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**Human Anatomy Teaching Group, Department Physiology, Development and Neuroscience, University of Cambridge**

**Abstract 1 (Oral presentation)**

**Neck extension and tracheal exposure in relation to open tracheostomy**

O Kenyon, ML Robinson and C Brassett

Open tracheostomy is traditionally performed at the second and third tracheal rings under moderate neck extension to optimise visibility and access to the trachea. As cervical spine pathology may limit flexion and extension, the risk of overextension is a concern for both surgeon and anaesthetist. This study aimed to describe the relationship between neck extension and tracheal exposure. The trachea was dissected and exposed from cricoid to suprasternal notch in 39 cadavers in the Human Dissection Room at Cambridge University. The neck was flexed and extended at 15o increments between 45-135o, as determined by a goniometer along a vertical line joining the external auditory meatus and nasal ala relative to the horizontal plane of the supine body, with full flexion and extension being 0-180o respectively. Digital calliper measurements were made of visible tracheal length and rings from cricoid to suprasternal notch. Our results showed that the mean tracheal length gained from 45-135o extension was 29.6mm(SD=8.9) in all subjects, with the mean number of tracheal rings exposed being 2.95 rings (SD=1.23). The mean tracheal length (and number of visible rings) at 45o, 60o, 75o, 90o, 105o, 120o and 135o was 28.8mm(6.0), 29.2mm(6.1), 32.3mm(6.6), 38.0mm(7.1), 45.1mm(7.7), 50.6mm(8.1) and 55.7mm(8.6) respectively. For an individual subject, the mean increase in length (and visible rings) between 45-60o, 60-75o, 75-90o. 90-105o, 105-120o and 120-135o was 14.9%(9.5%), 12.6%(11.6%), 19.3%(10.7%), 22.0%(10.4%), 17.9%(6.9%) and 13.7%(6.6%) respectively. In conclusion, we demonstrated that the maximum percentage change in tracheal length was elicited between 75-105o, with the maximum change in number of visible rings between 60-90o. Whilst increased tracheal exposure continues up to 135o, the above data suggest that neck extension of up to 105o is likely to yield a reasonable length for open tracheostomy, especially for those patients for whom further neck extension may pose unacceptable risks. Ethical approval was not required for this study.

**Abstract 2 (Oral Presentation)**

**Anatomical investigation of the ileocaecal junction in cadaveric specimens**

A.Choo, E.Wong, R.Townend, J.Brown and C Brassett

The ileocaecal junction (ICJ), located where the terminal ileum enters the caecum, is important in preventing caeco-ileal reflux. However, its precise nature remains unclear, with descriptions alternating between “valvular” and “sphincteric” or a combination of both mechanisms. This study aimed to investigate the morphological and functional features of the ICJ in 33 embalmed cadaveric specimens. The terminal ileum was observed to enter the caecum on its medial aspect in most cases (n=25), anteriorly in 5, and posteriorly in 3 specimens. The mean angle between the distal terminal ileum and ascending colon was 106˚ (SD=23.0˚). Similar to published literature, the internal appearance of most of the ICJs could be classified as labial (n=19), with 12 of papillary type and two morphologies (tube-like and rosette-like) which have not been previously described. Papillary ICJs had significantly thicker lips (mean=3.56cm) than labial ICJs (mean=1.76cm), whereas labial ICJs were longer horizontally than papillary ICJs (p<0.05). In 24 specimens, a transition zone, the “vestibule”, was present between the caecal and ileal walls, and had a mean depth of 2.21cm. A vestibule was present in a larger proportion of labial ICJs (18/19) compared to papillary ICJs (4/12). Caecal folds were noted on either side of the ICJ opening in 26 specimens, with only one or absent folds in the remaining cases. When air was pumped into the ascending colon with the specimens submerged in water, the caecum perforated in 4 cases without the occurrence of caeco-ileal reflux. These ICJs were deemed to be competent, suggesting that mechanical factors may contribute significantly to ICJ function. These findings provide additional quantitative and qualitative detail to existing descriptions of the ICJ, and indicate a degree of variation beyond current classifications. Demonstration of possible competence in cadaveric specimens without neuronal input also lends support to a valvular mechanism for the ICJ.

**Abstract 3 (Oral Presentation)**

**Predicting optimal central venous catheter length from surface measurements in adult humans**

R Thompson, N Chilvers, R Townend and C Brassett

The length required for optimal positioning of a central venous catheter (CVC) within the distal superior vena cava (SVC) is variable between patients, and must be estimated during insertion. However, this estimation is frequently incorrect, resulting in misplaced CVCs, poor catheter function, cardiac arrhythmias, or even cardiac perforation. This study aimed to determine which of several surface measurements was most closely correlated with optimal CVC length.

The distance between several anatomical landmarks was measured on forty embalmed cadavers. Measurements included: height; suprasternal notch to xiphisternum, umbilicus, and pubic symphysis; and right sternoclavicular joint (RSCJ) to ipsilateral costal cartilages (CCs). A thoracotomy was then performed, CVC guidewires were inserted via the right internal jugular vein 2cm above the RSCJ, and – confirming position by direct observation – a minimal and maximal length between which each tip lay within the SVC was recorded.

