ADAMS, J. Department of Anatomy and Developmental Biology, Monash University, Australia. **Noninvasive data capture methods of 3D anatomy for teaching and research**

**Purpose:** Anatomists wanting to use three-dimensional (3D) datasets for research, demonstration, or teaching have traditionally relied on computerized tomography (CT) or magnetic resonance imagery (MRI). The logistical issues of accessibility and costs of these technologies often limit gathering data for nonpatient research (e.g., cadaveric material and comparative anatomical studies). This poster presents data on using the commercially available Artec Spider as a portable, high-accuracy imaging tool for digitizing complex surfaces of anatomical dissections. We present our results of applying the scanner on a range of anatomical specimens as a heuristic for other anatomists looking to use alternative imaging technologies.

**Methods:** The Artec Spider (Artec Group, Luxembourg) was used to digitize a range of specimens, including prosections of cadaveric orbits with small neurovascular structures. Each scan was processed following a standard surface scan workflow using Artec Studio 9.0. Beyond visual inspection of the digital files and 3D prints produced through this process, fidelity of the digital specimens was assessed using concordance and intraclass correlation coefficients.

**Results and Discussion:** The accuracy (0.05 mm) and resolution (0.1 mm) were sufficient to resolve the morphology and course of small nerve fibers as well as the thickness of small muscular structures. Correlation coefficients were calculated for each pair of measurements with the original reference data. Results indicate that the scanner produces digital files and 3D prints with high concordance to the original (and error levels within that of intra-observer error for linear metrics). These scanned specimens demonstrate the potential of this relatively low-cost technology for imaging anatomy specimens for research and education especially for postgraduate ophthalmology and optometry trainees.

ADSTRUM, S. Department of Anatomy, University of Otago, New Zealand. **Excuse me, what do you mean fascia...?**

**Purpose:** The anatomic meaning of “fascia” has evolved during the past four hundred years. A recent change in the way fascia is acknowledged in the literature may signal a shift from how fascia has traditionally been known by anatomists to its more expansive interdisciplinary interpretation by contemporary writers. This study aims to determine whether there may be a similar change in the way fascia is understood in New Zealand, as it might, should it exist, affect cross-disciplinary and broader community discussion about the morphology and remedial treatment of the body's soft tissues.

**Methods:** This transdisciplinary study used ethnographic fieldwork methods (semistructured interviews and participant observation) to investigate how fascia is described during the instruction of several different groups of clinical health practitioners (dentists, doctors, massage therapists, osteopaths, and physiotherapists; and anatomy trains, craniosacral therapy, fascial kinetics, and kinesio taping practitioners) who are training to work, or already work, in New Zealand.

**Results:** Fascia is generally portrayed in either of two ways to the head is positioned erect for a facial approximation; yet most facial soft tissue depths (FSTDs) used in the method are measured from supine subjects. This position is discussed as having soft tissue distorted by gravity, which could affect depth values. However, there is a paucity of quantitative data to verify. This sonographic study primarily aimed to compare erect and supine FSTD values on a cohort of living, healthy adults to evaluate whether there were any significant measurement differences between same landmarks in these two positions.

**Methods:** Height, weight, and sonographic FSTD data for 17 land- marks (three midline and seven bilateral) totaling 1,020 measurements were obtained from 30 healthy living New Zealand (Caucasoid) women (18–30 or 40–55 years). Values were compared using ANOVA, P values, and Pearson’s correlations. Correlative strengths for age and body mass index (BMI, kg/m²) were determined to quantify their influence on results.

**Results:** Averaged FSTD differences between erect and supine measurements were significant for only four of the 10 landmarks.
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Agrin and rapsyn may cause this denervation, thereby establishing fiber atrophy in old age. Here, we have shown that decline in NMJ integrity is conducted in a purposeful and clinically relevant manner.

BOUWER H., K. VALTER, A. L. WEBB ANU Medical School, The Australian National University, Australia. A snapshot of current dissection utilization in Australian and New Zealand medical schools

Purpose: With the implementation of the modern integrated medical curriculum, there has been a reduction in the use of dissection. Evaluation of graduate outcomes has suggested that no alternative methods have been able to fully replace dissection, and thus there have been calls for its return. However, the crucial consideration now is how this "traditional" education method can be effectively integrated into modern medical curricula? The purpose of this study was to investigate the current utilization and integration of dissection in Australian and New Zealand medical schools.

Methods: An electronic survey that collected qualitative and quantitative data was distributed to all 21 Australian Medical Council-accredited schools, with an invitation to participate in an interview.

Results: Sixteen schools (76%) responded to the survey and five interviews (24%) were conducted. Dissection was a component of the medical program in 12 (75%) responding schools. Five schools (31%) integrated dissection with other science or clinical disciplines, including pathology, histology, imaging, and surgery. Seven schools (44%) reported integrating dissection with non-science themes including ethics, law, and social science. Innovative approaches integrating dissection included visiting clinicians and specialists and aligning lecture material with dissection classes. Case-based "first patient projects" combining dissection and pathology, presented by students, were also reported.

Conclusion: A number of medical schools have responded to the curriculum changes in medical education and have been developing novel and innovative approaches to ensure dissection remains an integral component of medical student education. Moreover, this integration is conducted in a purposeful and clinically relevant manner.

BRADY, J., A. GILLON, N. LAL, P. SHEARD Department of Physiology, University of Otago, New Zealand. Age-related declines in synaptic proteins, agrin and rapsyn, and their relevance to sarcopenia

Purpose: Sarcopenia is a disease involving the loss of muscle mass and strength; however, little is known about its cause. Some investigations have implicated nervous dysfunction (loss of synaptic integrity) in age-related muscle fiber atrophy. The loss of synaptic integrity manifests as age-related denervation of muscle fibers and seems to impinge on the expression of particular synaptic proteins. We therefore investigated age-related changes in the expression of two such proteins, agrin and rapsyn, with the aim to determine whether their age-related decline correlates with neuromuscular junction breakdown with age.

Methods: Fluorescent immunohistochemistry was used to compare relative amounts of agrin and rapsyn at the neuromuscular junctions (NMJs) of leg and neck muscles in young (20 months) mice. Relative amounts of protein present within morphologically intact (healthy) and fragmented (unhealthy, correlates with denervation) NMJs were compared with correlate nerve terminal health status with synaptic protein expression.

Results: Old mice had significantly (<0.05) less agrin and rapsyn present at the NMJ than young mice irrespective of NMJ health status. All fragmented NMJs were associated with a further decline in agrin and rapsyn expression.

Conclusion: Age-related denervation is a likely cause of muscle fiber atrophy in old age. Here, we have shown that decline in NMJ agrin and rapsyn may cause this denervation, thereby establishing these substances as potential targets for therapeutic intervention directed at the prevention of denervation by maintenance of NMJ stability in old age.

CALMA, A. D. B., A. S. COLIBABA, A. L. WEBB, K. VALTER, ANU Medical School, The Australian National University, Canberra, Australia. Exploring deep space: How to reveal the cerebral ventricular system

The three-dimensional (3D) anatomy of the human brain is complex and can be challenging for students to understand. In particular, the cerebral ventricles and their associated structures are difficult to visualize given their internal location in the brain. Coronal and sagittal cross-sections of the brain are traditionally used to demonstrate the morphology of the ventricles and their anatomical relationships. However, using two-dimensional (2D) slices alone to demonstrate a 3D structure requires students to render a mental image of a 3D space rather than providing them with a palpable structure for direct observation. The aims of this study were to devise a method for dissecting the human brain to expose the structure and spatial relationships of the ventricular system and to create a teaching resource that enhances student perception of ventricular morphology and relationships. The Klingler fiber dissection technique was chosen for the preparation of the lateral ventricles and to develop a written protocol with accompanying images as a study aid. We found that using the Klingler method of fiber dissection allowed the visualization of the superfi cial white matter tracts that are not easily viewed in 2D sections. The dissection enabled the structure of the lateral and third ventricles to be clearly seen and allowed appreciation of a number of structures closely related to the cerebral ventricles such as the limbic system, basal ganglia, and major superficial white matter tracts. We believe that this new dissection method allows for a reproducible brain preparation that will be beneficial in anatomy teaching.

CHAPMAN, J. School of Medicine, University of Tasmania, Australia. Development of interactive and engaging histology practical eBooks for first-year medical students

Purpose: Students are increasingly using mobile devices during classes, and one way to engage with these students, and to allow them to better engage with the content is through the use of resources that have been specifically developed for this purpose. Existing online histology practical notes were created into two eBooks using Apple's free software iBooks Author. These eBooks, initially only accessible via iPads, now also accessible by any Apple computer, contained a number of interactive features including image galleries, interactive images, multimedia content, review questions, and a glossary of almost 200 histological terms. These books were offered freely to students via their LMS in 2013 and 2014 as an alternative to, or to support the online histology practical notes. Students were asked to provide feedback through anonymous online surveys.

Results: Initially, because of the limitation of iBooks only being available on iPads, only around one in four students had access to these resources. With the release of the new OS and iBooks for Mac, approximately 63% of students downloaded and accessed the Histology Practical Notes iBooks. Many of these students used the iBooks during practical classes with many working in small groups to discuss the review questions. Survey results, while only sampling a small number of students, were all very positive.

Conclusion: The propriety of the iBooks limits its ability to reach all students. The interactive nature and instantaneous feedback to students on their progress make them a useful tool for engaging the students in a content-specific manner.

COLBORNE, G. R., A. B. WELLER, M. TRUGLIO, L. A. FULLARD, G. R. BARNES Institute of Vet, Animal and Biomedical Sciences, Massey University, New Zealand, Massey Genome Service, Massey University, New Zealand. Development of interactive and engaging histology practical eBooks for first-year medical students

Purpose: Students are increasingly using mobile devices during classes, and one way to engage with these students, and to allow them to better engage with the content is through the use of resources that have been specifically developed for this purpose. Existing online histology practical notes were created into two eBooks using Apple's free software iBooks Author. These eBooks, initially only accessible via iPads, now also accessible by any Apple computer, contained a number of interactive features including image galleries, interactive images, multimedia content, review questions, and a glossary of almost 200 histological terms. These books were offered freely to students via their LMS in 2013 and 2014 as an alternative to, or to support the online histology practical notes. Students were asked to provide feedback through anonymous online surveys.

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Conclusion: The propriety of the iBooks limits its ability to reach all students. The interactive nature and instantaneous feedback to students on their progress make them a useful tool for engaging the students in a content-specific manner.
University, New Zealand. Development of an OpenSim model of the canine lumbosacral spine

Purpose: In working dogs subjected to high levels of physical activity, like police and search and rescue dogs, the lumbosacral spine is subject to forces and torques that can cause breakdown. About 16% of the German Shepherd dogs used in police and military service broke down early in their careers. We are developing an OpenSim model of the lumbosacral spine to model the three-dimensional (3D) forces across the spinal joints during gait and other movements.

Methods: The process involves building a 3D computer model of the lumbosacral spine from high-resolution CT images. The CT file is taken into an open-source program (3D Slicer) which differentiates soft and hard tissue to create a 3D rendering of the vertebral elements. This is input to another open-source program (NMS build for SimBody) to further define the model with linear connectors representing ligaments and muscles. These soft tissue elements are measured directly from cadavers following CT of the spine. The completed model can then be used in OpenSim, an open-source platform (Stanford University), for modeling, simulating, and analyzing the neuromusculoskeletal system.

