies including (PubMed, Embase, Scopus, ScienceDirect, Web of Science, SciELO, BIOSIS). Afterwards, the data extraction and statistical analysis was conducted. PRISMA guidelines were strictly followed in this study. **SUMMARY.** 30 articles representing a total of 1,386 lower limbs were enrolled in this study. An overall pooled AL prevalence was 81.7% (95% confidence interval [CI], 69.3–91.6%). Its prevalence was the highest in intraoperative subgroup compared to cadaveric studies and MRI ones and equal 99.5% (95% CI: 97.9–100.0), 86.5% (95% CI: 73.8–95.7) and 57.3% (95% CI: 27.5–84.8) respectively with sensitivity 72.5% (95% CI: 51.5–89.6). In European studies, AL was present in 83.4% (95% CI: 58.9–98.8) of cases in comparison to 83.6% (95% CI: 59.1–100.0) in North American and 74.2% (95% CI: 49.3–93.3) in Asian articles. **CONCLUSIONS.** In conclusion, our meta-analysis shows that AL is highly prevalent structure. Surgeons should always remember about it when operating in PLC area.

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The posterior meniscomfemoral ligament and its anatomical significance

INTRODUCTION. The meniscomfemoral ligament consists of two divisions—anterior (aMFL) and posterior (pMFL). Many questions regarding them remain unanswered. In this research we aimed to conduct a meta-analysis to summarize the anatomy and prevalence of posterior (pMFL) meniscomfemoral ligament. **METHODS.** Major medical databases including (PubMed, Embase, Scopus, ScienceDirect, Web of Science, SciELO, BIOSIS) were examined by two independent reviewers. The reference lists of the studies were also searched. The data were extracted and statistically analyzed. PRISMA guidelines were strictly followed during all stages of the study. **SUMMARY.** Incidence of pMFL was assessed by 52 studies ($n = 5,070$ lower limbs). Mean pooled prevalence of pMFL was 71.0% (95% confidence

interval [CI]: 64.3–77.2), and it was more frequent in cadaveric than MRI or arthroscopic studies and was 74.6% (95%CI 68.1–80.6), 69.5% (95%CI56.4–81.1) and 65.1% (95%CI 0.0–100.0) respectively. pMFL was more common among females (81.1% vs. 76.7%) and more prevalent in Asian 74.8% (95%CI55.8–90.1) than in South American 74.8% (95%CI55.8–90.1), European 69.9% (95%CI 61.8–77.4) and North American 50.5% (95%CI 39.4–61.6) populations. Mean length was 27.4 mm (95%CI 27.1–27.7) and thickness 2.5 mm (95%CI2.4–2.5). **CONCLUSIONS.** pMFL has been revealed in our analysis to be highly prevalent and present in almost seven of 10 people. Moreover, it's a structure of substantial size. To our knowledge this is the first such a detail meta-analysis of prevalence and morphometrics of pMFL.

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The anatomical characteristics and clinical relevance of the persistent median artery

INTRODUCTION. Median artery is present during human fetal development and frequently degenerate on eighth week of gestation. Nonetheless, it may not regress and is called persistent median artery (PMA). It might develop to be the main blood supply of median nerve and contiguous structures of the forearm. PMA is specifically important for orthopaedic surgeon as a consequence of greater risk of damage during operations performed on the carpal tunnel. The aim of this study was to evaluate the anatomical characteristics and clinical relevance of the persistent median artery. **METHODS.** Two independent researchers conducted comprehensive search through major medical databases (PubMed, Embase, ScienceDirect, Web of Science, SciELO, BIOSIS, Current Content Connect, Korean Journal Database and Russian Citation index). Subsequently, performed the articles quality assessment using AQUA rules and data extraction. There were no date or language-based exclusions applied. Statistical analysis was performed with usage of MetaXL 5.0 software. **SUMMARY.** The study involved 71 articles (total of 12,082 limbs). The general pooled prevalence equaled 9.4% (95% confidence interval [CI]: 7.2–12.0). The PMA was more likely to find in cadaveric studies compared to

radiologic and ultrasonographic studies and equaled (9.2%; 95% CI: 6.9–11.8), (6.7% 95% CI: 3.7–10.6), (7.2%; 95% CI: 3.7–11.7) respectively. Moreover, in 3 papers evaluating infants the prevalence was 34.6% (95% CI: 5.5–70.7), significantly higher than among adults (8.6% (95% CI: 6.6–10.8)). **CONCLUSIONS.** PMA is a very common structure in general population and the highest in infants. The clinical significance of this data and high risk of complications combined with artery injury, it should always be kept in mind while performing surgeries on the carpal tunnel.

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The anterior meniscofemoral ligament and its anatomical significance

INTRODUCTION. The meniscofemoral ligament consists of two divisions—anterior (aMFL) and posterior (pMFL). Many questions regarding them remain unanswered. In this research, we conducted a meta-analysis to assess anatomic features and prevalence of anterior (aMFL) meniscofemoral ligament. **METHODS.** Major medical databases including (PubMed, Embase, Scopus, ScienceDirect, Web of Science, SciELO, BIOSIS) were examined by two independent reviewers. The reference lists of the studies were also searched. The data were extracted and statistically analyzed. PRISMA guidelines were strictly followed during all stages of the study. **SUMMARY.** Incidence of aMFL was assessed by 46 studies ($n = 4,380$ limbs). Mean pooled prevalence of aMFL was 56.2% (95% confidence interval [CI]: 46.7–65.4), and it was the more frequent in arthroscopic than cadaveric or MRI studies and equaled 82.3% (95%CI 36.6–100.0), 59.0% (95%CI 46.9–70.6) and 59.0% (95%CI 46.9–70.6) respectively. aMFL was more common among males (37.2% vs. 29.1%) and more prevalent in South America than in Europe 68.7% (95%CI 55.8–80.4), North America 56.8% (95% CI 45.1–68.1), or Asia 30.1% (95%CI 16.4–45.8). Mean length was 23.0 mm (95%CI 22.8–23.5) and thickness 1.7 mm (95%CI 1.6–1.8). **CONCLUSIONS.** aMFL have been revealed in our analysis to be highly prevalent structure. It occurs in over half of overall population i of

extraordinary size. To our knowledge this is the first such a detail meta-analysis of prevalence and morphometrics of aMFL.

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Graduate students' use and perceptions of learning resources provided in a human anatomy course

INTRODUCTION. Implementing curricular improvements to a graduate interdisciplinary anatomy course requires consideration and input of multiple stakeholders, including students. This study examined students' use and perceptions of anatomy resources integrated into the course. **METHODS.** Upon completion of an anatomy course, 4 cohorts of graduate health sciences students were invited to complete an online survey on frequency of resource use (never, rarely, occasionally, often) and perception of how influential the resource was to learning (1 = not influential at all, 4 = extremely influential). Resources were categorized as passive (websites, atlas, lab computers, filmed lectures, textbook), active (prosections, models, open lab), and collaborative (peers, teaching assistants, tutors, faculty). Descriptive statistics summarized respondents' use (frequency) and perceptions (mean \pm SD). **SUMMARY.** Respondents were 242 students (male = 69, 28.5%; age = 25.6 ± 4.1 years). The most used passive resources were atlases (77.0%, $n = 184/239$) and textbooks (53.8%, $n = 128/241$) while lab computers were never used by 44% of students ($n = 57/129$). Models (86.7%, $n = 208/240$) and prosections (83.0%, $n = 200/241$) were the most often used active resource followed by open lab attendance (67%, $n = 160/143$). Learning with peers (86.6%, $n = 207/239$) was the most often used collaborative resource; university tutoring (63.7%, $n = 142/223$) and individual meetings with faculty (46.1%, $n = 105/228$) were rarely used. All of the most frequently used resources were perceived as moderately to extremely influential on learning. Active learning with prosections (3.9 ± 0.3 , $n = 206/242$) and models (3.8 ± 0.5 , $n = 241/242$) were perceived to be most influential on learning. **CONCLUSIONS.** Students reported the most helpful passive and active learning resources were models, prosections, atlases and open lab hours. Educators may incorporate these resources when developing collaborative team-based lessons to further enhance peer-to-peer learning.

