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ASEEM, RABIYA, HASAN NAVEED, ASHRAF MESSIHA, Department of General Surgery, Royal Albert Edward Infirmary, Wigan, United Kingdom. **Anatomical variation of the marginal mandibular nerve: A literature review**

The marginal mandibular nerve (MMN), important for facial symmetry, expression and phonation, is implicated in many contemporary jaw and neck-related surgical procedures. Operating in the vicinity of this nerve caries a risk of permanent injury in up to 7% of cases. We present a literature review analyzing the positional variation of the MMN with respect to ethnicity and gender, and its implications for head and neck surgery. The Pubmed database was used to search for relevant articles published between 1997 and 2015. Our search terms included a combination of the following words: geometry, morphometric, anatomy, and marginal mandibular nerve. We selected anatomical studies that measured the position of the marginal mandibular nerve with respect to established landmarks. We identified 12 qualifying articles that studied the position of the MMN in relation to mandibular margin, facial vessels, gonion, antegonial notch, and masseteric tuberosity. The data from these studies was pertinent to Caucasians, Oriental Asians, South Asians, and Middle-Eastern peoples. There were no interethnic comparative studies conducted by a single group. Significant variation in the position and morphology of the MMN were identified. This highlights the paucity of advice to precisely predict position of this nerve. Popular landmarks and geometric relations are commonly used to predict the location of the marginal mandibular nerve during surgery. Given the variation of anatomy, there is a need for a gold standard measure with respect to each ethnicity. In light of this, we have reviewed the literature to determine relevant landmarks and measurements specifically applicable to gender and different ethnicities.

BADSHAH, MASROOR, FARHANABBAS BALOCH, QAISER INAYAT, JAMSHAID HASNAIN, JAVED NAWAB, ROGER SOAMES, Peshawar Institute of Medical Sciences, Pakistan. **The relationship of the origin of the cystic artery to Calot's triangle among the population of Khyber Pakhtunkhwa, Pakistan**

This study investigates the origin of the cystic artery and its variations related to Calot's triangle with the aim of reducing the chances of injuries to blood vessels and the biliary system during various hepatobiliary procedures. A retrospective analysis of surgical anatomical data of patients who underwent surgery for different lesions in the hepatobiliary region was carried out between August 2013 and October 2014 at Peshawar Institute of Medical Sciences, Hayatabad, Peshawar, Khyber Pakhtunkhwa, Pakistan. Data were retrieved from surgical notes of the patients and was entered into Microsoft Excel. Evaluation of the data entry was done using validity checks. Afterwards the data were exported to SPSS Version 19.0 for analysis. It was observed that in 92.4% ($n = 61$) of the patients the origin of cystic artery was normal i.e. from right hepatic artery and variations were seen in the remaining 7.6% of ($n = 5$) cases. It was also noted that in 66.5% ($n = 44$) of patients, the cystic artery entered Calot's triangle, while in 32% ($n = 21$) of patients the course of the cystic artery was outside the triangle. Most of the cystic arteries that passed through Calot's triangle had their origin from the right hepatic artery (95.5%, $n = 42$), while two instances were of common hepatic artery origin (4.5%). Further research should be carried out to understand the normal anatomy of the cystic artery to avoid injury to blood vessels and the biliary system during hepatobiliary procedures.

BEZDICKOVA, MARCELA, RADKA FILIPCIKOVA, PETR HUBACEK, STEFAN POLAK, DALIBOR PASTUCHA, Department of Anatomy, Faculty of Medicine and Dentistry, Palacký University, Olomouc, Czech Republic. **Orofacial atlas with clinical anatomy application (APP)**

The orofacial system represents an anatomically and clinically rich region with a wide variety of functions (initial part of digestive system, respiratory system, variety of reflexes, etc.) This region is not topographically complex, but disease in this system affects many aspects of a patient's life. The aim of establishing the interactive atlas is to present oro-maxillo-craniofacial topographical anatomy, and focus not only on excellent clinical-anatomical description but also on surgical therapy and its techniques, including depiction and description of surgical approaches. The atlas and APP of the orofacial system and its applied anatomy is easy to use, comprehensive and interactive, and largely without time constraints. The advantage of this medium is the possibility of continuous development and replenishment as new case reports and surgical approaches are published. The atlas covers the biomechanics of orofacial system, skull fractures, and subsequent functional integrity of the underlying systems, with a focus on the weak points and changes in bone thickness in the skull. The atlas finds wide application in the fields of otorhinolaryngology, neurosurgery, aesthetic surgery, orofacial traumatology, orthognathic surgery, and reconstructive surgery of the orofacial region. It is planned that the atlas will be updated regularly to reflect developments in medicine and in surgical techniques.

BEZDICKOVA, MARCELA, STEFAN POLAK, RADKA FILIPCIKOVA, IVAN VARGA, ZDENA BLAZKOVA, Department of Anatomy, Faculty of Medicine and Dentistry, Palacký University, Olomouc, Czech Republic. **Thymol-fixed specimens in plastination procedure: Experience with focus on the cardiovascular system**

Dissected cadavers are a principal tool for anatomists and medical students studying gross anatomy. The most frequently used fixatives and disinfectants are formalin, ethanol, and phenol. Dissection of embalmed cadavers exposes students, teachers, and other staff to chemicals used in fixation and preservation of cadavers. In a new embalming solution, we use thymol instead of phenol, according to evidence of higher safety. Thymol has antiseptic ability 25× more effective than phenol. The high antiseptic effect occurs even in the solution of 1:3,000. What is essential, thymol is not put into the group of carcinogens and, due to its lower solubility in water, it is less toxic than phenol. For fixation, we use a combination of formalin, thymol, ethanol, and distilled water. For preservation only, thymol, ethanol, and distilled water is used. We also attempted to use plastination on the anatomical specimens. First results show that during the last step of plastination—the curing phase—it is most important to pay attention to find the optimal time, much shorter than using with wet phenol-embalmed specimens. Dependent variables are size and type of tissue. Preliminary testing was done with heart specimens and neck complexes with a focus on vessels.

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BETTENCOURT-PIERES, MARIA, ANDREI YAKIMOV, JOSE ESPERANCA-PINA, JOAO GOYRI O'NEILL, Nova Medical School, New University of Lisbon, Portugal. **Revisiting the celiac artery**

The first accurate anatomical description of the celiac artery is usually attributed to the Swiss humanist Albrecht Von Haller (1756). We consulted the original notes of his Gottingen disciple Hermanni Boerhaave (1741) and also some of the earlier anatomical descriptions of the artery, by Vesalius (1543) and Virchow (1775), as both were referred to by von Haller in the description we consulted. In addition to this bibliographic research, we present the results of anatomical studies carried out in Portugal using injection-corrosion casting, with aortic injection of methacrylate (Perspex tenso/®) and addition of fluorescent dye and photography in a dark room. We present the results of our Portuguese series of 128 human arteries and 55 arteries obtained from dogs. They are consistent with the results of more recent studies, performed worldwide. The interest in knowledge of the anatomical variations of the celiac artery resides in the necessity to plan surgery on upper abdominal organs, such as segmental splenectomy or hepatectomy and/or organ transplants. Modern techniques of laparoscopic surgery and arterial embolization through interventional imaging also require previous accurate knowledge of the several anatomical variations of the aortic branches.

BURGER, ELSIE, ELSJE-MARIE GELDENHUYS, PAUL VAN HELDEN, SANET KOTZÉ, Division of Forensic Medicine, Department of Pathology, Faculty of Medicine and Health Sciences, Stellenbosch University and Western Cape Forensic Pathology Service, South Africa. **The prevalence and presentation of tuberculosis in a cadaver population in Cape Town, South Africa**

Pulmonary tuberculosis (PTB) is not only a major health problem in the Western Cape Province, South Africa but is also the most prevalent cause of death in the South African population. The aim of this study was to determine the prevalence and anatomical distribution of tuberculosis lesions in a cadaver cohort that originated mainly from low socio-economic communities in the Western Cape Province. Formalin-embalmed cadavers ($n = 127$) consisting of 87 males and 40 females were dissected by medical students. The organs, including the skeletal system, were examined and photographed. Standard histological processing and sectioning was performed on tissue samples. Pulmonary TB was the most common manifestation of tuberculosis (TB) and was observed in 97/127 (76.4%) cadavers. The most frequently observed forms of extra-pulmonary TB were splenic TB (16.9%), followed by hepatic TB (11.8%), tuberculous lymphadenitis (11.0%) and renal TB (10.2%). Gastrointestinal involvement and pancreatic TB were both individually observed in 1.6% cadavers, while one cadaver presented with spinal TB and one with testicular TB. This study gives detailed information on the prevalence of pulmonary and extra-pulmonary TB currently seen in cadavers from low socio-economic communities studied by medical students. These conditions will also be encountered by students in hospitals and clinics during further training, and therefore recognition of pathology in the dissection venue lays the groundwork for their studies. Thus, students dissecting these cadavers are made aware of typical TB lesion distribution and other pulmonary pathology which they will encounter frequently as future clinical practitioners.

BURWELL, R. GEOFFREY,[1] EMMA M. CLARK,[2] PETER H. DANGERFIELD,[3] ALAN MOULTON,[4] [1]Centre for Spinal Studies and Surgery, Queen's Medical Centre, Nottingham University Hospitals Trust, Nottingham, [2]Academic Rheumatology, Musculoskeletal Research Unit, University of Bristol. [3]University of Liverpool and Staffordshire University, [4]Department of Orthopaedic Surgery, King's Mill Hospital, Mansfield, United Kingdom. **Adolescent idiopathic scoliosis: Cascade concept of pathogenesis**

Many studies have reported abnormal body composition with lower body weight and BMI with adolescent idiopathic scoliosis (AIS). Although several concepts attempt to explain the pathogenesis of AIS, there is no agreed theory. Here, we suggest a novel Cascade Concept for AIS pathogenesis initiated by the longitudinal findings of Clark et al. (2014, J. Bone Min. Res. 8:1729–1736). These relate tissue abnormalities at 10 years of age namely, low fat mass, low circulating leptin, and low lean mass, to the presence of scoliosis, mostly AIS, at 15 years of age. We speculate that the leptin body composition effect is linked to central nervous system development (Steppan and Swick 1999, Biochem. Biophys. Res. Comm. 256:600–602) and the asynchronous neuro-osseous growth mechanism (Chu et al. 2008, Scoliosis 3:8). The latter, in combination with human upright posture, age, and gender-related anatomical variants of vertebral backward tilt (dorsal shear concept of Castelein et al. 2005, Med. Hypotheses 65:501–508; Schlosser et al. 2015, Eur. Spine J. 24:1158–1167), the Hueter-Volkmann effect in vertebrae and vertebral bone mass abnormality, lead to AIS, possibly both initiation and progression of scoliosis curvatures. Numerical simulation (Drevelle et al. 2010, Spine 35:E407–E412) may be applied to test these ideas for components of the scoliotic spine in sagittal and transverse planes, including the concepts of asynchronous neuro-osseous growth and dorsal shear for AIS pathogenesis.

BURWELL, R. GEOFFREY,[1] EMMA M. CLARK,[2] PETER H. DANGERFIELD,[3] ALAN MOULTON,[4] [1]Centre for Spinal Studies and Surgery, Queen's Medical Centre, Nottingham University Hospitals Trust, Nottingham, [2]Academic Rheumatology, Musculoskeletal Research Unit, University of Bristol. [3]University of Liverpool and Staffordshire University, [4]Department of Orthopaedic Surgery, King's Mill Hospital, Mansfield, United Kingdom. **Adolescent idiopathic scoliosis: Embryonic origin of cascade concept of AIS pathogenesis**

As a complex disease, AIS should involve genetic, environmental and lifestyle factors in development and growth (Cheng et al. Nature Reviews Disease Primers in press; Craig 2008, Nature Educ. 1:184). Although no specific environmental risk factors have been identified, the Avon Longitudinal Study of Parents and Children found factors at age 10 years associated with scoliosis deformity at 15 years (Clark et al. 2014, J. Bone Min. Res. 8:1729–1736); these factors are low fat mass, low lean mass, low circulating leptin, and high adiponectin levels. To explain the association of components of body composition identifiable before onset of scoliosis, Clark et al. (2014) suggested the origin of scoliosis affects a cluster of cell types in embryonic life, not only adipocytes and osteoblasts derived from the same progenitor cells (mesenchymal stem cells) but also myoblasts derived from different progenitor cells (somitic myotome) (Gilbert 2014, Developmental Biology, 10th Ed, Sinauer). Clark et al. (2014) related low lean mass to paravertebral muscle abnormalities with scoliosis. There is speculation that environmental factors differing in world regions, could act in the first year of postnatal life to initiate the expression of AIS years later (McMaster et al. 2015, Scoliosis 10:6). More epidemiological research is needed including early pregnancy.

