Original Research Paper

Integration of Traditional and Innovative Methods in Anatomy Dissections: A Sri Lankan Experience.

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Abstract

Introduction: Routine methods of teaching gross anatomy including cadaver dissections have been a keystone of the anatomy curriculum and certain difficulties have led medical educationists to explore teaching using modern technology. This study aims to share the institutional experience of incorporating new methods into routine dissections at the Department of Anatomy, Faculty of Medical Sciences, University of Sri Jayewardenepura, Sri Lanka.

Methodology: Prior to dissections, recommended anatomy 3D software and videos were shown in LED panels. Mock spots were conducted weekly. Applied anatomy sessions were conducted by clinicians. Ultra sound scan (USS) based teaching sessions were conducted by a consultant radiologist. Another study area with multiple illuminators with radiological films was present. Routine feedback was taken from students.

Results: The use of LED panels for teaching was found to be helpful by most (82.6%) students. A majority (84%) also found that mock spots were helpful for their studies and 89.2% preferred the use of 3D software. Percentage 82.6% of students found USS guided teaching useful while 85.4% of students found X-ray & CT useful. Majority (91.5%) found the applied anatomy teaching sessions useful. The majority of students' comments indicated recommendations for them to be continued for future batches.

Conclusion: This initiative demonstrates that the combination of traditional and innovative methodologies in the teaching of gross anatomy is favored by students and the applied anatomy sessions can provide vertical integration of the subject.

Keywords: 3D anatomy software, applied anatomy, cadaver dissection, medical education, ultra sound scan based teaching

Introduction

Anatomy is one of the basic sciences learnt by medical students in the first few years of their undergraduate life.

A core aspect of learning anatomy involves gaining knowledge of the body organs and systems and their spatial relationships. Cadaver dissection has been the first and foremost way of learning the anatomy of the human body for millennia and is still widely used in medical schools. Apart from this, other methods such as lecture-based teaching, use of models and prosected specimens too have been utilized and, together with cadaver dissection, make up the bulk of anatomy teaching (Hu *et al.,* 2018).

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Medical education is undergoing a revamp with constant evaluation of the curriculum in order to ensure that students graduating from medical schools are equipped with the knowledge, skills and attitudes necessary to weather the rapidly evolving field of medical practice. As such, even the practice of cadaver dissection is a debatable question at the moment to determine whether it is really essential for students to understand the subject of human anatomy (Hu, *et al.,* 2018; Ghazanfar *et al*., 2018). Although cadaver dissection has traditionally been regarded as a cornerstone of learning gross anatomy, its prominence has declined over time. Maintaining a dissection laboratory is a considerable financial undertaking and cadaver-based teaching is more time-consuming and requires more human resources than newer approaches to anatomy teaching (Ghosh, 2017; Ghazanfar *et al.*, 2018).

Various new methodologies have been introduced to enhance the anatomy curriculum as more emphasis is placed on clinical correlation of the subject matter from the start of the basic sciences modules themselves. These include virtual dissection laboratories, 3D animations and other electronic resources such as PowerPoint presentations and videos (Ghosh, 2017; Hu, *et al.,* 2018). These technologies can be used by lecturers for teaching as well as for self-learning sessions by individual students as most programs could be accessed via smartphones and computers. In addition, applied anatomy teaching sessions conducted by clinicians are also used from pre-clinical phase to lay the foundation for clinical teaching. Additionally, the use of ultra sound scans to give the students a visualization from another perspective is used to establish a better understanding of the human anatomy, alongside the facilitated access to commonly seen x-ray and CT films of both normal and pathological anatomy.

