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- 'docendo ac discendo' - 'by teaching and learning'

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We would like to take this opportunity to show appreciation to all those involved with the production of the International Journal of Clinical Skills (IJOCS). Many thanks to all members of the Editorial and Executive Boards.

The International Journal of Clinical Skills looks forward to contributing positively towards the training of all members of the healthcare profession.

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Foreword

Head of Clinical Communication King's College London

Since its inception, the International Journal of Clinical Skills (IJOCS) has provided a unique platform for the teaching and learning of clinical skills in a variety of healthcare disciplines. It has become a well established peer reviewed Journal publishing a diverse range of clinical skills articles.

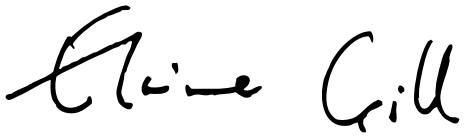
The Editorial Board consists of people active in the field of clinical skills teaching and this is reflected in the journals philosophy to encourage sharing of ideas and practice. Pertinent contributions aim to meet the current needs of researchers and practitioners.

Clinical skills teaching is going through a definite 'growth spurt' at present with increasingly responsive models, manikins and e-learning programmes - not dismissing financial investment that comes along with this. High quality clinical simulation is becoming more sophisticated as a teaching and learning methodology. The need to equip health professionals with the skills and competencies to improve patient-safety is one of the drivers behind this growth. However, alongside the purchase of the 'Sim'-men/women/babies and linked e-learning, let's not forget the importance of personal interactions through faculty support, i.e. experienced clinical teachers. In addition, simulated patients and the delivery of interprofessional sessions, bring clinical simulation closer to the realms of reality and validity, for both undergraduate and postgraduate health professionals.

The use of simulated patients, relatives and carers is well established in clinical communication education. More recently, additional interesting and innovative approaches to clinical communication teaching are in various stages of substantive core curricula and special study activity across medical schools in the UK.

The IJOCS is now established in the world of clinical skills publications by providing a niche specific arena that welcomes quality research, thereby promoting excellence in healthcare internationally. The wide range of papers covering research, discourse and reflection in clinical education and practice, plus the inclusivity of interprofessional approaches in one publication, raises the validity of this journal. There remains room for research based evidence to support teaching and practice of patient-centred clinical learning. The IJOCS welcomes additions to the literature that encourage critical debate.

Without doubt, the International Journal of Clinical Skills has continued to exceed its original ambitions and I wish it growing success.



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Studying living anatomy: the use of portable ultrasound in the undergraduate medical curriculum

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Abstract

This paper describes the use of portable ultrasound imaging in the teaching of living anatomy to undergraduate medical students. The paper outlines the rationale for using portable imaging technologies in undergraduate anatomy teaching, as well as the practical issues which must be considered in designing and delivering such teaching activities. The following areas are discussed in the paper: obtaining appropriate consent from the volunteers who are being scanned and ensuring their health and safety during and after scanning, ensuring optimum set-up of the learning environment, use of the equipment and designing appropriate learning activities for undergraduate teaching.

Background

In most medical curricula, medical students spend a significant proportion of their time learning human anatomy. Traditionally the cadaver has been the cornerstone of anatomical teaching, but recently it has been suggested that the *living body* is a more appropriate resource to aid anatomy teaching for the practice of medicine [1]. Despite the initial rejection of this argument by anatomists, in our experience, it seems that the study of the anatomy of the living body is now gaining popularity, for example, through peer physical examination (PPE [2]), body painting [3] and the use of image projection onto the skin surface [4].

In response to recommendations of the UK's General Medical Council (GMC) [5], anatomy teaching has been streamlined over the years [6] and, with the gaining popularity of problem-based learning curricula in medicine, it has also been increasingly delivered within a clinical context. Clinical contextualisation in anatomy teaching can been aided by the inclusion of radiological anatomy teaching in medical curricula, although in UK medical schools there seems to be a wide variation in how much radiology is taught, by whom it is taught, and the level of radiology teaching resources available [7]. More importantly, since the practice of diagnostic medicine routinely relies on clinicians' ability to interpret 2D clinical images of anatomical structures (e.g. MRI, CT and ultrasound scans), early development of these skills is important for undergraduates, and radiological anatomy is a topic which should not be neglected in undergraduate medicine.

With respect to ultrasound as an imaging technology, high resolution portable ultrasound equipment is now readily available and is relatively inexpensive compared to other imaging technologies; as such, the use of portable ultrasound is becoming more widespread. This is in part driven by the UK's National Institute for Clinical Excellence (NICE) who recommend that a number of clinical procedures should now be conducted under ultrasound guidance, e.g. insertion of a central venous line in elective situations [8] and ultrasound guided foam sclerotherapy for varicose veins [9]. Some other procedures are also under consultation for performance under ultrasound guidance, e.g. ultrasound guided catheterisation of the epidural space [10], endobronchial ultrasound-guided trans-bronchial needle aspiration (EBUS-TBNA) for mediastinal masses [11].