CAXAMBU NETO, MARIO, PAULO CÉSAR DELIBERATO, TATIANA CAXAMBU, CELIMARA GAMBA, JOSÉ RENATO ROMERO, AUGUSTO CÉSAR GAUGLITZ, Municipal University of São Caetano Do Sul, Sao Paulo, Brazil. **Anatomical variations of the median nerve and its relations with carpal tunnel syndrome**

This study documented anatomical variations of the median nerve within the carpal tunnel. We dissected and analyzed the palms of 10 hands of seven adult Caucasian cadavers, one female and six males,

previously treated by injection of glycerin and 10% formalin. We found anatomical variations in 7 of the 10 dissected hands. We analyzed the variations of the motor branch of the median nerve to the thenar muscles in relation to the transverse carpal ligament. In three specimens, the motor branch emerged from the distal median nerve beyond the carpal tunnel. In two hands, the branch arose inside the carpal tunnel. In two hands, the motor branch pierced the transverse carpal ligament to reach the thenar muscles. The presence of accessory thenar motor branches of the median nerve was recorded all 10 dissections. Doubling of the median nerve was recorded in two dissections. We conclude that anatomical variations of the thenar motor branch of the median nerve can increase the predisposition for carpal tunnel syndrome and may require modifications in treatment.

CHAUDHRY, MOHAMMED SHIRAZ, NEIL ASHWOOD, KARAGKEVREKIS BABIS, Queen's Hospital, Burton-on-Trent, United Kingdom. **Avascular necrosis of the right knee, left knee, and left talus: A unique presentation**

Avascular necrosis is defined as cellular death of bone due to ischaemia of osseous tissue and has been well documented with many theories proposed. However, there is little literature on avascular necrosis occurring at multiple sites within a short period of time. We present a 63-year-old woman who developed idiopathic avascular necrosis of the right knee, left knee, and left talus with no associated risk factors. Avascular necrosis at any site can be a debilitating disease and it is rare for it to occur at three different sites of the body within a short time frame.

CHOUDHURY, BIPASHA, INGRID GOULDBOROUGH, Faculty of Life Sciences, University of Manchester, Manchester, United Kingdom. **Digital histology: Superior to light microscopy?**

Students find it challenging to examine sections using the light microscope which can often be a barrier to learning the functional histology of a structure. With the advent of newer technologies where histological sections can be scanned and viewed digitally, new methods for teaching this subject have evolved. The aim of this study was to evaluate student opinions on studying histology using digitalized slides in comparison to traditional methods using light microscopy. Sixty-nine first year dental students at the University of Manchester, were asked to view slides of the gastrointestinal system using light microscopy (traditional method) and digitally (novel method) during a scheduled teaching session. These students had previous experience of light microscopy. Relevant slides had been scanned and were viewed using Pathonet. Student opinions on each method were collected using questionnaires. All students stated that the sections viewed were clearer when using the digitalized slides. Students found it easier to distinguish between different types of tissues (94%), easier to recognize specific structures (86%), and felt more confident (93%) using the imaging software when compared to light microscopy. Stated benefits of using the software included simultaneous viewing of a slide allowing productive discussion and reassurance of correct interpretation. Other benefits included easier focussing and a greater ability to produce more detailed drawings. Thirty-five students commented that the software did not allow them to develop skills in light microscopy. This new method of histology teaching provides an excellent way of getting students to engage with and understand microscopic structure.

CHUNG, BEOM-SUN, MIN-SUK CHUNG, YOUNG-HWAN AHN, JIN-SEO PARK, Department of Anatomy, Ajou University School of Medicine, Suwon, Republic of Korea. **Ten triangular spaces around the cavernous sinus, used in surgical approaches, observed by sectioned images and 3-dimensional models**

Lesions around the cavernous sinus (CS) are difficult to access surgically and triangular spaces adjacent to the sinus have been devised by clinical anatomists and surgeons. Advances in computer tomography and magnetic resonance imaging are enabling diagnosis of pathology in this region. The purpose of this study is to reassess the triangular spaces and to enhance understanding of their anatomy. Based on papers in the literature, 10 triangular spaces (superoposterior, superior, middle, inferior, anterior, middle, posterolateral, posteromedial, lateral, and medial) were organized into three groups (medial, lateral, and posterior). The triangular spaces were drawn onto a schematic diagram. The spatial relationships of the triangular spaces and nearby structures were observed on the serially sectioned cadaveric images. Three-dimensional models depicting the triangles and related surgical approaches were manufactured and embedded into a portable document format file. By comparing the schematic diagram with the 3D models and the sectioned images, the triangles around the cavernous sinus were recognized as being accurate. The borders of the triangles have been revised appropriately. The nomenclature of the triangles has been rearranged to yield consistency. The educational resources of this study will be provided free to aid medical students, radiologists, and surgeons requiring knowledge of the anatomy of the cavernous sinus.

CLEMENT, HANS, KALPESH VAGHELA, DAVOUD KHODATARS, LEE PARKER, Department of Trauma and Orthopaedics, St Bartholomew's Health NHS Trust, London, United Kingdom. **Syndesmosis-preserving osteotomy of the fibula for access to the lateral talar dome**

Surgical access to the posterolateral talar dome for the treatment of osteochondral defects is challenging, often requiring a segmental osteotomy of the fibula (fibula window) and division of the anterior inferior tibiofibular ligament (AITFL) or, alternatively, a fibular osteotomy with division of the AITFL and the anterior tibiofibular ligament (ATFL) (fibular door). These techniques require extensive surgical dissection. We have developed a fibula osteotomy that permits access to the lateral talar dome without disrupting the lateral ligamentous complex or syndesmosis. A 10 cm curvilinear incision is made over the lateral distal fibula to the peroneal tubercle of the calcaneum. The fibula is then exposed subperiosteally at the level of the lateral talar dome. A trapezoidal osteotomy is made using an oscillating saw around the insertion of the AITFL keeping a 1 cm wide posterior column of fibula behind. The fibula can then be reflected anteriorly hinging on the intact AITFL. Precise reduction and stabilization of the osteotomy can be achieved using a single 3.5 mm lag screw. A 43-year-old man was diagnosed with a osteochondral fracture of the superolateral talar dome on CT scanning. A trapezoidal osteotomy was utilized and the fracture with stabilized with two Herbert screws. A 3.5 mm lag screw was then used to stabilize the fibula osteotomy. The ankle was immobilized in a below-knee plaster-of-Paris for 6 weeks after which radiology showed complete union of the osteotomy and osteochondral fracture. We conclude that this novel osteotomy configuration can permit safe access to the lateral talar dome.

COEY, JAMES, SARA SULAIMAN, Department of Anatomy, St. George's International School of Medicine, University of Northumbria, Newcastle, United Kingdom. **Active learning in anatomy: An experience of introducing an ultrasound-based research selective**

Active learning in medical education is increasingly being recognized by both educators and governing bodies for its positive influence on students attitudes, critical analysis, and comprehension. Principles of scientific research are taught in medical schools but rarely applied beyond the classroom setting making them an obvious choice for active learning. A selective course for term-2 medical students was introduced in the St. George's Keith B. Taylor Global Scholars program at Northumbria University. The course was designed to introduce students to the research cycle and further their anatomical knowledge through a self-directing learning exercise. Twenty-four students within six groups participated in the selective in which

students formulated a research question, ran a feasibility study, and collected data before presenting their findings to the school and at an international conference. A questionnaire-based assessment of 30 Likert-type questions evaluating students' perception toward research and the learning process was administered. The selective was well received by students. Greater than 70% reported that they would like more research opportunities and concepts incorporated into the medical curriculum. Students also thought the course to be beneficial in terms of enhancing their curriculum vitae and affecting their career choices. Active learning in anatomy through research has proven to not only further anatomical knowledge and practical applications of ultrasound but also to developing skills in critical thinking, appraisal of evidence and scientific writing. Other skills such as team work, bed-side manner, and communication were also reinforced.

COSCIONE, ALBERTO, MICHAELIS VARNAVAS, SORAM PATEL, RAJESH NAIR, SAMER KAKMAWI-SABBAGH, Department of Urology, St George's Hospital, London, United Kingdom. **A historical perspective on the discovery and naming of the prostate**

The prostate gland is an important focus of modern urology, yet debate continues over its discovery and naming. We present a historical review of the discovery of the prostate as an organ and as a name. A review of manuscripts analyzing anatomical treatises was performed using databases and online resources. We found that Niccolo Massa (1485–1569) is widely credited with the first description of the prostate as: "a round, glandular structure sitting below the bladder." However Herophilus of Alexandria (325–255 BC) described two "glandular assistants" found below the bladder and joined at the midline. The use of the plural may imply the prostate was considered part of the seminal vesicles. The term "prostate" is attributed to André du Laurens (1558–1609) by Marx et al. (2009), but the term prostata is found in an essay by Jacques Dubois (1478–1555) published 50 years earlier. Herophilus's original description Αδενοιδεισ Παραστατεs translates to "glandular assistants" and we postulate the etymology of "prostate" may be a Latinization of "parastate." Although Massa may have been the first to recognize it as an organ, evidence exists of authors as early as Herophilus describing the anatomical location and characteristics of the prostate. Moreover, the origin of term prostate is unlikely to have been coined by Du Laurens as previously thought as it was in use several years prior to his works and may derive from a Latinization of the Greek term "assistant" rather than "protector."

DAVIES, ANDREW, NATALIE PEARSE, MARTIN WEINER, CIARAN HEALY, Department of Anatomy, University of London, London, United Kingdom. **Maximizing venous drainage in the paramedian forehead flap**

The gold standard for reconstruction of the nasal tip and alae is the paramedian forehead flap, a pedicled flap raised on the supratrochlear vessels. Venous congestion can occur due to inadequate venous outflow and may compromise flap survival. It is possible to identify superficial veins in the subcutaneous fat adjacent to the flap, and include them in the flap to aid venous drainage. We investigated the incidence and drainage pattern of these superficial veins. Paramedian forehead flaps were marked on eight fresh frozen cadaveric heads. Dissection was carried out in the subcutaneous fat adjacent to the flap. All superficial veins emanating from the flap and running within 10 mm of the flap margin were identified and their drainage patterns recorded. From the eight dissections, a superficial vein was identified medial to the flap in seven cases and lateral to the flap in six specimens. The mean distance of the vein from the peripheral margin of the flap was 6 mm. The point of emanation from the flap margin ranged from 10–70 mm from the radix. Nine superficial veins had multiple connecting branches to the flap. The veins drained to ipsilateral supratrochlear vessels in all but one case. We conclude that a superficial vein could be included in the forehead flap in all cases. This most commonly ran medial to the flap and drained to ipsilateral supratrochlear vessels. The close proximity of superficial veins allows their inclusion when raising paramedian forehead flaps, and should reduce the incidence of venous congestion.