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Unique doubled psoas quartus muscle variation

INTRODUCTION. Psoas quartus has been described with proximal attachments to quadratus lumborum and transverse process of L3 and distally to the lesser trochanter with the iliopsoas tendon. The current variation presented with multiple bellies, altered proximal attachments, and an entrapment site involving L3 ventral rami. **RESOURCES.** Typical dissection of the inguinal and pelvic regions of an embalmed 83-year-old, Caucasian female during the Physical Therapy anatomy course revealed the anomalous psoas quartus muscle on the left side. **DESCRIPTION.** The key discovery was a double bellied psoas quartus muscle that attached distally to the lesser trochanter with the combined tendon of the iliopsoas. Proximal attachments for the medial belly were from the mammillary processes and transverse processes of the lumbar vertebrae, L3- L4 and for the lateral belly from the pelvic surface of the iliac crest and the quadratus lumborum. The ventral rami of L3 passed through the medial belly via a tendinous tunnel created by the muscle. The muscle bellies joined 14 cm distal to the L3 attachment point and extended together another 13 cm in an infero-lateral direction spanning the iliac fossa before joining with the iliopsoas tendon. The muscle's width measured 31 mm from medial to lateral at its central point. The variant psoas quartus was positioned antero-medial to the iliacus muscle, and posterior to the psoas major muscle. Distally, the muscle belly gave way to a slender tendon that coursed between the tendons of the iliacus and psoas major muscles, delaying the typical conjoining of the iliacus and psoas major tendons. **SIGNIFICANCE.** The variation in the present case could have many clinical implications including entrapment of lumbar nerve root L3, altered abdominal imaging, altered hip function, along with possible disc herniation or back pain due to increased tension on transverse processes of L3 and L4.

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Can anatomical structures on a bisected cadaver donor head indicate a history of OSA?

INTRODUCTION. According to the SleepFoundation.org, more than 18 million adults have obstructive sleep apnea (OSA), a

disorder that can result in daytime fatigue, hypoxia, hypertension, arrhythmias, et al. Previous studies in live patients have suggested a correlation between OSA and uvular length (>15 mm) and width (>10 mm). We describe a possible correlation that can be seen in the gross lab setting. **RESOURCES.** Causes of death are often provided for donors in a gross lab setting. Recently, comorbidities have been included which enhances the potential for clinical correlations. In this case, 2 Caucasian female cadaver donors, ages 87 and 88, had documented OSA. For comparison, 2 Caucasian females, ages 87 and 90, of similar anthropometry were also studied. **DESCRIPTION.** OSA is most problematic when the patient is supine. The donors in our lab, like in most labs, were embalmed in the supine position. In an effort to document anthropometry, we measured donor height and specimens ranged from 151.1 to 162.6 cm. Because obesity has been implicated in OSA, we measured the distance from the dissection table to the anterior surface of the abdomen and specimens ranged from 193.7 to 304.8 mm. The heads and necks were then bisected in order to measure the distance between the epiglottis and uvula, width of the uvula, distance between the tongue and pharynx, and the distance from the nose to the inion. **SIGNIFICANCE.** Most anatomy faculty are not clinicians, yet they desire to share clinical correlations when appropriate. In our small study, we describe gross observations on 2 OSA versus 2 non-OSA donor cadavers. The most striking difference was the distance between the epiglottis and the uvula. In the OSA donors, the distance was 7.8 and 10.3 mm. In the non-OSA patients, the distance was considerably greater at 21.7 and 20.1 mm. When instructing on a bisected head, a short space between the uvula and epiglottis may be indicative of OSA.

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Mandibular nerve variation involving an accessory inferior alveolar nerve: A case report

INTRODUCTION. Variations of the mandibular nerve in the infratemporal fossa are of great interest to dental and medical clinicians and have been well documented. **RESOURCES.** In this case study, standard dissection of the infratemporal fossa on the right side of an anatomic donor revealed a unique variation of the inferior alveolar nerve (IAN). **DESCRIPTION.** The variation involves an accessory IAN in the infratemporal fossa that is formed by branching contributions from the auriculotemporal nerve and the posterior division of the mandibular nerve. The converging branches form a loop

around an unnamed maxillary artery branch. Distally, the accessory IAN bifurcates; one branch converges with the inferior alveolar nerve and the other continues separately into the mandibular foramen. **SIGNIFICANCE.** Awareness of IAN variants is clinically important for understanding potential complications in the effectiveness of intraoral anesthesia by clinicians working in the head and neck region.

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Ankle brachial pressure index: Critical appraisal of landmarks using pulsed wave Doppler ultrasound

INTRODUCTION. Peripheral arterial disease (PAD) is a prevalent, often undiagnosed, clinical condition affecting 202 million people globally. Evidence suggests that the Ankle Brachial Index (ABI) is a useful, inexpensive and non-invasive tool for diagnosing PAD. Current literature shows physicians and residents are inadequately trained to perform the test correctly, and early integration of ABI in medical education is recommended. One reason for the inadequate performance of the ABI is the extensive intraoperative variability in selecting the appropriate anatomical landmarks. This study both identifies and compiles published landmarks for ABI related arteries and assesses the feasibility of using ultrasound as a teaching tool for ABI. **METHODS.** A literature review, of ultrasound and cadaveric studies, was conducted to analyze anatomical landmarks for the brachial, dorsalis pedis, anterior and posterior tibial arteries. Two healthy volunteers were recruited for our team of medical students to apply the findings and perform the ABI using ultrasound. **SUMMARY.** Our preliminary data demonstrated there are limited studies on arterial landmarks for ABI. In performing the ABI, the brachial artery was identified 2 cm medially from the center of the cubital fossa at the elbow crease. The posterior tibial artery identified between the lateral edge of the medial malleolus and calcaneus. The anterior tibial artery was identified 3 cm proximal and 1 cm medial to the lateral malleolus. The dorsalis pedis artery was located distal to the prominence of the navicular bone. Based on our findings, landmarks of ABI arteries are consistent with the available literature. Calculations for the ABI using ultrasound should use the brachial, and anterior tibial or posterior tibial artery. **CONCLUSIONS.** This study provides an overview of the landmarks and demonstrates the feasibility of integrating ABI in medical education. We recommend future studies to implement ABI teaching in medical education.

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Preclinical selectives: Head & neck anatomy with dissection and ultrasound for medical students

INTRODUCTION. Part One Selectives at The Ohio State University College of Medicine began two years ago with the goal of allowing students to obtain advanced knowledge and skills that fall outside the scope of the preclinical (Part One) medical curriculum's learning objectives. These selectives provide students more opportunities for enriching experiences and allow them get more out of medical school in a manner that is tailored to meet their own needs and interests. **RESOURCES.** A Knowledge for Practice: Head and Neck Anatomy with Dissection and Ultrasound selective was created to provide second year students with a 4-day advanced experience wherein they were able to dissect head and neck anatomical structures and have access to ultrasound imaging to further enhance their understanding of the anatomy and the clinical applications available to them. **DESCRIPTION.** Students spent 3 days dissecting the anterior neck, parotid gland, deep facial structures as well as a brain removal and orbit dissection. This was followed by a 1-day ultrasound experience that started with a didactic session on ultrasound terminology and knobology. Students then had the opportunity to scan at different stations, which included parotid gland, pharynx, larynx, trachea, thyroid gland, common carotid artery, internal jugular vein, brachial plexus and ocular imaging. At each station, students were led by trained proctors on how to use the features of the ultrasound to obtain high quality 2D images as well as color Doppler, pulse wave Doppler, and 3D volume renderings. **SIGNIFICANCE.** The use of ultrasound in concert with anatomy dissection can provide students with early exposure to clinical applications that can be used in practice and help to secure an understanding of the anatomy. The feedback was positive and now offers a framework for combining a multidisciplinary approach to anatomy education in pre-clinical medical education.

