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The use of real time ultrasound scanning as a teaching method of anatomy in an undergraduate sonography and medical imaging degree in an Australian university

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ABSTRACT

Background: Real-time ultrasound scanning is increasing in popularity as a teaching tool for human anatomy because it is non-invasive, offers real-time 3-D anatomy and is cheaper than dissections.
Aim: To assess real-time ultrasound scanning as a teaching method of human anatomy, and to determine what teaching methods medical imaging and sonography students consider effective for understanding human anatomy.
Method: Surveys were distributed to two consecutive cohorts of first year medical imaging and medical sonography students at CQUniversity. Participation was voluntary. Comparisons among teaching methods were made using repeated measures ANOVA.
Results: Real-time ultrasound scanning was the most preferred method of delivery for anatomy classes overall especially compared to computer programs, videos, 3-D radiological images and dissection. Specifically, students indicated that ultrasound scanning was the preferred method to encourage learning from experience ($F_{7,231} = 2.942$, $p = 0.006$), to develop team skills ($F_{7,231} = 4.550$, $p < 0.006$), to follow complex instructions ($F_{7,231} = 4.656$ $p < 0.001$) and to appreciate anatomical variation ($F_{7,231} = 2.067$, $p = 0.048$). Dissection was the least favoured teaching method.
Conclusion: Real-time ultrasound scanning is a useful tool for teaching anatomy, and animal dissections are a poor substitute for the use of human cadavers.

Introduction

Despite anatomists' preference for human dissection as a means of teaching anatomy, use of human cadavers is declining. Dissection continues to be a recognised teaching tool, combined with other teaching methods. However, there are two issues. Firstly, technology has advanced so that the use of other methods, such as non-invasive ultrasound scanning, enables a view of human anatomy on a par with dissection. Until now, real-time ultrasound scanning has had limited evaluation as a teaching method for anatomy, despite its use in this context in undergraduate medical education. Secondly, access to human cadavers is expensive and often impractical for universities. Dissection is often replaced with animal organs, as opposed to human. The purpose of this paper is two-fold: firstly to assess real-time ultrasound scanning as a teaching method of anatomy, and secondly to determine what teaching methods medical sonography and imaging students consider effective for understanding human anatomy. Medical imaging and medical sonography students at an Australian university were surveyed. Ultimately, real-time ultrasound scanning was rated highly by students, while animal dissection was rated poorly. There are two implications to this research – real-time ultrasound scanning can be a useful tool for teaching anatomy, and animal dissections are a poor substitute for the use of human cadavers.

Background

Teaching methods for anatomy have been hotly debated.[1–4] The most common methods include dissection, lectures, models,

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computer programs, videos, 2-D and 3-D radiological images, textbooks and real-time ultrasound scanning.[5,6] Anatomage tables also increasing in popularity.[7] Whilst dissection has been the traditional teaching method of choice for anatomy,[8] it may be resisted by students[9] or not be practical (or affordable) depending on university facilities.[5,10] Patel and Moxham[4] determined that an ideal anatomy curriculum incorporated dissection with other teaching methods. Their study included a list of six teaching methods originally developed by Brenner et al.,[6] but the use of real-time ultrasound scanning was not included. Patel and Moxham surveyed anatomists rather than students, so the student perspective was not considered, nor did they recognise ultrasound scanning as a teaching method for anatomy. Kerby, Shukur and Shalnoub[11] adapted Patel and Moxham's survey and assessed medical students at two UK medical schools. They, too, did not consider ultrasound scanning as a teaching method for anatomy. Both studies found that dissection was overall the most "fit for purpose" teaching method of anatomy, but that other methods would still be required to fulfil all anatomical curriculum requirements.

The use of real-time ultrasound scanning as a teaching method for anatomy students is increasing. Ultrasound is non-invasive, offers visualization of real-time 3-D anatomy and uses a technology which reinforces the clinical relevance of anatomy. Further, the use of ultrasound can reinforce both the 3-D anatomical and physiological relationships and the application of sonography equipment in students' future medical careers.[3,12] Dreher, DePhilip and Bahner[13] found that first year medical students not previously exposed to ultrasound increased their understanding of anatomy and interest in imaging following a lecture which incorporated imaging. Hammoudi et al.[14] found that second year medical students appreciated exposure to an ultrasound machine however this took place at the end of the academic year and was not a formal part of the curriculum. Other medical students were exposed to ultrasound through the use of a projector and volunteer where the image was projected to the lecture theatre.[15] Medical students found this approach to teaching anatomy "innovative".[15] Whilst these studies identified student perception of ultrasound as a teaching method, none of the studies investigated learning and teaching of using ultrasound within curriculum compared to other teaching methods. So, whilst ultrasound has been used as a teaching method of anatomy[13–16] there is limited research available that directly compares ultrasound to other methods, as perceived by the student.

