The Role of Imaging in Teaching Anatomy to Radiography Students: A Preliminary Study

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Abstract

Background: Teaching radiographic anatomy to radiography students is an important component as it relates anatomical studies to clinical medicine and the same time prepares them for the radiology they will encounter in their clinical years.

Objectives: The aim of the study is to assess the role of radiological imaging in teaching anatomy.

Materials and Methods: This is a descriptive, cross-sectional study involving 200 and 300 levels radiography students of Usmanu Danfodiyo University, Sokoto. Self- administered questionnaires were given to the students, which they filled and returned. Data obtained was analyzed using EXCEL.

Results: A total of 62 (28 second and 34 third year) radiography students participated in the study. In assessing the perception of students, 38 (61.3%) had lecture on imaging use in teaching anatomy and 23 (37.1%) had not and 3 (4.8%) not responded. Out of those that had lecture, 13(20.9%) had one, 4 (6.5%) had two, 5 (8.1%) had three and 14 (22.6%) had more than three. On the usefulness of imaging techniques, 58 (93.5%) found it useful and 2 (3.2%) as not useful. 50(80.6%) rated it as very useful and 8 (12.9%) as useful. Majority of the respondents, 59(95.2%) were aware of the radiology specialty and 44 (70.9%) intended to specialize on it. Radiography and ultrasonography were found to be the most useful imaging techniques by 23 (37.1%) of the respondents. 57 (91.9%) of the respondents thought there is need to increase the use of imaging in teaching anatomy.

Conclusion: There is poor understanding of radiological imaging amongst undergraduate radiography students. There is an urgent need to increase awareness and teaching methods of radiological imaging among the students.

Keywords: Radiological Imaging, Teaching Anatomy, Radiography, Students.

Introduction

Human anatomy is one of the basic sciences in medical studies. Since the advent of x-rays to the present day, visualization techniques to image the human body have become an essential tool for diagnosing and treating multiple diseases. Human Anatomy has always been one of the core sciences in medical studies. If anatomical information is fundamental to medical studies, it is indispensable to the training of specialists in diagnostic medical imaging. Diagnostic medical imaging techniques include conventional radiology, ultrasonography, helical or multidetect computed tomography (CT) and magnetic resonance imaging (MRI). Each of these techniques is described in terms of its relevance and usefulness to clinical and anatomical studies. The different ways in which CT and MRI present information: multiplanar reconstruction (MPR), maximum intensity projection (MIP), 3D, volume rendering (VR), and virtual endoscopy. In particular, VR is a very important method for understanding cross-sectional anatomy because it affords a perfect perspective of all body structures on different spatial planes, so the fact that the cross-section can be 3-dimensionally viewed makes it a particularly attractive and illuminating technique. Virtual endoscopy provides images that until very recently were unavailable [1].

Recent years have witnessed curricular changes in how anatomy is taught to medical students to meet the challenges posed by advances in the field of medicine [2]. New learning strategies have emerged worldwide for revamping the anatomy curriculum [3].To effectively utilize radiological images to teach spatial anatomy, conventional CT

scan films, wherein the images are very small, measuring only 70 mms × 70 mms is unsuitable [4]. 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 [5].

Vertical integration and system-based learning are now central components of the curricula delivered to medical students [6-16]. Reported benefits of these methods include improved student learning, increased student satisfaction and interaction, enhanced applied knowledge and ultimately, greater preparedness for post-graduate employment. Anatomy remains a core topic for 1st-year medical students in this new environment, but the volume and method of delivery has changed such that problem-based and self-directed learning (SDL) are utilised to a greater degree than previously [6,16-19]. In addition to this, imaging anatomy is increasingly acknowledged as important and the rapid advancements in cross-sectional imaging, including developments in computed tomography (CT) and magnetic resonance (MR) angiography, venography and cholangiography, now means that these images represent powerful tools for teaching human anatomy. As a result, at many medical schools there are moves to develop modules in imaging anatomy and for clinical radiologists to deliver modules in small and large group sessions. These developments are particularly seen in postgraduate/graduate entry medical programmes [20-25].

Traditional medical school training consists of two years basic science component, which focuses on classroom based courses in anatomy, physiology, histology, biochemistry, microbiology, immunology, pathology and pharmacology. The application of the basic science knowledge to diagnosis and management of real patients occurs during the two years of clinical clerkship [26].

