

BODIES DO MATTER: RETHINKING ANATOMICAL PEDAGOGY, FROM THE SCALPEL TO THE MOUSE: A REVIEW

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ABSTRACT

Anatomy and dissection have long been considered a cornerstone in medical education, irrespective of nation, racial background or medical school. By learning gross anatomy, medical students get a first “impression” about the structure of human body which is the basis for understanding pathologic and clinical problems. Anatomy teaching methodology has been revolutionized in the 21st century, due to time constraints, less availability of cadavers, stress on computer aided learning, scarcity of qualified teachers, changes in the demands of medical profession and neglect of vertical integration of anatomy teaching. Until recently, dissection and didactic lectures were its sole pedagogy, worldwide. But over the last few decades, traditional anatomy teaching based on topographical structural anatomy taught in lectures and gross dissection classes has been replaced by a vivid range of study modules like problem based learning(PBL) and computer assisted learning(CAL),and curricula integration. Though the anatomy curriculum is undergoing international reformation but it lacks uniformity among institutions. The available modern international literature, describing various methodologies for teaching/learning anatomy conclude that Anatomists are constantly debating over the following questions-How much to teach, when to teach and how to teach gross anatomy. We endeavor to answer these questions and contribute to the debate on the ideal methodology for teaching /learning anatomy. Alternative strategies and resources are also discussed so that we can re establish more effective teaching /learning tools while maintaining the beneficial values of orthodox dissection .If we are not concentrating on optimum anatomy education, it will inevitably lead to incompetent anatomists and healthcare professionals, leaving patients to face unwanted consequences of medical error.

KEY WORDS: Dissection, gross anatomy, Problem based learning (PBL), Computer assisted learning (CAL), curriculum.

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INTRODUCTION

In his Student's Guide to Anatomy in 1961, David Sinclair emphasizes the potential benefits of dissection to the character and intellectual development of students and doctor [1].

“The study of anatomy develops qualities which are essential to everyone who has to deal with patients, and many of these qualities are not called upon to the same extent by any other discipline in the professional curriculum. It is in

the anatomy department that you learn the vital lesson of observing instead of passively looking, and it is also here that you slowly and painfully acquire the habit of exactness of speech, of saying what you mean and meaning what you say. You have to learn to express yourself in public and to think on your feet instead of merely accepting what you hear or read."

"For doctors, the human body is the focus of investigation and intervention on a daily basis"(Turney 2007) [2]. Both anatomists and clinicians agree that accurate knowledge of anatomy and individual variations is vital to ensure safe and efficient clinical practice. In ancient Egypt, dissection (actually a crude autopsy) was a religious ritual required as a rite of passage to the kingdom of dead [3]. First medical school was founded in Salerno, Italy in 1235, followed by Padua (1490) and Bologna (1637) during the Renaissance period. The era of scientific human anatomy is highlighted by the publication of the main opera from Andrea Vesalius (von Wesel), the real father of modern anatomy [4].

Till the end of 20th century, dissection was the core of anatomy learning. Defining the exact anatomical site of a lesion was considered crucial for the physicians as well as surgeons for resolving the problem effectively. Gone are the days when hundreds of hours of dissection alone were believed to be essential for proving medical competency. Many institutions have officially deemed conventional cadaveric dissection obsolete in lieu of model substitutes and computer assisted learning [5].

Anatomy education has been persistently controversial with disputes over its significance and its teaching standards. Unfortunately, national and international publications have alarmingly highlighted the problem of decreased anatomy knowledge of today's medical students. Also, quality of anatomy teaching has fallen below the optimum level. This fact is echoed by Warner and Rizzolo (2002) [6] and Turney (2007) [2]. Present Scenario: At present, the most prevalent pedagogy consists of didactic lectures, which discuss gross anatomy, while navigating students around the body with clinical photographs and computerized animations. Having established lectures as the basic