Results: We have generated the high-resolution 3D rendering of the vertebral elements for input to SimBody.

Conclusion: With accurate muscle and other soft tissue inputs, we will manipulate these variables to examine the effects of different spinal conformations on the forces and torques across motion segments and to evaluate whether there are spinal conformations that predispose to spinal injury.

COLLINS-PRAINO, L. J. BURTON, I. P. JOHNSON Discipline of Anatomy and Pathology, University of Adelaide, Australia. Evaluation of the utility of an in-house three-dimensional teaching tool for undergraduate neuroanatomy

Purpose: Learning neuroanatomy can be challenging, as it involves integrating complex, three-dimensional (3D) circuitry with knowledge of physiology and pathology. At face value, electronic 3D teaching resources could help to resolve these difficulties, but some are anatomically incorrect, whereas others lack interactivity, or focus much depth on an individual brain area which may not be appropriate for some courses. The current study aimed to improve on existing resources in the field by developing in-house an electronic, anatomically correct teaching tool for teaching nerves to the three courses, objects, while being visually stimulating and engaging.

Methods: Anatomically accurate 3D models from CT and MRI images were created and manipulated using Autodesk 3DS Max. These were then exported and embedded, along with appropriate teaching material, into a Prezi presentation platform. The resource was deployed in a third-year neuroanatomy course. Following completion of the course, participants were administered a brief, anonymous survey (10-item, 7-point Likert-scale, with space for comments) in which they were asked questions related to their attitudes toward the resource.

Results: Thirty-six of 50 (72%) students in the course completed the questionnaire, with 15/36 (42%) reporting that they had used the resource. The main reason given for nonuse was inability to open the resource on a Mac computer. Of those that used the resource, there was 86–93% broad agreement (BA) that the resource was useful, with 71% BA that the resource improved learning. The aspects of the resource that were particularly useful were the visual layout and 3D nature of the images (93% BA).

Conclusion: Despite the ready availability of generic 3D learning aids for anatomy, our in-house course-specific resource was popular amongst students who believed it improved their learning. Whether it improves learning outcomes remains to be determined.

CROWLEY, C., M. HANLEY, M. A. MALIK, S. SINHA The School of Medicine, University of Notre Dame, Australia. Utilizing gross anatomy, surface anatomy, radiological anatomy, and procedural anatomy learning activities to compliment student learning of clinical procedures whilst “waiting for their turn.”

Purpose: This research seeks to incorporate clinical anatomy learning activities during the idle time second-year medical students experience whilst waiting for their turn to practice clinical skills on models.

Methods: Initial questionnaires were given to second-year medical students to assess how they used their class time whilst waiting for their turn to practice clinical skills on models. The information collected from the initial questionnaires was then used to develop adjunct learning activities, which composed of quizzes using real and virtual anatomical images, short answers questions addressing anatomy/clinical reasoning, and a step-by-step checklist of the clinical procedure. Images and questions aimed to reinforce and integrate prior learning relevant to each procedure. Students worked on these independently and received answer sheets during the session to self-assess their responses. Checklists were used to allow students to utilize a “see one, do one teach one” approach to the procedure, using the checklist to work in pairs with one student giving feedback to the other student performing the procedure. Forty second-year medical students who chose to enroll in the study were given these adjunct activities during four clinical skills sessions. At the end of each clinical skills session, participants completed a detailed questionnaire to express their views on the use of these activities.

Results: The results of the questionnaire revealed that the adjunct learning activities were useful to the students during their waiting times, aided the students in learning their topic, and did not overload the students. The positive comments and results increased appreciation of this intervention, and the negative comments included not having high-quality images and not having enough printed copies for each individual participant.

Conclusion: This study found that providing students with adjunct learning activities while they wait for their turn enhances their learning experience. However, care must be taken that the materials are of high quality, standardized, and available to all. The use of adjunct activities translating into long-term knowledge retention was not assessed in this study.

DIAS, G. J.,¹ R. K. R. DE SILVA,² T. SHAH,¹ E. SIM,¹ N. SONG,² S. COLOMBAGE,² N. LAL,³ J. CORNWALL,¹,3,4,5
¹Department of Anatomy, University of Otago, New Zealand, ²Department of Physiology, University of Otago, New Zealand, ³Department of Anatomy, University of Otago, New Zealand, ⁴Centre for Society, Governance and Science, University of Otago, New Zealand, ⁵Centre for Health Sciences, Zurich University of Applied Sciences, Zurich, Switzerland. Multivariate assessment of lingual nerve location

Purpose: Lingual nerve injury can cause debilitating symptoms. Knowledge of lingual nerve location is necessary to assist with its identification. Studies describe lingual nerve location in the retromolar region detailing variations relating to sex, age, intrasubject variation, or dentate status; none have examined all these variables in a single study.

Methods: Thirty Caucasian cadaveric heads were available for dissection. Primary and secondary reference points were taken from the internal oblique ridge, and measurements to the lingual nerve were made in the sagittal, vertical, and horizontal planes. The position where the nerve was closest to the lingual plate was recorded.

Results: Forty-six hemimandibles (23 male) were dissected (mean age: 79 years); 26 were left sided. Mean sagittal, vertical, and horizontal distances from the primary reference point were 9.3 ± 3.4 mm, 9.2 ± 3.9 mm, and 0.57 ± 0.60 mm, respectively. Mean vertical and horizontal distances from the secondary point were 7.79 ± 5.45 mm and 0.59 ± 0.64 mm, respectively. There was large interindividual variation in lingual nerve proximity to the lingual plate (range, 13.00–15.17 mm from primary reference point). Dentate status was significant for sagittal measurements from the primary point and vertical measurement from the secondary point. No difference was observed for age, sex, or contralateral nerve location (n = 16 pairs).

Conclusion: Findings suggest homogeneity between the lingual nerve and adjacent retromolar structures, with consistency in nerve location both between and within subjects, and for sex and age, but not dentate status. Some variation was seen in the relationship between the lingual nerve and the lingual plate, suggesting care should be taken when performing surgery in this region.

DIAS, G. J.,¹ J. M. C. KOH,¹ N. LAL,¹ J. CORNWALL,¹,3,4
¹Department of Anatomy, University of Otago, New Zealand, ²Department of Physiology, University of
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Otago, New Zealand, 3Centre for Society, Governance and Science, University of Otago, New Zealand, 4Centre for Health Sciences, Zurich University of Applied Sciences, Switzerland. The origin of the auriculotemporal nerve and its relationship to the middle meningeal artery

Purpose: The morphology of the auriculotemporal nerve and middle meningeal artery is necessary to assist medical diagnosis and intervention. Current textbook descriptions describe a relationship between these structures that has not been reported or published; furthermore, it is unclear whether symmetry or ethnicity affects the relationship between these structures. This study aims to provide information on the relationship between the auriculotemporal nerve and the meningeal artery to further our understanding of the morphology of this region.

Methods: The infratemporal fossa of 19 elderly Caucasian cadaveric heads was dissected bilaterally, and the relationship between the auriculotemporal nerve and middle meningeal artery was scrutinized visually and recorded. Exclusion criteria included previous damage to structures in the infratemporal region.

Results: Twenty-five samples were included for analysis, including six bilateral (12 sides, eight female) and 13 unilateral (nine female) specimens. Nerve root contributions to the auriculotemporal nerve from the mandibular and inferior alveolar nerve included eight specimens with one root, 12 with two, five with three, and one with four. Three of six bilaterally dissected specimens had asymmetrical numbers of nerve roots. Two specimens were found with a “button hole” arrangement of the auriculotemporal nerve; these did not enclose the middle meningeal artery.

Conclusions: Variation was found between the auriculotemporal nerve and middle meningeal artery both between and within specimens. No specimens demonstrated a morphology that was consistent with common anatomical texts. Findings suggest that modern texts require revision to accurately describe the relationship between these structures.

DIAS, G. J.,1 N. LAL,2 M. CHANDRASEKERA,3 J. CORNWALL1,4,5 1Department of Anatomy, University of Otago, New Zealand, 2Department of Physiology, University of Otago, New Zealand, 3Centre for Society, Governance and Science, University of Otago, New Zealand, 4Centre for Health Sciences, Zurich University of Applied Sciences, Switzerland. An unusual case of post-traumatic bifid mandibular condyle

Purpose: Bifid mandibular condyle is a rare anatomical anomaly with uncertain etiology and pathogenesis. Theories for the development of this condition include bony alterations post-trauma; however, little evidence exists to support this theory. Furthermore, long-term changes to joint morphology with this condition have not been previously described. We describe a case of post-traumatic bifid mandibular condyle with associated degenerative changes.

Methods: One male skull of Sri Lankan origin was examined by an ex vivo expert team of anthropologists and anatomists. Detailed recordings were made of the abnormal condyle, and comparisons were undertaken with the contralateral region and other normal skulls (morphological baseline).

Results: The skull had various skull fractures in addition to a bifid left mandibular condyle that had anteromedial and posterolateral condyles as well as remodeling of the mandible consistent with a fracture of the mandibular neck. Degenerative alterations to joint surfaces and osteophyte formation around articular margins.

Conclusions: This case supports the development of bifid mandibular condyles post-traumatic, as well as long-term alterations to temporomandibular joint morphology can lead to degenerative changes and a loss in joint function. Such details are of use clinically and can contribute to decisions on clinical management of bifid mandibular condyle.

DIAS, G. J.,1 V. PERUMAL,1 C. SMITH,3 J. CORNWALL1,2,3 1Department of Anatomy, University of Otago, New Zealand, 2Centre for Society, Governance and Science, University of Otago, New Zealand, 3Centre for Health Sciences, Zurich University of Applied Sciences, Switzerland. The relationship between jugular foramen asymmetry and superior sagittal venous sinus laterality

Purpose: The reason for asymmetry of jugular foramen (JF) size is unclear. Historical reasons include suggestions that handedness may influence development of a larger JF on the ipsilateral side of handedness. Postnatal venous asymmetry has not previously been considered in relation with JF size. We aimed to investigate if the asymmetry of the superior sagittal venous sinus (SSVS) drainage is related to JF size.

Methods: Two hundred forty-five skulls from collections in Otago, New Zealand (Indian skulls), and Coimbra, Portugal (European skulls), were assessed for JF size and SSVS laterality. Data were analyzed to determine relationships between the variables JF symmetry, side of drainage of SSVS (laterality), location of the skull collection, and sex using χ² and proportion tests (P < 0.05).

Results: Two hundred forty skulls were included in the final analysis (140 from Otago and 100 from Coimbra). A significant relationship was seen between larger JF and SSVS laterality, with ipsilateral SSVS laterality and larger JF more frequent (54.6%). Differences were noted between the locations: Otago had significantly more right-sided combinations (66.4% vs. 38%), and Coimbra had significantly more left-sided combinations (39.0% vs. 28%). Drainage side of SSVS was different across, but not between, skull collections; sex had no effect on any variable.