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Online anatomy self-assessment: Valuable tools for enhancing engagement and improving performance

INTRODUCTION. Self-assessment and self-directed learning are becoming essential components of effective and successful

medical school curricula. It has been proven that millennial learners' comprehension and performance are enhanced with formative assessment and regular feedback. The new integrated basic sciences curriculum implemented at Weill Cornell Medicine-Qatar in 2016 necessitated a thorough evaluation of educational resources. In anatomy, new measures have been introduced with the aim of facilitating students' understanding and performance. **METHODS.** A set of online self-assessment questions have been incorporated as weekly practice quizzes through Canvas platform to first year medical students. Anatomy questions were of the USMLE Step 1 format; and, as item-recognition in relevant regional anatomy images. Students were allowed multiple attempts and received scores at the end of each attempt. Feedback was in the form of an explanation of the correct answer only, in addition to scores. Performance was monitored and compared to students' weekly course quiz grades. **SUMMARY.** Students who took the practice quizzes did better in anatomy. The more often students did the quizzes the better their actual quiz scores were. The online survey showed that the majority of students were satisfied with the self-assessment modules. Our observation supports the concept that self-assessment does enhance students' performance and satisfaction. **CONCLUSIONS.** The self-assessment quiz questions made a noticeable contribution to improving students' engagement and performance in anatomy. The advantage of embedding questions into Canvas platform allowed a closer follow up and feedback. Having an explanation of the correct answer only may have a limited benefit compared to explaining all item choices. We plan to assess the long-term impact of this measure. Self-assessment, if well-designed, can significantly improve students' motivation and interest to learn. (IRB Approval:1499001-1.)

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Radiation induced nuclear changes in oral and oropharyngeal cancer patients—A cytogenetic study

INTRODUCTION. Estimation of radio sensitivity of individual tumor is essential for planning optimum radiation schedule for each patient. Evaluation of radiation induced histomorphological modifications in the nucleus is known marker of radio sensitivity. Our study was to determine relationship between nuclear changes with radiation dose and to explore the prospect of utilizing them as an assay to envisage tumor response to radiotherapy in oral and

oropharyngeal cancer. **METHODS.** The study included 60 patients (age range of 25-65 years) which were histopathologically confirmed cases of oral and oropharyngeal carcinoma and being treated by radiotherapy alone with a radiation dose plan of 4, 14, 24, and 60 Gy, respectively, on second, seventh, 12th and 30th day. All patients which were included in our study, buccal smear of the oral mucosa was collected. Smear was air dried and fixed with methanol. The Nuclear variations of Micronucleus (MN), Multinucleation (MNU) and Nuclear Budding (NB) were evaluated after staining with Giemsa and May-Grunwald's stain under the bright field microscopy. **SUMMARY.** Out of 60 patients included in our study, 42 were males and 18 were females (Mean percentage increase of MN and MNU were found to be statistically significant ($p = .001$) when equated with pre-treatment day. Analogous findings were observed with NB, except between pre-treatment and after 14 Gy of dose ($p=0.110$). In this study the measurement of relative increment index done in regard to all nuclear variations show a sustained rise with increasing dosage of radiation. **CONCLUSIONS.** The progressive rise in nuclear variations indices with increasing dose of radiation proves that these parameters may be used as indicators for evaluating the response of tumor for radiotherapy. Study was undertaken to explore the probability of establishing a relationship between the incidences of nuclear variations in patients of oral and oropharyngeal carcinoma with applied dosage and duration of radiotherapy.

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Computer active learning integrates histology and pathology in a condensed medical curriculum

INTRODUCTION. Medical school basic science curricula have become more condensed with stand-alone histology courses replaced by incorporation into systems-based courses. LCME accreditation requirements place emphasis on student-directed active learning and clinically relevant teaching. In preparation for transition to a condensed combined medical gross anatomy/histology course, we developed a set of virtual microscopy diagnostic exercises that integrated normal histology with pathology. **METHODS.** Students were academically sorted into groups and required to find and describe pathological features on a set of selected specimens. Students were provided with feedback and allowed multiple attempts. They were then required to describe and diagnose unidentified pathological specimens. The specimens corresponded with tissues/organs covered in normal histology lectures and labs. We created a website where students could view and label specimens, enter text

and share comments with group members and faculty. Student participation was enforced through software restrictions. **SUMMARY.** Students resisted applying pre-assigned normal histology material to the exercises. They preferred to use web resources to search for all known diseases of a tissue/organ and compare to the assigned specimen and they diagnosed without labeling features. Revision of the exercises placed emphasis on pathological feature recognition. The allowance of multiple attempts and faculty feedback and guidance encouraged more student “educated guessing” making the exercises a stepwise active learning process. **CONCLUSIONS.** The exercises greatly increased student interaction and teamwork and facilitated student recognition of key pathological features, giving them the necessary framework to hypothesize tentative specimen diagnoses. We are currently developing similar introductory normal histology interactive exercises to facilitate student application of normal histology to abnormal.

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From concept to creation: 3D printed anatomical structures without modeling expertise

INTRODUCTION. Plastic models are frequently used to supplement anatomical education, particularly when cadaveric tissue is inappropriate or unavailable; however, these products are often associated with high costs, lack of detail and realism, and are often too rigid for students to manipulate. Comparatively, three-dimensional (3D) printed anatomical models are cost effective, can replicate variation and pathology, and can be made from flexible plastics. A potential limitation to 3D printed models in anatomy is the inherent belief they require advanced knowledge to create. This project's aim is to demonstrate the ease for anatomists to design 3D printed structures without modeling experience. **RESOURCES.** Anatomy faculty conceptualized and created new anatomic models using commercially available software (NextEngine [NextEngine, Santa Monica, CA] and MeshMixer [Autodesk, San Rafael, CA]) and a 3D printer (Stratasys Mojo printer, Eden Prairie, MN) available at the university library. Faculty received no formal instruction or training on the software or process. **DESCRIPTION.** Three common Adachi variations of the internal iliac artery were built using standard modeling clay.

Scaling was determined based on the dimensions of pelvis bone models available to students. Once dry, clay models were scanned using NextEngine then exported to MeshMixer for gap-filling to ensure the model would print successfully. The final standard tessellation language (STL) files were printed using a flexible filament to allow student manipulation and finished in an acid-wash bath by university library staff. **SIGNIFICANCE.** Creating novel 3D anatomical models is an affordable solution that allows for representation of diverse and clinically relevant anatomical variations. The successful creation of unique models such as these demonstrates how educators are capable of designing their own models with little-to-no advanced 3D modeling training. (Sponsored by Grant No. 501-661, A.T. Still University.)

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Barriers to ischemic stroke care in patients from an NYC suburb: A pilot study

INTRODUCTION. Stroke is the leading cause of disability in the US and ischemic stroke (IS) is the most common type. A barrier is operationally defined as a cause that prevents continuity of care; continuity is a physician-led, team-oriented process for delivering medical services. Many IS patients lack post-stroke care because of barriers such as language, physical ability, transportation, and cost/access to medicines. These barriers contribute to high morbidity and mortality. The purpose of this exploratory pilot study was to identify which variables (barriers) prevent IS patients from receiving post-stroke care. **METHODS.** IRB approval was granted. An instrument was distributed to IS patients ($N = 14$) during their post-stroke visits to a university-hospital stroke clinic (convenience sample) in Staten Island, NY. Patients must have been 18 years or older and diagnosed with IS. An instrument adapted from the valid and reliable SASC-19 survey was used to identify the following barriers: medicine non-compliance, transportation to and from clinic, physical/emotional support, physical rehabilitation, language, and understanding treatment plan. Data analyzed with IBM SPSS Version 24 (Armonk, NY). **SUMMARY.** Respondent demographics: sex (F:43%, M:57%), age (79% were 50 or greater) and ethnicity (79% White, 14% Hispanic, 7% Asian). 29% missed taking post-stroke medicine due to forgetfulness, 7% missed because they perceived they did not need it anymore, and 7% missed because they had trouble obtaining the medicine. 14% felt

their provider did not educate them on their treatment plans, nor did they receive clear discharge instructions on who to follow-up with. **CONCLUSIONS.** Based on these data, access to post-stroke medicine and provider follow-up instructions are important variables (barriers) that will be investigated in a future study. Our data can help clinicians create better discharge plans and ensure their patients have access to post-stroke medicine.