framework, students are expected to consolidate their learning process by atlases, skeleton models, fiber models as well as computerized aids. This type of teaching style is actually the Teacher centered approach defined as "A style of instruction that is formal controlled, and autocratic in which the instructor directs how, what and when students learn." (Dupin- Bryant) [7] On the other hand Learner centre style is "A style of instruction that is responsive, collaborative, problem centered, and democratic in which both student and the instructor decide how, what and when learning occurs." Brandes and Ginnes [8] quoted "the main principle of student centered learning is that the learner is fully responsible for her/his learning and teacher is a facilitator and resource person." The net result of student centered approach should be an individual who is potentially a lifelong learner. Medical education reforms documented in "Vision 2015" proposal of MCI (Medical Council of India) declared adoption of contemporary education technologies such as e-learning, simulations, skill labs etc. and stressed on self directed learning (SDL) in order to produce lifelong learners committed to continuous improvement of skills and knowledge. Medical educators over the globe are continuously debating over the fact, that, weather the orthodox teaching method of formal lectures followed by dissection should be replaced by student centered approach with newer modalities like Self-directed learning (SDL), Team based learning (TBL), Problem based learning (PBL), and Computer assisted learning (CAL) [2]. In the present article, we have tried to analyze the role and effectiveness of various teaching/ learning modalities of this colossal subject in the present scenario.

METHODS

The present article is a review article based on literature search. Key words were selected for each topic and used to search Pub med and Medline. All searches were limited by English language and publication date (1950-2015). The articles were published in educational, anatomical, surgical, radiological or general medical journals (like The Lancet, British Medical Journal). Most articles were retrieved by a search for keywords in the title, others by

scrutinizing references of relevant articles. The titles and abstracts of the retrieved articles were screened after which the potentially relevant articles were printed. A thorough analysis of the printed articles helped us to elucidate the exact scenario of teaching /learning anatomy, factors influencing it, effectiveness of newer methodologies as well as usefulness of the integrated curriculum. Whole research work was summarized into five factors regulating the role of teaching /learning anatomy in the digital world. Finally we discussed the findings and present conclusions with recommendations for further research.

Significance of Anatomy education: Anatomy provides a platform of knowledge indispensable to all the segments of medicine. The principles of anatomy are best taught during dissection, further consolidated by modern visual aids. Anatomy, like any other taught modules, needs to be constantly revised and examined to demonstrate competency, especially when integrated into the clinical setting as students and even after graduation (Moxham and Plaisant,2007)¹⁰. Yet, graduates are expected to retain and rely on the knowledge from their preclinical years for the rest of their careers. Gross anatomy is highly regarded by students as being clinically relevant compared to other subjects [11]; but with dilemmas like the increasing number of new medical schools particularly in developing countries like India [12,13], shortage of cadaver donation and their preservation [14], medical faculties are thinking of eliminating the dissection laboratory altogether in favor of teaching conventionally undermined skills, like professionalism [15]. As the future of surgery in economically developing countries heads towards super specialization and minimally access interventions, anatomical details previously regarded as minor have become significant to the success rate of operations [16]. Yet, the foundations required for budding endoscopic surgeons do not correlate with the importance given to anatomy today.

I. Lectures: Didactic lecturing in anatomy education is as traditional as dissection itself and provides a summary of the learning objectives for students but may seem outdated

to many [16]. Although lectures are thought to be largely passive, they can be specially effective for providing huge information to a large group of students in a small time. Lectures also serve an important and effective way of communicating the enthusiasm of the teachers to the learners, thereby motivating them [17]. Till date, lectures continue to remain the most common teaching method in contemporary undergraduate medical education. Nevertheless, in traditional lecture style, the teachers deliver information with minimal student involvement. It encourages memory retention rather than thinking, understanding and problem solving. Traditional lectures that encourage passive learning are still the mainstay of teaching in Indian medical colleges. Three styles are in vogue-1) Conventional chalk and talk method 2) Use of overhead projector (OHP) and 3) Power point presentations (PPT). During chalk board lectures, students get ample time to take down notes, draw diagrams as well as follow the lesson, ensuring active participation of learners. However disadvantages of this method are illegible hand writing of teachers (sometimes) and more time required to deliver the same information as compared to OHP or PPT [18].

In OHP and PPT, teacher can prepare the oral and visual material well in advance. Mayer and Anderson [19] reported that in PPT, the ability to integrate the text, pictures, videos and animation is a big advantage and it enhances the learning process. It has been reported that an educator is most effective when the text is placed adjacent to picture/diagrams and is spoken simultaneously (spatial contiguity effect) resulting in better integration and retention of knowledge [19]. However, PPT usage does not promote interaction or critical thinking. Student sits passively, just watching without taking any notes or interacting.