In Paul L Foster School of Medicine Curriculum, basic science disciplines are integrated with clinically relevant information from the very first day. For example, anatomy is transformed into a course combining laboratory-based teaching, imaging technology and advanced clinical diagnostic tool. The radiology component includes use of computed tomography (CT) scans of each cadaver at the dissection table, and three-dimensional (3-D) ultrasound scanning of the cadaver prior to dissection of every region. Through 3-D ultrasound visualization of human organs, students improve their understanding of anatomy and better assimilate basic science material [26].

Imaging methods play an essential and increasing role in modern medicine. Indeed, may be said that the pathological picture is no more than a variation or distortion of the anatomical picture. Medical students, physicians in general, and specialists in particular must understand anatomical images to be able to identify pathologic conditions, control the results of their treatments, and monitor the progress of their patients. Cadaveric ultrasound may also be used in training and evaluation of medical practitioners who are training in diagnostic ultrasound, and those who are entering the field of ultrasound guided procedures. The use of imaging prior to dissection is very useful in training internal medicine, obstetrics and gynaecology, anaesthesiology, orthopaedic and surgery residents. There are multiple purposes of cadaveric CT and ultrasound. They inform prosectors about any pathology and foreign bodies that may interfere with dissection process [27-28].

Diagnostic images are simply depictions of anatomy, and the interpretation of these images requires a solid understanding of anatomy and its normal variants. Diagnostic imaging has the ability to exquisitely display anatomy in 2 dimensions. The emergence of picture archiving and communication systems (PACS) and software capable of complex image post processing now allows instructors to display 2-dimensional (2D) and 3-dimensional (3D) digital images for the purpose of anatomy teaching. This has led some undergraduate medical faculties to involve imaging modalities and radiology department personnel in their anatomy teaching in light of increasing curriculum pressures [20,29-32]. This has aided in narrowing the gap between basic anatomy and clinically relevant anatomy, which many believe has been lacking [33]. Furthermore, the inclusion of imaging anatomy has been shown to be advantageous for students in their future careers [34], and this approach has already been implemented in medical schools around the world, including Germany [26,35], Brazil [34], England [36], and Turkey [37]. It has also sparked many

studies that concern inter-institutional reviews of anatomy teaching processes for best practices in Ireland, the United Kingdom, and the United States [38-39] A recent review of the use of computed tomographic (CT) imaging of cadavers juxtaposed with cadaveric dissection [40], further enforces the utility of the integration of radiology into anatomy teaching by deploying the appropriate hardware and software to deal with the DICOM-based images generated by modern CT scanners. The investigators reinforce the previously mentioned strengths of this strategy, but they also demonstrate improved performance on objective evaluation tools applied to the anatomy curriculum [40].

Imaging was most commonly used to learn radiological anatomy (94.5%). Procedural observation was most commonly used to learn laparoscopic (89.0%), endoscopic (87.3%) and endovascular anatomy (66.2%). Imaging was the most recommended method to learn radiological anatomy (92.1%). Procedural observation was the most recommended method for learning laparoscopic (80.0%), endoscopic (81.2%) and endovascular anatomy (42.5%). Specialist trainees and specialists recommended introduction of specialist anatomy during undergraduate training [41].

An increasing number of computer assisted learning tools (CAL) have been introduced to fill in the practical aspects of teaching human anatomy[42-44]. In the absence of cadaveric dissection, prosected specimens have increasingly been used in teaching anatomy to medical undergraduates [19]. Newer techniques like plastination have been developed and used increasingly. With the advent of sophisticated imaging modalities such as 3D CT reconstructions, high resolution cadaveric CT scans have found its way to anatomy laboratories [45]. Introduction of ultrasound in anatomy teaching session has been received with much enthusiasm [46].

Demography: Male female distribution and mean age were nearly equal in both groups. Scores for spatial anatomy (SA) and radiological anatomy (RA) as well as the cumulative scores (CS) were higher among the test group when compared with the control group. Differences observed among the scores were statistically significant ($P<0.05$, CI 95%) [47].

Majority of the students in both control and test groups agreed that cadaveric cross section may be useful for them to understand spatial and radiological anatomy (97.6% and 98.7%, resp.). Similarly vast majority in both groups (control 97.6% test 97.4%) also thought that radiological imaging may be used more often as adjunct to teaching anatomy [47].