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Integration of virtual microscopy podcasts in histology discipline: Learning outcomes

INTRODUCTION. Virtual microscopy podcasts comprise an innovative Histology laboratory manual. The study evaluates the outcomes of integrating narrative podcasts of virtual Histology Slides into teaching Histology discipline to medical students. The hypothesis is that the inclusion of the podcasts would positively influence the students' perception and their academic performance. **METHODS.** Seventy short podcasts of digital slides were used as supplementary resources of Histology during the first and second years of the medical curriculum. Since the podcasts were introduced in 2017, classes of 2020 and 2021 could access these resources in some but not all the courses and the class of 2022 used them in all the courses. A voluntary and anonymous survey was administered to all three classes using a Likert-scale based questionnaire regarding the students' perception of the virtual microscopy podcasts. The Examssoft reports of all the classes were analyzed to find differences among the cohorts. **SUMMARY.** The survey yielded an overall response rate of 49%. All of the respondents rated the quality of podcasts as excellent or good. The majority indicated that the podcasts enabled more efficient study time and improved their confidence in the Histology content on examinations. The differences among the study groups indicated a positive association between podcast viewing and efficient utilization of study time and confidence about the Histology content and the class performance. This summary of students' feedback and academic performance will help us understand the significance of integrating multimedia with Histology teaching. **CONCLUSIONS.** The virtual microscopy podcasts were found to be beneficial by the students and they were often used as pre-exam review material. Based on the survey and examination report analysis, the inclusion of podcasts in Histology teaching enhances Histology learning. The study will also facilitate planning a curricular modification when needed.

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Use of ultrasonography in evaluation of straight leg test

INTRODUCTION. The straight leg raise (SLR) test is used to assess if a patient with sciatica experiences pain when tension is applied to the sciatic nerve (SN). Pain in the leg is considered to be associated with lateralizing compression of a peripheral nerve. A positive SLR test is considered indicative of an L4-S1 nerve root compression. However, the SLR has variable sensitivity, specificity, and may or may not be present. Ultrasound (US) will be used to test the validity of the SLR test in assessing peripheral SN compression by measuring the circumference and cross-sectional area of the SN in response to the applied tension from SLR. **METHODS.** SLR test was performed on 20 healthy volunteers with US imaging using GE Healthcare Logiq E with 12-L transducer. Imaging was completed at 20°, 40°, and 60° passive hip flexion in a supine position and 0° hip flexion in the prone position. The circumference, cross sectional area, and the distance of the sciatic nerve from the popliteal artery were measured. **SUMMARY.** The preliminary data showed the circumference and cross-sectional area of the SN progressively decreased as passive flexion increased. The distance of the sciatic nerve from the popliteal artery increased as passive flexion increased. There was a significant difference between nerve circumference during passive flexion of the hip at 20°, 40°, and 60° when compared with 0° in the prone position ($p < .05$). **CONCLUSIONS.** The preliminary data suggest SLR is a valid test to assess peripheral sciatic nerve compression. Additional studies need to be conducted to further assess the validity of the SLR test.

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Congenital absence of right coronary artery: A case report and review of the literature

INTRODUCTION. Isolated single coronary artery is a rare congenital anomaly documented in 0.014 to 0.066% of population in the literature. These patients are commonly diagnosed incidentally and may be

misdiagnosed as complete occlusion of the particular coronary artery. **RESOURCES.** The observations were made in an 84-year-old female donor during a regular dissection in the gross anatomy lab. **DESCRIPTION.** While dissecting the thorax, the heart and the lungs occupied normal position in the thoracic cavity. The lungs did not show any abnormality. The pericardium and the pericardial cavity were normal. The left ventricle of the heart was slightly enlarged. During the dissection of the coronary arteries, the right coronary artery was absent. Examination of the aortic sinuses showed only one ostium. This ostium was located in the left posterior aortic sinus with left coronary artery arising from it. The left coronary artery supplied the whole heart. It divided into Left anterior descending and circumflex branches. The circumflex branch gave an additional posterior interventricular artery. **SIGNIFICANCE.** The congenital absence of right coronary artery should be kept in mind by physicians. Abnormal origin, long traveling distance, intramural course of the aberrant coronary artery may precipitate endothelial injury, atherosclerosis and myocardial infarction. Although cardiac catheterization is a gold standard for the identification of the coronary anomalies, the coronary CT angiography and cardiac MRI are excellent noninvasive imaging techniques to detect the anomalous vessels and their relationship with the aorta, pulmonary trunk and other structures.

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Lemmel syndrome VP shunt IOL sphincter implants in 4 cadavers—Surgical anatomy blended HD videos

INTRODUCTION. Cadaver dissections are still considered the gold standard for anatomy learning, recent digital technologies notwithstanding. However, with the paucity of morbid anatomy in standard cadaver dissection labs, leveraging unique pathology findings render anatomy learning more relevant. **RESOURCES.** Cadavers are prospected from scalp to sole every semester by the principle author who is also a surgeon. Close attention is paid to pathology, anatomical variations, prostheses and evidence of any other surgeries on the bodies. All findings are recorded by Samsung Galaxy[®] S8 12/8 MP forward/rear-viewing cameras and integrated with gross anatomy teaching of MD students. **DESCRIPTION.** One cadaver had a large periampullary

duodenal diverticulum, which can produce obstructive jaundice in life, typically described as Lemmel syndrome. A second cadaver had a ventriculoperitoneal shunt from occipital horn of right ventricle. The pump was implanted under the scalp. The outflow tube was tunneled subcutaneously across right neck and chest and inserted into the right subcostal peritoneal cavity. Reason for the shunt was indecipherable. A third cadaver had aphakic posterior chamber intraocular lens implant. A fourth cadaver had an artificial urethral sphincter. Tubes from the balloon reservoir in left lower rectus abdominis were tunneled subcutaneously into the left scrotum, which housed the valvular pump. The inflatable artificial sphincter cuff was wrapped around the root of corpus spongiosum. **SIGNIFICANCE.** Multi-disciplinary correlation of duodenal, biliary, cerebral, ocular and genito-urinary pathology and surgeries with their normal anatomy was the cornerstone of these four dissections. Apart from actually visualizing the morbid anatomy itself, students also saw the intricacies of surgical procedures that were employed. High definition videos of relevant pathology and surgery greatly supplemented anatomy learning and clinical relevance, not to mention students' enthusiasm.

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Factors influencing non-required lecture attendance for first- and second-year medical students

INTRODUCTION. Medical educators have reported a decline in lecture attendance. There are likely various reasons affecting medical students' decision to attend non-required lectures. Therefore, the purpose of this study was to determine which factors have the greatest influence on medical students' attendance of non-required lectures. **METHODS.** A questionnaire consisting primarily of closed-ended questions regarding lecture attendance, influencing factors, and perceived outcomes was distributed to all first- and second year students ($N = 304$) at the Arkansas College of Osteopathic Medicine. Results were analyzed by tallying students' responses to survey items and reported as percentages. **SUMMARY.** One-hundred and seventy-six students (58%) completed the survey, of which 76 respondents provided additional comments to an optional open-ended question. Ninety percent of respondents reported attending 75% or more of required lectures, whereas 60% of students reported going to 75% or more of non-required lectures. The top five reasons students identified for attending non-required lectures were: faculty member presenting the lecture (81%), time to next major exam (44%), course (42%), topic (40%), and personal schedule (39%). Many students commented that being able to change the speed of recorded lectures, lecture time of day, and total number of lectures per day were additional

factors in the decision to attend non-required lectures. Students' perception of course performance due to lecture attendance was equivocal. **CONCLUSIONS.** The faculty member giving the lecture was the chief factor influencing students' decision to attend non-required lectures. Future studies are needed to assess specific factors about a faculty member's lecture and presentation style that drive students to the lecture hall, and what are faculty members' perceptions when faced with an empty classroom.