Conclusions: Findings demonstrate an association between the ipsilateral SSVS drainage laterality and a larger JF and support previous findings of asymmetry in JF size. Further investigations are necessary using imaging modalities to explore the nature of the association between JF asymmetry and SSVS drainage laterality.
observations. The project will see if these changes show geographical variance within the pancreas. Through the release of clinical notes from cadavers, it will allow for a point of comparison to understand whether such changes present clinically.

**Methods:** Small tissue samples were excised from the head, body, and tail regions of 23 human cadavers. The samples were processed for light microscopy and stained with hematoxylin and eosin (H&E). Subsequently, special stains were used to confirm preliminary observations using H&E. These stains showed a significant array of histological changes in the pancreas in elderly cadavers.

**Results:** Acinar changes include lipomatosis, necrosis, acinar distortion/dilation, and vesicular change. Ductal changes include hyper trophy, periductular fibrosis, nonpapillary ductal cell hyperplasia, papillary ductal cell hyperplasia, focal ductular proliferations, and adenomatous hyperplasia. Arterial changes include hypertrophy, atherosclerosis, and amyloidosis. Extra-acinar changes illustrated interstitial fibrosis.

**Conclusions:** In addition to the current understanding of histomorphological structure of the human pancreas in old age, further findings were observed. These novel observations allow for a greater understanding to explain the decrease in pancreatic function with age.

EIZENBERG, N., C. M. CHIDLOW, P. G. MCMENAMIN
Department of Anatomy and Developmental Biology, Monash University, Australia. *The flipped dissecting room: Discovering abnormal anatomy while uncovering normal*

**Purpose** (expecting the unexpected): Every human body is unique, which applies to a cadaver anatomically (as the visible structure and position of its individual parts), pathologically (modified throughout its lifespan by disease) and surgically (altered via associated interventions). Can we capitalize on this to provide students with a similarly unique learning experience? The aim of this study is to investigate the yield of cadaver abnormalities found by medical students during dissection classes.

**Methods** (dissecting the unexpected): A total of eight cadavers were dissected by first- and second-year medical students at the Monash University in 2014. A set of dissection instructions in eight progressive stages was constructed for each week of the program. A cadaver record folder (akin to a patient history) with age, gender, and cause of death (according to the death certificate) was situated at each table. It also contained specially designed check lists of anatomical variants, pathological conditions, and surgical interventions for students to record their own findings.

**Results** (collecting the unexpected): Entries on the cadaver check lists have been tabulated for presentation with maps including sites on each cadaver where the 25 anatomical variants, 34 pathological conditions, and 14 surgical interventions were found.

**Conclusion** (reflecting the unexpected): A wealth of potentially instructive abnormalities was documented, which all students and tutors could access to verify or interpret. Although the specific impact on student learning will be investigated in the next phase of this research, incorporating a focus on finding deviation from the norm certainly stimulated curiosity and inquiry.

FARRELL, S. F., P. G. OSMOTHERLY, D. A. RIVETT, J. C. CORNWALL, Discipline of Physiotherapy, University of Newcastle, Australia, 2Centre for Health Sciences, Zurich University of Applied Sciences, Switzerland, 3Centre for Society, Governance and Science, University of Otago, New Zealand, 4Department of Anatomy, University of Otago, New Zealand. *Can E-12 sheet plastination be used to visualize intra-articular spinal meniscoids?*

**Purpose:** Intra-articular meniscoids of spinal joints have been described in anatomical research using dissection and imaging; however, their morphology and role in pathology are not well understood. E-12 sheet plastination (E-12SP) has been used to investigate various morphological structures, but not for studying meniscoid anatomy. Identifying intra-articular meniscoids with E-12SP may facilitate our understanding of their morphology and functional significance.

**Methods:** Ninety-two zygopophysial and four lateral atlantoaxial joints were inspected for meniscoids in two female cadavers (65 and 86 years) that had undergone E-12SP in 2 mm sagittal and transverse sections. Each section was photographed using a digital camera, macro lens, and light box, and then inspected under magnification using Adobe Illustrator.

**Results:** In sagittal sections, 24 meniscoids were identified in the cervical spine (four joints one meniscoid and 10 joints two meniscoids) and 32 in the thoracic spine (four joints no meniscoid, eight joints one meniscoid, and 12 joints two meniscoids). In the transverse sections, 14 thoracic spine meniscoids were identified caudal to T6 (three joints no meniscoid, eight joints one meniscoid, and three joints two meniscoids) and 12 in the lumbar spine (two joints no meniscoid, four joints one meniscoid, and four joints two meniscoids). Articulat cavities of joints palpable to T6 could not be effectively visualized on transverse sections due to articular surface orientation.

**Conclusion:** Cervical and thoracic meniscoids were best visualized on sagitally sectioned plastinates and lumbar meniscoids on plastinates sectioned transversely. E-12SP can be utilized in research and education to further explore the morphology of spinal meniscoids.

FERNANDEZ, A., E. GHEBREMEDIHIN, J. M. M. BROWN
1School of Biomedical Sciences, University of Queensland, Australia, 2Institute for Clinical Neuroanatomy, Goethe University, Frankfurt am Main, Germany. *Electromyographic analysis of segmental fatigue in superficial hamstring muscles*

**Purpose:** The aim of this study was to determine whether individual segments of biceps femoris long head (BF) and semitendinosus (ST), in response to an acute bout of exercise, fatigue simultaneously or independently.

**Method:** Twenty healthy young adults (aged 18–25 years) performed a submaximal cycling task (60%) at 85 rpm (revolution per minute) until volitional exhaustion. Surface electromyography (sEMG) was used to record the activity of two segments within BF and ST. The magnitude of fatigue was characterized by a decline in knee flexion maximum voluntary contraction (MVC) and segmental median frequency (MFP). The ability to deoxy (or not) in MVC and MFP was used to separate those subjects who experienced hamstring fatigue ( hamstring fatigued: N = 11) from those that did not ( hamstring nonfatigued: N = 9).

**Results:** As the hamstring fatigue group subjects approached exhaustion, the duration of BF muscle burst activation significantly ( P < 0.05) varied in its proximal (~493 ms) in comparison with its distal (~540 ms) segment. No such variations in duration were noted within the segments of ST or within rectus femoris (RF) in this group or in any segments in the hamstring nonfatigue group.

**Conclusion:** Structural variations between the lateral and medial hamstring muscles may account for this finding. Medially, ST shares its biomechanical load with the larger semimembranosus (SM), while laterally, the BF (both heads) acts alone. Furthermore, the evidence of segmental fatigue only within the BF may reflect greater internal stress due to its reduced capacity to generate force (PCSA) when compared with the medial hamstring muscles.

FUJISIRO, H., S. TSUKADA, A. NIMURA, K. AKITA
Department of Clinical Anatomy, Tokyo Medical and Dental University, Japan. *An anatomic study of spatial relationships between the anterior cruciate ligament and the lateral meniscus*

**Purpose:** Although the laxity of the lateral meniscus (LM) is occasionally observed in patients with anterior cruciate ligament (ACL)-deficient, the anatomic background of these cases is still unclear. To investigate the anatomy of LM, with special reference to the positional relationships to the anterior cruciate ligament (ACL).

**Methods:** Twenty-four knees from 12 Japanese cadavers (six males and six females) were used in this study. All cadavers were fixed in 8% formalin and preserved in 30% ethanol. ACLs were cut off at the femoral insertion, and all other supporting tissues including the posterior cruciate ligament, capsule, and collateral ligaments in response to an acute bout of exercise, fatigue simultaneously or independently.
Results: Outer fibers of the anterior horn of LM extended to the ACL and seemed to be intermingled with ACL fibers in macroscopic observations. However, after histological examinations, a border between the ACL and ACL was clearly shown. Inner fibers of the anterior horn of the LM ran beneath the lateral intercondylar tuberculum and attached to the lateral intercondylar eminence. Fibers of the posterior horn of the LM were separated from the anteromedial crus and the posteromedial crus and attached to the posterior aspects of the lateral and medial intercondylar eminences, respectively.

Conclusions: The ACL is joined with the outer fibers of the anterior horn of the LM, and the posterior horn of the LM is firmly attached to the posterior aspects of the intercondylar eminences of the tibia.

HAFIZ, M.,1 A. L. WEBB,2 K. VALTER,1,2 ANU Medical School, The Australian National University, Australia, 2Eccles Institute of Neuroscience, The Australian National University, Australia. A student view of the value of dissection in modern medical education: lessons learned at the Australian National University Medical School

Purpose: The dissection of human cadavers has been a cornerstone of medical education for centuries. The recent changes in medical education around the world have resulted in decreased time devoted to dissection. Opportunities for students to dissect have been reduced and sometimes even omitted from the curriculum. The purpose of this study was to gauge the views of medical students at the Australian National University Medical School (ANUMS) on the usefulness of cadaveric dissection for learning anatomy.

Methods: An electronic survey was distributed to all students (n = 376) for the collection of quantitative and qualitative data.

Results: A total of 172 students (46%) responded. The majority of respondents (124; 72%) found dissection to be very important for learning anatomy, and thus preferred to have dissection during their preclinical years of study. Students listed the main benefits of undertaking dissection as (i) its power to help to consolidate their knowledge of anatomy (56; 78%) and (ii) to gain new experience (57; 79%). Students perceived dissection to be helpful in learning anatomy by enabling a three-dimensional awareness of the body and developing an appreciation of anatomical variations. Students also reported that dissection provided them with an opportunity to discuss issues related to death. Of the 51 students who did not participate in dissection, the main reason given was a lack of time (34; 67%).

Conclusions: In agreement with the previous studies, the majority of ANUMS students valued the opportunity to undertake dissection, preferably in the early years of the program, to best aid their study of anatomy.

HAYASHI, N.,1,2 T. SAKAGUCHI,1,2 H. FUJISHIRO,1,2 K. YAMAGUCHI,1,2 K. AKITA1,2 1Department of Clinical Anatomy, Tokyo Medical and Dental University, Japan, 2Department of Orthodontic Science, Tokyo Medical and Dental University, Japan. Positional relationships between the muscle bundle of the temporalis and the lateral pterygoid muscle

Purpose: The condylar process of the mandible is generally accepted to be an insertion site of the lateral pterygoid muscle. In addition, it has been reported that the process receives attachments from various muscle bundles of the temporals and the masseter. In this study, we examined the positions of insertion of the muscle bundles from the middle part of the medial surface of the temporals (the midmedial muscle bundle: MM).

We investigated 34 head halves from 23 Japanese cadavers. After observations of the impressions and ridges on the condylar process by three-dimensional reconstruction images obtained using data from micro-CT (SMX-100CT, Shimadzu, Kyoto, Japan), we dissected and removed the muscles to investigate areas of the muscular insertions on the process. Histological observations were also performed in six specimens. In addition, we observed 29 processes from 56 mandibles from bone collections. Results: On the anterior surface of the condylar process, the pterygoid fovea and the bony ridge lateral to the fovea were clearly observed in all specimens. The lateral pterygoid muscle inserted into the area of the pterygoid fovea medial to the ridge. The ridge was situated laterally at about 66% of the maximum width of the process.
Conclusion: As the muscle bundle of the temporals as well as the lateral pterygoid muscle distinctly attaches to the condylar process, the temporals would directly play a role in the temporomandibular joint.