Various research works suggested lecture as the best style of teaching if it is complimented by two or more learning methods. Irrespective of the methodology used, our target should be to make our lectures impressive, so that students are encouraged to think actively about the topic, to raise questions and to respond. Some simple activities, when introduced into the lecture session, encourage student engagement during

the lecture and raise long term retention of the subject ,like: quizzing the student ;asking them to find out the anatomical basis of a clinical problem ,by applying the lesson taught in the class; role playing by students; writing and drawing in lecture work books and use of electronic audience response systems(ARS) [20]. ARS not only engages listeners but also has equally gained wide acknowledgement for effectively allowing students to self assess their anatomy knowledge. Along with real time feedback, using ARS demonstrated a statistically significant positive correlation with student performances in summative examinations [20]. Abovementioned student centered approaches, shifts the focus from teaching to learning thereby promoting a learning ambience, essential for learners to become self directed, independent, and critical thinkers.

II. Dissection/Prosection: Cadaveric dissection allows the first visual and tactile experience of 'Human life' for aspiring health professionals. From ancient times, dissection/ prosection, have been considered the very essence of anatomy teaching. After Renaissance, anatomy ascended to a prominent position in the medical curricula and human dissection was performed as a sacramental procedure that illustrated the dissertations of honored ancient authors. Thus pedagogical merits of dissection have already passed the test of time. The study of gross anatomy requires two learning strategies: Memorization of vast technical terminology and visual recall of three dimensional relationships of various structures in human body. Hands on teaching with anatomy specimens (through dissection/prosection permits the first experience of the structural organization of the body and leads to a real understanding of 3D configuration of patient's anatomy [21]. Active observation and participation in cadaveric dissection also promotes both psychosocial development and attitudes towards professionalism and team work [14,16]. The first contact of medical students with professional values, occurs during first year in the dissection hall. Here they learn the art of self directed learning (SDL), team building, cooperative learning and the respect for human life. Lempp [22] studied the reactions and outcomes that undergraduate

students described about their own experiences and found that majority of the students really appreciated the close personal supervision of the anatomy demonstrators and more experienced non teaching staffs as well as the opportunities to learn together in small groups. Dissection has its obvious limitations, such as not being useful for teaching various important areas like skeletal/nervous system and muscular anatomy in contracted state. Therefore alternative tools came into vogue, like articulated skeletal models, radiology films, computer simulations, plastinated models and Thiel embalmed bodies.

Introduced by Von Hagen's et al (1987) [23], Plastination is a novel technique of tissue preservation of entire body, some organs or cross sectional body slices [12]; using polymers like resin, polyester and silicon in order to create life-like specimens, which can be used in teaching gross anatomy and radiology [12]. Plastination, therefore allows realistic views of anatomical concepts that are simply too difficult to describe while maintaining bodies' natural variance or pathology that, instead, plastic models lack. Conversely, some recent studies reveal that students who were trained only on prosection or plastination believe their anatomical knowledge to be misleading and ineffective [12]. Secondly, a new method of embalming bodies named Thiel method is worth mentioning. Developed by late Professor Walter Thiel [24] at the University of Graz (Austria), thiel embalming looks a promising training tool in the field of anatomical surgery.

Advances in science and information technology, newer medical diagnostic techniques and various methodologies available for teaching anatomy, have stimulated the discussion regarding importance of dissection as a teaching tool. Studies comparing the utility of cadaveric dissection against the use of multimedia programs, virtual bodies etc have suggested retaining dissection supplemented with novel multimedia techniques [19]. Amadio [25] reported that the cadaveric dissection is the only tool that gives the students an appreciation of the natural variety of human structure as opposed to virtual cadavers. Moore [26] in his article "To dissect or not to dissect" delineated

the disadvantages of non-cadaver based curriculum. Once again it is emphasized that the cadaver must not be dismissed as obsolete, since exposure to dissection develops important cognitive skills [15] and manual dexterity [26] required by all medical practitioners.

The recent trend towards minimal access surgery and the frequently performing interventional procedures were demand sound knowledge of anatomy. Also thorough knowledge of anatomical details is required for success of a clinical procedure. Thus dissection being an essential tool in the training of future physician and surgeons can neither be undermined nor is an adequate substitute.

Some of the challenges faced in cadaver based teaching include difficulty in procuring cadavers, emotional impact on some students on exposure to the cadavers, health and safety issues associated with cadaver use. So recommendations should be made to reduce these challenges, instead of eliminating dissection from medical curriculum.

Lempp (2005) [22] commented dissection as an opportunity to reinforce familiarization and respect for the body and integration of theory into clinical practice. Nevertheless, it will be shameful if we are not taking full advantage of the available technology to supplement revision of the learning objectives from dissection classes [27].