Both traditional cadaver dissections as well as newer technology-based approaches to the teaching of gross anatomy have their merits and drawbacks. However, the use of one approach should not exclude the possibility of using the other as studies have revealed that the use of these techniques concurrently has more benefit than the use of either alone (Hu, *et al.,* 2018). Therefore, medical schools should pay closer attention to incorporating both cadaver dissections and technological resources to the teaching of gross anatomy. Cadaver dissection provides an authentic experience of learning anatomy with prominence given to visuo-tactile mode of learning (Hu, *et al.,* 2018; Flack & Nicholson, 2018). This can be supplemented by clinical-oriented anatomy teaching and technological innovations to provide holistic education.

The aim of this pilot project is to incorporate interactive 3D digital animations and cadaver-based applied anatomy sessions to traditional cadaver dissections as a teaching methodology.

Methodology

Procedure

Three dimensional (3D) LED panels measuring fifty-five inches in width were installed in the dissection halls and commercially available recommended anatomy software and videos were purchased. The Human Anatomy Atlas 2017 by Visible Body® includes both male and female gross anatomy models, select microanatomy of tissues and organs, cadaver slices and diagnostic images that are paired with 3D cross sections and interactive animations of muscles and bones. It contains 3D models of 11 systems. The dissection schedules were given to the students in advance. In the initial 15 minutes of the dissection session, an overview of the area to be dissected was summarized using the 3D software (Figure 1). The students were then directed to their respective dissection tables. These cadavers had been donated to the faculty with consent from donors prior to their demise for teaching and research purposes. Whenever an anomaly was found in a cadaver, it was telecast using the LED panels so that the students at other dissection tables too could observe it. During sessions on cross-sectional anatomy, the human cadaver cross-section was displayed on the dissection table while demonstrating the exact similar cross-section with labelling on the installed panels (Figure 1).

The computed tomography (CT) scan image of the relevant cross section was also displayed simultaneously to provide radiological anatomy knowledge. Weekly mock spot examinations were conducted using these panels to familiarize students with the examination format. Clinicians were invited on occasion to conduct mock viva voce examination to improve the presentation and communication skills (Figure 2). In addition, applied anatomy cadaver-based teaching was conducted by an invited clinician once a week (Figure 2). The software, videos and other learning material were made available at the IT laboratory for free student usage (Figure 3).

Figure 1 (A). An overview of the area to be dissected was provided prior to the session. (B). Cross sectional anatomy was demonstrated using prosected specimens and 3D software

Figure 2 (A). Mock viva voce examination conducted by clinicians. (B). Applied anatomy sessions conducted by clinicians.

Figure 3 Students were given access to software, videos and other learning material at the IT laboratory

Keeping with current trends in medical education, teaching sessions using USS was commenced. This was the latest augmented teaching component added to anatomy teaching. Students in small groups took turns during the dissection sessions. The relevant regions were described where they could witness the functional and anatomical integration. These sessions were conducted by a consultant radiologist (Figure. 4).

Students were able to correlate the gross structures seen during the dissection sessions and the real time functional importance of the relevant organs and systems. A clearer picture of the blood flow to the systems, functions of cardiac valves and placement of organs in potential spaces would be hence be available to the students, which would aid in their anatomy education.

Figure 4 Students being taught by the consultant radiologist

Furthermore, a dedicated imaging room was reserved with multiple illuminators and a variety of X-ray, CT and MRI films, ranging from normal to pathological, with free access to all students, given with the idea that everyday clinical application of anatomical knowledge in investigations is practiced in routine teaching.

Routine departmental feedback was obtained from 213 students who had finished their pre-clinical years to assess the effectiveness of the change in anatomy teaching. Students were instructed to rate their experiences on a Likert scale of 1-5 in response to questions about the new teaching methodology and also to provide their comments regarding the same. Response 1 and 2 of each question were considered as inadequate or dissatisfactory. The response "3" was considered neutral and response 4 and 5 were considered as adequate or satisfactory.