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Beyond head and neck dissection: What I learned from fourth-year anatomy teaching clinical elective

INTRODUCTION. As a fourth-year medical student of Weill Cornell Medicine-Qatar who chose otolaryngology-head and neck (H&N) surgery for residency training, I enrolled in a 2-week "Anatomy Teaching Clinical Elective: H&N Dissection" to reinforce my anatomy and practice my dissection skills. The course's syllabus included: cadaveric dissection, tutorial of first-year medical students, utilization of medical imaging technology, and preparation of review materials as a presentation and online quizzes. **RESOURCES.** I prepared for anatomy lab sessions by reviewing the anatomy lecture material and dissecting the oral cavity, paranasal sinuses and larynx. The cadaveric specimens combined with images from radiology and 3D imaging were used to teach first-year medical students' anatomy. After lab, clinically relevant anatomy questions prepared as modules were posted on Canvas, and I presented interactive PowerPoint anatomy review sessions. **DESCRIPTION.** This was an intense 2-week clinical elective that required me to self-directly solidify my anatomy knowledge, prepare for the laboratory dissection sessions, and tutor medical students about the clinical relevance of anatomy. Stepping into the role of an instructor demanded a deeper level of engagement; my H&N anatomy knowledge was enriched especially during the preparation for student online self-assessments and review presentations. **SIGNIFICANCE.** This hands-on experience surpassed my objectives of merely revisiting my H&N anatomy and refining my manual dexterity as a future surgical resident. Ending this elective, I gained more confidence upon imparting knowledge to students and building my strong anatomical comprehension. I had a deeper appreciation of the H&N and was able to spark the interest of first-year medical students for otolaryngology-H&N surgery. Presenting and tutoring cultivated my communication skills, professional values and self-directed learning which are crucial in delivering patient care at a teaching hospital.

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Dissection and analysis of a complex cadaveric hand dysmorphism

INTRODUCTION. Embryonic hand development occurs in approximately week 5 of gestation. The normal course of limb development can be affected by environmental or genetic factors leading to various anomalies. The variability and severity of the anomalies could lead to significant functional deficits. The present study aimed to investigate the anatomical make-up of a cadaveric limb presenting with a complex congenital hand malformation. **RESOURCES.** Plain film x-rays and CT scans were obtained prior to dissection of the hand. The forearm and hand dissections were completed, while preserving the musculoskeletal and neurovascular structures. **DESCRIPTION.** Imaging results revealed normal development of the carpal bones with the exception of the trapezoid, which appeared to be hypertrophied. Thumb development appeared normal. The second and fourth digits appeared to each have a metacarpal with primitive development of a phalange. The third digit had an incomplete development of the metacarpal and no associated phalanges. Interestingly, the fifth digit presented with clinodactyly. Examination of the flexor and extensor musculature revealed an abnormal distribution pattern as well. The associated flexor and extensor tendons of the first and fifth digits appeared relatively normal in their distribution patterns. The extensors of the 2–fourth digits attached to the base of the metacarpals. The distribution of the flexor digitorum superficialis and profundus had highly altered distribution pattern, with some digits lacking all or some of the tendons. **SIGNIFICANCE.** The congenital hand malformation has several classifications of obvious hand dysmorphologies, including brachydactyly, clinodactyly, and syndactyly of the soft tissues. However, the flexor and extensor muscles were not atrophied suggesting some functionality of the hand remained.

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Gross and histological examination of tracheoesophageal constriction from a circumflex aortic arch

INTRODUCTION. Circumflex aortic arches are rare developmental anomalies of the aortic arch. One variant, called circumflex

retroesophageal right aortic arch (CReRAA), results in the aortic arch developing over the opposite (right) primary bronchus and coursing left across the midline behind to the esophagus prior to a normal descent. As a result, the ligamentum arteriosum can create a vascular ring around the trachea and esophagus and cause tracheoesophageal constriction (TEC). The present study involves a 57-year-old human female cadaver who was discovered to have a CReRAA and vascular ring. The objective of this study is to investigate the extent and effect of TEC along the trachea and esophagus. **METHODS.** The CReRAA was dissected and photographed. The TEC was dissected, sectioned, imaged, and stained with hematoxylin & eosin (H&E). Trachea and esophagus luminal areas were measured in triplicate along with the angles of tracheal descent and bifurcation using ImageJ software. **SUMMARY.** The proximal trachea lumen ($105.2 \pm 6.4 \text{ mm}^2$) gradually narrowed to the maximum TEC (61.6 mm^2), while the esophagus lumen ($12.0 \pm 2.4 \text{ mm}^2$) was consistent along its length aside from a sizable dilation (42.5 mm^2) just proximal to the maximum TEC. The CReRAA induced multidirectional tracheal angulation, resulting in a steeper vertical angle to the left primary bronchus (139.6°) than the right (125.2°). Histological examination revealed decreased structural integrity in the longitudinal layer of muscularis externa and trachealis muscle at the location of maximum TEC. **CONCLUSIONS.** TEC altered trachea and esophagus gross presentations, affected tissue integrity, narrowed the trachea lumen, and dilated the esophageal lumen proximally. Grossly and histologically examining TEC from a CReRAA patient may help physicians understand CReRAA-related respiratory distress and esophageal dysphagia. Additional analyses are planned to fully understand the implications of CReRAA-related TEC.

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Morphology of blood vessels—Relation to microanatomical features of degeneration in aortic valves

INTRODUCTION. Normal aortic valves are avascular, but in patients with calcific aortic valve disease, the presence of vessels

in the aortic valves is often observed. However, little attention is paid to the morphology of these neovessels. The aim of this study was to morphologically classify neovascularization in calcified aortic valves and to evaluate the possible association between neovessels characteristic and features of valve degeneration. **METHODS.** Seventy-five consecutive aortic valves were obtained during routine aortic valve replacement surgeries and processed using histochemical and immunohistochemical methods to reveal blood vessels (CD34, laminin), calcifications (Alizarin red), hemorrhages (glycophorin, PTAH) and macrophages (CD68). In all specimens following parameters were examined: the presence of hemorrhages, structural degeneration (modified Warren and Yong scoring system), bone formation, and intensity of inflammatory infiltration. **SUMMARY.** Neovascularization was found in 63 (84.0%) valves. In 21 (28.0%) cases only capillary-like vessels were observed, while in the remaining 42 (56.0%) valves also large, sinusoid-like vessels were present. Between-group comparisons (I: avascular valves; II: valves with capillary-like vessels; III: valves with sinusoid-like vessels) revealed significant differences in the valve degeneration characteristics. The presence of sinusoid-like vessels was associated with the most severe hemorrhages ($p < .001$), osteogenic metaplasia ($p = .002$) and the highest level of structural degeneration ($p = .001$) as well as inflammatory infiltration ($p = .01$). **CONCLUSIONS.** Calcific aortic valve disease may lead to the development of different forms of blood vessels in the valve. The occurrence of blood vessels and their sinusoid-like morphology are significantly associated with inflammation, hemorrhages, osteogenesis and advanced valve destruction.