Another driver which has increased the use of portable ultrasound in the UK is the continued shift of emphasis from secondary care to primary care. Many primary care centres now offer services which would traditionally have been provided by the secondary care sector, e.g. ultrasound scanning to check for aortic aneurysms, heart valve problems and gall stones. A recent report provides preliminary evidence to support the performance of ultrasound examinations by general practitioners within the primary care setting, demonstrating benefits to cost, treatment and patient satisfaction [12]. Use of portable ultrasound is also well documented in applications such as emergency medicine [13], anaesthesia [14] and cardiology [15, 16] and other specialities are now seeking training in the practice of ultrasonography.

Given the increased availability and use of portable ultrasound in clinical practice by clinicians, it is anticipated that medical students will have access to portable ultrasound equipment early in their clinical practice or even during training. Indeed recently, the UK's Royal College of Radiologists have now issued clear recommendations for ultrasound training for non-radiologist staff in medical and surgical specialities [17]. Other medical colleges have also identified a need for ultrasound training as part of their trainees' education [18].

There are therefore, a number of reasons to justify the use of portable ultrasound devices in undergraduate anatomy teaching. Firstly students can learn anatomy in a clinically relevant manner using an imaging device which they are very likely to encounter during their clinical training and subsequent practice. Use of ultrasound as a learning tool may reinforce existing anatomical knowledge and simultaneously allow students to develop skills in interpreting 2D ultrasound images; these skills may be transferable to other imaging modalities which will also be routinely encountered in clinical practice. Studying living anatomy using ultrasound adds a dynamic element to the study of anatomy that the cadaver cannot, i.e. visualising how structures move in a living person during respiration, how blood flows through an organ, observing the depth of structures from the skin surface and appreciating anatomical variation amongst individuals.

Recently, ultrasonography has been used to supplement undergraduate clinical anatomy teaching across Europe and North America [19 - 26]. Teichgräber et al (1996) introduced medical students to ultrasound by incorporating it within anatomy classes; the students scanned their peers and reported that use of ultrasound improved their understanding of clinical anatomy. Barloon et al (1998) have reported that use of ultrasound, when used as an aid in teaching physical examination of the liver, improved the accuracy of second year medical students' ability to measure liver size. Shapiro et al (2002) and Butter et al (2007) have also explored the use of ultrasound as an aid to physical examination, reporting that basic ultrasound skills can be taught to students in a short time frame and that inclusion of ultrasound training improves medical students' technique in physical examination. Most recently Syperda et al (2008) report that with training, medical students can develop basic proficiency in ultrasonography technique and image interpretation. Other institutions are also using portable ultrasound in anatomical teaching [19, 24], e.g. radiology staff at the UK's Peninsula Medical School demonstrate anatomical structures in volunteers during undergraduate teaching sessions in anatomy and clinical skills [1].

Objective

Clearly there has been some success with regard to the introduction of ultrasound into undergraduate medical teaching in terms of the student learning experience. However, to support the safe practice of ultrasound in teaching there needs to be careful consideration of some ethical, consent and health and safety issues, and there is little guidance in the teaching literature regarding these matters. This paper examines these issues and suggests solutions to overcome some of the problems educators will inevitably encounter when using ultrasound to teach clinical and living anatomy.

Issues for consideration when using portable ultrasound in the undergraduate medical curriculum

Ensuring the health and safety of the volunteer

The British Medical Ultrasound Society (BMUS) have issued clear guidelines on the safe use of ultrasound equipment and also its role in learning and teaching [27]. The authors recommend these guidelines are adhered to and draw particular attention to the following:

- The tutor leading the session should have an understanding of current ultrasound safety issues
- If students are to use the equipment under supervision, they too should have an understanding of current ultrasound safety issues
- When volunteers are being used, the Thermal Index (TI) should always be less than 0.5 and the Mechanical Index (MI) should always be less than 0.3
- Scans should not be carried out during pregnancy

Ensuring the health and safety of the operator

Work related upper limb disorders are common amongst sonographic practitioners. These disorders are not always linked to the duration and/or frequency of the examination, therefore, it is advisable to ensure teaching on ergonomic practice is incorporated into teaching sessions [28].