Results

Overall feedback regarding the use of LED panels for teaching was encouraging, with 176 students (82.6%) finding it helpful. A majority of students [179 (84%)] also found that conducting mock spots using these panels were helpful for their studies and 190 students (89.2%) preferred the use of 3D software during dissection sessions. Students were asked to mention which areas were best taught using the 3D software and head and neck region and neuroanatomy were named as the two areas that were best explained in this manner by 62 and 42 students respectively while 21 students mentioned all anatomical areas. The student's preference for areas taught via this manner is illustrated in Figure 5. Out of 213 students, 195 (91.5%) found the applied anatomy teaching sessions to be useful.

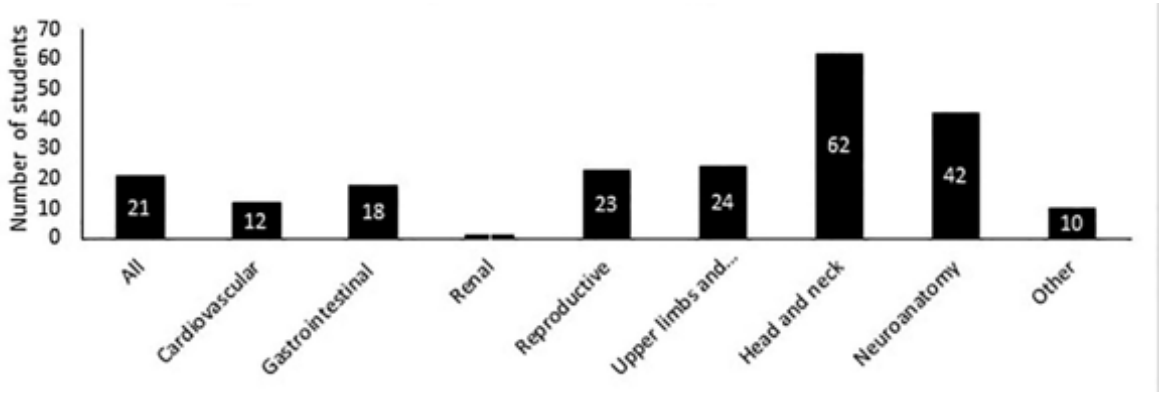

Figure 4 Students' preference of areas taught via 3D software

A majority of 83% which amounted to 176 students of the participating 213 found that the aid supplied with the USS teaching sessions was helpful in the learning process, while 182 (85.4%) claimed that regular viewing of x-ray and CT films alongside the dissections was beneficial.

Student's comments regarding the change in anatomy teaching and their suggestions for improvement are included in the discussion.

Discussion

The results of this study suggest that a majority of the students found the innovative methodologies to be useful in the study of anatomy. These innovations were introduced in the background of existing traditional techniques of teaching anatomy such as cadaver dissection, didactic lectures and the use of prosected specimens and models. Overall, most students preferred the integrated approach to learning anatomy and welcomed it as a refreshing change to the curriculum.

The use of 3D software in the dissection halls as an introduction to the area before engaging in cadaver dissection has been the most technologically advanced innovation carried out during this study. Students' comments indicated that they regarded it as one of the greatest assets to be introduced into the anatomy curriculum and that it helped them get

a clear idea of the area to be dissected prior to the session. They also found the 3D view more helpful to carry out the dissection rather than the 2D view in textbooks. Almost all of the comments about weaknesses of this approach were about technical difficulties such as the lack of an adequate number of LED screens to accommodate the entire batch of students. Inwood and Ahmad (2005) reported that students who used multimedia dissection software found it convenient and that it enhanced their dissection experience**.** A study done in Canada integrated virtual dissection laboratories into a cadaver-based anatomy course and assessed the students' response to the changes. Students reported a positive learning experience and found the introduction of virtual technology to improve their understanding of cadaveric anatomy (Darras *et al*., 2019).