Materials and Methods

Study Design

This is a descriptive, cross-sectional study involving 200 and 300 levels radiography students of Usmanu Danfodiyo University, Sokoto. A total of 62 (28 second and 34 third year) radiography students participated in the study. All students were informed of the purpose and ethical approval status of the study. Questionnaires were distributed by hand to students at the beginning of each assessment and collected at the end of the session. Self- administered questionnaires were given to the students, which they filled and returned. The survey was designed by a multidisciplinary team of anatomists, clinical radiologists and medical educators. A large survey was designed which extensively evaluated perceptions of radiology in anatomy teaching. Data collected pertained to student demographics, preferred anatomy learning methods, opinions regarding radiology as a specialty and understanding of imaging modalities. A closed format was used, utilizing mainly multiple choice questions, for ease of analysis and binomial "yes/no" questions were utilized.

Data were coded and converted into appropriate variables and entered manually into an Excel spreadsheet. Data were then exported to the Statistical Package for Social Scientists version 20 (SPSS, IBM, Chicago, Illinois, USA).Descriptive and inferential statistics were employed. Independent sample t-test was used to investigate the role of radiological imaging in teaching anatomy were used to analyze the data and detect associations, where appropriate. P-values of ≤ 0.05 were considered to be statistically significant.

Results

Demographics of respondents and opinions on SDL

The response rate was 99% (61/62). Almost two-thirds (60 %) of participants were male and the median age of respondents at the time of the survey was 20 years (range, 18–38 years). All the students in this direct entry programme had no previous degrees.

Students' perception on imaging lecture

Students were asked for their perception on imaging lecture, which showed that 38 (61.3%) had lecture on imaging use in teaching anatomy and 23 (37.1%) had not. Out of those that had lecture, 13(20.9%) had one, 4 (6.5%) had two, 5 (8.1%) had three and 14 (22.6%) had more than three as shown in Figure I.

Students' perception on the usefulness of imaging techniques

Students were assessed on the usefulness of imaging techniques by way of rating, and showed 58 (93.5%) found it useful and 2 (3.2%) as not useful. 50(80.6%) rated it as very useful and 8 (12.9%) as useful.

Understanding of clinical radiology techniques

Students were asked as to the various imaging techniques they know about within a hospital and clinical radiology setting and found out that radiography and ultrasonography were found to be the most useful imaging techniques by 23 (37.1%) of the respondents. (Figure II)

Clinical radiology awareness and intention as a specialty

Students were asked opinions on their awareness on radiology specialty in radiology, 59 (95.2%) were aware of the radiology specialty and 44 (70.9%) intended to specialize on it in keeping with a significant decrease in interest (p=0.003).