Ethical issues: which anatomical areas to study & why

It is not uncommon in the practice of ultrasound scanning of subjects to discover benign cysts, or appearances suspicious of malignancy; we have termed such discoveries *'circumstances which require further investigation'*. In the case of females, a pregnancy could be discovered. A teaching session amongst a group of peers is an inappropriate setting for a volunteer or student to discover the presence of an abnormality (significant or not) or pregnancy. Discovery of such a circumstance in a teaching environment may have significant consequences for the volunteer; it is therefore advisable to avoid scanning certain body regions where such findings are more likely to occur. The upper and lower limbs, head and neck and thorax are relatively 'safe' regions to be scanned and student volunteers may therefore be scanned within a teaching session, but we suggest that the scanning of students' abdominal and pelvic regions should be avoided in group activities.

An alternative to using student volunteers, which also enables other body regions to be scanned, would be to engage with clinical skills partners (CSPs), that is, volunteers who are willing to be examined and scanned to support the delivery of clinical skills or living anatomy teaching. In this case, a bank of CSPs should be recruited and, for each CSP, during their induction process, a complete ultrasound examination of all body regions to be scanned should be conducted by a relevantly qualified health professional in advance of the class; this is to ensure that they have no observable conditions requiring further examination. Moreover, it is also prudent to scan volunteer subjects just prior to the teaching session to ensure the volunteer has no observable conditions requiring further examination.

Should there be a discovery of a *'circumstance which requires further investigation'* there must be a mechanism for further investigations and/or health care to be provided e.g. using the services of the occupational health department within the teaching institution or by referral to a general practitioner.

Consent

Written consent from the volunteer to be scanned using ultrasound must be obtained; BMUS have published a consent form which can be used for this purpose [29]. It may also be prudent at this time to request consent for the use and/or publication of any anonymised ultrasound images if an intention is to collect a database of ultrasound images with which to develop learning resources for students. In addition, the scanning of students or other volunteers with portable ultrasound for teaching purposes may require ethical approval from the host institution; ethical approval was granted by Durham University for the activities described in this paper.

Summary Box 1
Ensuring health & safety for all participants

- Instructors and students should adhere to the British Medical Ultrasound Society (BMUS) guidelines pertaining to ultrasound safety
- When volunteers are being used, the Thermal Index (TI) should always be less than 0.5 and the Mechanical Index (MI) should always be less than 0.3
- Practice good ergonomic technique when scanning
- Obtain written consent from the volunteer to be scanned
- Scans should not be carried out during pregnancy

Design of the learning opportunities

Areas of the body to scan

Not all regions of the body lend themselves to demonstrating anatomy using ultrasound. Some areas which the authors feel can be demonstrated to good effect using clinical skills partners (CSPs) or student volunteers are:

- the neck
- the upper limb vasculature and nerves
- the lower limb vasculature and nerves
- the wrist or carpal tunnel
- upper abdomen *(in CSPs only)*
- pelvic region *(in male or non-pregnant female CSPs only)*

The correct type and frequency of probe should be used and optimum equipment settings utilised for each body region being scanned.

Summary Box 2
Which anatomical areas to study

- Only scan the upper and lower limbs, head, neck and thorax of volunteer students
- Avoid scanning the abdomen and pelvic regions in students; use CSPs instead
- When scanning the abdomen or pelvic regions of a CSP, a relevantly qualified health professional should conduct a pre-scan of all body regions prior to the teaching session
- A mechanism for engaging with appropriate healthcare services must be in place should there be a discovery of a *'circumstance which requires further investigation'*

Designing the optimum learning environment

Prior to the ultrasound demonstration, students should always receive instruction on ultrasound image orientation and interpretation. To help the students reinforce their anatomical knowledge, it is advisable to incorporate ultrasound demonstrations into anatomy teaching sessions where other anatomy teaching resources are also used, for example, prosections and models. These provide students with a 3D reference for the location of anatomical structures beneath the skin surface of the area of the body being scanned.

Small group sessions should be utilised and ambient lighting conditions should be optimised to ensure the ultrasound image can be clearly seen. Imaging screens on portable ultrasound equipment are too small to be viewed by a group of students in a teaching session, therefore high quality audio-visual equipment should be used to display the image (such as dual plasma screens or lecture capture systems). The students must be able to see the operator's hand to allow them to orientate the image; ideally the operators hand and the ultrasound probe should also be displayed alongside the ultrasound image (Figure 1).

Figure 1: Setting up the optimum learning environment.

The students must be able to see the operator's hand holding the ultrasound probe, the position of the ultrasound probe on the volunteer's body and a projection of the ultrasound scan; all three elements of the demonstration must be observable within a small field of view. Lighting of the room should be low enough to ensure optimum viewing of the projected ultrasound images.