HAYSON, S., N. A. M. S. FLACK, S. J. WOODLEY Department of Anatomy, University of Otago, New Zealand. **Validity of ultrasound for measuring hip abductor muscle volumes**

**Purpose**: Hip osteoarthritis is a common chronic condition that may compromise the hip abductors. Evaluating changes in hip abductor muscle volume using ultrasound may be a useful adjunct in the assessment and treatment of osteoarthritis; however, no ultrasonographic volumetric data are available for gluteus medius (GMed), glutus minimus (GMin), and tensor fascia lata (TFL). This study aimed to investigate the validity and reliability of ultrasound to measure hip abductor muscle volume when compared with MRI and dissection.

**Methods**: Eight cadaveric hips (four males, mean age: 86 years) were scanned using MRI and ultrasound. The cross-sectional area (CSA) of each muscle were taken at multiple, evenly spaced levels across its length and measured using OSIRIX, for both modalities. Volumes were estimated from CSA using Cavalieri’s equation. Subsequent improvements were conducted to measure fascicular length and volume to determine overall muscle volume. Mean data were compared between muscles, and methods, using Student’s paired t-tests. Intra-rater reliability was assessed with intraclass correlation coefficients (ICC).

**Results**: Ultrasonographic volume data were unobtainable for GMin. Hip abductor muscle volumes varied between limbs and specimens, but were significantly different from one another, for all modalities (GMed: -205 cm³; GMin: -70 cm³; TFL: -35 cm³, P < 0.05). Volume differences between methods were not statistically different. Intra-rater reliability was almost perfect (ICCs > 0.98).

**Conclusion**: Ultrasound may be a valid and reliable alternative to MRI for determining GMed and TFL muscle volume. Further study on the accuracy of ultrasound to measure hip abductor volumes in living participants with and without hip osteoarthritis is needed.

HUGHES, D., S. WENTWORTH, H. MCGOWAN Department of Human BioSciences, La Trobe University, Australia. **Staff experience of the switch to blended learning in a first year anatomy subject**

There is a push to offer blended learning at universities to meet the needs of a diverse student population. Blended learning is meant to take the best of face-to-face and online learning and synthesize this into a new pedagogy of different timing and modes of learning. The first-year health science anatomy subject Human BioSciences B at the La Trobe University moved from face-to-face with some online resources to a blended mode of delivery in 2014. Face-to-face time was reduced from 4 to 2 hr with a loss of lecture time. All learning content was provided online, with much of it produced by staff, although some commercial resources were utilized. Many studies analyze the student experience; however, this study sought to examine the staff experience of creating online learning resources to meet the criteria of blended learning. The study involves a survey of staff for variables such as understanding of blended learning as a distinct pedagogy, the time spent to produce online learning resources, and the need for up-skilling of content experts into new technologies and video production and editing. Survey results will not be available until after the end of semester. The results from this study could be used to help plan for better staff training to prepare them for the development of new and improvement of existing online learning resources. These results will be pooled with student feedback as to what style of online presentations is effective.

KENNEDY, M. S., H. D. NICHOLSON, S. J. WOODLEY Department of Anatomy, University of Otago, New Zealand. **Clinical anatomy of the bursae associated with the shoulder joint**

**Purpose**: Bursae associated with the anterolateral shoulder should be typically found in four locations with variations in size, portions, and consistency. The results provide new morphological detail, which are of significance when considering assessment and treatment of anterolateral shoulder pain.

KIPPERS, V., N. PATHER, P. LANDY, D. MAGUIRE, A. SHOHAM 1School of Biomedical Sciences, University of Queensland, Australia, 2School of Medical Sciences, University of New South Wales, Australia. **Use of analytics in gross and radiological anatomy virtual adaptive tutorials**

**Purpose**: Learning analytics were used to identify and remediate common misconceptions of students using virtual anatomy adaptive tutorials designed on the SmartSparrow Adaptive Learning Platform (AeLP) and available via the BEST Network.

**Methods**: Students are provided with adaptive feedback and allowed multiple attempts at a question before continuing in the tutorial. A lesson summary report represents the median time, usage over a set period, percentage completion, average grade, and percentage using adaptive feedback. Analysis are represented in different formats. For student selections from drop-down menus, pie charts indicate the initial responses of all students, and for drag-and-drop style questions, where students identify features, heat maps of all incorrect responses clearly demonstrate whether there are consistent or random errors in the cohort.

**Results**: As an example from one gross anatomy lesson, 85% of the students completed the exercise in a median time of 55 min, and the average percentage was 77. Forty-five percent of the students took advantage of the adaptive feedback when they made a mistake. For one of the radiological anatomy quizzes, 10–15% of students were confused about the difference between the pedicle and lamina on a lateral X-ray image of the chest. On the same image, students who did not correctly identify the manubrium consistently placed their marker too superiorly.

**Conclusions**: Benefits for students include the ability to more easily reach their desired performance level, and benefits for teachers include the editing of tutorial resources to anticipate identified student misconceptions.

LAL, N., J. C. COWAN, P. SHEARD 1Department of Physiology, University of Otago, New Zealand, 2Department of Anatomy, University of Otago, New Zealand, 3Centre for Society, Governance and Science, University of Otago, New Zealand, 4Centre for Health Sciences, Zurich University of Applied Sciences, Switzerland. **Elderly dying myofibers are characterized by Dystrophin Encircled Vacuoles and invaginations with Intracellular Localization (DEVILs)**

**Purpose**: Loss of skeletal muscle mass and strength (sarcopenia) are accepted characteristics of aging, yet the mechanisms underpinning these changes are poorly understood and the existence of individual myofiber death in dispute. We have observed abnormal dystrophic myofibers in normal elderly mouse, rat, and human muscles of these bursae is essential to clinical techniques such as palpation, injections, and imaging. As there are no complete anatomical accounts of all the bursae in this area, the purpose of this study was to provide the numbers, locations, communicating, and anatomic associations.
characterized by the presence of Dystrophin Encircled Vacuoles and invaginations with Intracellular Localisation (DEVILs). The morphological resemblance of such myofibers to those seen in autophagic vascular myopathies led us to examine DEVILs in a murine model to determine if these cells are candidates for classification as age-related dying myofibers.

Methods: DEVILs were visualized by dystrophin immunostaining in frozen transverse sections of young (1–6 months) and elderly (22–26 months) mice (C57Bl/6); soleus, extensor digitorum longus, cleidomastoid, and sternomastoid muscles from young and old). A dye exclusion test (Trypan Blue) was performed to assess myofiber viability. Myofibers were quantified by digital image analysis of processed specimens and photographed using wide-field fluorescence microscopy.

Results: DEVILated myofibers were increasingly prevalent in aged muscles (common in myofiber loss susceptible muscles: extensor digitorum longus, r = 0.6, P = 0.004; and soleus, r = 0.5, P = 0.03; but virtually absent in myofiber loss-resistant muscles: cleidomastoid and sternomastoid). 17% ± 14% of DEVILated myofibers admitted Trypan Blue when compared with 1% ± 1% of normal myofibers (P = 0.029).

Conclusions: DEVILated myofibers in mice potentially represent the first ever identification of myofibers undergoing age-related cell death. Further work is necessary to elucidate the triggers and modality underpinning these changes and to corroborate these findings in humans.

LAZARUS, M., 1 J. DOS SANTOS,2 P. HAIDET3 1Neural and Behavioral Sciences Department, Penn State College of Medicine, PA, USA, 2Penn State Hershey Plastic Surgery, Penn State College of Medicine, PA, USA, 3Penn State Hershey Internal Medicine, Penn State College of Medicine, PA, USA. Preclinical anatomy education: An ideal environment for learning clinical communication skills

Current literature highlights significant deficits in the peer hand-off process within and across specialties. These shortcomings result in negative impact on patient care, healthcare costs, and clinical outcomes. Although medical school curricula often focus on communication with patients, few address physician to physician communication, particularly with regard to patient hand-offs. Given its focus on key concepts to clinical practice, the anatomy laboratory provides a unique and pedagogically appropriate setting in which to introduce early opportunities for students to practice hand-off communication. As part of our school’s introduction of a peer-teaching component into dissection learning, we developed a novel approach to integrate hand-offs into the peer-teaching process. In our laboratory, students are organized into sets of two peer dissection teams. Within each set, the teams each perform half of the dissections, and hand-off the cadaver to each other in alternating fashion. For the hand-offs, we adapted the widely used clinical SBAR framework (Situation, Background, Assessment, and Recommendations), creating a process that integrates anatomy learning with peer-to-peer communication. Our future studies focus on the evaluation of the impact this intervention has on anatomy knowledge, learning, and retention; the identification and development of the “best practices” for peer-to-peer communication; and developing methods for increasing the efficiency and effectiveness of the peer-hand-off process for these future physicians. These results will help us to develop a model for peer-to-peer communication skill integration into other clinical curricula and to enhance early exposure of this essential clinical process.

MASSEY-WESTROP, N., 1 N. PARANGE,3 I. P. JOHNSON2 1Division of Health Sciences, University of South Australia, Australia, 2Discipline of Anatomy and Pathology, University of Adelaide, Australia. Ultrasound simulators as aids to learning anatomy

Purpose: Students often struggle to relate structures seen in medical imaging to those in dissection. Ultrasound simulators can provide an opportunity for students to develop a better understanding of the spatial relationships of the structures on both views of the patient and to help them develop an awareness of the different views in which the structures are imaged. We have developed a set of ultrasound simulators for teaching anatomy using realistic ultrasound images and corresponding, three-dimensional anatomical structures.

Methods: Three Vimedix ultrasound simulators consisting of a plastic torso containing sensors, an ultrasound probe, and monitors showing real-time ultrasound images and corresponding pseudo-colored 3D graphics were used. The simulators were incorporated into anatomy laboratory teaching, and undergraduates taking health sciences courses surveyed about their usefulness.

Results: Totally, 164 of 175 (94%) students in the courses completed the questionnaire. There was general agreement (91% broad agreement) that the ultrasound simulators were useful in anatomy laboratory sessions. Thematic analysis of written comments showed that 3% found the simulators helped with visualization of structures, and 37% found they helped with understanding anatomical relationships, whereas only 2% reported them helping with surface anatomy. About 12% found that the simulators helped to understand structures-function relationships and 11% made various comments ranging from “really interesting” to “it gave me a headache.”

Conclusion: Ultrasound simulators help students to understand the 3D arrangements of structures and their anatomical relationships. A study is underway to scope the views of University of Adelaide students on these simulators.

MCMENAMIN, P., J. ADAMS, S. COLLINS, M. QUAYLE Centre for Human Anatomy Education, Monash University, Australia. 3D Printing—A novel means to reproduce anatomical teaching resources

Purpose: The reduction in dissection-based teaching in medical and allied health professional training programs has been in part due to the financial considerations involved in maintaining bequest programs, concerns with health and safety considerations for students and staff exposed to formalin-containing embalming fluids. Faced with the prospect of enormous costs of establishing a plastination suite and the high costs of cadavers at the Monash University, Centre for Human Anatomy Education, we chose a novel method of producing reproductions of prosections.