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En-bloc central nervous system dissection: Considerations for broadening neuroanatomy dissections

INTRODUCTION. Prosections are extremely beneficial in aiding students to help identify fine detail otherwise obliterated by novice dissection skills; neuroanatomy and a view of the central nervous system in gross structure is one area where this cadaveric education model can be beneficial for students. In regards to removing the central nervous system (CNS) en bloc, this process is laborious and time consuming; therefore, this dissection is not often conducted by anatomy educators during neuroanatomy courses. **RESOURCES.** This dissection was conducted by one first year, one second year, and three third year medical students. First and second year

students conducted a laminectomy of the lumbar and thoracic spine, cleaned and freed brachial plexus, intercostal nerves, thoracic sympathetic trunk, and greater splanchnic nerve. The third-year students were responsible for removal of the cervical spine, brain, and intact nervous system. Instruments used are scalpels, hemostats, probes, scissors, bone saws, chisels, and mallets. **DESCRIPTION.** Primary goals were to create a comprehensive step-by-step guide to visualize the CNS grossly intact without the musculoskeletal or vascular systems. Secondary aims were to determine the capabilities of pre-clerkship medical student's skill in removing an intact CNS as well as creating optimal dissection methods that are easy to understand and conduct. The intent of this removal is for future students to have a well-documented model so they can form a better understanding of the nervous system as a whole during gross neuroanatomy. **SIGNIFICANCE.** The gross CNS is difficult to visualize and conceptualize due to its apparent non continuity and course throughout the body. It travels between bones and terminates in muscle tissue. If students were able to visualize the nervous system by itself, then students understanding of the relationships between the brain, spinal column, sympathetic trunks, and plexuses may improve.

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Review of musculoskeletal ultrasound shear wave elastography: Past, present, and future

INTRODUCTION. Ultrasound shear wave elastography (US-SWE) is a relatively new advancement in medical imaging that is commonly used to assess soft tissues, such as the liver, thyroid, and breast. Musculoskeletal (MSK) applications of this technology, in particular, are in their early stages. US-SWE measures the speed of shear wave propagation through a tissue, yielding quantitative and/or qualitative estimates of tissue stiffness and elasticity. In this study, we conducted a scoping review of the current MSK US-SWE literature to evaluate the evolving status of the field and to identify gaps for future research. **METHODS.** We searched for primary, peer-reviewed literature in two databases (MEDLINE and EMBASE), resulting in a total of 587 articles dated 1995 to 2020 for initial analysis. Screening included language of publication (English), species (human), age (adult), tissue(s) of interest (contractile tissues of skeletal muscles), and elastography modality (shear wave). **SUMMARY.** Hundred and sixty-three studies were included in the final analysis. We identified several broad categories of application for

MSK US-SWE: (a) normative tissue properties ($N = 61$); (b) pathology or injury, including assessment and treatment ($N = 44$); (c) muscle activity/force ($N = 16$); (d) aging ($N = 7$); and (e) exercise/stretching ($N = 35$). The majority of studies evaluated feasibility and/or reliability of US-SWE in some capacity, reporting widely variable levels of success. The most commonly discussed limitation of MSK US-SWE was the anisotropic nature of MSK tissue—a challenge that has begun to be addressed using custom-built phantoms and animal models. **CONCLUSIONS.** MSK US-SWE is an emerging field with a diverse range of applications in both research and clinical settings. Future research should focus on optimizing and standardizing protocols, establishing consistent normative ranges of muscle stiffness, and improving the fidelity of anisotropic tissue measurement. (Supported by a CIHR Vanier Canada Graduate Scholarship).

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Cephalic vein: Anatomical study/evaluation of the coracoid process as a topographical bony landmark

INTRODUCTION. Clinicians require accurate anatomical information when gaining central venous access. Despite the cephalic vein cut down (CVCD) procedure being described as a superior choice to other methods, the cephalic vein's (CV) anatomical variations can make it challenging to locate. We asked if the coracoid process (CP) could be utilized as an accurate topographical landmark to locate the CV. The present study set out to prove the CV will be located within 1 cm of the CP with statistical significance. **METHODS.** We conducted bilateral shoulder dissections on 42 cadavers to determine the location of the CV in relation to the CP. Distances were measured horizontally, vertically and directly from the CP to the CV utilizing digital calipers. **SUMMARY.** Resulting means were: Straight line distance: 9.48 ± 4.45 mm, horizontal distance: 13.50 ± 6.45 mm, vertical distance: 11.03 ± 5.17 mm. A one sample student *t*-test on the straight-line distance, with the expected population mean set to >1 cm, had a resulting $p = .000134446$. This *p*-value decreased to $-1.11022e-16$ at population mean set to >2 cm. **CONCLUSIONS.** We showed that the CV can be located within 1 cm of the CP with statistical significance. The average incision for the CVCD procedure is 3–6 cm. It can safely be assumed that the incision will be spread to a width of 2 cm. If the clinician does not quickly locate the CV, they can assume it is likely a variation or absent. This will aid clinicians in avoiding unnecessary time searching for the vein and instead rapidly transition to an alternative approach, transitioning the original CVCD incision to the reservoir incision. With this new

information, we hope to persuade more clinicians to make the CVCD their first and primary attempt for central venous access over the subclavian puncture.

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Ultrasound assessment of morphological features of sections of the anterolateral abdominal muscles

INTRODUCTION. Ultrasonography is a non-invasive and useful means of evaluating abdominal muscle function, especially a contraction of the transversus abdominis. Evaluation of the function of the anterolateral abdominal muscles includes measuring thickness of the transversus abdominis and internal oblique muscles and changes in length of the aponeuroses of the lateral abdominal muscles. In this study, we performed ultrasonography to investigate the gross anatomical morphological features of the anterolateral muscles. **METHODS.** All layers of the anterior and lateral abdominal walls were extracted from formalin-preserved cadavers for investigation in this study. The abdominal wall from the xiphoid process to the pubic symphysis was divided into 10 horizontal specimens. The relationships between, and lengths of each muscle and aponeurosis, were assessed. **SUMMARY.** The findings of this study differed from descriptions of the abdominal wall in major textbooks of anatomy. In this study, the cranial to the umbilicus was divided into 6 horizontal specimens (including the level of the xiphoid process), more sections were found that the transversus abdominis muscle was located in the deep part of the rectus abdominis muscle. In such textbooks, attention is usually paid to the relationship between the rectus abdominis muscle and rectus sheath in cross-sectional views of the anterior and lateral abdominal muscles. Two or three sections of the abdominal wall are usually shown: cranial to the umbilicus (or arcuate line), at the level of the umbilicus, and caudal to the umbilicus (or arcuate line). We examined more sections cranial to the umbilicus and found that the descriptions in most textbooks are insufficient. **CONCLUSIONS.** More detailed anatomical characteristics of the abdominal wall are necessary for accurate ultrasound diagnosis. We plan to further develop ultrasonography of the lateral abdominal muscles by adding dynamic assessment of their function.

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The clinical anatomy of the hallucal sesamoids

INTRODUCTION. The hallucal sesamoids are vital in the biomechanics of the foot, and are regularly targeted during surgery, especially hallux valgus (HV) surgery, in which soft tissue releases (STR) are utilized to encourage realignment of the sesamoids. STRs are suggested to target specific attachments to the sesamoids, but this is not based upon reliable anatomical data. There has yet to be an accurate description of these attachments and how they can be safely targeted, nor what critical nearby structures are at risk. **METHODS.** Unembalmed ($n = 5$) and Genelyn embalmed ($n = 30$) cadaveric feet were used for a number of diverse methodologies, such as: fascicular micro-dissection, microscribe digitization, arterial perfusion with a contrast mix, CT and micro-CT scanning, sectional data from 1 to 2 mm sections and histology. **SUMMARY.** The data from this research shows that the anatomy around the hallucal sesamoids is complex and understudied. However, these data clearly demonstrate significant attachments to the medial and lateral sesamoids that were previously refuted, or not even considered. The course of essential nutrient vessels for each sesamoid was mapped and related to surrounding tissues; the various imaging modalities enabled high-resolution visualization of many of these structures for the first time. **CONCLUSIONS.** These detailed anatomical descriptions of hallucal sesamoid attachments and vascularity have contradicted or built upon much of the reviewed literature. This thorough understanding of sesamoid anatomy will inform more considered and evidence-based surgical decisions in podiatric surgery and may reduce complications and improve functional outcomes.