III. Computer-Assisted Learning (CAL): Advanced web based technology and easy availability of educational software and information database has reshaped medical education by incorporating e-learning as a method to replace the traditional anatomy teaching [28]. McNulty et al.(2009) [29] commented that future of anatomy teaching must rely more on visual aids outside the dissection room because students who accessed web based computer aided instruction resources scored significantly higher in examinations than those who never accessed the online content. He explained that, students will naturally forget topics covered in the dissection class and resources like web streamed lectures and instructional videos could prove vital for revision. Numerous websites and software for anatomy teaching/learning are

available nowadays which can be incorporated in the curriculum."Brainstorm" [28] developed at Stanford University is an interactive atlas of neuroanatomy, with images of dissections and cross sections, diagrams and extensive supporting text. Other popular software in vogue is: "ADAM Interactive Anatomy", "The Dynamic Human", "Anatomy laboratory" which show 3D relationships, through the use of multilayered drawings that can reveal progressively deeper structures for virtual dissection [28]. To overcome the dramatic decrease in time allotted to neuroscience, an interactive 3D atlas software have been launched [30] where randomization of cerebral and vascular anatomy slices can create versatile tests for practice and self assessment for student users. In addition DVD demonstrations may be introduced to overcome the ongoing shortage of qualified anatomy demonstrators. Also senior anatomists can use Tele conferencing software's for online didactic lectures and live demonstrations with prospect of global participation [31]. However by no means is two dimensional filming adequate substitution for direct visualization and handling of 3D tissue [32] to appreciate size, texture, colour, and weight [12]. In dissection rooms, students are able to construct their personal interpretations of the abstract body while exercising spatial orientation [16,33]. Furthermore, multimedia resources are also providing opportunities to study microscopic anatomy. Virtual microscopy, web based multimedia animations and software magnification with associated labeling is widely accepted for studying histology and pathology [34]. Effective integration of CAL in the anatomy curriculum, along with the conventional teaching/learning methodologies would enable the educators (teachers) to help the students grow from dependent learners to autonomous self directed lifelong learners [28]. Some advantages of CAL are: a) student needs less time for studying b) quick access to huge number of references c) student has the freedom to choose the place, time, pace and process of learning. Some disadvantages of CAL are: a) compared to live demonstration by the teacher, it lacks human contact which greatly impacts learning b) Inability of the student to ask questions [28].

IV. Problem Based Learning (PBL): PBL is defined as an educational format where learning takes place in a small self directed group and learning results from the process of creative thinking towards the understanding or resolution of a case or real clinical problem (which may or may not be explained in the textbook) [27,28]. PBL is usually conducted in the following five steps: 1) A clinical problem is presented to a small group of students. 2) Each member of the group is assigned to resolve specific questions related to the problem. 3) Students gather information from relevant sources (experts in the field, books, journals, internet etc.) 4) They analyze the facts, discuss the problem and develop hypotheses 5) Students share the findings with their peers, and after discussing with the facilitator, present an interpretation of the solution [27,28].

For the past two decades, Harvard Medical school has been promoting PBL tutorials in anatomy curriculum to bridge between lectures and laboratory experience while still counting on dissection [35]. Anatomy PBL and small group teaching [36] have resurged in more institutions internationally, thus making their syllabi more dependent on student initiative and less reliant on rudimentary lecture notes.

Majority of the medical institutions across the globe, including those in India, have decided to change the medical curriculum from the conventional single discipline based to an integrated interdisciplinary style. The logic behind the objective is that, if the basic sciences are learnt in relation to each other (Horizontal integration) and in relation to the clinical sciences (Vertical integration), then it will encourage active learning [28]. Knowledge acquired via PBL is clinically relevant, and retained longer by the student as it requires active participation of the student in obtaining the information. According to Nayek et al [37] the integrated curriculum based on organ systems that use PBL as the major instructional method results in a certain degree of fragmentation of anatomy, and if the curriculum is not carefully planned, it may result in omission of some important components of the subject.

PBL session may include staff supervision but reciprocal peer teaching (RPT) enables

participants to alternate as student as well as chairperson. The chairperson leads the discussion, covers all learning objectives, as well as encourages dialogue between fellow team members while developing necessary transferable skills for professionalism and leadership. Besides also becoming more independent learners, the students attained improved attitude to anatomy and majority agreed that RPT further developed essential communication skills [38]. Other advantages of RPT include requiring less number of cadavers, a more economical teaching budget and a smaller student teacher ratio.