Methods: These 3D prints are high-resolution, accurate color reproductions of prosections based on the data acquired by surface scanning or CT imaging. The application of 3D printing to produce models based on contrast CT radiographic data using segmentation software is illustrated.

Results and Discussion: This alternative approach to produce anatomically accurate reproductions offers many advantages over plastination as it allows rapid production of multiple copies of any dissected specimen at any size scalable to the preferences of students. For example, we could have a large end in mind model to meet the needs of the whole class. Typically, 6–7 problem sets were discussed during a 50-min class. Students were expected to view a series of short anatomy tutorials and complete an accompanying workbook prior to each classroom session to garner reasonable preknowledge of the subject at hand. During the F2F time, the professor and students worked through a series of problem solving questions aimed at synthesizing the learning objectives introduced through the tutorials. The students were given between 2 and 4 min to pair-up and work through a solution in their paired groups. A student then chose to discuss their solution and defend it to the whole class. Typically, 6–7 problem sets were discussed during a 50-min class. The power of the flipped classroom is in the higher order learning activities such as discussion of solutions and defense of
answers. Students overwhelmingly preferred this method of learning (ability to view tutorials as many times as necessary, benefit for reviewing for tests and the effective use of F2F time) to our previous lecture model.

NALLA, S. Department of Human Anatomy and Physiology, Faculty of Health Sciences, University of Johannesburg, South Africa. **Clinical anatomy or anatomy for clinicians in the context of a South African university**

Traditional anatomy offerings at tertiary or higher education institutions have focused on ensuring a comprehensive delivery of all the elements that constitute human anatomy teaching, learning, and assessment. These elements formed the foundation on which the clinical modules in subsequent years of study, for example, pathology and diagnostics, are built. However, over the past three decades, the offerings of the anatomy modules at many institutions have been reduced in terms of both duration and content. The proposal was to integrate basic science of anatomy (knowledge acquired) in the first with clinical science (applied in problem solving and critical thinking) in especially the second year. The skill of curriculum integration is, however, not intuitive to many students especially at a first-year level. Traditional anatomy education that was based on topological anatomical structures taught in lectures, and the dissection hall has been replaced by a plethora of study modalities including problem-based learning, computer-assisted learning, and curricula integration. Cadaveric dissection and microscope histology had in many instances been replaced by specimen resections and histology computer programs. This reduction in curriculum has had a negative impact on the assessment and evaluation of fundamental anatomical concepts, which needs to be bed-rocked before progression to the clinical years. The resultant lower level of knowledge gained in the basic science of anatomy has created uncertainty as well as presumed deficiencies in clinical subjects of subsequent years of study. The reversion to a traditional offering blended with some "new methods" is thus emphasized for future professional competency.

NICHOLSON, H. D. Pro-Vice Chancellor International, University of Otago. **The state of anatomy in Australasia**

Historically, anatomy schools and departments in Australasia were established to assist in the training of medical and dental students. At this time, the subject of anatomy focused on the morphological structure of the human body as revealed by dissection of cadavers. Public interest in anatomy was also high. Over the last two centuries, the discipline of anatomy has grown to encompass a wide range of areas including histology, embryology, development sciences, and biological anthropology, as well as the more traditional gross and clinical anatomy. The functions of anatomy departments or units have also changed. Many departments now teach into a wide range of courses both in science and health sciences as well as the arts. Some departments have significant research activities and many also engage in public outreach. The discipline of anatomy appears to be evolving, but is it becoming less visible as a stand-alone subject, to the point of losing its identity? Does this matter? The history of some of these departments will be explored and the many also engage in public outreach. The discipline of anatomy appears to be evolving, but is it becoming less visible as a stand-alone subject, to the point of losing its identity? Does this matter? The resultant lower level of knowledge gained in the basic science of anatomy has created uncertainty as well as presumed deficiencies in clinical subjects of subsequent years of study. The reversion to a traditional offering blended with some "new methods" is thus emphasized for future professional competency.

OKUDA, I., K. AKITA, Y. NAKAJIMA. Department of Diagnostic Radiology, International University of Health and Welfare, Mita Hospital, Japan. **A study of the nasolabial fold: radiologic and anatomic evaluations to the aging alterations**

**Purpose:** Wrinkles and sagging affect the facial aging appearance, and deep nasolabial fold (NLF) should be one of the key factors of alterations during aging. The structures and mechanisms have not been fully elucidated yet. We examined facial magnetic resonance (MR) imaging of living persons and faces of cadavers to establish the evaluation.

**Methods:** Facial MR imaging features of the healthy volunteers were analyzed. Four cadaver faces (two males and two females) were used. Half of their faces were dissected, and soft tissue structures of the cheeks and oral regions were examined. Left halves were used for histological examination, and subcutaneous connective tissue structures were examined. These morphological findings were compared with the MR images.

**Results:** The levator labii superioris alaeque nasi, the levator labii superioris, the zygomaticus minor, and the zygomaticus major structures were observed macroscopically in this order. These muscles were attached mainly to the orbicularis oris, and parts of the fibers were attached to the inner aspect of the skin of the NLF. On MR imaging, it was observed that the adipose tissue medial to the NLF was thinner and was lower in its intensity than that lateral to it.

**Conclusion:** Facial muscles can be evaluated by MR images as well as by anatomic and histological methods. Tension to the skin from the facial muscles and the distribution of adipose tissue around the facial muscles are very important factors in forming the NLF. It is considered that MR imaging should be a very useful device to evaluate the NLF.

PERUMAL, V., S. J. WOODLEY, H. D. NICHOLSON Department of Anatomy, University of Otago, New Zealand. **Ligament of the head of the femur or ligamentum teres: What do we know?**

**Purpose:** The ligament of the head of femur (LHF), or ligamentum teres, has recently received attention in clinical practice and has been suggested to provide significant mechanical stability to the hip joint. However, the morphology of this ligament is only briefly mentioned in the major textbooks. The aim of this study was to undertake a systematic review to explore the current understanding of the anatomy of the LHF and to identify any gaps in the literature.

**Methods:** A systematic search of MEDLINE, Embase, ProQuest, Web of Science, and Scopus databases was performed to ensure all relevant literature was retrieved. The search yielded 55 original articles; one web resource and 13 textbooks were included.

**Results:** The majority of publications were related to clinical studies (n = 16) rather than gross anatomy (n = 5). Few studies were found on imaging (n = 3), histology (n = 7), and others (n = 38); only one reported on the variation of the LHF. Considerable inconsistency in the naming of the ligament was observed. Except for the acetabular notch, transverse acetabular ligament, and the femoral fovea, the reported attachments were variable. Descriptions of the presence and patency of the ligamental arteries and their exact location were also variable and often incomplete. The ligament is believed to be taught in extreme hip adduction; however, little evidence was found to support this claim.

**Conclusions:** Further research into the anatomy of the LHF is needed to clarify the mechanical role of the ligament and its vascular contribution to the developing and adult femur.

PORTA, D. Department of Biology, Bellarmine University, Louisville, Kentucky, United States of America. **Everything I do is wrong, but seems so right! Confessions of a clinical anatomist**

I love teaching anatomy and sharing normal, abnormal, and variations in the human form. It is cliché, but we really do teach the introductory-level language of medicine to our students. I also love helping to expose students to the ancillary benefits derived from taking a gross anatomy course. The examples are many: learning to work as a team; professionalism between colleagues, instructors, and patients; issues of patient privacy; the role of inductive and deductive research in anatomy and medicine; the role anatomy plays in virtually all fields of medicine; ethical use of donations, and so forth. It is a tall order to infuse all of these concepts into a single medical or dental school course, but gross anatomy is the ideal (perhaps only?) opportunity to do so. After teaching gross anatomy for 20 years as part of various institutional teams in professional schools, I was afforded the opportunity to teach a different, relatively small student population by myself. I have been able to implement several methods of instruction that many colleagues have told me are simply wrong. Yet they...
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see to work well. Preliminary information provided to students and daily instructional delivery methods are considered by some to be controversial or outdated. Even the order of body regions dissected and is it important is thought to be unchangeable by many. Now, after 5 years of fine-tuning, I believe the resultant course is worthy of consideration as a model for traditional, introductory gross anatomy courses. Although such an animal may be nearing extinction given the push toward integrated longitudinal curricular design, some of the methods would likely work well within the integrated curriculum models as well.

PRETORIUS, N. E. 1, 2 1University of Johannesburg, South Africa, 2Central Queensland University, Australia. A tale of two captains... igniting anatomy’s passion.

"Captain my captain." I was 16 years old when I saw “Dead Poet’s Society” the first time. It changed my life. From that moment, I wanted to enroll in university, spending my days with like-minded, knowledge-thirsty individuals, and guided into my future career by passionate lecturers like “Mr Keating” who would teach me to view life from a different perspective. In 1994, I encountered another “captain,” my second-year anatomy lecturer—dynamic, knowledgeable, and infectiously passionate about his subject. However, even more so, he loved teaching. It was not merely about imparting knowledge but about enriching his students’ lives, guiding us to delve deep, and give more we had ever thought possible. We did not all excel, but we all tried our best. We did it because we were inspired, and more importantly, because we could not bear disappointing this person who gave us his all. Fast forward 20 years. What has changed between 1994 and 2014? I find myself faced with a completely different scenario. Why are modern students so drive-less, discipline-less, and apathetic? Perhaps it is all in the delivery. Is it still possible to marvel at the intricacies of the human body. It is not the content that remains the same. Perhaps it is all in the delivery. Is it still possible to be a lecturer who is someone’s “Captain my captain”?

QUAYLE, M. 1, MAOVAENI, A. 2, J. CROCK, J. 3, ADAMS, S. 1, COLLINS, P. G. 1, MCMENAMIN, 1 1Department of Anatomy and Developmental Biology, Monash University, Australia, 2Upper Limb Orthopaedic Surgeon, Monash University, Alfred Health, Melbourne, Australia, 3Plastic and Reconstructive Surgery, Melbourne, Australia. Bespoke modeling and 3D printing for pre-surgical planning

Purpose: Three-dimensional (3D) printing technology allows for the production of physical patient-specific models from computed tomography (CT) scan data for presurgical planning of complex bone fractures or deformities. We aim to improve diagnosis and aid presurgical planning through the provision of patient-specific 3D printed models to healthcare professionals. Here, we detail the use of 3D printing in a number of cases including distal radial fractures.

Methods: The process involves taking CT scan images (DICOM format files) using bone algorithms with a thin interslice distance which are then converted into a digital 3D model of the bones using segmentation software. Segmentation of the scan data allows for individual bones to be displayed separately or for the joint to be modeled as a whole depending on the nature of the case (i.e., fractured radius or the whole wrist). The digital models are then 3D printed in full color using a ZPrinter 650 (3D Systems).

Results and Conclusion: The resolution of this printer (0.1 mm layer thickness) allows us to print extremely detailed models making the visualization of even very slight fractures possible. Finished models are useful as visual aids of the underlying anatomy in preparation of the surgery, explanation of the procedure to the patient, or are able to be drilled and cut for simulation of the surgical procedure.

