EDUCATION NOTE

Dissection as a Teaching Tool: Past, Present, and Future

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Cultural changes, scientific progress, and new trends in medical education have modified the role of dissection in teaching anatomy in today's medical schools. We discuss in this article the role of dissection itself, the value of which has been under debate for the last 30 years. The importance of dissection is considered from different points of view: educational, bioethical, and human values. Included are different opinions from professors and students. Finally, the current practice of dissection is described for some universities in the United States and Europe, showing its use as a learning tool. ***Anat Rec (Part B: New Anat) 285B:11–15, 2005.*** **© 2005 Wiley-Liss, Inc.**

KEY WORDS: dissection; anatomy education; cadaver

INTRODUCTION

Cultural changes, scientific progress, and new directions in medical education have modified the role of dissection in teaching anatomy in today's medical schools. In order to understand the present situation, it is necessary to mention some important facts that have changed the way in which anatomy is taught and also to analyze the role of the dissection in this process. The main purpose of this article is to show a general view of dissection as a teaching aid throughout history, from its beginning until now and highlighting some works that have been decisive in its evolution. Finally, the discussion considers the relationship of dissection to other teaching resources that could determine an important change in the history of anatomy teaching.

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THE PAST AS A WAY TO UNDERSTAND THE PRESENT

In ancient Greece, logic emerged as a deductive method in the study of science in general. For many centuries, physicians of ancient Greece gained much information about the human body and health. In the 5th century BC, the development of Greek medicine culminated with Hippocrates, who founded a medical school on the island of Cos. Praxagoras, another famous physician from Cos, had Herophilus as a disciple, who later became a well-respected anatomist in the school of Alexandria. Herophilus is known as the father of scientific anatomy. In the school of Alexandria, the practice of anatomic dissection was the dominant means of learning anatomy and it was considered the first place where dissection was done in a regular and systematic way. At that time, some empiricist physicians like Filinos from Cos (Herophilus' disciple) considered that dissection had no practical utility.

Greek medicine after Hippocrates bloomed in Alexandria and was later introduced to Rome. The Greek physician Galen traveled to Rome, where he had been summoned by emperor Marcus Aurelius, and became the most prestigious and successful physician in the city. Galen practiced dissection on animals (principally Barberia monkeys) and wrote *Treaty of Anatomy*. Despite multiple mistakes in its descriptions, especially those referring to the anatomy of organs, his work was transmitted and taught for more than 14 centuries until the Middle Ages.

In Europe during the Middle Ages, the study of medicine developed around the transmission and interpretation of the work of Galen and it was taught mainly in monasteries. During this period, all that related to "material" things was considered to be of little importance. Because material things are temporary, the human body was not studied. Anatomical dissection was considered to be blasphemous and so was prohibited (Gregory and Cole, 2002). At that time, anatomy was taught by professors who recited Galen's texts (Dyer and Thorndike, 2000); however, during the 14th and 15th centuries AD, some professors in French and Italian universities began to use cadavers as teaching tools in their classes (Greg-

ory and Cole, 2002). One of them was Mondino dei Luzzi (1275–1326), who reintroduced the practice of the Alexandrian School, emphasizing the importance of dissection by performing a series of public dissections in the early part of the 14th century. He systemized dissection and in 1315 published a manual called *Anathomia* (*De anatome*), which, due to the clarity of its text, became the textbook of choice in nearly all European medical schools for the next 3 centuries.

During the Renaissance, Galen's errors were exposed. This occurred when Andreas Vesalius, a professor at the University of Padua, published his masterpiece *De humani corporis fabrica* (1543). The impact of this publication was that it produced one of the most important changes in science in general: dogmatic teaching from ancient books was transformed into learning by direct observation, setting the foundation for the present scientific method (Aziz et al., 2002). In that context, cadavers were considered to be like "books" from which students learned by observation. By the end of the 15th century, renewed interest in dissection led to closer inspection of skeletons. Jacobo Berengario da Carpi proposed possible names for skeletal parts. He also seemed to have been the first anatomist to approach systematically the tissues of which the body is composed by describing the properties of fat, membrane, nerve, ligament, tendon, and muscle. Another important anatomist was Alessandro Achillini, who wrote *Carports humani anatomia* and *Anatomicae annotationes*, in which he was the first to describe the malleus and to demonstrate that there are seven tarsal bones. Later, as the Renaissance evolved, emphasis was once more placed on the arts, sciences, and the human body. Painters such as Leonardo da Vinci and Michelangelo studied anatomy from cadavers, which helped them in the creation of impressive works of art (Calkins et al., 1999). Cross-sectional anatomy was developed by Leonardo da Vinci. In the anatomical drawings of the era, the spiritual and humanist context of that period was portrayed (Dyer and Thorndike, 2000).

In the 17th century, microscopic anatomy was developed by Marcello Malpighi, but it was a period without innovation as far as medical education was concerned. Anatomy was taught inadequately and the majority of professors faithfully followed classical methods. In the 18th century, although it was felt that the tyranny of medieval dogmatism had been overcome, the conservative nature of physicians impeded medicine from evolving at the same speed as other scientific areas. During this period, ancient medical schools in northern Italy lost their hegemony, and others located in Vienna and Edinburg grew in importance. The study of anatomy progressed in an orderly fashion during this period, and there was greater interest in new subject areas such as comparative anatomy and embryology (Lyons and Petrucelli, 2001).