Demonstrations of US scanning have been used to teach living anatomy with reported success in terms of student satisfaction and anatomical knowledge gained/understood (Fernandez-Frackelton *et al.*, 2007; Brown *et al.*, 2012). In the present Sri Lankan very 1st USS based anatomy teaching from preclinical years, there is an 83% positive attitude towards the new addition. However, Finn *et al* (2012) report that there is no additive effect of combining cadaveric prosections with ultrasound scan-based teaching. When it came to the imaging modalities incorporation in our setting, the comments were highly positive, with special mention of how teaching from the consultant radiologist enhanced the learning activity. Students found that they could clarify their queries and at the same time get a new perspective of the learnt anatomical details.

The free access to the X-ray and CT films where the students were able to explore, discuss and understand the views of the images that they come across often and the responses from students highlighted the fact that this self-learning experience helped to make the learning activities more interesting.

The applied anatomy sessions were met with great enthusiasm from the students. The clinicians who participated in these sessions were able to provide vertical integration to the content taught in anatomy, and stress on the important areas which would be useful to the students further along in their medical student journey. Such vertical integration and surgeon educators have been identified to be effective but underutilized resources in the teaching of anatomy (Hu, *et al.,* 2018). Most respondents of this study were of the idea that these interactive sessions shed light on clinical applications of what they study in the dissection halls. One comment mentioned that "it's always helpful to know where your knowledge will be applied in real life rather than blindly learning the content for exams".

Studies that focused on the efficacy of e-learning resources found them to be generally favourable in that they were easily accessible to students in their own time and improved understanding of anatomical structures (Choi-Lundberg *et al.,* 2016; Park *et al.,* 2019). In this study, respondents had mixed reactions to the e-resources with the balance more towards the favourable side. Students appreciated the opportunity to access resources at the IT laboratory and admitted that these were helpful to them in their studies. However, a considerable proportion of students expressed that it would be more useful if these resources were available to them during dissection sessions. The e-learning resources may have been utilized more if they were available to students on their personal devices as the process of visiting the IT laboratory to access them appears to be a deterrent to their use.

Considering the results of this study, it is evident that these novel approaches to the teaching of anatomy have been warmly welcomed by the student population. It is of essence then to consider the impact of these findings on the future of anatomy teaching in medical schools. The practice of cadaver dissection is considered to be irreplaceable in the study of gross anatomy even with the advent of modern technology-based teaching methodologies (Ghosh, 2017; Darras *et al*., 2019). This view is held not just by educators and clinicians but also by students who believe that cadaver dissections provide them with an immersive educational experience that cannot

be replicated by any modern technology 2018; (Ghazanfar *et al.,* 2018; Flack and Nicholson, Jeyakumar *et al.,* 2020). Therefore, it is at the discretion of educators to strike a balance between the use of traditional and innovative methodologies in the curriculum in order to reflect the learning needs of their students (Ghazanfar *et al*., 2018).

Studies have found that integrated curricula offer more in terms of competency and test results when compared to the use of either traditional or modern techniques alone (Hu, *et al.,* 2018). Students' suggestions on further improvement of the anatomy curriculum indicated that they preferred more applied anatomy sessions and the continued use of 3D anatomy software. These ideas should be incorporated when updating the current curriculum as students have reported increased understanding of difficult anatomy concepts, improvement of their test scores and very importantly, a heightened interest in the subject of anatomy.

One of the main limitations of this study is the lack of objective data to assess the impact of the integrated approach to teaching gross anatomy. The students' perceptions were assessed and found to be generally positive. However, the feedback did not collect any measurable data such as test scores to analyze the students' subsequent performance at examinations. Further research could also be carried out to include students further along in their medical student pathway to in order to evaluate how these curricular changes helped them in their paraclinical and clinical subjects.

Conclusion

This pilot project demonstrates that the integration of traditional methods of teaching anatomy and newer methods such as the use of 3D anatomy software, e-learning resources and imaging modalities for teaching and conducting applied anatomy sessions are preferred by a majority of students. The innovative methods were found to be complementary to the existing methodologies and act synergistically to improve the anatomy knowledge of students and enhance their interest in the subject. These new methods can be easily adapted by any medical faculty and should be considered in curriculum revisions.

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