RANGER, T. A. 1, A. TEICHTHAL, 2 F. M. CICUTTINI, 2 Y. WANG, 2 A. WLUKA, 2 D. M. URQUHART, 1 1Department of Anatomy and Developmental Biology, Monash University, Australia, 2Department of Epidemiology and Preventive Medicine, Monash University, Australia. Low-fat infiltration in the lumbar paraspinal compartment is associated with reduced risk of severe degenerative disc disease in the lumbar spine: A cross-sectional study

Purpose: Overweightness (BMI > 25 kg/m²) has been associated with an increased risk of lumbar disc degeneration. However, adiposity within the paraspinal compartment and muscles may be more closely related due to their spinal mobility and stability functions. This cross-sectional study aimed to investigate fat infiltration in specific regions of the paraspinal compartment and its relationship to disc degeneration.

Methods: Disc degeneration was graded (Pfirrmann system) in a community-based cohort (n = 72), not selected for low back pain, and a semiquantitative assessment of paraspinal fat was performed using magnetic resonance imaging. Whole compartment fat was measured, then subcategorized as being (i) within the paraspinal musculature or (ii) outside the muscle but inside the compartment.

Results: Low-fat (<10%) infiltration into the paraspinal compartment at the level of L2 was associated with reduced risk (P < 0.05) of severe disc degeneration at L3/4 (OR = 0.19, 95% CI = 0.037–0.96) and L5/S1 (OR = 0.10, 95% CI = 0.018–0.59), with a trend at L4/5 (OR = 0.28, 95% CI = 0.057–1.4, P = 0.12) after adjusting for age, gender, and BMI. When fat external to the muscle was added to the regression equation, results were strengthened for the L3/4 (OR = 0.178, 95% CI = 0.037–0.96) and L5/S1 (OR = 0.077, 95% CI = 0.012–0.48) levels (P < 0.05).

Conclusions: This study demonstrated that low paraspinal compartment fat is associated with a reduced risk of severe disc degeneration in the lumbar spine. Our results suggest that this benefit was particularly conferred by low fat within the muscular component of the paraspinal compartment, whereas external longitudinal studies will be required to determine the cause and effect.

RATNAYAKE, J., E. GHEBREMEDHIN, J. M. M. BROWN, 1 School of Biomedical Sciences, University of Queensland, Australia, 2Institute for Clinical Neuroanatomy, Goethe University, Frankfurt am Main, Germany. Pathological changes in parasympathetic head ganglia in patients with Parkinson’s disease

Purpose: Parkinson’s disease (PD) is the most prevalent motor disorder. Recent studies, however, have shown nonmotor symptoms, such as reduced saliva and tear production to precede the onset of motor symptoms. The hallmark neuropathological feature of PD is the occurrence of intraneuronal Lewy pathology (LP). This study aimed to investigate the presence and severity of LP in parasympathetic head ganglia (otic, pterygopalatine, and submandibular) as well as in corresponding tear and salivary glands.

Methods: Bilateral head ganglia as well as gland tissues from clinically and neuropathologically diagnosed PD cadavers (n = 2, mean age ± SD 61 ± 10 years) and age- and sex-matched controls (n = 2) were investigated using an immunostaining protocol that detects LP. Conventional histochemical staining was used to determine tissue integrity and the presence of ganglionic and gland tissue.

Results: The presence of LP was observed in all parasympathetic head ganglia as well as in the submandibular and parotid glands of the two PD cases, but not in those of controls. Analysis of the gland mass and density found no significant difference between the PD cases and controls.

Conclusion: This is the first study that has investigated and found LP in parasympathetic head ganglia as well as in the parotid gland. The presence of LP in these ganglia presumably is the major morphological correlate of hyposalivation and dry eye syndrome in patients with PD.
Methods: Each production had input from a clinical anatomist and a member of the technical staff. After initial planning, we ended up making miniatures of the models and then larger or same size as in the original, less-expensive material.

Results: The outcome is the production of novel teaching modalities, which benefit both the students faced with integrating their anatomical knowledge with the clinical context, as well as benefits to the program from strengthening the ties with the clinicians. We have produced a number of models for embryology, neuroanatomy, regional clinical anatomy, and for reproductive and developmental anatomy as well as teaching aids with minimal costs.

Conclusion: This undertaking shows the use of material such as fabric to make peritoneum and silicon to illustrate the contours of the vagina simply and cheaply. This production can be shared with other clinical anatomy teachers and inspire them as well.

SANGWAN, S., N. F. TAYLOR, R. A. GREEN Department of Rural Human Biosciences, La Trobe University, Australia. Stabilizing characteristics of rotator cuff muscles: A systematic review

Purpose: To systematically review the evidence in support of the purported function of the rotator cuff muscles as dynamic stabilizers of the glenohumeral joint.

Methods: Electronic searches were conducted using AMED, CINAHL, and SPORT Discus. For inclusion, studies were required to report evidence of at least one characteristic of a stabilizer muscle, that is, shorter moment arms than global muscles, earlier activation than prime movers in response to an expected perturbation, contribute to joint stiffness by limiting translation or co-contraction with other muscles. Quality analysis was completed by two assessors independently. Data were extracted for four main characteristics of stabilizer muscles: (i) moment arm, (ii) muscle onset, (iii) joint stiffness or reduced joint translation, and (iv) co-contraction aiding to electromyographic muscle activity and expressed as a coactivation ratio.

Results: Twenty of the 1,726 identified studies provided empirical evidence and were selected for review. Rotator cuff muscles can limit joint translation (five studies) and contribute to joint stiffness (one study), possess shorter moment arms only in some movements (three studies), but show limited evidence for stabilizing characteristics of early onset (seven studies) and co-contraction (seven studies).

Conclusion: On the basis of our current low to moderate quality evidence, the most likely, but as yet unverified, stabilization role for the rotator cuff muscles is dynamic stabilization of the glenohumeral joint.

SATYAPAL, K. S., B. Z. DE GAMA, P. PILLAY Discipline of Clinical Anatomy, University of KwaZulu Natal, South Africa. Ethical and sociocultural controversies relating to cadaver procurement: A South African perspective

Cadaveric dissection has been the backbone of anatomy teaching and research. Cadaver acquisition continues to be the topic of extensive debates as there are a variety of sociocultural and ethical issues that needs to be confronted internationally while also respecting national indigenous views. In South Africa, during the colonial and apartheid era, cadavers were overwhelmingly obtained from unclaimed bodies which were invariably from the poor, black, and marginalized of our society. Currently, in South Africa, the National Health Amendment Act 61 of 2013 caters for bequests, donations, and unclaimed bodies. An analysis at the authors’ institution (UKZN) reflected that the Black African unclaimed bodies sourced from the local metropolitan regional hospitals in the apartheid and democratic era were 96% and 54%, respectively. A current preliminary survey of Black African medical science students revealed that 21% were willing to be body donors. Crucial events such as the findings of the TRC, repatriation of Baartman, and the final traditional burial ceremony of Mandela spotlighted the importance of understanding and respecting the cultural and religious beliefs of the majority indigenous black population. An appreciation of ancestral veneration, customary rituals performed at burial, and the importance of the journey of the Spirit to becoming an ancestor or Idlozi are important. There is a need for a national review of the different sociocultural and religious belief in body donor campaigns for cadaver procurement.

SEIDL, L., D. TOSOVIC, J. M. M. BROWN School of Biomedical Sciences, University of Queensland, Australia. Determining a submaximal stimulation intensity for the mechanomyographic assessment of skeletal muscle recovery from injury

Purpose: Efficient rehabilitation of musculoskeletal injuries (MSKI) relies on effective clinical diagnostic and evaluation techniques. Non-invasive mechanomyography (MMG) utilizes submaximal percutaneous neuromuscular stimulation (PNSmax) to measure muscle contractile properties, including contraction time (Tc). MMG-derived Tc is indicative of a muscle’s physiological state (healthy/fatigued/injured) and thus may provide invaluable physiological information to a treating clinician. However, the delivery of a maximal PNS (PNSmax) to an already injured muscle may result in pain, discomfort, or re-injury. This research aims to determine whether a submaximal PNS (PNSmax), designed for patient comfort, can still produce acceptable Tc values for clinical monitoring of MSKI.

Methods: MMG was conducted on 10 skeletal muscles with varying architectures and fiber type compositions (FT): adductor magnus, biceps femoris, rectus femoris, sartorius, vastus medialis, dorsal intersosseous, biceps anterior, soleus, brachioradialis, and triceps brachi. PNS current, beginning at 30 mA, was increased by increments of 10 mA until a maximal muscle contraction was produced, and an optimal Tc (Tc_opt) was determined.

Results: Preliminary analysis of the first five muscles tested determined PNSmax values ranged from 190 to 260 mA; however, for 95% of the tested population, a PNSmax of 130 mA was found to accurately obtain Tc values within 5% of Tc_opt in all five muscles. Additionally, lower Type I FT compositions correlated with higher PNSmax values (r² = 0.87).

Conclusions: By utilizing a submaximal PNS, clinicians can accurately measure muscle Tc, while enhancing patient comfort through reduced stimulus intensities. Furthermore, the relationship between FT and PNSmax may aid clinicians in determining appropriate stimulus intensities for mechanomyographic investigations.

SMITH, J. School of Biomedical Sciences and Pharmacy, University of Newcastle, Australia. Learning facial anatomy through play: Drawing muscles of facial expression on customized 3D-printed heads

Purpose: Human facial anatomy may confront students with limited prior exposure to cadaveric-based learning. Alternative activities, designed to teach facial anatomy in three-dimensions (3D), interactive, and engaging ways, are desirable in this situation.

Methods: A trial was undertaken to create, evaluate, and integrate a teaching activity utilizing 3D printed heads and an associated drawing task into a facial anatomy laboratory course. Twenty heads were CAD designed and printed by the Blended Online Learning Development Team (Centre for Teaching and Learning, University of Newcastle) utilizing a Makebot Replicator 2 3D printer. The heads and associated drawing activity were incorporated into a laboratory class delivered in the second week of a head and neck anatomy course. Students used highlighters to draw the muscles of facial expression, parotid gland, facial artery, and facial and trigeminal nerve branches onto the 3D-printed heads prior to viewing surface anatomy photographs, models, and cadaveric specimens. Engagement, interest, and participation in the drawing activity were evaluated utilizing student evaluations and video recordings.

Results: Student volunteers (n = 37) rated the activity on the following characteristics utilizing a 5-point scale: (i) 3D understanding (mean = 4.75, SD = 0.38), (ii) prefer (mean = 4.90, SD = 0.32), and (iii) learn (mean = 4.70, SD = 0.42). Video footage, trialed as a means of assessing student engagement, further illustrated the interactive and engaging nature of the activity.

Conclusion: Innovative activities may enhance engagement and learning. Further design, development, and research into the integration of 3D-printed anatomical models and associated learning activities will be undertaken.

SNOWDEN, S., G. DIAS, J. L. M. BAILLIE Department of Anatomy, University of Otago, New Zealand. Cranio-metric measurements from 3D digital images
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**Purpose:** An important preliminary step to Forensic Facial Approximation (FFA) is to determine the likely ancestry and sex of the skull. A computer program, CranID, determines likely ancestry of a skull by matching 29 measurements taken from the skull to a database of skulls that represent specific population samples. This database is incomplete and lacks measurements representative of many modern populations. It has been proposed to increase the size of this database by collecting measurements from digital images produced by computerized tomography (CT) scans. A standardized method of taking all 29 measurements from the digital skull is needed.