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From Brisbane to Melbourne—Facilitating engagement in anatomy across multiple campuses online

INTRODUCTION. Anatomy is the foundation for exercise science (kinesiology) professionals and success in the industry is dependent

on an in-depth knowledge and application of this in real-world scenarios. However, teaching a concurrently run, multi-campus curriculum creates challenges when attempting to engage student's in their learning and the ability to use these scenarios. Therefore, we created a range of alternative digital approaches to enable an engaging and consistent, National learning environment. **RESOURCES.** A group of region-specific anatomy YouTube videos, with associated lecture content were created using visual and verbal examples. They incorporate specific anatomical images, diagrams, explanations and real-world scenarios to assist with student engagement which is crucial for adult learning in a kinesiology course. Audio explanations are used in conjunction with various digital tablet applications to guide students and explain the relevance of anatomy. **DESCRIPTION.** To design a suite of videos and lecture content which provides an engaging platform and an alternative method of helping students learn content outside of traditional face to face teaching. This approach allows for the consistent delivery of content across multi campus, National curriculum. **SIGNIFICANCE.** YouTube videos provide an alternative teaching method for anatomy that makes the most of various digital, social media platforms with which the students are increasingly engaged with. The additional challenge of a multi campus, National curriculum separated by 1,800 km, is managed by having digitally accessible content which provides a consistent delivery across sites. Furthermore, the YouTube videos include applied examples which students may encounter as professionals, therefore facilitating purposeful learning. These approaches may not replace the face to face delivery of anatomy, but they do provide a unique alternative in an accessible, engaging and interactive environment.

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Evaluation of nerve capture using classical landmarks for knee radiofrequency denervation

INTRODUCTION. Radiofrequency (RF) denervation of the superolateral (SLGN), superomedial (SMGN), and inferomedial genicular (IMGN) nerves are commonly used to manage chronic knee pain related to osteoarthritis. Development of novel image-guided procedures, to increase capture rates, requires a detailed understanding of the classical target sites and their 3D relationships to articular branches of SLGN, SMGN, and IMGN. The capture rates of these genicular nerves, using classical target sites, have not been thoroughly investigated. Therefore, the purpose was to determine which articular branches of SLGN, SMGN, and IMGN are consistently captured using classical landmarking. **METHODS.** In this pilot study, RF cannulae were placed in 5 specimens. The cannulae were adapted to enable a

metal insert to pass through the barrel and be embedded at the site of the needle tip. Next, the specimens were dissected to expose articular branches of SLGN, SMGN, IMGN and their relation to the metal insert. The articular branches and metal insert were digitized and modeled in 3D using Autodesk[®] Maya[®]. Nerve capture rates were assessed and quantified based on the visualization of articular branches overlapping with the 3D model of the lesion volume placed at the location of the metal insert. **SUMMARY.** In all specimens, the classical landmarks captured proximal branches of the SLGN and SMGN, while sparing the more distal branches. Also captured were the anterolateral (5/5 specimens) and anteromedial (4/5) branches of the nerve to vastus intermedius. Inferiorly, anterior branches of the IMGN (5/5) were captured while the more distal and posterior branches were spared. **CONCLUSIONS.** The classical landmarking techniques for RF denervation of the knee joint was found to only capture a select number of targeted articular branches. Additional landmarks to supplement current practice require further anatomical and clinical investigation to reduce the sparing of articular branches.

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Occurrence and spatial morphometric characteristics of the coumadin ridge

INTRODUCTION. A coumadin ridge (or left lateral ridge) is a band-like embryological remnant in the left atrium (solid fold of tissue) located on endocardial aspect of left atrium, between the left-sided pulmonary vein ostia and the left atrial appendage orifice. Although the ridge is considered as an anatomical variant, its shape and location may be mistaken for a tumor or thrombus or be obstacle during electrophysiological interventions. Therefore, the aim of this study was to evaluate occurrence and morphometric features of the ridge. **METHODS.** A total of 200 autopsied human hearts were investigated (Caucasian, 22.5% females, 48.7 ± 4.9 years old). We macroscopically assessed the anatomy of the coumadin ridge. **SUMMARY.** The ridge was noticed in 59.5% of cases and in the remaining 40.5% it was absent. The width of the ridge at the level of left superior pulmonary vein ostium was 7.9 ± 3.2 mm, while at the level of left inferior pulmonary vein ostium was 9.1 ± 5.0 mm ($p = .028$). The occurrence of the coumadin ridge was not associated with sex ($p = .17$) and ridge dimensions were not significantly different between the sexes ($p > .05$). **CONCLUSIONS.** The coumadin ridge is present in almost 60% of human beings. The ridge is significantly thicker at the level of left inferior pulmonary vein ostium than at superior pulmonary vein ostium. Awareness of coumadin ridge typical location and morphological properties are critical to avoid unnecessary interventions or complications during invasive procedures.

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Topographic characteristics of the left atrial postero-septal region

INTRODUCTION. The purpose of this study was to provide a detailed topography of the left atrial medial isthmus (right inferior pulmonary vein ostium to the medial part of the mitral annulus). **METHODS.** A total of 200 human hearts were investigated (Caucasian, 22.5% females, 48.7 ± 4.9 years old). **SUMMARY.** The mean length of the medial isthmus was 42.4 ± 8.6 mm. The isthmus line was divided by the presence of the oval fossa into three sections with equal mean length (upper: 14.2 ± 7.2 , middle: 14.1 ± 6.1 , lower: 14.9 ± 4.6 mm; $p > .05$). The left atrial wall was thinner in the upper section when compared to the lower section (2.5 ± 1.1 vs. 3.4 ± 1.6 mm; $p < .0001$). Three variants of the spatial arrangement of the oval fossa and the isthmus line were distinguished: type I (54.5%) had an oval fossa located outside the isthmus line; type II (32.5%) had an oval fossa crossed by the isthmus line; type III (13.0%) had an oval fossa rim located tangentially to the isthmus line. In 68.5% of cases the isthmus area was smooth whereas in 31.5% of cases various additional structures (diverticula, recesses and tissue bridges) were observed. **CONCLUSIONS.** This study presented the first morphometric and topographical description of left atrial medial isthmus area. In 32.5% of hearts, when the oval fossa was crossed by the medial isthmus line, interventions within the medial isthmus line may be difficult and dangerous. In 31.5% of cases, the left atrial medial isthmus line had unwanted structures within it which could entrap a catheter and complicate ablation procedures.

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Case report: Incidental finding of a circumaortic left renal vein

INTRODUCTION. Renal vein anomalies are considered to be relatively rare; however are becoming more frequently diagnosed due to the increased utilization of medical imaging. They can be classified into three main categories: multiple renal veins, a retro-aortic left renal vein (RLRV), and a circumaortic left renal vein (CLRV). A

circumaortic left renal vein occurs due to the persistence of both the ventral and dorsal limbs of the renal collar. **RESOURCES.** A series of MRI lumbar spine images without contrast was obtained and reviewed. **DESCRIPTION.** We present a case of a 26-year-old Caucasian female who underwent investigation for lumbar radiculopathy. An MRI incidentally revealed the presence of a circumaortic left renal vein. The ventral branch of the left renal vein ran anterior to the aorta whereas the dorsal branch ran between the aorta and the vertebral body. Reanastomosis of the two branches was evident prior to insertion into the inferior vena cava. The result was a venous ring that encased the aorta. **SIGNIFICANCE.** This anomaly is usually asymptomatic, but has been shown to be associated with intermittent hematuria due to increased pressure within the left renal vein. In cases of hematuria, the presence of a circumaortic left renal vein should be considered in the differential. Its occurrence also has significant implications regarding retroperitoneal surgery. Failure to identify the existence of a retro-aortic renal vein intra-operatively could lead to massive hemorrhage. Its presence is also a relative contraindication to donor nephrectomy at some institutions. Therefore, it is crucial that the presence of a circumaortic left renal vein is identified with the assistance of pre-operative imaging to prevent adverse outcomes.