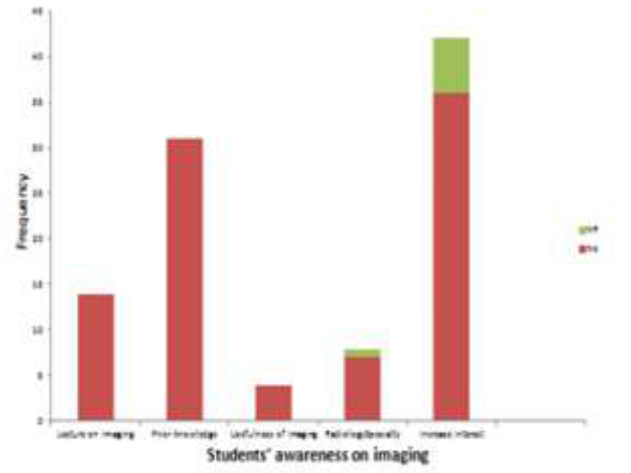

Figure I: 200 level Radiography Students' Awareness on Radiological Imaging

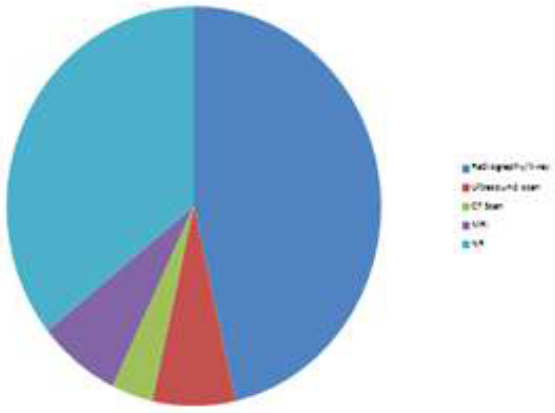

Figure 2: 200 level Students' knowledge of radiological imaging options

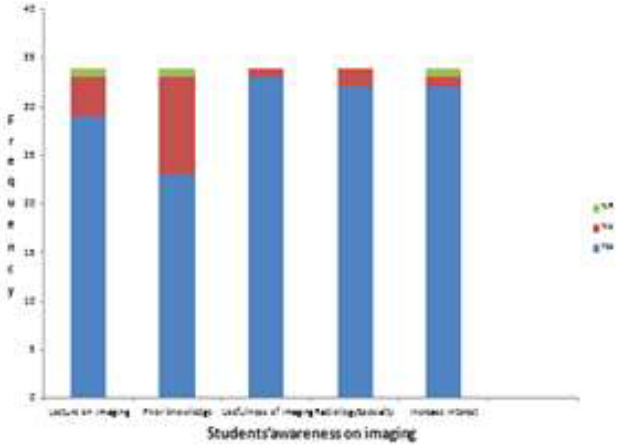

Figure 3: 300 level Radiography Students' Awareness on Radiological Imaging

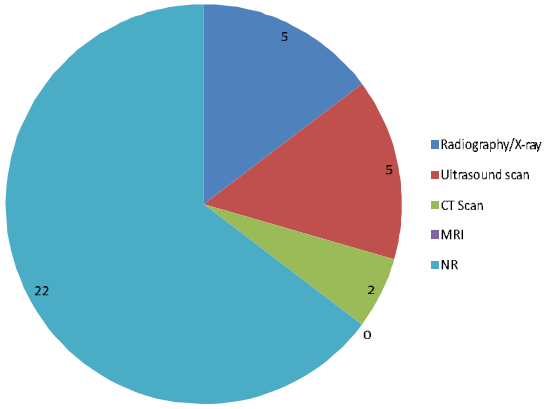

Figure 4: 300 level Students'

Discussion

Student's knowledge regarding perception on imaging lecture, radiology as a clinical specialty and regarding awareness of the usefulness of imaging techniques as well as their knowledge on various imaging techniques. Students perceived their attitude towards lectures on imaging, clinical radiology as an important specialty and the majority of students were interested in radiology,

though, unlike other studies, the numbers interested in the specialty significantly decreased compared to previous studies conducted by Kevin *et al* [48]. The number considering radiology as a career showed an insignificant improvement in their intention.

One could argue that the results are not unexpected given that radiological anatomy was the main focus of this teaching module and that clinical radiology was not the focus of the module especially to the radiography students. One could argue that integration of an imaging anatomy module into the anatomy curriculum is challenging in the pre-clinical context when students do not have experience of hospital procedures and basic awareness of the pivotal role of imaging in clinical diagnosis. There is an obvious potential for information overload when students are confronted with new concepts and terminology (angiography, cholangiography, contrast examinations) and the many minimally invasive and more invasive ways of acquiring these images (CT angiography, MR angiography, conventional angiography, MR cholangiopancreatography [CP] and endoscopic retrograde [ER] CP). Once clinical rotations commence, however, students gain first-hand experience of everyday medical practice and the roles of various medical specialties and subspecialties; learning is gradual through observation and tuition. These issues have implications for planning of vertical integration and curriculum design. Analysis of the study findings amongst anatomists and clinical radiologists who participated in the study led to the conclusion that education of medical undergraduates in imaging and clinical or applied anatomy is important, but that further modules in clinical and imaging anatomy should be integrated into modules in clinical medicine, surgery and radiology at a later stage in the undergraduate curriculum, when familiarity with imaging examinations will be much greater. As innovative medical education incorporating cutting edge medical imaging into anatomy, embryology, physiology and pathology courses during the first and second years of medical school will help the students to practice efficient and cost-beneficial medicine tomorrow [49].

A follow-up study of this cohort, to examine alterations in career aspirations, is planned to ascertain if student perceptions of radiology as a career change over time and to assess the impact, if any. In conclusion, knowledge of roles within a clinical radiology department showed little change on follow-up. A possible explanation is that students recall knowledge imparted in didactic lectures but do little reading around the subject. It is obviously easier to incorporate imaging studies into anatomy if there is someone on staff who is specifically trained in radiology, one who understands how the imaging can be used to its fullest potential. In a study by Erkonen *et al*[39] as well as in subsequent studies, it has been stated that, if radiologists do not formally teach radiology to students, then non-radiologists will [50].

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