**Methods:** The author transcribed such a method for measuring a digital version of the CranID training skull (BC-110 skull) on the Osiris computer program. A preliminary interobserver study was conducted where five observers were trained in measurement by the author and then asked to record 27 of 29 measurements from both the digital and dry BC-110 skull. The study assessed both the reliability (by quantifying the amount of observer variation in each measurement) and validity (by comparison with the standard set of dry skull measurements) of the digital method.

**Results:** The study overall found good reliability and validity of the proposed digital measuring method. Only three measurements of 27 had either significant interobserver variation or bias from the standard set of measurements.

**Conclusions:** This study proves that it is possible to take CranID measurements from the digital skull. The study now needs to be repeated with more skulls for greater statistical power.

**STONENSMITH, R. Dean, Graduate Research School, University of Otago, New Zealand. The changing landscape of higher education**

In the recent years, the higher education landscape has undergone substantial change, responding to the call for more student-centered pedagogies, internationalization initiatives, an increasing focus on graduate outcomes, and of course, changes in technology. Furthermore, our student cohort is now more diverse, with different expectations and experiences of higher education. In this session, we will explore each of these changes and highlight the challenges for lecturers.

**TOSOVIC, D., J. M. M. BROWN School of Biomedical Sciences, University of Queensland, Australia. Prediction of musculoskeletal injuries**

**Purpose:** Mechanochemistry (MMG) is a noninvasive muscle stimulation technique which measures a muscle’s contraction dynamics. These MMG-derived contraction dynamics are known to be altered by muscle fatigue, a factor known to cause muscle strains/tears. As there is currently a dearth in the field of injury prediction, this study aims to determine whether MMG has utility in the prediction of musculoskeletal injuries.

**Methods:** Fifteen semiprofessional Australian Football League players were monitored fortnightly throughout the course of a regular season. Contraction dynamics were recorded from the biceps femoris and rectus femoris muscles in both limbs of each player. Contraction dynamics investigated included contraction time ($T_c$), relaxation time ($T_r$), and maximal muscle displacement. A further 18 controls (sedentary) were monitored concurrently throughout the season.

**Results:** No significant differences ($P < 0.05$) were observed for any contraction dynamics throughout the season for either the player (noninjured) or control groups. Four players sustained strains to the investigated muscles. Two of the muscle strains were contact-induced, and data preceding the injury showed the predictivity of each subject’s biceps femoris was monitored for a 7-day period as measured by changes in muscle contractile properties (mechanochemistry), MVC, and subject self-reports of pain and discomfort (VAS).

**Conclusions:** Significance was achieved for MVC and VAS scores post-exercise, with recovery of the biceps femoris on Day 6 in both parameters ($P < 0.05$). No significant changes were found in muscle contractile properties over the study to indicate fatigue; however, interesting trends of slowing and gradual resolution were observed for contraction times of the muscle.

**THAN, A., L. SEIDL, J. M. M. BROWN School of Biomedical Sciences, University of Queensland, Australia. Mechanomyographic, psychological, and force production indices of eccentric muscle fatigue in the biceps femoris of humans**

**Purpose:** Eccentric exercise protocols often lead to Type I muscle strains, typified by a delayed onset of muscles soreness (DOMS), joint stiffness, and a reduction in maximum voluntary contraction force (MVC). This study followed the onset and recovery from DOMS in the biceps femoris muscle through the mechanomyographic, psychological, and force production indices of fatigue that it presents.

**Methods:** Twelve subjects (nine male and three female) aged 18–25 years underwent a maximal eccentric exercise protocol to induce their dominant biceps femoris. Each subject’s biceps femoris was monitored for a 7-day period as measured by changes in muscle contractile properties (mechanochemistry), MVC, and subject self-reports of pain and discomfort (VAS).

**Results:** Significance was achieved for MVC and VAS scores post-exercise, with recovery of the biceps femoris on Day 6 in both parameters ($P < 0.05$). No significant changes were found in muscle contractile properties over the study to indicate fatigue; however, interesting trends of slowing and gradual resolution were observed for contraction times of the muscle.

**Conclusions:** The biceps femoris appears to be a fatigue-resistant muscle as indicated by the lack of significance in contractile properties during the bout of DOMS. Despite this, there appears to be a correlation between muscle force production (MVC) and an individual’s perception of pain (VAS) in regards to muscular fatigue. Furthermore, the mechanomyographic technique also appears beneficial in providing insight to a muscle's physiology during fatigue.
Purpose: Previous research has identified a strong relationship between the percentage compositions of fast and slow twitch (Types 1, 2a, and 2x) muscle fibers and muscle contraction time (Tc). The purpose of this study was to determine whether muscle architecture, as measured in vivo using ultrasonography, also affects the Tc of human skeletal muscle.

Methods: The fiber length (FL), pennation angle (PA), fiber length/muscle length (FL/ML) ratio, and the physiological cross-sectional area (PCSA) were measured from eight muscles in 12 healthy subjects (age 21–1.58 years) using a B-mode ultrasound. The muscle Tc and Tc of the eight muscles were determined using a linear mixed model that found that the only predictor of Tc was FL/ML ratio (P = 0.0126).

Conclusion: This study successfully measured the architectural and contractile properties of skeletal muscle in vivo, allowing inter-subject variability to be investigated, rather than relying on population means. The results of this study indicate that in addition to fiber type composition, the muscle architecture also influences the time it takes a muscle to reach maximum tension following neuromuscular stimulation.

WANG, Q.,1,2 L. LIANG,3 Y.-H. LIU,1 M. ZHANG1 The First Affiliated Hospital of Anhui Medical University, China, 2The Second People’s Hospital of Hefei, China, 3Department of Anatomy, Anhui Medical University, China. Verification of a visor-like jumping of the arytenoid cartilage on the cricoid cartilage in the living subject

Purpose: Recently, we found that the superomedial aspect of the cri- coarytenoid joint was much wider and looser than its posterior aspect and proposed that a visor-like jumping of the arytenoid cartilage on the cricoid cartilage may provide further adjustments in the gliding, rocking, and rotation motions of the vocal cord. However, our findings were based on elderly cadaveric observation and need to be verified in the living subject. The arytenoid cartilage has an anatomesodermal vocal process and a posterolateral muscular process. Thus, the purpose of this study was to test whether the vocal and muscular processes of the arytenoid cartilage were synchronously distanced from the cricoid cartilage during phonation.

Methods: Axial CT images were collected from 35 patients (70 sides) with no laryngeal disorders. The distance between the cricoid cartilage and the vocal or muscular process of the arytenoid cartilage was measured and compared at prephonation and postphonation.

Results: (i) During phonation, the range of the vertical movement of the vocal process (2.09 ± 1.42 mm) was wider than that of the muscular process (1.39 ± 1.18 mm; P < 0.01). (ii) The direction of the vertical movement of the vocal process was either superior (16%; 11/70 sides) or inferior (84%; 59/70 sides). (iii) No difference was found between the sides (P > 0.05).

Conclusion: This study revealed that during phonation, the vertical movement of the vocal process was greater than that of the muscular process, indicating that a visor-like jumping of the arytenoid cartilage on the cricoid cartilage most likely exists in the living subject.

WATANABE, R.,1,2 J. M. M. BROWN,1 E. GHEBREMEDHIN,1,2 1School of Biomedical Sciences, University of Queensland, Australia, 2Institute for Clinical Neuroanatomy, Goethe University, Frankfurt am Main, Germany. Severity and extent of Lewy pathology in sympathetic ganglia of Parkinson’s disease

Purpose: The histopathological hallmark of Parkinson’s disease (PD) is the presence of intraneuronal misfolded protein aggregates described as Lewy pathology (LP). Based on neuronal connectivity and severity of LP, numerous studies have identified vulnerable regions and suggested predictable directionality of expansion of LP in the brain and the enteric nervous system. Sympathetic ganglia are one of the major predilection sites of LP, and its involvement is associated with nonmotor manifestation of the disease. The issue of possible differential vulnerability of sympathetic ganglia to LP, however, has not yet been addressed in greater detail.

Methods: Severity of LP in the cervical and prevertebral sympathetic ganglia has been studied in two PD subjects that have been a part of the UQ donor program. A sensitive immunohistochemical method was used to identify LP. Semi-quantitative assessment of LP was performed to estimate LP severity.

Results: The presence of LP was observed at all levels of the sympathetic ganglia; however, most severe pathological burden was...
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observed in the most cranial (cervical) paravertebral sympathetic ganglia, with gradual decrease of LP density toward thoracic and lumbar ganglia. Similarly, celiac ganglion showed denser LP than the superior mesenteric ganglion.

Conclusion: LP showed a cranio-caudal gradient that may help in understanding the evolution of LP in patients with PD and enable the prediction of nonmotor manifestation that occurs throughout the course of PD.

WEWEBB, A. L. ANU Medical School, The Australian National University, Australia. Making sense of black, white, and a little bit of gray—Training medical students to be competent in medical imaging

Purpose: The purpose of this project was to design, implement, and evaluate an enhanced medical imaging curriculum within an existing 4-year postgraduate entry problem-based learning medical program. The aim of the new curriculum was to prepare graduates entering internship with the necessary knowledge and skills to safely and competently arrange and interpret basic radiological investigations in the context of the individual patient.

Method: The new medical imaging curriculum design was based on a combination of experiential and situated learning theory. In the first 2 years of the program, medical imaging was strategically aligned with anatomy teaching. Fundamental medical imaging concepts were introduced during lecture sessions. Then, in anatomy practical sessions, students undertook active learning instructional activities using a near-PACS system to create a contextualized learning environment integrated with their study of anatomy. Primary outcomes were students’ ability to describe common imaging modalities and to apply a systematic approach to image interpretation to identify and describe normal and abnormal anatomical structures. Application of anatomy and medical imaging was further consolidated using educational technologies for independent learning and during problem-based learning where students had an opportunity to actively experiment with their skills and knowledge in a patient-centered context.

Results: The curriculum was successfully delivered with minimal impact on the existing timetable. Initial student and staff feedback was positive.

Conclusion: Student medical imaging knowledge, skills, and attitudes can be augmented through effective integration of active conceptualized learning experiences in existing teaching sessions such as anatomy.

WENTWORTH, S., D. HUGHES, H. MCGOWAN 1 Human BioScience, School of Public Health and Human Bioscience, La Trobe University, Australia, 2Rural Human Biosciences, LRHS, La Trobe University, Australia. How students engage with online material in a blended first-year anatomy subject

Purpose: To examine how first-year health science students engage with the online material that has replaced lectures in a blended core first-year anatomy subject. All online material was accessible via the La Trobe Learning Management System which utilizes Moodle software. Online material was made available in weekly blocks. Each block was open for 10 days before there was an online quiz that assessed the intended learning outcomes (ILOs) for that block. In the week following, each student was expected to attend a 2-hr workshop, which reviewed the material and enabled them to clear up any questions.