DEMIRYUREK, DENI, ALPER VATANSEVER, BURCE OZGEN MOCAN, Department of Anatomy, Faculty of Medicine, Hacettepe University, Ankara, Turkey. **To be or not to be: the triticeal cartilage?**

The larynx is an anatomical structure in the neck region, involved in breathing and sound production. Its skeleton is formed by hyaline cartilages which may ossify with age, except the elastic epiglottis. Triticeal cartilages are a part of the laryngeal skeleton and, if present, are located inside the lateral thyrohyoid ligament at the level of third and fourth cervical vertebrae. Clinically, the triticeal cartilage has no known function, although recently it has been suggested that it might help reinforce the lateral thyrohyoid ligament. When calcified, the triticeal cartilage can be readily seen on radiographic and CT images, and can be misdiagnosed as calcification in the carotid artery or other dystrophic calcifications of soft tissue. As calcified carotid atheroma is a risk factor for stroke, clinicians need to differentiate between a calcified triticeal cartilage and calcified carotid atheroma. The objective of this retrospective study with 100 cases was to determine the prevalence of calcified triticeal cartilages, their age and sex distribution, the relationship between the superior horn of the thyroid cartilage and the greater horn of the hyoid bone on CT images, and to document whether the shape of the triticeal cartilages differs from that of carotid atheroma. The thickness of the lateral thyrohyoid ligament was measured on MR images of subjects with triticeal cartilages. The triticeal cartilage was detected in 70%. The thickness of the ligament was increased and its length decreased in such cases. Some subjects had both a calcified triticeal cartilage and calcified arterial plaque. Further studies are required for determining the function of the triticeal cartilage.

DODEVSKI, ACE, DOBRILA TOSOVSKA-LAZAROVA, MARIJA PAPAZOVA, NIKI MATVEEVA, JULIJA ZHIVADINOVIK, BILJANA ZAFIROVA, BILJANA TRPKOVSKA, Institute of Anatomy, Medical Faculty, Ss. Cyril and Methodius University, Skopje, Macedonia. **Morphological characteristics of the posterior inferior cerebellar artery**

The posterior inferior cerebellar artery (PICA) has the most complex and variable course of the cerebellar arteries. The aim of this study was to investigate the origin and diameter of PICA in the Macedonian population and to emphasize their clinical significance. We examined radiographs of 103 patients who had undergone CT angiography for a variety of clinical reasons at the University Clinic for Radiology in Skopje, Macedonia. The study population was 103 patients (58 male and 45 female), age range from 25 to 82, mean age 58.4 years. The diameter of the left PICA was 1.24 ± 0.42 mm, and the diameter of the right PICA was 1.18 ± 0.40 mm. The left PICA in 90.4% had origin from the intracranial part of the left vertebral artery, in 4.3% from the basilar artery and in 5.3% PICA had origin from the extracranial part of the left vertebral artery. The right PICA had origin from the intracranial part of the right vertebral artery in 87.2%, in 4.3% from the extracranial part of the right vertebral artery and in 8.5% PICA arose from the basilar artery. We conclude that, as well as being anatomically interesting, an awareness of the PICA anatomy and variations is clinically important for the safe performance of diagnostic and interventional procedures in radiology and for surgeons during the planning and accomplishment of surgical interventions.

DURSUN, AHMET, CIHAN BEDEL, ÖNDER TOMRUK, SONER ALBAY, Department of Anatomy, Faculty of Medicine, Suleyman Demirel University, Turkey. **Adult malrotation: A case report**

Malrotation of the midgut is an abnormality in the embryological development of the gastrointestinal tract. The estimated incidence of

intestinal malrotation is 1 in every 500 live births. Adult malrotation is very rare and its incidence has been reported to be between 0.0001% and 0.19%. In our case study, a 21-year-old man presented with vomiting, nausea and abdominal pain for nearly 1 week. His physical examination was remarkable for severe right lower quadrant pain to palpation without guarding or rebound. The patient's haematology, biochemistry, and urine tests were within normal limits. Abdominal ultrasonography and radiology were non-specific. In contrast-enhanced abdominal CT, all colonic loops were located centrally and in the left side of the abdomen. This appearance was interpreted as malrotation by the radiologist. This variation is encountered more frequently in pediatric practice but its possibility in adult patients should not be overlooked.

HAQUE, ABUL, NEIL ASHWOOD, Department of Trauma and Orthopaedics, Queen's Hospital, Burton on Trent, United Kingdom. **Pathological neck of femur fracture suffered in hospital following trauma to a left head of femur fibrous dysplasia: A case report**

Fibrous dysplasia is a commonly seen developmental anomaly of bone formation in which normal bone and marrow is replaced by fibrous-osseous tissue. The condition is benign and can affect one bone (monostotic) or multiple bones (polyostotic). The lesion is often asymptomatic and can be treated conservatively. However, in certain cases, fibrous dysplasia can lead to a pathological fracture and may require surgical management. We looked at the case of a 67-year-old man who presented to A&E following a fall ten days previously. Radiology and CT showed he had a well-circumscribed lesion in the left head of the femur which on further MRI was found to be a fibrous dysplasia. This was to be treated conservatively and the patient was awaiting clearance from physiotherapy before being discharged. However, during his stay in hospital he sustained a traumatic knock to the left hip which resulted in a pathological fracture at the left neck of femur. This required surgery and the patient ended up having a left total hip replacement.

HILAL, HAIDER, DERRICK EBOT, JAMES COEY, SARA SULAIMAN, Department of Anatomy, St. George's International School of Medicine, University of Northumbria, Newcastle, United Kingdom. **The identification of Acrel's "ganglion" using ultrasound**

Acrel's "ganglion" is a controversial structure found toward the dorsum of the wrist. It is thought to be either the distal swelling of the posterior interosseous nerve or even a cystic tumor on an extensor tendon of the wrist named after the Swedish surgeon Olof af Acrel in the 18th century. The function and exact location of this swelling is poorly described within the published literature. It has been in the past a target for anaesthetic blocks, but histological studies suggest it to be devoid of nerve cell bodies and hence it is deemed to be a "pseudoganglion." This study aims to determine the possibility of identifing Acrel's "ganglion" using ultrasound. Ten wrists were examined and compared using a GE Logiq e ultrasound system with a 12 L-RS transducer. A hypoechoic structure was found within the fourth extensor compartment in all the wrists investigated. Our findings suggest that a structure located at the described site of Acrel's "ganglion" appears to be hypoechoic, contrary to the typical hyperechoic appearance of a nerve. It is possible to visualize Acrel's "ganglion" using ultrasound. Our findings also support histological studies indicating it is not the termination of the posterior interosseous nerve. Documentation of the exact location of this pseudoganglion has clinical implications. Future studies should focus on the benefits of introducing an anaesthetic agent in a precise location rather than the distal part of interosseous nerve as there are probably no cell bodies at this site.

IAKIMOV, ANDREI, Department of Human Anatomy, Ural State Medical University, Yekaterinburg, Russia. **Trabecular junctions in the fetal heart: A new anatomical feature?**

Our study aimed to investigate the trabecular morphology of the ventricular septum in the normal hearts of human fetuses aged of 17–28 weeks. Myocardial structures which looked like flattened tubercles or plateau-like areas slightly elevated over the septal surface were identified in the septum in 14 of 89 hearts (15.7%) using a stereomicroscope. The structures seemed to be the coalescence points of the adjacent trabeculae carneae, therefore we propose to call them trabecular junctions (TJs). The TJs were more evident in the inlet portion of right side of the septum. Also the TJs were found to be in the apical third of the left septal side. From 3 to 10 free trabeculae and fine parietal myocardial ridges ran radially and entered one TJ. The TJs were multiangular or irregularly dentated; in some specimens they appeared to be approximately round or ovoid. The mean dimensions of the TJs were 1.6 $\times$ 2.05 mm with a range of 0.6 $\times$ 0.7 mm – 2.1 $\times$ 2.8 mm. Unlike the trabeculae and papillary muscles, there were no significant differences between the length and width of the same TJ. We have never seen chordae tendineae originating from TJs; thus, the TJs are not papillary muscle precursors.

IMRE, NURCAN, N. APAYDIN, Y. KIRICI, Department of Anatomy, Gulhane Military Medical Academy, Etlik, Ankara, Turkey. **Location of the infraorbital foramen with reference to the soft-tissue landmarks**

The purpose of this study was to determine the positions of the infraorbital foramen based on soft-tissue landmarks to facilitate prediction of the locations of these structures during periorbital surgery. Twenty intact adult cadavers (40 sides; 10 male, 10 female) were obtained from the Department of Anatomy of Gulhane Military Medical Academy. We created a triangle combining the medial and the lateral canthus and the ala of the nose. The location of the infraorbital foramen was evaluated according to its relation to the borders of this triangle. In addition, for each specimen, the number of infraorbital foramina was noted. In all the cadavers examined, the mean distance between the infraorbital foramen and the inferior orbital rim was 8.74 mm. The mean distance of the infraorbital foramen from the facial midline was 29.43 mm. The length of the line extending between the lateral canthus and the ala of the nose was 54.79 mm. With reference to the triangle formed by the three soft-tissue landmarks, in 11 of the 40 sides (27.5%) the infraorbital foramen was found outside of the triangle. In 29 of the 40 sides (72.5%), the infraorbital foramen was on the line extending between the lateral canthus and the ala of the nose. Multiple ipsilateral foramina were found in only one of the 40 sides (2.5%). Such information may allow clinicians to better approximate the location of the infraorbital foramen for nerve blockade and periorbital surgery.

IMRE, NURCAN, NECDET KOCABIYIK, Gulhane Military Medical Academy, Department of Anatomy, Etlik, Ankara, Turkey. **Anatomical and morphometric evaluation of the foramina transversaria of cervical vertebrae**

The purpose of this study is to determine the prevalence of double foramen transversarium, a variant at the transverse processes of cervical vertebrae and to document the dimensions, shape variations of the foramen transversarium as well as clinical symptoms that may be caused by these conditions. For this study, 82 cervical vertebrae available at the laboratory of the Gülhane Military Medical Academy Department of Anatomy were studied. The foramen transversarium was present in all vertebrae. Double foramen transversarium were observed in 18 of 82 cervical vertebrae. Of these, six vertebrae exhibited unilateral and 12 vertebrae exhibited bilateral double foramen transversarium. Of the unilateral transversarium, one was on the right side and five were on the left side. Foramina transversaria observed were predominantly round in form. Anterior-posterior and medial-lateral diameters of right foramina transversaria were 5.7 and 6.5 mm, respectively, while the anterior-posterior and medial-lateral

diameters of left foramina transversaria were 5.5 and 6.6 mm, respectively. In this study, prevalence of double foramen transversarium was found to be 24.0%. The prevalence of double foramina transversaria was noted to be twice that of the unilateral group. Clinicians should be aware of this variation as it may lead to neurological conditions due to impaired flow of blood through the openings in C6 to the atlas.

JOCKOO AMIL, NEIL ASHWOOD, JOGISHA KUKADIA, Department of Trauma and Orthopaedics, Queen's Hospital, Burton-on-Trent, United Kingdom. **A rare, low impact mid-foot injury: A case report**

Low impact traumatic ankle and foot injuries are normally associated with either torn or sprained ligaments or fractures. We present a case report exploring the rare occurrence of an isolated medio-plantar subluxation of the talonavicular joint. The 76-year-old woman presented following a low impact injury to her ankle with minimal bruising but tenderness over the medial malleolus, cuboid, cuneiforms and anterior aspect of the talus, and no tenderness over the metatarsals or the navicular. Initial radiographs of the foot and ankle demonstrated subluxation of the talonavicular joint. Manipulation using Entonox was undertaken and congruency restored at the joint. Further CT imaging after manipulation confirmed congruency with no discernible associated fractures.