This research specifically targeted sonography and medical imaging students. No research about teaching anatomy was identified featuring sonography and medical imaging students. At CQUniversity Australia, medical imaging and sonography students are taught anatomy using a combination of methods including: real-time ultrasound scanning and 2-D static ultrasound images, anatomical and imaging related textbooks, anatomical models, interactive computer programs demonstrating 3-D anatomy, didactic lectures, 2-D and 3-D post process radiological images, animal organ dissection, construction of 3-D models of anatomy using play dough and videos demonstrating learning activities such as anatomical rhymes, dances and construction of 3-D models. These activities took place in the three anatomy courses in the first year of the medical imaging and sonography programs, and students will have experienced learning anatomy using different teaching methods throughout their study. In particular, students work in small groups using a Phillips iU22 ultrasound unit to conduct real-time ultrasound scanning on a student volunteer, focussing on the neck, abdomen and pelvis. Student volunteers were required to sign a volunteer consent form and support was available in the event that pathology was identified.

Method

The purpose of this study was two-fold: firstly to assess ultrasound scanning as a teaching method of anatomy, and secondly to determine the teaching methods medical sonography and imaging students consider most effective for understanding human anatomy. Ethics approval for the study was obtained through the CQUniversity Human Research Ethics Committee.

Two consecutive cohorts of CQUniversity Australia medical imaging and sonography students were surveyed. The survey instrument was adapted from the Patel and Moxham[4] survey and the Kerby et al.[11] survey to also include real-time ultrasound scanning as a delivery method. The survey was set out in a matrix of eight delivery methods (columns) and nine learning aims (rows). The delivery methods were lectures, models, animal dissection, computer programs, videos, 3-D radiology imaging, ultrasound scanning and textbooks. The nine aims were: to impart anatomical information; to provide information for the other science courses; to provide a background for a clinical discipline; to provide an anatomical vocabulary; to provide 3D appreciation; to encourage learning from experience; to develop team skills; to develop the skill of following complex instructions; and to appreciate anatomical variation. No free text comments were obtained, because the intention was to compare the results with the previous studies where comments were also not collected.

Students placed the numbers one to six in the matrix for each method and aim, where the number one indicated that the delivery method did not achieve the aim and the number six indicated there was an excellent match between method and aim. On a scale of one to six, six was the "best fit" between delivery method and learning aim, and one was the "worst fit". The numbers in between indicated a scale, with number becoming a "better fit" as they increased in value. So the number three was a better fit than two, and so on. Students were provided an information letter and participation was voluntary. Students received instruction on how to complete the survey matrix, and the survey was conducted during class time. Students had the option of handing in the complete survey at the end of class or they could mail the survey back to the researchers if they preferred. All students who completed the survey chose to return it during the class. Surveys that were incomplete were excluded from the analysis. Over two years (2012 and 2013), 34 useable surveys were obtained.

Findings

The analysis was conducted in two parts: student perceptions of each delivery method, and preferred delivery methods in relation to each of the nine learning aims.

First, to compare the overall effectiveness of each of the eight delivery methods we summarised the data as did[4] and Kerby, Shukur, Shalhoub.[11] The scores given for each delivery method across the nine learning aims by each student were summed to give a single number within the range from 9 (i.e. if a student rated a delivery method the worst fit for every of the nine learning aims) to 54 (i.e. if a student rated a delivery method the best fit for every of the nine learning aims) per student per delivery method. This generated a reduced matrix of eight columns (the methods) by 34 rows (the students). These are related data because each student gave a score to every delivery method and therefore comparisons among delivery methods should be made with a non-parametric (e.g. Friedman) or parametric (e.g. repeated measures ANOVA) test. Previous studies (Patel and Moxham[4] and Kerby et al.[11]) used a Kruskal–Wallis test which is not appropriate because it is for independent data. The data are ordinal scale and did not show significant heteroscedasticity or lack of normality so repeated