Methods: Activity logs were downloaded for all learning activities for the first major topic area (musculoskeletal system) and analyzed for correlation with the online material that has replaced lectures in a blended core anatomy teaching. Fundamental medical imaging concepts were introduced during lecture sessions. Then, in anatomy practical sessions, students undertook active learning instructional activities using a near-PACS system to create a contextualized learning environment integrated with their study of anatomy. Primary outcomes were students’ ability to describe common imaging modalities and to apply a systematic approach to image interpretation to identify and describe normal and abnormal anatomical structures. Application of anatomy and medical imaging was further consolidated using educational technologies for independent learning and during problem-based learning where students had an opportunity to actively experiment with their skills and knowledge in a patient-centered context.

Results: The curriculum was successfully delivered with minimal impact on the existing timetable. Initial student and staff feedback was positive.

Conclusion: Student medical imaging knowledge, skills, and attitudes can be augmented through effective integration of active conceptualized learning experiences in existing teaching sessions such as anatomy.

WILLIAMS, A. D. CHOI-LUNDBERG, W. CUELLAR, J. CHAPMAN School of Medicine, University of Tasmania, Australia. If you build it, will they come? The nature of student engagement with online anatomy resources

Purpose: One of the major pedagogical benefits of providing online resources is the ubiquity of learning opportunities. This discussion paper collates research into the online study habits of medical students at the University of Tasmania and their engagement with in-house produced online histology and gross anatomy resources.

Method: Medical students were surveyed about their mobile device usage. Usage of online histology resources for Year 1, and gross anatomy resources for Years 1–3. MBBS students was collected from the learning management system and analyzed for correlation between engagement and student performance. Students were also surveyed on their satisfaction with these resources.

Results: Mobile devices are virtually ubiquitous with 97% of students owning at least one device. Fewer than half of the students accessed online resources prior to, or shortly after, the corresponding assessment. The numbers of students accessing online quizzes peaked just prior to major assessment tasks, whereas about 20% of students never accessed a particular resource. Weak positive correlations were found between the number of dissection resources viewed and scores on cadaver exam questions (r = 0.155 and r = 0.226 in Years 2 and 3, respectively) and with histology results and access to virtual microscopy resources (r = 0.183 in Year 1). The vast majority of students replying to surveys rated the in-house online resources highly.

Conclusion: There is a wide range of usage of online resources, and many students may not be meaningfully engaging with the content. Factors relating to student engagement with online resources will be discussed.

WONG, G., M. BAIRD, K. CHUANG Department of Medical Imaging and Radiation Sciences, Monash University, Australia. Action research and reflection on the implementation of a clay modeling approach for teaching sectional anatomy

Purpose: Using an action research framework, we present the process and our reflections on redesigning a previously lecture-based sectional anatomy component within a second-year radiography unit, with a focus on encouraging more active forms of learning.

Methods: By studying sectional anatomy, students may form better intra-anatomical relationships and visualizations. Using an evidence-based approach, we designed a team-based activity, which involved building three-dimensional clay models, section by section, using radiographic images. Information from student feedback, self-reflection, and postpractical discussions were used in revising the practical structure. Specifically in Cycle 2, changes included more closely aligned learning objectives and activities; greater focus on prepractical knowledge; and increased in-class cognitively engaging activities.

Results: The action research framework to instructional design and review created opportunities for improving the teaching of sectional anatomy. This resulted in a positive, socially dynamic, and interactive learning experience for students. Reflection during the first cycle provided valuable insights into the benefits and potential limitations of the specific clay modeling approach adopted. More importantly, insights were used to identify practical and theoretic issues including use of appropriate pedagogy and long development times.

Conclusion: A lecture-based sectional anatomy course was revised using a clay modeling, team-based, and active learning approach. This has been continually reviewed using an action research model for reflection and change. Updates to the current cycle are evidence based and draw on student feedback. Insights were gained into issues when designing innovative, hands-on learning that is engaging and beneficial to learning.

WONG, G., N. EIZENBERG, P. G. MCMENAMIN Department of Anatomy and Developmental Biology, Monash University, Australia. Evaluating a new anatomy practical manual based on constructive alignment
Purpose: Current theories in education, particularly constructive alignment, were utilized in designing a new practical manual for second-year medical students. Key features were specially constructed objectives with prepractical and intrapractical questions, aligned to the learning activities. The major aims were to gauge student perceptions of the manual and whether it helped them in their learning during the classes.

Methods: A quantitative questionnaire (using a five-point Likert scale) complemented by qualitative written open questions were used to evaluate the learning intervention. These were given in the second last week of practical classes.

Results: The response rate was 91% (n = 290). Prepractical questions, learning objectives, and the practical book generally were regarded by students to be helpful for their learning (average scores 4.34, 4.06, and 4.62, respectively). Responses to open questions (e.g., "What are the best things about this practical book?") were grouped into themes. These corresponded well with the above findings, and specifically, the following responses and themes were frequently cited: "general topics and questions" (prepractical questions), 148 times; "specimen questions" (intrapractical questions), 128; learning objectives, 51; and structure and organization, 56.

Conclusion: Practical manuals can be designed based on constructive alignment to help students in their learning during classes. This can be achieved by constructing objectives, prepractical and intrappractical questions which are aligned to the learning activities. Although a specific manual needs to be designed for each particular class, the underlying principles and the example presented can easily be adapted.

YANG, J. H.,1 J. M. M. BROWN,1 E. GHEBREMEDHIN1,2 1School of Biomedical Sciences, University of Queensland, Australia, 2Institute for Clinical Neuroanatomy, Goethe University, Germany. An anatomical study of extraocular muscles in Parkinson’s disease

Purpose: Cardinal motor symptoms in Parkinson’s disease (PD) are widely recognized in limb muscles. However, 75% of patients with PD also display extraocular movement (EOM) abnormalities, including convergence of the eyes. Given the neurodegenerative process in PD, and the plasticity of muscle fibers in general, PD may lead to structural and histochemical changes within the extraocular muscles (EOMs) themselves. To date, there has been no study to address the structural changes of EOMs in PD.

Methods: Six EOMs, from two PD subjects and two age-sex matched controls (90.5 ± 2.4 years), were obtained through the UQ body donor program. Gross anatomical measurements and histological analyses were carried out to determine the effect of PD. Descriptive and statistical analyses were used to determine pathological changes observed in the two groups.

Results: There was a decrease in physiological cross-sectional area of EOMs in PD subjects when compared with controls (P = 0.023) particularly in the medial and lateral recti muscles (P < 0.05). In addition, prominent atrophic features such as endomysial fibrosis associated with shrinkage of muscle fiber cells and increased perivascular adipose tissue and hyperneuralpervascular adipose tissue and hyperneural were shown in PD subjects.

Conclusion: Degeneration of EOMs was found in PD subjects. This suggested that the morphological features correlate with the impaired ocular movement in PD. The structural changes of EOMs may have been influenced by a process primarily underpinned by PD. Although definitive conclusions cannot be drawn due to low sample size (n = 4), this study provides evidence and understanding that the EOMs of PD undergo structural alterations consistent with their reported functional impairment.

YASSAI, O.,1 K. REILLY,2 S. A. MIRJALILI2 1Southland Hospital, New Zealand, 2University of Auckland, New Zealand. Is the calcaneal spur an anatomical entity?

Purpose: The concept of the calcaneal spur (CS) has existed for more than a century and yet there is no clear anatomical or pathological definition of this entity. Calcaneal spurs are bony outgrowths that usually occur around the attachment of ligaments or tendons arising from the calcaneus. The presence of a spur can lead to significant heel pain in some individuals; however, they may be asymptomatic in others and detected incidentally on radiology.

Methods: A systematic literature review was undertaken to investigate the normal gross and histological anatomy of the CS using the electronic databases MEDLINE, PubMed, Cochrane Library, and Google Scholar.

Results: The two common sites of these outgrowths are just anterior to the calcaneal tuberosity, the plantar calcaneal spur (PCS), and posteriorly around the attachment of the Achilles tendon, the retrocalcaneal spur (RCS). There is no consensus on the etiology of CS, and there are various theories postulating the pathology behind these structures. Studies of CS have shown no evidence of bone microstructure at this site when compared with the calcaneus or its tuberosity.

Conclusions: There is evidence that a CS can be defined anatomically and pathologically. A further understanding of the etiology may help to guide us in the treatment for patients suffering from heel pain.

ZACHARIAS, A.,1 T. PIZZARLI,2 D. ENGLISH,1 T. KAPAKOULAKIS,3 R. A. GREEN1 1Department of Rural Human Biosciences, La Trobe University, Australia, 2Department of Physiotherapy, La Trobe University, Australia, 3Bendigo Health Care Group, Australia. Hip abductor muscle volume in hip osteoarthritis patients and matched controls: Preliminary findings

Purpose: Atrophy and strength deficits of the muscles are commonly seen surrounding some joints affected by OA. This study aims to compare the volume of gluteal muscles and TFL in a unilateral hip osteoarthritis (OA) population and age- and gender-matched controls.

Methods: Demographic data and activity levels were collected from 16 participants (eight OA and eight controls). Using 3T MRI, a series of 6-mm axial slices were taken from the iliac crest to the lower margin of the fascia lata bilaterally to measure muscle volume. Muscle volume was calculated by a blinded assessor and determined by tracing muscle outline and multiplying by slice thickness. A second independent, blinded assessor examined a subsection of MRIs to allow inter-rater reliability of volume measures to be calculated (intraclass correlation coefficients; ICC: 2–1). Muscle volume was normalized by dividing by BMI, and muscle volume difference between sides (unaffected – affected) was determined for each muscle. Demographic and muscle volume difference data were compared using independent sample t-tests.

Results: Muscle volumes on the affected side in the OA group were reduced for all muscles when compared with the unaffected side. This asymmetry was not present in the control group, but the difference between groups failed to reach significance in this preliminary sample. Reliability of volume measures was good with the majority of ICCs > 0.90.

Conclusion: Trends in muscle volume asymmetries may become significant with increased participant numbers and could provide direction on specific muscle to target for prevention and rehabilitation of hip OA.

ZIMANYI, M. A., K. J. TERRY Department of Anatomy and Pathology, James Cook University, Australia. The use of mannequins in anatomy practicals

Purpose: To increase active participation in anatomy practical classes and to improve students’ outcomes, body painting has been recommended by many. Limitations to its uptake include reluctance to disrobe, lack of artistic skills, and religious beliefs. In this study, mannequins as well as body painting was used to increase student participation in anatomy practical classes.

Methods: Four mannequins, two male and two female, were purchased and painted with whiteboard paint. Students were given a surface anatomy station during each 2-hr anatomy practical with ideation to what could be drawn on the mannequins or painted onto colleagues. These activities were used to supplement the usual use of imaging, prosected specimens, posters, bones, and sketches.

Results: Students engaged with the surface anatomy activity, with an approximately equal number of students drawing on mannequins and body painting; however, this was variable depending
on the topic of the week. For instance, the mannequins were used more during the weeks in which the gluteal region and femoral triangle were covered. Students enjoyed the activity and were proud of their work.

**Conclusion:** There are a number of limitations to use the mannequins, such as its stiffness and lack of palpable bony landmarks, but it was well received, enjoyable, and allowed those students who would not normally participate in surface anatomy activities to take part.