KIM, SULGINA, JONGHO BANG, HEEJUN YANG, BYUNGGI YU, HYEYEON LEE, Department of Anatomy, Yonsei University College of Medicine, Seoul, Republic of Korea. **The anatomy of the axillary nerve and the branches supplying deltoid and teres minor muscles**

The axillary nerve divides into anterior and posterior divisions to innervate the deltoid and teres minor muscles. In cases of axillary nerve injury, nerve transfer surgery is performed to remodel the innervation of the deltoid muscle. In this study, we investigated the morphology, ramification, size, and the number of axons of the axillary nerve using fifty upper extremities from 29 adult Korean cadavers. The axillary nerve divided into the anterior and posterior branches before passing through the quadrangular space in all specimens. In 48.0% of upper limbs (Type I), the anterior branch of axillary nerve innervated all three parts of the deltoid muscle (spinous, acromial, and clavicular parts) and the posterior branch innervated the teres minor muscle and the spinous part of the deltoid. In 38.0% (Type II), the anterior branch innervated the deltoid muscle and the posterior branch innervated the teres minor muscle only. In 14.0% (Type III), the muscular parts innervated by the anterior branch were confined to the clavicular part and acromial part while the posterior branch innervated the spinous part and teres minor. In the subjects with Type I and III, the deltoid muscle is not expected to be fully restored by nerve transfer only to the anterior branch because the posterior branch also innervates the deltoid. Thus, double surgical anastomosis of both anterior and posterior branches of the axillary nerve to donor nerves would be helpful for the restoration of shoulder function.

KOSALKA, ROBER, ZHE SHUN J. LI, CHEN-EN HSIEH, JASON LATSKY, KHOI P. DANG-HO, SEAN LEVY, SARA SULAIMAN, JAMES COEY, St. George's International School of Medicine, Keith B. Taylor Global Scholars Program, Northumbria University, Newcastle, United Kingdom. **Prevalence of persistent median artery: An ultrasound study**

Typically, two arteries, the radial and ulnar, supply the hand. During the first eight weeks of gestation a median artery is present. This artery can persist and may continue to contribute to the circulation of the hand. Previous cadaveric, MRI and ultrasound studies have cited prevalence rates ranging from 2.2 to 27.1%. This study aims to investigate the prevalence of the persistent median artery in vivo through the use of ultrasound and determine its contribution to the circulation of the hand. One hundred and forty wrists from 70 individuals were examined using a Sonosite Micromaxx ultrasound machine. An L38e/10-5Mhz transducer was used to scan the wrist from proximal to distal. When present, the diameter of the artery was measured and Allen's Test performed to determine its contribution to the circulation of the hand. The persistent median artery was present unilaterally in three individuals with a mean diameter of 1.3 ± 0.5 mm. Allen's Test indicated that the artery is not a source of significant circulation to the hand. The prevalence rate of the persistent median artery obtained in this study is lower than that reported in the literature. The study further reinforces the use of ultrasound as a safe and effective tool for investigating anomalous vasculature in the general population. Moreover surgeons can quickly identify aberrant vessels in the wrist prior to surgery using ultrasound and avoid potential iatrogenic injuries.

KOTZÉ, SANET, ELSJE-MÁRIE GELDENHUYS, ELSIE BURGER, AMANDA ALBLAS, LINDA GREYLING, Division of Forensic Medicine, Department of Pathology, Faculty of Medicine and Health Sciences, Stellenbosch University and Western Cape Forensic Pathology Service, South Africa. **The association between alcoholic liver disease and healed cranio-maxillofacial fractures suggestive of interpersonal violence in a South African cadaver population**

Alcoholic liver disease (ALD) and interpersonal violence (IPV) are both major problems in South Africa, particularly in the Western Cape Province. Chronic alcohol abuse results in varying stages of ALD, depending on the timespan and the amount of alcohol consumed. Cranio-maxillofacial fractures, particularly fractures to the zygoma and maxilla, are suggestive of IPV. The aim was to find a statistical association between the prevalence of ALD and cranio-maxillofacial fractures in a Western Cape cadaver population. Embalmed cadavers ($n = 124$) were dissected by medical students at the Division of Anatomy and Histology, Stellenbosch University. During dissection, the liver of each cadaver was investigated for macroscopic pathological lesions. Samples for histology underwent routine processing and were sectioned at 5 μm. The cadavers were also investigated for healed cranio-maxillofacial trauma. In this study, 37/124 (29.6%) cadavers showed signs of healed fractures with the left nasal 16/124 (12.9%), right nasal 12/124 (9.7%), and left zygomatic 11/124 (8.9%) the most commonly affected bones. More males were affected than females and left-sided facial fractures were statistically more common than on the right. Morphologic features of ALD were observed in 24/124 (19.4%) cadavers with hepatic steatosis (fatty change) in 13/124 (10.5%) and cirrhosis in 10/124 (8.1%) cadavers. Only 12/124 (9.6%) cadavers showed both ALD and healed cranio-maxillofacial trauma concurrently. Although literature indicates a statistically significant relationship between alcohol abuse and cranio-maxillofacial fractures, the present study could not confirm this correlation in our cadaver population.

KUKADIA, JOGISHA, KAWALJIT DHALIWAL, ANOUSKA AYUB, JONATHON REFSON, Department of General Surgery, University Hospitals of North Midlands NHS Trust, Stafford, United Kingdom. **Intussusception following metastatic malignant melanoma: A case report, review of anatomy, and evaluation of surgical options**

Intussusception is where a segment of bowel invaginates into itself, consequently causing intestinal obstruction. The majority of intussusception cases are found in paediatric patients. Adult intussusception is rare and accounts for approximately 5% of cases and 1% of all bowel obstruction. The mechanism is not fully understood but in some cases a single lesion can become the focus of intestinal prolapse, known as

the lead point. In adult cases, it is possible for a malignant lesion to be the lead point. A low threshold for suspecting intussusception should be adopted in patients with non-specific abdominal signs and symptoms and a history of melanoma. Surgery, wherever possible, is the definitive treatment for these patients to alleviate bowel symptoms but may not prolong overall patient survival. There is great debate on the topic of malignant lead point intussusception and its operative management, in terms of possible post-operative metastatic spread through seeding. We present the case of a 51-year-old man with a history of cutaneous malignant melanoma presenting with small bowel intussusception which was reduced and resected.

KUKADIA JOGISHA, CHRISTINA ENGLEZOU, NEIL ASHWOOD, Department of Trauma and Orthopaedics, Queen's Hospital, Burton-on-Trent, United Kingdom. **Ulnar collateral ligament injury of the thumb: A case report, review of anatomy, and surgical options**

The metacarpophalangeal joint of the thumb involves a complex interplay of ligaments, osseous elements and muscles to produce one of the body's most variable ranges of joint movement. Gamekeepers' thumb is chronic strain of the ulnar collateral ligament (UCL) of the thumb resulting in pain and instability of the joint, as a result of long-standing extension-abduction forces. In its acute form, it is known as skiers' thumb, usually resulting from a number of sporting activities such as skiing and volleyball, where it can present as rupture or an avulsion fracture of its attachment. It can be difficult to distinguish these injuries from sprained thumbs and detailed history and examination are essential. Early operative intervention has a better functional outcome and a delay in diagnosis and thus treatment can result in long-term weakness and progressive arthritis. Investigation usually comprises plain radiographs and repair includes reconstruction using free or local tendon transfers. We present a case of a 44-year-old man who sustained a penetrating injury to the base of his left thumb. He was found to have an injury to his UCL with no bony involvement. He underwent successful repair after prompt diagnosis and returned to normal function.

KUKADIA, JOGISHA, MIRANVIR JASPAL, Department of General Surgery, University Hospitals of North Midlands NHS Trust, Stafford, United Kingdom. **The epiploic foramen: A case report of two consecutive intra-abdominal hernias in the same patient**

The epiploic foramen, also known as the foramen of Winslow, is the anatomical opening to the lesser sac. Reports of hernias through this entity are rare. Structures reported to have herniated through this structure include the caecum, small intestine and gallbladder. We present a case of a normally fit and well 51-year-old man with signs and symptoms of large bowel obstruction, with a one day history of sudden severe upper abdominal pain and vomiting on a background of complete constipation. Computed tomography revealed a large bowel hernia through the epiploic foramen. He underwent open release of the hernia to find a redundant caecum requiring a right hemicolectomy. Post-operatively he developed a small bowel obstruction resulting from herniation of the ileum under the right colon with a local perforation which was treated with an extended right hemicolectomy.

KUKADIA, JOGISHA, FOUAD KALDAS, Department of General Surgery, University Hospitals of North Midlands NHS Trust, Stafford, United Kingdom. **Obturator hernia repair with biological mesh: A case report and review of anatomy**

Obturator hernia is a rare pelvic hernia, characterized by protrusion of intra-abdominal viscera through the obturator foramen. There are three anatomical stages of formation: first with preperitoneal fat entering the foramen, formation of the sac, then eventual herniation of the viscera. These hernias predominantly occur in elderly females and are associated with significant morbidity and mortality. Its presentation is often vague with non-specific signs and symptoms which pose a diagnostic challenge. While computed tomography (CT) provides definitive diagnosis, no single method of repair has been established to date. Here, we present an 81-year-old woman with a one week history of symptoms of small bowel obstruction whose CT confirmed an obturator hernia. Biologic materials are becoming popular in hernia mesh repairs, but there has been no report of its application to an incarcerated obturator hernia and its integrity in the face of an anastomotic leak. This case report is one of the first of its kind to report such a repair. We review the clinical anatomy including CT findings and discuss the advantages of biological mesh over traditional synthetic mesh.

LEE, HYEYEON, SOOJUNG KIM, YOUNGCHUN GIL, HEEJUN YANG, Department of Anatomy, Gachon University School of Medicine, Incheon, Republic of Korea. **Associations of multiple connections between the ulnar and median nerves**

Multiple interconnections between the median and ulnar nerves may provide detours for afferent and efferent nerve conduction. We investigated the prevalence of interconnections and the associations between them in 90 cadaveric upper limbs. Contribution of the lateral cord to the ulnar nerve was found in 58.9% of upper limbs. This variation was associated positively with the contribution of C8 to the lateral cord which occurred in 16.7%, negatively with the contribution of C7 to the medial cord which existed in 12.2%, and positively with ulnar innervation of the superficial head of the flexor pollicis brevis which was found in 50.0%. Ulnar innervation of this muscle was also associated positively with Riche-Cannieu anastomosis which occurred in 50.0%. Antebrachial ulnar-median interconnections existed in 26.7% and were negatively associated with the C8 contribution to the lateral cord. These associations may be related to unexpected findings about median and ulnar conduction that are contrary to traditional anatomical teaching.

LI, LILY X., CHRIS P. HUBER, Department of Trauma and Orthopaedics, West Middlesex University Hospital, London, United Kingdom. **An unusual cause for locking of the knee**

A 22-year-old man presented to our orthopaedic clinic with a painful, locking right knee. He complained of pain on extension of the knee associated with a palpable "clunking" sensation and an audible snap. This was reproducible in the clinic. The rest of his knee examination was normal. He denied any antecedent trauma and was otherwise fit and well. Plain radiography demonstrated a large bony protuberance over the right proximal posteromedial tibia. Magnetic resonance imaging confirmed that this mass was a benign osteochondroma, and the patient was listed for excision of the lesion. Intra-operatively the bony swelling was found to be 5 cm in length with a cartilaginous cap. It was discovered that his semitendinosus tendon overlay this protuberance such that the tendon could glide over the bone whilst lax in knee flexion, but on gradual extension of the knee, the tendon was stretched over the protuberance, increasing tension and so creating the sensation of locking. On further extension the stretched tendon would eventually slip laterally and inferior to the protuberance, creating the snapping sound and sensation. The lump was completely excised. Intra-operative testing of the semitendinosus tendon after excision revealed normal tendon gliding without snapping. Subsequent histological analysis confirmed osteochondroma. Follow-up of the patient demonstrated resolution of knee symptoms and the full range of normal knee movements.

LIGHTFOOT, REBECCA, PAUL REA, Laboratory of Human Anatomy, School of Life Sciences, College of Medical, Veterinary and Life Sciences, University of Glasgow, Glasgow, United Kingdom.