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Fibrous structures connecting the buccinators and the dermis in the deep medial cheek fat pad

INTRODUCTION. The deep medial cheek fat pad (DMCFP) is surrounded by the zygomaticus major superiorly, the body of the mandible inferiorly, the orbicularis oris anteriorly, the buccal fat pad posteriorly, the buccinators deeply, and the SMAS superficially. Furthermore, this fat pad, as well as the malar fat pad, are considered to be involved in the aging changes of the face. However, the exact mechanisms by which this fat pad controls facial aging changes remains unclear. Furthermore, the branches of the facial nerve, facial artery, and facial vein run intricately in the deep medial cheek fat pad, and its detailed anatomy is very important for facial surgeons. **METHODS.** Twenty sides of 10 formalin-preserved cadavers were used for this study. Five sides were used for creating frontal sections, five sides for horizontal sections, and ten sides for layer-to-layer dissection. For creating sections, the tissues were cut at a width of 5 mm either on a horizontal plane or a frontal plane. The loose

connective tissues and fat tissues were dissected under a surgical microscope, with hyperextension of the sections by pulling the skin outwards. Each structure in the sections was carefully confirmed in gross anatomical dissection. The direction and distribution of the fibrous tissue in the medial cheek region were observed in a magnified view. **SUMMARY.** In all cases, the fibrous tissues connected the lining of the buccal mucosa and SMAS passing through the buccinator and the DMCFP. The fibers united to create the fascia at the superficial surface of the buccinator. As the SMAS is thin and unclear in this area, the fibers entering the deep medial cheek fat pad intermingled with the honeycomb-shaped fibers in the malar fat. **CONCLUSIONS.** This fibrous structure likely plays a role similar to a retaining ligament of the face, and may contribute to creating the cheek dimple. These detailed anatomical findings of this unique structure are also important for improving facial surgeries.

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Relationship of PFOs to sex and fossa ovalis diameter

INTRODUCTION. During development, the atria start as a common chamber, ultimately divided by the combination of the septum primum and septum secundum, forming the interatrial septum. Prior to birth, communication between the atria is via the foramen ovale. When the lungs inflate after birth, a pressure increase in the left atrium and decrease in the right ventricle induce closure of the foramen ovale, forming the fossa ovalis. In approximately 25% of the general population, the foramen ovale does not close and is termed a patent foramen ovale (PFO). We identified associations between the presence of PFOs and sex and fossa ovalis diameter. **METHODS.** Forty-one hearts were obtained between 2018 and 2019 from cadavers in our lab. Data was collected with respect to PFO tunnel diameter, PFO tunnel length, fossa ovalis diameter, age, sex, and cause of death. **SUMMARY.** A statistically significant difference exists between the fossa ovalis diameter of hearts with PFOs and hearts without PFOs determined by one-way ANOVA $F(1,39) = 4.897$, $p = .033$. Hearts with a larger fossa ovalis diameter were more likely to have a PFO. A chi-square test of independence was performed to examine the relationship between sex and the presence of a PFO. These variables were significantly different, $\chi^2(1, N = 41) = 4.7$, $p = .031$. Men were more likely than women to have a PFO. **CONCLUSIONS.** The results suggest two relationships that may be of clinical importance. The association between increased fossa ovalis diameter and the failure of the foramen ovale to close, and the relationship between male sex and the failure of the foramen ovale to close. These factors will be helpful in identifying patients at higher risk for conditions associated with PFOs who would benefit from corrective measures.

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The tendon of latissimus dorsi as an alternative landmark for distal border of the axillary artery

INTRODUCTION. Nearly all dissectors and gross anatomy textbooks refer to the first, second and third segments of the axillary artery, and their corresponding branches, based on specific anatomic landmarks. Most often, the distal end of the axillary artery (and hence the beginning of the named brachial artery) is marked by the distal border of the teres major tendon. In our years of dissection experience, we have noted that perhaps an easier landmark for this axillary/brachial artery boundary would be the distal edge of the latissimus dorsi tendon. Both tendons have insertions within millimeters at or near the intertubercular groove of the humerus. **RESOURCES.** 38 axillary dissections were reviewed. **DESCRIPTION.** Following exposure of the tendons for both latissimus dorsi and teres major, we have noted that the distal edge of the latissimus major tendon aligns nearly perfectly with the distal edge of the teres major. Also, the final branch of the axillary artery (posterior circumflex humeral artery; PCH) occurs with regularity proximal to the latissimus tendon, with one noted bilaterally anomalous specimen. **SIGNIFICANCE.** Since most cadaveric dissections of the axillary artery are performed with an anterior approach, the more superficial latissimus tendon proves an easier landmark to demarcate the boundary between the axillary and brachial arteries. We would argue that this landmark change is supported by the fact that the blood supply to latissimus (thoracodorsal branch of subscapular artery), the most distal shoulder muscle, is from the axillary artery. In the one specimen with bilateral anomalous branching of PCH distal to teres major, the suggested landmark change would still include PCH as a branch of the axillary artery. Moreover, this suggested change is clinically applicable, since the latissimus is more readily palpable than the teres, providing the clinician a better idea of the axillary artery location in the patient.

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Google image as a resource in the anatomy laboratory

INTRODUCTION. In anatomy laboratories equipped with internet-enabled computers, faculty often observe medical students using Google Image searches to view anatomical structures as opposed to hard copy or computer-based official course resources (e.g., atlases). This study investigates the educational quality of images resulting from these searches. **METHODS.** We performed a Google Image search of 3–5 “high yield” anatomical structures, groups of structures, or relationships per unit of the first-year anatomy course and analyzed the top 10 search results for each term to (a) report the type of image and the name and type of website publishing the image and (b) assess the relevance or educational quality of the image

using a four-point Likert-type scale. **SUMMARY.** A total of 24 Google Image search terms yielded 240 results. Most of these were atlas-style illustrations or schematics; only 3 of the 240 images were cadaveric photographs. Of the 240 images, 40% were from student or clinician education sites (including anatomy tutoring sites), 17.5% were from patient or public education sites (e.g., hospital and provider webpages), 15.4% were from Wikipedia, 14.2% were from academic reference sites, and 12.9% came from social media or other sites. The search term was depicted in 95.4% (229) of the results; these images were defined as “relevant.” Of the relevant images, 42 (18.3%) were considered to adequately depict all key components and relationships of the searched structure. While the relevant images were largely accurate, many of the images were incomplete (e.g., not all components depicted or labeled) or missing important context or anatomical relationships that would aid students in identifying the structure in question. **CONCLUSIONS.** Google Image results for commonly-searched anatomical structures can be reliable and useful resources in the anatomy laboratory; however, students must exercise caution by first considering the source and context of the image.

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Reflections on life's passing in the anatomy course— An international 14 university comparison

INTRODUCTION. Reflections on the topic of death and life's passing during the anatomy course can have a significant impact on medical and dental students' emotions. The goal of this qualitative study was to perform an international comparison at 14 universities, and to study whether variations in anatomy course formats may have an impact on the students' experiences. **RESOURCES.** Participants were pre-clinical students who volunteered in an international exchange program (65% female, 35% male; 24% were <20, 70% were between 20 and 25, 6% were >25 years old). Students were asked to reflect on one question (“How did your experience in the anatomy laboratory bring about your reflections on the meaning of life and human existence as well as the sanctity of one's passing?”)—in self-reflection and together as an international small focus group (68 groups of 3 to 4 students connected online). Written assignments were anonymously coded into themes by 4 individuals—sorted by schools. Information on anatomy courses was obtained via faculty questionnaires. **DESCRIPTION.** 151 individual and 44 group responses were received. One school does not offer cadaver dissection for all. Another school teaches via pro-sections only. Major themes included dignity, beneficence, dichotomy, appreciation, fragility of human life, spirituality, relationship, indifference. Themes varied among the different schools—cultural differences and possibly the way anatomy is taught may have an impact. Students who do not dissect tend to avoid responding on the topic of death. Students who visit donor families prior to the course mentioned dignity. **SIGNIFICANCE.** Anatomy dissection courses can have a major influence on initiating students' thinking about life's passing. Differences in responses by schools indicate cultural differences and the way how anatomy is taught.

How to cite this article: (2021). Abstracts accepted for the 37th Annual Meeting of the American Association of Clinical Anatomists, June 15–19, 2020. *Clinical Anatomy*, 34(8), E40–E92. <https://doi.org/10.1002/ca.23694>