The maximal length of each CVC in the SVC was significantly correlated with the distance between the RSCJ and the ipsilateral 4th and 5th CCs (p<0.001, <0.002). A CVC inserted a length equidistant to that from the RSCJ to the 4thCC would lie in the SVC in 38/40 (95%), and the right atrium (RA) in 0/40, but the distal third of the SVC in only 2/40 (5%). A CVC inserted a length equidistant to that from the RSCJ to the 5thCC would lie in the SVC in 35/40 (87.5%), and the distal third of the SVC in 23/40 (57.5%), but the right atrium (RA) in 5/40 (12.5%). These findings provide a clinically relevant gide for CVC length, depending on the perceived relative importance of placement within the distal SVC and/or avoiding placement within the RA.

**Abstract 4 (Oral Presentation)**

**Sexual dimorphism and ethnic variance: their impact on the reliability of the antilingula as a landmark in human mandibular surgery**

M Kapur, R Shah, A Ferro, S Basyuni, C Brassett and V Santhanam

The antilingula is a prominence located on the lateral aspect of the mandibular ramus, arising as a consequence of the attachment of the masseter muscle. Its clinical signficiance relates to its potential use as a surgical landmark to prevent iatrogenic damage to the inferior alveolar nerve (IAN) during intra-oral vertical ramus osteotomy (IVRO). This osteotomy is performed from the lateral aspect of the mandibular ramus, which precludes direct visualisation of the nerve. Although variation in the incidence and location of the antilingula is recognised, no comprehensive studies have previously been conducted with the aim of evaluating the relationship between the antilingula, mandibular foramen and lingula in different populations and sexes. In this study, 478 dry hemimandibles from right different geographic populations were used to map the relationship between the lingula, antilingula, mandibular foramen and midwaist point of the ramus on each hemimandible. Skulls were sexed by discriminant function analysis of visually assessed sexually dimorphic traits. Positional relationships were determined by digitizing nine anatomical landmarks per hemimandible. Mean inter-obserser discrepancy in locating the antilingula was 0.59mm. No significant sex difference was identified in the spatial relationship between lingula and antilingula. The relationship between the lingula and antilingula, and the relationship between the antilingula and the mandibular foramen, showed multiple differences between geographic populations. Irrespective of geographic population or sex, the mandibular foramen was less than 5mm posterior to the antilingula in 90.4% of cases. This study suggeststhat the antilingula may be used as a reliable surgical landmark to predict the location of the IAN, and that osteotomy 8.6mm posterior to this point will avoid damage to the IAN in 98.8% of cases.

**Abstract 5 (Poster Presentation)**

**Should anatomy demonstration be a compulsory component of core surgical training?**

T Hughes, W Moussa, C Brassett

Anatomy demonstration is currently a non-compulsory component of core surgical training (CST), with only a few deaneries including it as a mandatory requirement at the ‘Annual Review of Competence Progression’ for surgical trainees. However, a thorough knowledge of anatomy is not only important for success at postgraduate membership examinations but is also essential for a career in surgery. At the University of Cambridge, there are 12 anatomy demonstrator positions linked to surgical on-call commitments at Addenbrooke’s Hospital in 6 surgical specialties. This study aims to assess the opinions of a group of CST trainees regarding the value of anatomy demonstration within their training programme. At a regional intensive MRCS anatomy revision course, 19 delegates were asked to attempt 20 pre and post-course multiple choice questions taken from past examination papers to aid standardization and to complete a post course questionnaire. The grouped average results showed an improvement of 12% in their anatomical knowledge. Analysis of the post-course questionnaire showed that the vast majority of delegates felt strongly that anatomy demonstration should be incorporated into the CST curriculum. The trainees were asked to rank between 1 (not incorporated) to 10 (incorporated), and the average score for the group was 8.8 (SD 2.3). Interestingly, when asked how frequently they felt demonstrating should take place, over half the group (68%) considered this should be at least monthly. While the numbers in this study are small, they represent trainees from a large deanery, and the results suggest that surgical trainees would embrace the inclusion of anatomy demonstration within their curriculum. Those who have chosen to take a year out of their training to do anatomy demonstration are able to improve their anatomical knowledge, develop teaching and research skills, and gain insight into what a surgical career involves from senior demonstrators on the teaching team.

**Abstract 6 (Poster Presentation)**

**Anatomical variations of sternocleidomastoid and their relationship to internal jugular venous cannulation**

ML Robinson, O Kenyon and C Brassett

The apex of the triangle formed by the clavicular and sternal heads of the sternocleidomastoid (SCM) muscle, Sedillot’s triangle, is recognised as a landmark for internal jugular vein (IJV) cannulation. However, anecdotal evidence suggests that significant variation exists in the height and width of the triangle and its relation to the IJV. Previous research demonstrated reduced likelihood of successful cannulation on the left relative to the right.