Neurovasculature of the temporalis muscle for orbital reanimation

Lagophthalmos is a major problem associated with facial nerve palsy and can lead to blindness. Facial reanimation procedures for the orbit are limited. The regional transfer of the temporalis muscle is a dynamic surgical technique used to correct lagophthalmos and restore orbital animation. To ensure a successful muscle transposition, a detailed knowledge of the intramuscular neurovasculature of the temporalis is essential, but there is limited literature on this field. This study aimed to investigate the neurovasculature of the temporalis for transposition to the outer canthus in eyelid reanimation. Cadaveric dissection of a single male cadaver was carried out, from which two temporalis muscles and one deep temporal fascia were obtained and divided into 28 segments in total. Ten sections from each temporalis and fascia segment were stained with haematoxylin and eosin to identify the neurovascular pattern of the temporalis. A pattern of neurovasculature was identified in which an abundance of arteries, veins and nerves was observed in the temporalis muscles and fascia, especially in the segments of the inferior regions of the muscle tendon. It can be concluded that the temporalis is an ideal candidate for orbital reanimation due to its densely populated nature and proximity to the surgical field. An enhanced understanding of the intramuscular neurovasculature is essential for selection of the optimum window of temporalis for transposition to the outer canthus. Increased knowledge of the anatomy of the temporalis muscle would aid the facial surgeon to ensure the success of this procedure.

MCCLEARY, PAIGE, ADAM MANN, NINA NOGHREHKAR, AQUIB NOORANI, SARA SULAIMAN, JAMES COEY, St George's International School of Medicine, Keith B. Taylor Global Scholars Program, Northumbria University, Newcstle, United Kingdom. **The relationship between knee menisci neovascularization and self-assessment of knee functions**

Inflammatory responses are initiated in both acute and degenerative knee meniscal tears, inducing angiogenesis and bringing about repair. Diagnosis of these lesions, however, is heavily dependent on clinical examination and patient history, as routine imaging techniques are resource-dependent. Our study proposes the use of ultrasound assessment of neovascularization as an early clinical diagnostic addendum for impaired knee functioning. Twenty-five asymptomatic participants were selected at random to take part in this study. Participants' perception about their knee and associated problems was assessed by Knee Injury and Osteoarthritis Outcome Score (KOOS). With the knee flexed at a 45° angle, the lateral and medial menisci of each participant were examined using a Sonosite Turbo ultrasound machine, with a L38e 10-5MHZ transducer. Vascularization, if present, was identified and confirmed with Color Doppler imaging. Meniscal neovascularization was found in at least one side of each knee in 19/25 (76%) participants. Presence of vascularization significantly correlated with the subtotal scores obtained from the KOOS related to pain, $r = -0.513$ [-0.70 to -0.299], function, sports and recreational activities, $r = -0.353$ [-0.580 to -0.118], and quality of life, $r = -0.435$ [-0.639 to 0.188]. The overall KOOS was also found to be significantly related to neovascularization, $r = -0.352$ [-0.535 to -0.150] (all $P < 0.05$). Knee meniscal neovascularization was found to correlate with impaired daily functioning and pain experienced by individuals. The results displayed a graded relationship, in which the extent of neovascularization followed a decline in subjective knee outcomes.

MATVEEVA, NIKI, DOBRILA LAZAROVA, MERI PAPAZOVA, JULIJA ZHIVADINOVIK, BILJANA ZAFIROVA, Institute of Anatomy, Faculty of Medicine, University Ss. Cyril and Methodius, Skopje, Republic of Macedonia. **Relation of lumbosacral transitional vertebra and degenerative spinal stenosis**

The association of lumbosacral transitional vertebra (LSTV) pseudoarthrosis and degenerative spinal stenotic changes has been sporadically reported. The aim of the study was to examine the relation between LSTV pseudoarthrosis and degenerative stenotic changes of the nerve root canals. Thirty-five patients with low back pain and S1 nerve root radiculopathy who underwent MRI examination of the lumbosacral spine and were classified as positive for LSTV pseudoarthroses were included in the study. Coronal (T1W1) and oblique MRI sequences were added to the MRI investigation of the lumbar spine. We found that the MRIs of the lumbar spine of all patients demonstrated degenerative stenotic changes of the S1 nerve root canals at the transitional level, and in seven patients at the adjacent proximal level as well. Patients with unilateral LSTV pseudoarthrosis demonstrated more severe degenerative stenotic changes. In conclusion, we emphasize the relation of LSTV pseudoarthrosis and degenerative stenotic changes of the nerve roots canals at the transitional level and symptoms of S1 radiculopathy.

MATVEEVA, NIKI, NATASHA NAKEVA, MERI PAPAZOVA, ACE DODEVSKI, BILJANA BOJADZIEVA, BILJANA TRPKOVSKA, Institute of Anatomy, Faculty of Medicine, University Ss. Cyril and Methodius, Skopje, Republic of Macedonia. **Morphologic alterations of sacra associated with transitory lumbosacral state-sacralization**

Sacralization is the most frequent transitional state that may reflect the biomechanics of load transmission and the range of movement at the lumbosacral junction. The aims of the study were to identify morphostructural characteristics of sacra that showed bony fusion to the last lumbar vertebra (sacralization), to compare them with the normal sacra and to analyze their biomechanical impact. Seventy-one dried human adult sacra were divided into three groups: normal sacra with five segments (35 specimens), sacra with five segments and accessory articulating facets on their ala (17), and sacra with six segments (19), with complete osseous fusion with the last lumbar vertebra. Linear dimensions and surface areas on their articular surfaces were measured with the help of digital sliding caliper, medical tape (Micropore), and a digital planimeter. In sacra with accessory articulations, mid-ventral straight lengths were less, with more pronounced concavity of the sacral curvature. The divergence of the superior arms and the convergence of the inferior arms of their auricular surfaces were less pronounced. The superior articulating facets were smaller, coronally oriented and mostly flat. In sacra showing bony fusion with the L5 vertebra, the mid-ventral straight and curved lengths were greater than in normal ones, and the superior articular facets were placed closer to the sagittal plane and further from the sacral vertebral body.

MAYORDOMO, RAQUEL, ANA PEREZ PICO, FELIX MARCOS TEJEDOR, JOSÉ IGLESIAS SANCHEZ, Department of Anatomy and Cellular Biology, University Centre of Plasencia, Extremadura University, Plasencia, Cáceres, Spain. **Deformities of forefoot are predominant in institutionalized psychiatric patients**

Forefoot deformities can affect walking and cause immobility in elderly patients. In a population with special features such psychiatric disorders and learning disabilities, forefoot deformities are more limiting because there is the added difficulty of patients not being able to describe their situation, ailments, and needs to healthcare professionals. Few studies have addressed deformities and pathologies on the feet of a population with psychiatric disorders, even though it has been demonstrated that this population has a high level of postural instability. This study shows the prevalence of deformities of the forefoot in two very different populations, a control population and another population consisting of patients confined in a psychiatric institution. A study of the forefoot of 298 patients shows that in general, deformities of this part of the foot are more frequent in psychiatric patients. The most frequent deformity is hallux valgus in both populations, followed by claw toes.

MITROUSIAS, VASILEIOS, ARISTEIDIS ZIBIS, KYRIAKI BAXEVANIDOY, DIMITRIOS ARVANITIS, Department of Anatomy, Medical School of Larissa, University of Thessaly, Greece. **Anatomical variations of the foramen transversarium in cervical vertebrae: Findings, embryological basis and clinical significance**

This study aims to describe certain anatomical variations of the foramen transversarium of cervical vertebrae, and to determine their possible etiology and to explore their clinical importance. We examined 102 cervical vertebrae (C2–C7) from 17 different skeletons from the collection of the Department of Anatomy. All foramina were measured with digital callipers. The average size of the normal foramina was: 6.49 mm $\times$ 5.74 mm on the right side and 6.65 mm $\times$ 5.76 mm on the left side. Regarding the variations, we found two cervical vertebrae (1.96%), one C3 and one C6, in which the right foramen transversarium was clearly smaller than that on the left. The exact dimensions of these foramina were: 2.3 mm $\times$ 2.5 mm on the right side and 6.54 mm $\times$ 8.0 mm on the left side in the first vertebra and 2.8 mm $\times$ 3.74 mm on the right side and 6.0 mm $\times$ 7.5 mm on the left side in the second one. We also observed double foramina in 14 vertebrae (13.72%). In seven vertebrae, the duplication was bilateral (6.86%). Finally, we found one vertebra (0.98%) with triplication of the foramen transversarium on the left side. Summarizing, ten out of our 17 skeletons (58.82%) showed variations (extremely narrow – 11.76% or multiple foramina – 47.06%). The finding of hypoplastic, duplicated, and triplicated foramina transversaria in unexpectedly high rates raises questions about the integrity of the contained structures, the possibility of a different path for them, as well as the clinical impact that the above may have.

MUSBAHI, AYA, Medical Student, University of Glasgow, Glasgow, United Kingdom. **Novel way of teaching embryology to second year medical students: Using analogies and mnemonics**

Traditional teaching of embryology has been reduced in undergraduate medical curricula or replaced by more clinically relevant teaching of the subject. Students often find this subject matter difficult to comprehend and learn for examinations. This study aimed to introduce a novel way of teaching the subject. An embryology revision lecture was delivered to 49 second year medical students approaching end of term exams. The lecture was delivered using novel, humorous analogies and new, easy to remember mnemonics describing the various stages of embryo development. Ten new analogies and mnemonics were created for this lecture. Questionnaire-based data were collected covering overall rating, knowledge covered, visual material, enthusiasm, interactivity, communication, and structure. Students were asked to rate the tutor on the above categories from 1 to 5 (5 being the best and 1 being poorest). Mean scores were calculated for each session. The mean overall rating for student satisfaction was 4.65. Students made positive comments on the feedback forms regarding the mnemonics and analogies used. It is concluded that students were highly satisfied with the teaching techniques used and that teaching embryology can be facilitated by novel analogies and mnemonics without compromising student satisfaction.

NAKEVA-JANEVSKA, NATASHA, NIKI MATVEEVA, BILJANA ZAFIROVA, BILJANA BOJADGIEVA, BILJANA TRPKOVSKA, Department of Anatomy, Faculty of Medicine, UKIM, Skopje, Macedonia. **The structural components of the body in Macedonian teenagers**

Establishing the structural components of the body (bone, muscle and fat) is of great significance in sport orientation and selection and in studying the biophysical development in young people. On the basis of manifested anthropometrical variables, structural components of the body were defined in Macedonian children at the age of 16 years who lived in the Skopje area in approximately equal socio-economical conditions. The material comprised personal files of 200 Macedonian examinees 16-years old, 100 males and 100 females. For quantitative determination of the absolute values of: bone (O kg), muscle (M kg), fat tissue (D kg), the dynamic anthropometric method of J. Mateigka has been applied. At the age of 16 years the absolute values of bone mass (O kg) was 10.88 (16.98%) in males and 8.09 (14.38%) in females. The sex difference was highly significant ($P < 0.001$) and was in high correlation with the diameter of the knee joint in both sexes. The muscle mass (M kg) was 36.86 (56.82%) in males and 30.46 (53.78%) in females. The sex difference was again highly significant ($P < 0.001$) and was in high correlation with the upper arm circumference in males (0.92) and with the forearm circumference in females (0.92). The fat structural components (D kg) was 7.60 (10.72%) in males and 7.73 (13.32%) in females. There were no significant differences between males and females, and there was no correlation with measured anthropometric parameters.