Summary Box 3
Designing the optimum learning environment

- Set up should be for small group teaching
- Project the ultrasound image onto a high quality screen
- Optimise lighting conditions
- Ensure students can easily see the probe, the volunteer being scanned, the operator and the projected image
- Ensure the correct type and frequency of probe for each body region being scanned
- Explain image orientation at the start of any teaching session
- Refer to a three-dimensional model or prosection of the area of the body being scanned

Discussion

In our experience the value of using ultrasound when teaching anatomy relates to the modality's dynamic nature and its ability to image the anatomy of a living person in a non-invasive manner. Our students report the sessions to be memorable, enjoyable and useful in providing a clinical contextualisation and the opportunity to see a diagnostic imaging modality in action. The learning of anatomy becomes relevant to clinical practice and allows anatomical relationships and variations to be assessed in real-time.

Although the literature consistently reports high levels of student satisfaction for ultrasound teaching sessions, there is no clear evidence to date to illustrate increases in students' ability to interpret ultrasound images or to perform an ultrasound examination. In particular, there are no studies which investigate the longitudinal development of skills in ultrasound imaging. In most of the literature it is unclear who is instructing the students and what their experience of ultrasound is. No studies to date assess the retention of skills and knowledge; clearly this needs to be addressed if ultrasound is formally introduced into the undergraduate medical curriculum.

Apart from the ethical, consent and health and safety issues discussed, there are other considerations which may prohibit the use of ultrasound in anatomy teaching. A major consideration is cost, although it is possible to purchase refurbished equipment. At the time of purchase in 2006, the approximate cost of a Sonosite Micromaxx® with two probes was £30,000 notwithstanding the cost of audiovisual equipment of adequate specification. There are also cost implications for insurance and maintenance of the equipment.

Ideally, teaching sessions should be conducted by a sonographic practitioner (which will also have its own cost implications) who has experience and expertise in using the equipment. However, with adequate instruction, and practice, it is possible for a non-expert to gain enough expertise and confidence to produce a good learning experience for the students. Whoever delivers the teaching session must have an understanding of the working guidelines around safety and consent. The teaching sessions must be carefully designed and the facilitator must consider what body areas are being scanned and by whom. Other issues which contribute significantly to the success of the learning activity concern the optimisation of the learning environment. The health and safety of the practitioner and good ergonomic operation of the equipment by the operator are paramount, but the viewing conditions for the students must also be incorporated into this. Ideally the student should be able to simultaneously view the operator scanning the volunteer and the ultrasound image projected onto a large, high-quality screen, without having to shift their gaze excessively. We have found that students also benefit from having the live ultrasound image explained to them in terms of the structures which are being scanned. Prior to the teaching taking place an orientation session to explain ultrasound image interpretation is essential.

It is important that students are clear of the intended learning outcomes of the ultrasound sessions. Our intention was to demonstrate living anatomy in a clinical context and to enable students to develop skills in interpreting 2D ultrasound images of anatomical structures; the aim was not to train students in the use of ultrasound equipment. Students frequently struggle to interpret cross-sectional images of anatomy and the dynamic nature of ultrasound imaging adds further complexity to this task. Development of skills in ultrasound image interpretation in the earlier undergraduate years will inevitably be advantageous to students.

With regard to training undergraduate students to operate ultrasound equipment it is important to note that in the hands of an expert ultrasound is a very powerful diagnostic tool, but in the hands of a novice it can be a dangerous tool. Presently, the UK Royal College of Radiologists recognises that ultrasound has a wide application throughout medical and surgical practice and that medical practitioners other than radiologists may wish to develop skills in ultrasound imaging, but they are explicit in their

recommendations for ultrasound training for non-radiologist staff in medical and surgical specialities [17]. Within the UK, the minimum recommended qualification to practice diagnostic ultrasound is a postgraduate certificate in medical ultrasound, which is studied by registered healthcare professionals, commonly over a one year period. Most courses require a recommended number of clinical hours to be performed and require the completion of a final assessment.

Portable ultrasound has been referred to as the *"new stethoscope"* and may well be a tool accessible to future medical students. In the first instance, facilitating students' development of skills in ultrasound image interpretation is a sensible first step towards ensuring they are better prepared for future clinical practice, but if the intention is to formally train undergraduate medical students in the practice of ultrasound, then collaboration with the professional bodies and institutions responsible for ultrasound training is required to ensure that appropriate learning, teaching and assessment strategies are implemented, to safeguard the student and patients.

On a cautionary note, there are wider issues to consider if training in ultrasound scanning were to be introduced formally into medical undergraduate training. For example, ultrasound trainers report from experience that some individuals will be unable to develop the particular set of psychomotor skills required by sonographers. Given the recommendations that some clinical procedures should be conducted under ultrasound guidance, it is inevitable that some students will be unable to achieve competency in performing these clinical skills due to their lack of skills in sonography and consideration must be given to these students. Is it appropriate to fail an otherwise competent student, who lacks these skills? If this is the case, this has much wider implications for admissions procedures onto undergraduate medical courses.

Declarations

The authors have no financial or other interests to declare in relation to this paper.

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