This study aims to describe anatomical variation in the heads of SCM and the relationship of Sedillot’s triangle to IJV cannulation.

The SCM was dissected in 41 cadavers in the Dissection Room at Cambridge University. Digital calliper measurements were made. A marking pin was inserted perpendicularly at the apex of Sedillot’s triangle to simulate IJV cannulation. The muscles were subsequently reflected to identify the position of the pin relative to the IJV.

Results showed considerable variation in the clavicular distance between the heads, ranging from 0-67.6mm, with mean=12.6mm (SD=12.2mm) and a mean triangle height of 35.2mm (SD=14.7mm). There was no significant difference in laterality. A pin inserted at the apex punctured the IJV successfully in most cases (left, 23/40; right 33/40). Of the unsuccessful punctures, the IJV on both sides lay either lateral or medial to the apex. On the left, the mean distance from apex to IJV was 0.2mm (SD 7.6mm), with a range of 17.4mm (lateral) and -14.8mm (medial); whereas on the right, the IJV was lateral in most cases (mean 5.7mm, SD 6.0mm, range 13.9mm and -2.3mm).

In conclusion, while this study confirms the efficacy of the apex of Sedillot’s triangle for IJV cannulation where bedside ultrasound imaging is unavailable, it also highlights the risks of this procedure in view of the variability of the relationship of the SCM heads to the location of the IJV on both sides.

**Abstract 7 (Poster Presentation)**

**The ‘textbook aorta’: a *rara avis*?**

W Moussa, R Thompson, J Goode, I Fay, C Brassett, A May & A Howard

The widespread adoption of endovascular aortic aneurysm repair in recent years has necessitated an accurate understanding of the infracoeliac aortic anatomy. Anatomical textbooks typically depict a straight abdominal aorta with the right and left renal arteries (RRA + LRA) arising symmetrically at a 90° angle, gonadal arteries arising immediately below the renal arteries, and the aorta bifurcating into the common iliac arteries at a 60-90° angle. This study aimed to describe the infracoeliac abdominal aorta and to determine the accuracy of this representation. The retroperitoneum was dissected and the branches of the abdominal aorta were identified in 35 embalmed adult cadavers in the Human Dissection Room at the University of Cambridge. The location, angle, and length of each branch were measured, with the mean of three measurements being used in data analysis. Results differed from the typically depicted aorta in a number of areas. The left renal artery generally arose more inferiorly than the right as measured from the origin of the superior mesenteric artery (SMA to RRA 0.9±0.7cm, SMA to LRA 1.3±0.7cm). Both renal arteries were typically angled caudally (RRA 74±17°, LRA 72±17°), with marked angulation (≤ 40°) in 3 and cephalad angulation in 2 cases. Accessory renal arteries, considered uncommon, were nonetheless found in over 30% (11/35) and bilaterally in 3 subjects. Interestingly, the gonadal arteries did not arise from the abdominal aorta in 28/35 cases (80%). The angle between the common iliac arteries was most variable, with an average angle of 42± 20°. This study demonstrates that the infracoeliac abdominal aorta differs from its ‘textbook’ description in several features: the location and angle of the renal arteries; the prevalence of accessory renal and gonadal arteries; and the angle of the aortic bifurcation. This considerable variation must be taken into account in preoperative planning of endovascular aneurysm repair.

**Abstract 8 (Poster Presentation)**

**Mapping the lateral cutaneous nerve of the forearm and its relation to the superficial radial nerve in human cadavers**

R Hasan, T Hughes, M Wright, C Brassett, L Van Rensburg

The lateral cutaneous nerve of the forearm (LCNF) is typically described as mediating sensory innervation from both dorsal and palmar surfaces of the radial forearm proximal to the wrist. However, anecdotal evidence suggests it may also mediate sensation frm the skin of the anatomical snuffbox and first dorsal web space, classically attributed to the superficial radial nerve (SRN). This study aims to map the course of the LCNF, the site where it pierces deep fascia, and its relation to the SRN in the distal forearm and dorsum of the hand. Superficial dissection of 25 cadaveric forearms was performed with 2.5x magnification loupes, with careful mapping of both LCNF and SRN as far as the MCP joints. Our results showed that the LCNF emerged at a distance of 7.14cm (SD=2.36cm) from the lateral epicondyle, with up to 5 dorsal branches, although the majority (17/25, 68%) gave only one. It was observed that 7/25 (28%) did give branches to the skin over the anatomical snuffbox and 5/25 (20%) to the first dorsal web space. In addition, 6/25 (24%) showed a connection between the two nerves, at an average distance of 22.37cm (SD=2.38cm) from the lateral epicondyle. These data highlight the variation that exists in the branching pattern of the LCNF and its relationship with the SRN, as well as confirming that branches of the LCNF may supply areas previously only ascribed to the SRN. Surgeons operating in the cubital fossa should be aware of this possibility, as injury to the LCNF may lead to sensory loss in the hand. More importantly with regard to clinical diagnosis, these findings also bring into question the belief that the anatomical snuffbox and first dorsal web space are autonomous zones for testing the integrity of the radial nerve.