PAPAZOVA, MARIJA, DOBRILA LAZAROVA, JULIJA ZHIVADINOVIK, NIKI MATVEEVA, ACE DODEVSKI, BILJANA TRPKOVSKA, Institute of Anatomy, Medical Faculty, Skopje, Macedonia. **Anterior communicating artery: Anatomy and clinical significance**

The anterior communicating artery (ACoA) is an essential component of the cerebrovascular system with great morphologic and clinical significance resulting from the importance of the structures which it supplies as well as from the polymorphism of the pathological processes which affects this artery. The investigation of the anatomical characteristics of the ACoA were made on 133 human brains with no frank cerebrovascular pathology, from both sexes at age 23 to 68 years. Some of the specimens were fresh and some were fixed. The length of the ACoA varied from 0.6 to 7.6 mm, with mean value 2.6 mm. The diameter of the ACoA ranged from 0.5 to 5.1 mm, with mean value 2.0 mm. The classical ACoA as a single transverse anastomotic channel was found in 54% of the cases. The following morphological variations were found on the ACoA: hypoplasia in 1%, double ACoA in 4%, the ACoA with configurations like the letters Y, X, H, and O were observed in 29% of the subjects. In 4%, a fusion was observed between the two anterior cerebral arteries instead of an ACoA. We conclude that each ACoA is unique, and knowledge of anatomical characteristics of the ACoA is useful in teaching anatomy, but also for clinicians in ensuring safe surgery and interventional radiology.

PAPAZOVA, MARIJA, SUNCIC PETROVSKA, NIKI MATVEEVA, JULIJA ZHIVADINOVIK, ACE DODEVSKI, BILJANA ZAFIROVA, Institute of Anatomy, Medical Faculty, Skopje, Macedonia. **Morphological characteristics of the middle cerebral artery**

Cerebral circulation, especially arterial, in recent decades has attracted the interest of anatomists and clinicians. The aim of this study was to determine the morphological and topographic characteristics of the middle cerebral artery (MCA). Investigations of morphological and topographic characteristics of the MCA were performed in the Institute of Anatomy. The examination was made on 50 specimens of the human brain, fixed in 10% formalin. The average diameter of the proximal segment M1 ranged from 2.4 to 4 mm, and the average length was 15 mm. The average diameter of the distal segment M2 ranged from 2.2 to 3.9 mm. The ending of the distal segment M2 was singular in 15% of cases. In 52% of cases, it divided into two terminal branches, dorsal, and ventral, and in 24% of cases in three terminal branches (dorsal, ventral, and medial). There were four terminal branches (dorsal, ventral, and two medial) in 9% of cases. A duplication of the MCA was registered in 0.7–2.7% of cases. An accessory MCA brain artery was present in 0.3–2.7% of cases.

PARK, JIN SEO, Department of Anatomy, Dongguk University School of Medicine, Gyeongju, Republic of Korea. **Advanced sectioned images of whole female body and its surface models**

The aim of this research was to present high-quality sectioned images of a whole female body which would be helpful in creating an atlas, virtual dissection, and various applications for medical education and clinical trials. In addition, the authors sought to demonstrate the applicabilities of sectioned images. A female cadaver was sectioned serially using the cryomacrotome and photographed to make the sectioned images. Structures in the images were segmented to produce segmented images in Photoshop. The sectioned and segmented images were stored in self-developed browsing software. Based on the segmented images, surface models were created on commercial software and saved as PDF files. High-quality sectioned images of the female body were taken (intervals, 0.2 mm or 1 mm; pixel size, 0.1 mm; color depth, 48 bit color). In the images obtained, very small and complicated structures could be identified in the color of the living body. To ascertain the applicability of the images, the browsing software including sectioned and segmented images and the PDF file containing the surface models. The sectioned images and surface models produced during this research will prove to be a useful source for medical software. All data generated are available free of charge.

PARMAR, ANAMIKA, GLENN WAKLEY, Centre for Comparative and Clinical Anatomy, University of Bristol, Bristol, United Kingdom. **Standing in practical anatomy teaching increases student interaction**

Student interaction with cadaveric specimens enhances the educational value of didactic anatomical teaching. Anatomy teachers noticed students were more proactive during anatomy practical classes when standing rather than when sitting: we aimed to quantify the effects that sitting and standing have on student behavior and learning. Ethics approval was granted to observe 68 dental undergraduates (split into six teaching groups) over two practical anatomy classes at the University of Bristol. Student behavior was observed in a crossover study where three groups were seated and three groups were standing during practical anatomy classes. After each practical class, students completed a survey to evaluate their opinions regarding their own learning. This study revealed that students were more interactive when standing during practical anatomy classes compared to those seated. Results from observations showed that standing students positioned themselves significantly closer to cadaveric specimens ($P = 0.003$) and handled specimens 11 times more than those seated (although this was not statistically significant). In contrast, seated students made notes more frequently compared to standing students ($P = 0.006$). The survey did not show significant differences in the seated and standing students' perceived difficulty of the practical or perceived improvement in understanding the anatomical topic. This may be due to compensatory activities of the teacher for students who were further away and appeared less engaged. Our results highlight the wider impact that room layout of practical anatomy classes has on student behaviors. Furthermore, educational institutions may be obliged to consider environmental factors more seriously when designing practical anatomy classes.

PATRON, VINCENT, CLÉMENT ESCALARD, JULIE BERKAOUI, ANNE-LISE ROUSSEL, MARTIN HITIER, Department of Anatomy, Chu De Caen, France. **Anatomical and radiological study of the anterior olfactory cleft**

The olfactory cleft has garnered interest as the advent of endoscopic skull base surgery. Its precise anatomy, however, is still partially unknown. According to Rouvière, an "ethmoidal foramen" is located in its anteromedial part and contains a process of the dura mater. In a more lateral and anterior location, a second foramen, the "cribroethmoidal foramen," contains the anterior ethmoidal nerve. The aim of this study was to verify the existence of these elements and to establish landmarks for surgery. We carried out an anatomical and histological study of eight olfactory clefts in four cadavers using both endonasal endoscopic and endocranial dissection. Six more cadavers were studied radiologically by CT-scan. An ethmoidal and a cribroethmoidal foramen were found in, respectively, 100% and 75% of subjects. Their mean lengths were, respectively, 4.1 mm and 1.8 mm. They were located respectively at a mean of 5.3 and 5.8 mm from the anterior ethmoidal artery. The radiological study allowed the identification of the ethmoidal foramen in all subjects and to establish landmarks to allow its radiological identification. CT-scan did not allow clear identification of the cribroethmoidal foramen. Our anatomical study demonstrates the existence of both foramina. The ethmoidal foramen clearly represents an area of least resistance in the anterior part of the olfactory cleft, readily identifiable on routine CT-scan. The ethmoidal foramen could predispose to anterior skull base cerebrospinal fluid leaks and meningoceles.

PORZIONATO, ANDREA, MARIA MARTINA SFRISO, VERONICA MACCHI, LUCIA PETRELLI, ALEX PONTINI, VINCENZO VINDIGNI, RAFFAELE DE CARO, Section of Human Anatomy, Department of Molecular Medicine, University of Padova, Italy. **Development of biological scaffolds through decellularization of human arteries and veins**

The objects of this study were to develop a new type of biological scaffold through decellularization of human arteries/veins and to evaluate its integration capability in a rabbit model. Human blood vessels were sampled from donated bodies and amputated limbs. Artery/vein scaffolds were obtained through a detergent-enzymatic decellularization protocol. Morphological and ultrastructural analyses, together with DNA quantification, were performed. Human artery and vein scaffolds were then implanted at femoral vessels in four rabbits, and were maintained for 2 weeks. Perfusion analyses of the implanted scaffolds were tested during the above period to verify the occurrence of possible thrombogenic events. After sacrifice, structure and ultrastructure of implants were analyzed. The decellularization process was effective, resulting in biologic scaffolds free from cell materials and mechanically suitable for surgical sutures. The collagenic components of the arteries and veins were not altered by the use of detergents and enzymatic solutions, preserving the native three-dimensional organization around the vascular channels, as also demonstrated by TEM analyses. The preservation of the elastic fibers was also confirmed. After implant in rabbits, the human artery and vein scaffolds were completely biointegrated and partly recellularized by host cells after two weeks. No rejection or inflammation were observed. Blood perfusion appeared to be satisfactory in in vivo analyses and microscopical study confirmed the absence of thrombotic events. New biological vascular scaffolds derived from artery/vein decellularization could be useful for regenerative medicine when small vessels are needed and autologous vessels are not sufficient.

ROMANI, MICHAEL, GEORGIOS MIHALOPULOS, ANDREW SHLIMUN, JAINESH PATEL, MICHAEL TOMANI, MAXIMILIAN SOLOW, RYAN TOEWS, SARA SULAIMAN, JAMES COEY, St. George's International School of Medicine, Keith B. Taylor Global Scholars Program at Northumbria University, Newcastle, United Kingdom. **Ultrasound assessment of patellar ligament length in athletes and non-athletes**

Determining the length of the patellar ligament is important both clinically and in research where it has been linked to various knee pathologies including patellar dislocation and instability. Within the published literature, plain film radiography, magnetic resonance imaging and computerized tomography have been used to study/assess the patellar ligament. Ultrasound has been proposed as a non-invasive, low-cost alternative but there is currently no consensus as to the techniques used and questions remain about inter-operator variability. This study aims to evaluate variations in patellar ligament length (PLL) between athletes and non-athletes and address inter-operator variability through the use of ultrasound. Each ligament was measured following a modified form of a recently published technique by two investigators, blinded to each other's results and using a GE LOGIQ e system with a 12 L-RS transducer. Once the technique was clearly defined, there was no statistically significant difference between the measurements obtained from the two investigators.

Average PLL was found to be 47.1 ± 7.8 mm and 45.1 ± 4.0 mm in athletes and non-athletes respectively with no significant difference in means between the two groups regardless of limb dominance, sex or height. The difference in the PLL between the two limbs was significantly affected by body mass index value ($H(2) = 9.577$, $P = 0.008$), specifically between the normal and overweight groups ($P = 0.007$). Previous work has related patellar ligament length to force output rather than age but our findings show no significant correlation between the two. This study validates a pre-existing ultrasound technique with specific modifications to control inter-operator variability.

SAGA, TSUYOSHI, YOKO TABIRA, KOICHI WATANABE, JOE IWANAGA, AYANO SAKURAGI, KOH-ICHI YAMAKI, Department of Anatomy, Kurume University School of Medicine, Asahi-Machi, Kurume, Fukuoka, Japan. **Rediscovery of the musculus cricotrachealis**

The musculus cricotrachealis is a small muscle on the front of the larynx. In 1871, Macalister reported in the publication titled Additional Observations on Muscular Anomalies in Human Anatomy of the Transactions of the Royal Irish Academy that he had once found the musculus cricotrachealis passing from the lower border of the anterior part of the cricoid cartilage, below the origin of the cricothyroid muscle, and inserting into the fifth ring of the trachea; it passed behind the isthmus of the thyroid. In 1959, Manjome studied many different laryngeal muscles in Japanese individuals but found no musculus cricotrachealis. To the best of our knowledge, no reports about this muscle were published thereafter. In 2014, we found several musculi cricotrachealis in Japanese cadavers donated to the student gross anatomical course. A typical musculus cricotrachealis was identified in 6 of 15 cadavers; the origin in all cases was the lower border of the anterior part of the cricoid cartilage, and the muscle inserted into the second or third ring of the trachea. The width of this muscle ranged from 1.4 to 4.1 mm, and the length ranged from 8.2 to 20.8 mm. A small musculus cricotrachealis was observed in front of the ceratocricoid ligament in 2 of 15 cadavers; the origin of this muscle was the same as that described above but the muscle inserted into the first ring of the trachea. The musculus cricotrachealis may not have an important function but may be an important muscle with respect to phylogeny.

STOKHOLM, CAMILLA, JIM PRICE, CLAIRE F. SMITH, Brighton and Sussex Medical School, Brighton, United Kingdom. **Understanding medical students' approaches to learning anatomy**

In recent years there has been international debate concerning how students learn anatomy. The rapid increase in scientific knowledge has put pressure on the place of anatomy within the medical curriculum, as well as on the design and structure of anatomy courses. In this regard, relatively little is known about what medical students want from an anatomy course or how they learn it. To assess students' learning approach and perceptions of anatomy, we administered a Likert-style questionnaire to 82 first year medical students on a bachelor 5-year programme in the United Kingdom. Analysis of the Anatomy Learning Experience questionnaire revealed a predominantly positive attitude toward anatomy and the dissection room, most not seeing the latter as a daunting environment and also valuing cadaveric dissection. Additionally a majority of students felt that reading textbooks was a useful way of learning. Further to this, analysis of the Approaches to Studying Inventory for Students (ASSIST) revealed a striking preference for the deep and strategic approaches with 46.3 and 51.2% of students preferring them respectively. Conversely, only 2.4% were found to prefer a predominantly surface approach. We conclude that traditional ways of learning anatomy remain important for students, including textbooks and cadaveric dissection. Furthermore, any curriculum reform should take into account that there is a strong preference for deep and strategic approaches from an early stage in the course. This has implications for curriculum reform to support these learning approaches, such as the implementation of the "flipped classroom" model.