V. Alternative Pedagogical Resources and Strategies:

1. Medical imaging: Radiology imaging offers in vivo visualization of anatomy as well as insight into pathological processes. It has created a need for new expertise to interpret radiography, ultrasound, multiplanar (virtual 3D) constructions and high resolution CT cadaveric scans [34]. Though alliance with radiologists to teach part of anatomy course has been successful in English universities [32] yet, radiological images cannot substitute the benefits of conventional dissection. But hybrid teaching modalities would undoubtedly contribute to better understanding and retention.

2. Small group teaching: In an era of declining time devoted to anatomy teaching, small group teaching with cadavers in the dissection hall forms the basis of gross anatomy teaching of the future. Small group teaching has a plethora of benefits like positive interaction among students from diverse cultural backgrounds, exchange of informations, academic achievement, developing fine skill, aptitude to work out clinical problems, motivation to learn, confidence and social development [39]. Although students may not learn as much detailed information in small group teaching as they would in a lecture, they will learn other skills crucial to their academic success, such as problem solving, critical thinking, and leadership, communication and group spirit [39]. Without refuting the significance of traditional lectures, a growing number of anatomists are appreciating small group teaching as an important supplement to lectures [40].

3. Professionalism and Attitude to Ethics Encompassing Anatomy Education:

Teaching professionalism within anatomy education has become a recent topic of interest. Anatomy training in the initial days of medical school enables students to reflect on the logic and ethical implications behind cadaver donation [16]. Hence self reflection and emotional pressure develops the maturity and empathy that is required to face other difficult questions, such as bio-psycho-social impact on the donor families especially in context with different cultures [41].

The instructor also plays an important role in helping students to overcome the qualms and anxiety over working with cadavers [42]. Although some desensitization is inevitable over time and correlated with extent of exposure, a career in medicine heavily depends on retaining a strong sense of humanity. Learning humane values cannot be achieved by solely focusing on anatomical principles, a revolutionary idea promoted since 1960s followed by the pledge of "Behavioral rehumanisation by 1970s so as to preserve the art in medicine [43]. It is crucial to educate students about death as part of the life cycle, so that they are appropriately equipped to support themselves and more importantly the patients emotionally, particularly those who require end of life care [44] and their families to the best of their abilities.

Pawlina et al.,(2006) [45] demonstrated the need of teaching both professionalism and leadership skills from as early as first year medicine in anatomy courses where responsibility increases significantly and it is positively correlated with gaining high scores in examinations. Furthermore, gaining leadership adaptability contributes to optimal healthcare delivery due to more effective interpersonal and communication skills with the healthcare team, patients, and their families [45]. Essential nonteaching transferable skills with respect to qualities such as altruism, integrity, and compassion can be introduced and evaluated by peer evaluation [46].

CONCLUSION

As medical education has progressed exponentially over the past decades, there are unanimous concerns over the decline in student's

knowledge of anatomy [44]. The problem should be aggressively solved; otherwise the degradation of anatomy education and undermining the vital skills gained from the course will inevitably lead to under qualified educators as well as unsafe and incompetent doctors for future generations [47].

Finally, at the end of our study, we conclude Anatomy to be integrated vertically into medical education so that students are exposed to anatomy teaching/learning throughout undergraduate (preclinical and clinical), postgraduate, and later in professional training. Modern digitalized methods of teaching anatomy are undoubtedly useful. However, body donation can still significantly benefit medical students, and the dissection and prosection procedures should be reintegrated into modern medical curriculum which give a 3D experience in real life that can't be attained by most advanced digital anatomy programs available. Novel digital tools CAL, PBL and integrative teaching methods should complement the gross anatomy education and the lecture experience, thus maximizing the teacher activity and learner performance.

Provision of safe and optimal healthcare to our patients, should be our utmost priority. Fortunately, there are a wealth of new innovative resources and more pioneering methodology to enhance the lifelong learning experience of something as fundamental as anatomy and to objectively measure progression within the course while maintaining the individual learning environment of universities. It now depends on universities all over to unite for promoting the significance of anatomy education and an optimal curriculum for all medical, surgical, nursing and biomedical specialties, before its decline will lead to inevitable dire consequences for global patient healthcare [29,30,48].

Conflicts of Interests: None

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