STONELAKE, STEPHEN, DOMINIC POWER, JOANNE WILTON, Department of Anatomy, University of Birmingham, United Kingdom. **Transfer of triceps nerves to a vascularized sensory conduit for re-innervation of intrinsic hand muscles for patients with lower cervical cord injury: A cadaveric feasibility study**

Re-innervation distances to intrinsic hand muscles in lower cervical cord injury remains a challenge. Unlike recently described nerve transfers to hand extrinsics, direct suturing to motor nerves at the mid-arm leaves insufficient time to recover denervated intrinsic muscles of the hand. We explored whether the sensory fascicles of the ulnar nerve could be used as a vascularized conduit for triceps motor axons that are still under voluntary control. The dorsal and superficial sensory branches of the ulnar nerve could then be anastomosed to the deep motor branch. Re-innervation to intrinsic hand muscle end-plates, still attached to the spinal cord below the level of cord injury (therefore not having undergone Wallerian degeneration), might potentially be achieved. Using a single male cadaver, triceps nerves were dissected posteriorly. The triangular interval was dissected medially and triceps nerves assumed to be transferred through this space onto the ulnar nerve. The distance from this point to the intrinsic hand muscles was then measured. We found that nerve lengths from their origin to the muscle bellies of the long, medial and lateral heads of triceps were 77, 85, and 60 mm, respectively. The distance between the point of anastomosis on the ulnar nerve and hand intrinsic muscles was between 490 and 510 mm, giving an innervation time of 16–17 months. In conclusion, this study confirms the anatomical feasibility of transferring triceps nerves through the triangular interval to the ulnar nerve. Re-innervation times, in theory, are not unreasonably longer compared with transfer procedures for extrinsic hand muscle restoration.

SULAIMAN, SARA, JAMES COEY, Department of Applied Sciences, Faculty of Health and Life Sciences, Northumbria University, Newcastle, United Kingdom. **Effect of peer-teaching in learning and teaching anatomy: Pilot study of the effect of introducing tutor training sessions**

The use of peer-teaching has been well recognized as an effective tool within medical school curricula. Published literature provides some evidence of its advantages for both the tutor and the tutee. Often, in practice the planning and implementation of the peer-teaching sessions are left to the tutors with little or no guidance. This study aims to (i) investigate the effect of participation in peer-teaching on tutors' anatomical knowledge with the application of a training program, (ii) evaluate the perceptions of peer-tutors and tutees of the effectiveness of the peer-teaching program. Ten term-2 medical students took part in three training sessions focusing on the clinical applications of the anatomy of the upper limb, thorax and abdomen prior to their peer-teaching sessions, which included 23 tutees. The questionnaire-based assessment included: tutors' appreciation of the relative anatomy assessed by 30 clinical vignettes, tutors' and tutees' perception of the peer-teaching experience measured by 23 and 12 questions, Likert-type-scale questionnaires respectively. Tutors' perception correlated favorably with respect to improving their teaching abilities (mean scores of 3.5/5.0). The peer-teaching sessions were well received by the tutees, providing them with a student-perception and an alternative explanation of anatomical concepts (mean score of 3.7/5.0 and 3.8/5.0 respectively). Peer-teaching provides students with not only an opportunity to reinforce their anatomical knowledge, but also allows them to develop essential teaching skills and further develop various competencies. Creating a peer-teaching program allows for a clear learning strategy which can be implemented, evaluated, and improved.

SULAK, OSMAN, CEMIL BILKAY, GÜLNUR ÖZGÜNER, AHMET DURSUN, KENAN ÖZTÜRK, ESRA KOYUNCU, MEHMET ALI MALAS, Department of Anatomy, Faculty

of Medicine, Suleyman Demirel University, Turkey. **Development of fontanelles during the fetal period**

A newborn baby has six fontanelles: the anterior and posterior, two mastoid, and two sphenoid. The anterior and posterior fontanelles close by 24 and 3 months of age, respectively. According to our literature search, there is no study about the shape and closing time of the mastoid and sphenoid fontanelles. A large fontanelle or delayed fontanelle closure may be caused by achondroplasia, congenital hypothyroidism, Down syndrome, or rickets. Craniosynostosis and abnormal brain development are associated with a small fontanelle or early fontanelle closure. The present study aims to describe the normal development and classification of the fontanelles and their shapes during gestation. We examined 40 fetuses between 9 and 40 weeks of gestation with no external or internal pathology or anomaly. Signed informed consent to use the fetuses for research purposes was obtained from the families. Anatomical dissection exposed the fontanelle. Fontanelles were classified by their shape, then photographed and their areas measured with the Netcad 5.1 program. During the fetal period, all of the anterior fontanelles were observed to be open. However, the posterior, mastoid and sphenoid fontanelles were closed in 30%, 42.5%, and 27.5%, respectively. We observed that the anterior fontanelles were rhomboid-shaped in 90%, the posterior fontanelles were triangular-shaped in 86%, the mastoid fontanelles were triangular-shaped in 73%, and the sphenoid fontanelles were irregularly shaped in 34%. The findings of this study will be of interest to clinicians in pediatrics, pediatric neurosurgery, and obstetrics.

SWAMY, MEENAKSI, ROGER SEARLE, School of Medicine, Pharmacy and Health, University of Newcastle, Newcastle, United Kingdom. **Evaluation of body painting as a learning gap in anatomy and clinical examination session**

Body painting is reported as a fun learning activity and a useful tool for learning anatomy. The aim was to introduce body painting in the anatomy and clinical examination of the shoulder session at Newcastle University for enabling students to better relate anatomy learned to clinical skill examination and to obtain students' feedback. Thirty medical students on the graduate entry MBBS programme participated. Students body painted skeletal landmarks around the shoulder joint on their peers in groups of two for fifteen minutes. Body painting was used as filler interspersed between anatomy and clinical examination of the shoulder joint. Students completed a feedback questionnaire with questions rated using five point Likert scale (strongly disagree to strongly agree). The majority (83%) found the experience interesting and would like to have similar sessions for future teaching; 69% found it helped their understanding of anatomy; 90% felt that sufficient time was allowed and none of them felt that the technique was difficult; 90% did not find the session embarrassing. Some of the comments were that it is "really helpful as a memory aid," "more bright vivid colors," "doing the muscles could also be useful," "someone to check after they have painted." We conclude that body painting can be used to fill a learning gap which could facilitate experiential learning of surface anatomy and aid in visualizing structures during clinical examination of the shoulder joint. It is useful as a visual aid and an interesting tool to reiterate clinical anatomy knowledge.

TABIRA, YOKO, TSUYOSHI SAGA, KOICHI WATANABE, JOE IWANAGA, KEIKO KAJI, KOH-ICHI YAMAKI, Department of Anatomy, Kurume University School of Medicine, Fukuoka, Japan. **Muscle fiber types of triceps surae muscle demonstrated by immunohistochemical staining in formalin-fixed cadavers**

We studied types of muscle fiber and muscle structure of the triceps surae muscle (TSM) in formalin-fixed cadavers to clarify the characteristics of the TSM by gross anatomical and histological examinations. Five right lower limbs of male cadavers from the anatomy course of our laboratory were included in this study. The TSM comprises the medial gastrocnemius (MG), lateral gastrocnemius (LG), and soleus (SOL) muscles. The SOL has a unique architectural feature characterized by a bipennate (BP) muscular portion on its anterior surface. Therefore, we divided the SOL into the medial BP portion and lateral BP portion, and analyzed each portion. The muscle fibers were categorized into slow and fast fibers by immunohistochemical staining. The MG and SOL were unipennate muscles. The LG and BP were bipennate muscles, which contained an intramuscular tendon as shown by gross anatomical observation. In these five portions, the MG had a higher number of the fast-type than the slow-type of muscle fibers. The LG had the same ratio of slow to fast types of muscle fiber. The SOL and BP had a higher number of the slow type than fast type of muscle fiber by histological examination. We note that previous studies of fresh cadavers and/or biopsies have shown that the MG and LG have a higher proportion of fast fibers than the SOL muscle, which is similar to our results. However, our results suggest that the MG and LG are dissimilar in the arrangement of muscle fibers and types of muscle fiber.

THOMPSON, KRISDTJAN, HENRY YOUNG, Mercer University School of Medicine, Savannah, Georgia, United States of America. **Student performance in and perception of gross anatomy in varied curricular material organization**

The first and second year curriculum at Mercer University School of Medicine provides students with an opportunity to learn the subject material in a problem-based learning (PBL) case format. The musculoskeletal phase provides students with their first gross anatomy laboratory dissection experience. This study looks at student performance when one group of students followed a case order that paralleled the laboratory dissection sequence (Dissection) compared to that of one which did not (Traditional). This study also evaluated student perception of their learning experiences in the anatomy laboratory. Students in the Dissection group ($n = 59$) scored a gross anatomy average of 77.82 and an overall phase average of 78.40. Students in the Traditional group ($n = 46$) had a gross anatomy average of 79.63 and an overall Phase average of 79.74. The results indicate that the case order presentation does not significantly alter the overall student performance within the discipline ($P = 0.371$) or the phase ($P = 0.368$). Seventy-one out of the 105 students participated in the survey assessing their perception of the learning experience within the phase. Students felt the laboratory was helpful in learning the phase material and that they would prefer to dissect in the same order as the PBL cases were presented. Those students within the Dissection group felt more prepared for laboratory experiences compared to their Traditional order counterparts. We conclude that the order of case presentation does not have an effect on student performance in the discipline or examination as a whole.

TRPKOVSKA, BILJANA, DOBRILA LAZAROVA, MARIJA PAPAZOVA, NATASA NAKEVA, NIKI MATVEEVA, BILJANA ZAFIROVA, ACE DODEVSKI, Department of Anatomy, Faculty of Medicine, UKIM, Skopje, Macedonia. **Anthropometrical characteristics in 3-year-old children**

Growth and development are essential biological characteristics of each individual and can be described by certain anthropological parameters that can be used as indicators of growth and assessment of obesity in preschool children. We analyzed two groups of healthy preschool children from kindergarten aged 3 years. The first group was 90 boys and the second was 80 girls. The study included ten variables: body weight and height, length of arm, leg length, head circumference, chest circumference, abdomen circumference, diameters of knee and elbow and BMI. The research was conducted according to International Biological Program methods. The research showed that there are sex-differences in some parameters, slightly higher in boys but they were not significant. Three-year old boys had body weights of 18.7 ± 2.8 kg, heights of 101.1 ± 5.2 cm, and BMI of 18.3 ± 2.5 kg/m^2. These parameters in girls were body weight 18.4 ± 4.4 kg, height 103.3 ± 6.6 cm, and BMI 17.3 ± 3.3 kg/m^2. The results

obtained can be used to monitor levels and trends of obesity and to detect deviations in growth in preschool children.

VAGHELA, KALPESH, LEE PARKER, DAVOUD KHODATARS, STEPHAN GRECHENIG, WOLFGANG GRECHENIG, Department of Trauma and Orthopaedics, St Bartholomew's Health NHS Trust, London, United Kingdom. **Is it possible, or wise, to undertake minimally-invasive plate osteosynthesis of the medial distal femur?**

In situations where there is extensive comminution of a distal femoral fracture, it may be desirable to offer both stable lateral and medial buttresses to enable fracture healing. In this situation minimally-invasive plate osteosynthesis (MIPO) techniques can minimize soft tissue stripping thus preserving blood supply and aiding fracture healing. We undertook a cadaveric anatomical study to investigate the safe positioning of a submuscular locking plate (AO/Synthes 9-hole LCP) using a MIPO technique on the medial distal femur of ten randomized cadaveric femora, noting the proximity of the plate and its locking holes to the neurovascular bundle on the medial side of the thigh. We found that the safest location for plate positioning was on the anteromedial distal femur in the 1–3 o'clock position, staying anterior to the adductor longus tendon. The average distance of the perforator branching off into the vastus medialis oblique muscle was 13 cm from the joint line where the perforator was seen to cross the plate after the overlying soft tissues were dissected. In addition, we found it was safe to use plates that were $<$25 cm in length to be well distal to the site where the femoral neurovascular bundle crosses the femur from anterolateral to medial toward the groin. We conclude that MIPO plate position in the distal medial femur is safe in the 1–3 o'clock position anterior to the adductor longus tendon. Moreover, using plates $<$25 cm long avoids the femoral neurovascular bundle.

VATANSEVER, ALPER, NESE CETIN, ASAAD ALSHOUK, HASAN ILGAZ, MUSTAFA SARGON, Department of Anatomy, Faculty of Medicine, Hacettepe University, Ankara, Turkey. **Bilateral double layers of quadratus plantae muscle: A case report**

The quadratus plantae (flexor accessorius) muscle originates by two heads and inserts into the tendons of the flexor digitorum longus muscle. Variations of the muscle are very common, especially of the medial head. In this case report of a cadaveric dissection, we describe the right and left quadratus plantae muscles having double layers: superficial and deep. The subject was a formalin-fixed 45-year-old male with no surgical interventions on the feet. After removal of the skin and superficial fascia of the sole and the plantar aponeurosis, we reflected the flexor digitorum brevis muscle from proximal to distal to demonstrate the quadratus plantae muscle more clearly. We found that the superficial layer of the quadratus plantae inserted into the superficial aspect of the flexor digitorum longus tendon and the deep layer of the muscle inserted into the deep side of this tendon. Examination of studies reported in the literature showed that the insertion of the muscle to different aspects of the flexor digitorum longus tendon was common. We found no previous reports, however, demonstrating bilateral quadratus plantae muscles having double layers.

VATANSEVER, ALPER, SEDA UYGUN, BURCE OZGEN, DENIZ DEMIRYUREK, Department of Anatomy, Faculty of Medicine, Hacettepe University, Ankara, Turkey. **Relationships between nasal septal deviation and volume of paranasal sinuses: A retrospective study**

Many people have a nasal septal deviation and its detection is important in surgical planning. Surgeons have to plan the operative methods for each patient and also need to be aware of septal deviation. Many factors may lead to nasal septum deviation. We aim to determine whether nasal septal deviation is correlated with the volume of the paranasal sinuses using CT images. In this study, we examined a total of 30 patients: 15 male, 15 female. We quantified CT images and evaluated total paranasal sinus volume using Osirix software. The volume of right paranasal sinuses was 34.20 ± 9.96 cm^3 for women and 44.9 ± 9.20 cm^3 for men. The volume of left paranasal sinuses was 34.17 ± 9.45 cm^3 for women and 46.48 ± 7.03 cm^3 for men.

VERGARA, MARIA ELENA, SEBASTIÁ LAZA, MARIE POUMAIRAC, ALEJANDRA NEIRREITER, MARCOS TAZANO, PABLO CABRAL, JAUN PABLO GAMBINI, ALEJANDRA CASTILLO, Departamento De Anatomía, Facultad De Medicina, Universidad De La República, Montevideo, Uruguay. **Cadaver preservation using gamma rays**

Based on experience in the food industry with radiopreservation using gamma rays, methods of sterilization by ionizing radiation for preserving cadavers were explored. A cobalt gamma ray source was used. Twelve kidneys from fresh adult cadavers were harvested within 12 hr of death. They were placed in plastic bags with double heat sealing. A Gamma Chamber 4000 A was used to irradiate the material in a consistent manner. Once ionized, the tissue was removed from the ionizing source and stored in the dark and below 30°C. After a month, a sample was analyzed for microbial flora. The result was negative. This study was conducted between 10 September and 14 October 2014. No deterioration was observed in the material with respect to the macroscopic appearance and the presence of microbial flora. We conclude that the appropriate use of gamma rays is suitable for the preservation of small cadaveric samples for at least 1 month.

VISAGAN, RAVINDRAN, Department of Anatomy, University of London, London, United Kingdom. **Uncovering the neuroanatomical secrets of the sistine chapel**

Between 1508 and 1512, Michelangelo Buonarroti, architect, painter, anatomist and engineer, was commissioned to paint the inspiring frescoes on the ceilings of the Sistine Chapel in Rome. Greater than 500 years after this feat, a stirring among anatomists and art scholars has surfaced. Was Michelangelo concealing what he believed to be the gift of cerebral intellect he had received from his creator? Often neglected is that Michelangelo, among other things, was an exceptional student of anatomy. He performed detailed cadaveric and animal studies, performing his own public dissections aged 18 and producing a text on medical anatomy. This review, considers two frescos The Creation of Adam and the Separation of Light From Darkness in the Sistine Chapel. In the former, an anatomically accurate image of the human brain is concealed in the final four panels. Neuroanatomical structures including the sulci, brain stem, basilar artery, pituitary gland and optic chiasm have been mapped onto the fresco. Some emotions conveyed in the piece are even argued to represent neuroanatomical correlates of functional imaging. The anatomy of pituitary, pons, and medulla overlaid on this piece are a recurring theme in another fresco. In the Separation of Light From Darkness, God's neck is anatomically distorted and this has been proposed to represent a ventral view of the brainstem, perisellar, and chiasmal areas concealed within the anterior neck. This fresco is of iconic importance, signifying the beginning of creation. The concealed neuroanatomy reported in the literature, its accuracy and controversies are explored and reviewed.

VISAGAN, RAVINDRAN, JAMES BATES, Department of Anatomy, University of London, London, United Kingdom. **Submandibular tiger country: Revisiting variations of the course of the marginal mandibular nerve in adult cadavers**

The objective of this cadaveric study was to evaluate the surgical anatomy of the marginal mandibular branch (MMB) of the facial nerve. Due to its location, the nerve is susceptible to damage during a variety of surgical procedures resulting in salivary incontinence and aesthetic impairment. Such damage may be sustained, for example, in cervical surgery, parotidectomy, open reduction of mandibular angle fractures, rhytidoplasties, and other interventions in the submandibular triangle. The authors dissected 12 hemifaces and parameters of the MMB including its source, branchings, and relationship to the lower border of the mandible (LBM) and to the facial artery and vein were recorded. All 12 nerves dissected originated from the inferior border of the parotid gland and 100% had a single branch at origin. Along the course, 25% further divided into two branches. A quarter of the nerves lay directly along the LBM but the remaining 75% were all inferior to the LBM with none in this series coursing superior to the LBM. When the MMB or, the inferior division of the MMB, was inferior to the LBM, the mean distance from the LBM was 3.9 ± 2.03 mm. All of the MMB divisions in this series were superficial to the facial artery and vein. Our findings add to the literature and debate about variation in the course of the MMB. Traditionally, a 2 cm infra-mandibular incision is advised in most surgical texts.

ZAFIROVA BILJANA, NIKI MATVEEVA, DOBRILA LAZAROVA, NATASA NAKEVA, MARIA PAPAZOVA, BILJANA TRPKOVSKA, ACE DODEVSKI, Department of Anatomy, Faculty of Medicine, UKIM, Skopje, Macedonia. **The meaning of some anthropometrical indices in a child population**

Anthropometrical measurements are sensitive, non-invasive and reliable and have a special place in the child population. This study aimed to determine the meaning of some anthropometrical indices in a population of children for assessment on nutritional status and growth. We examined 220 Macedonian children (110 boys, 110 girls) at the age of 6 years. We selected five anthropometrical parameters to measure and the following indices were calculated: weight-for-age, height-for-age, BMI-for-age, mid-upper arm circumference-for-age, skin-folds: scapula and triceps-for-age and weight-for-height, respectively. Results showed sex-specific differences for all parameters, but BMI, weight, height were significantly higher in boys. Conversely, mid-upper arm circumference (MUAC), and skinfolds were significantly higher in girls. The values of the indices for the 50th percentile for the boys were: 23 kg (weight), 119.1 cm (height), 16.18 kg/m^2 (BMI), 16.7 cm (MUAC), and for skinfolds: 5 mm (scapula) and 8.1 mm (triceps). Corresponding values for the girls were: 21 kg, 117.2 cm, 15.41 kg/m^2, 17.2 cm, 5.5 mm, and 8.8 mm, respectively. These results could be used as criteria for assessment on the nutritional status and growth in the child population.

ZAMFIR GEORGIANA, CHRISTINA ENGLEZOU, NEVAN MEGHANI, NEIL ASHWOOD, Department of Trauma and Orthopaedics, Queen's Hospital, Burton on Trent, United Kingdom. **Cauda equina syndrome as the presentation of primary multiple sclerosis**

Multiple sclerosis (MS) is an autoimmune inflammatory demyelinating disorder of the central nervous system (CNS). It is the commonest cause of non-traumatic neurological disability, especially in ages of 20–40 years. Diagnosis is made based on the clinical presentation supported by the McDonald Criteria for MS. Clinical presentation varies, resulting in different clinical pictures of the same entity. We present the case of a 24-year-old woman who presented with a two-day history of back and thigh pain. There was no history of trauma, and no significant past medical history. Normal sensation and power of all four limbs was noted. Sphincter function was also normal; per rectum examination was performed with normal sphincter tone and perianal sensation. The patient was sent home with analgesia. Two days later she returned with evolving numbness in her lower limbs and the finger tips, constipation for four days and no urge to pass urine. Cauda equina syndrome was suspected and MRI of the brain and whole spine was performed. The imaging report satisfied the McDonald criteria and a diagnosis of primary MS was made. It has been said that MS is the "modern great imitator." Common clinical signs include optic neuritis, diplopia, ophthalmoplegia, and limb numbness but non-specific symptoms, such as fatigue, pain, and depression, can also occur in MS attacks. Unusual presentations, such as cauda equina syndrome, can mislead the specialist and create a diagnostic challenge.

ZAMFIR, GEORGIANA, NEVAN MEGHANI, CHRISTINA ENGELZOU, NEIL ASHWOOD, Department of Trauma and Orthopaedics, Queen's Hospital, Burton-on-Trent, United Kingdom. **Aggressive osteochondroma in a patient with Tatton–Brown–Rahman syndrome: A unique case report and literature review**

Tatton–Brown–Rahman syndrome is a rare overgrowth disorder caused by a mutation in DNMT3A, a gene which is responsible for growth control during embryonic development. Characteristic features include tall stature, a round face with heavy horizontal eyebrows and narrow palpebral fissures, as well as intellectual disability. The authors describe a unique case report of osteochondroma of the proximal humerus associated with this uncommon overgrowth syndrome. The 13-year-old female presented with an 8-week history of noticing a lump in her left upper arm causing occasional discomfort but not impacting on the function of the arm. Physical examination revealed a lump in the left axilla with a full range of shoulder movements and no neurological functional loss. The patient underwent radiology of the left shoulder which revealed an osteochondroma arising from the proximal third of the left humerus, measuring 10 cm $\times$ 6 cm, with no radiographic features of malignancy. The patient was managed conservatively and subsequent radiographs over the following 6 years showed no change in the size of the lesion and no features of malignant transformation. We were unable to find any other recorded case of osteochondroma in a patient with Tatton–Brown–Rahman syndrome. Following diagnosis, the management of this condition has remained conservative as surgical options are complex. If required, debulking of the lesion with or without a tibial autograft has been described in the literature but the significant risk of neurovascular damage associated with this procedure was deemed unacceptable for our patient.