The fundamental characteristic of medicine in the 19th century was the attempt to correlate discoveries in the laboratory and the autopsy room with observations made at the patient's bedside. The first medical school in America was founded in 1765 at the College of Philadelphia. In 1767 and 1782, other schools of medicine were founded in New York and Boston, respectively. The curriculum of the College of Philadelphia included a vigorous anatomy course with dissection laboratory. During this period, the introduction of anesthesia, sterile techniques, and the development of surgery all contributed notably to the change from descriptive anatomy to practical anatomy.

At the beginning of the 19th century, there was an increase in the demand for cadavers in the United States but not enough bodies to meet the demand. This was largely because in some states, the only cadavers that were legally available were those of executed criminals. The robbery of graves became more common and frequent. The most infamous grave-robbing incident occurred in 1788 in New York, where a doctor working in a laboratory at the Society Hospital waved to a child who was looking through the window with the hand of a cadaver he was dissecting. The frightened child told his father that he had just seen the cadaver of his mother, who had recently died. The laboratory was subsequently burned down, and seven persons died in the fire. In response to this event, a law was passed in New York in 1789 that prohibited the robbing of tombs and established that only the cadavers of criminals could be dissected.

Simultaneously, in the city of Edinburgh, Scotland, occurred the case of William Burke and William Hare. The latter was the owner of a boarding house where a customer died, leaving a debt of 4 pounds. A local laboratory offered 7 pounds for the body of the subject, and Burke and Hare accepted the offer. After this, these men conspired to intoxicate guests with alcohol, murder them by asphyxiation, and then sell the bodies. Burke and Hare were found guilty in 1829 of the murder of 16 persons. Burke was hung, dissected, and exhibited (Tward and Patterson, 2002).

In 1825, in order to end the robbery of tombs, Harvard University and the Medical Society of Massachusetts began a movement to legalize dissection in medical schools and in 1831 the Massachusetts Anatomical Act was passed, which established that unclaimed bodies could be used for anatomical dissection (Dyer and Thorndike, 2000). A similar law was established in the United Kingdom in 1832. Thus, most of the cadavers used for dissection at the beginning of the 20th century were exclusively those of unclaimed bodies. This was the most common way of obtaining cadavers in the United States until 1968, when a Uniform Anatomy Gift Act was adopted, in which the right of donation was recognized based on free choice and volunteerism. The act was modified in 1987, making the process of donation clear, and the donor's intent was recognized as irrevocable (Jones, 1994). At present, the great majority of cadavers are obtained by donation (Tward and Patterson, 2002).

The role of dissection and the teaching of anatomy evolved during the last half of the 20th century, resulting in new preservation techniques and technological tools based on the imaging. Plastination, created by Gunther Von Hagens, was an innovation in the anatomy laboratory at Heidelberg University in Germany in 1978 (Weiglein, 1997), and it is currently used in both teaching and research. This preservation technique has changed the ability of ordinary people to see the

human body, and there are exhibitions of plastinated bodies and body parts around the world (called *BodyWorlds*), resulting in the concept of "anatomical art" (Jones, 2002). Not surprisingly, there are different opinions about exhibits like *BodyWorlds* (Jones, 2000; Wetz, 2000).

Around this same time, a number of anatomists noted the computer's potential as a teaching tool and started to create anatomical software (Carmichael and Pawlina, 2000; Aziz et al., 2002; Van Sint Jan et al., 2003). Some local projects were initially developed and then, in 1988, the Visible Human Project (VHP) of the U.S. National Library of Medicine began (Jastrow et al., 2002) and stimulated a change in teaching from descriptive to clinical (Dangerfield et al., 2000; Miller, 2000; Latman et al., 2001; Kagan, 2002), with the use of VHP sectional anatomy combined with radiographs, CT, MRI, and other imaging methods (Tavares et al., 2000; De Barris et al., 2001).

PRESENT SITUATION OF DISSECTION AS A TEACHING TOOL IN SOME COUNTRIES

Dissection has persisted as a primary teaching tool for a long time. The benefits include the gaining of practical skills such as appreciation of the human body, first-hand understanding of anatomical variability, learning teamwork and peer interaction, as well as ultimately gaining a first-hand appreciation of human life through a first-hand understanding of death and dying (Granger, 2004). But do all countries teach anatomy using anatomical dissection? Information is available from the majority of universities in the United States and Canada (Collins et al., 1994), United Kingdom (Heylings, 2002), and Russia (Kagan, 2002).

Collins et al. (1994) surveyed 112 different anatomy departments in the United States (102/123) and Canada (10/16) and found that all of the schools have some form of laboratory practice. In the United States, 97% of the reporting schools (99/102) used dissection in addition to other tools, such as prosection, plastic models, bones, and computer laboratories. Only 3 of the 112 universities in both countries reported that they did not dissect cadavers.

In the United Kingdom, Heylings (2002) carried out a similar study in which he surveyed 21 anatomy departments (19 in England and 3 in Ireland) with the following results: 16 of the departments surveyed (76%) practice dissection. In 12 (12/16), dissection is combined with some other type of laboratory work and only 25% (4/16) use dissection as the only type of laboratory. In the 5 (5/21) departments that do not use any type of dissection, anatomy is taught by demonstration.

In Russia, Kagan (2002) reported that dissection, prosection, and other anatomical materials were used in the teaching of macroscopic of human gross anatomy.

At present, there are no large-scale studies showing the prevailing situation in the anatomy departments of the schools of medicine in Mexico. The School of Medicine of the Autonomous University of Nuevo León was founded in 1859 with six teachers who were in charge of teaching all the subjects of that time. It was not until 1940 that a body dissection program was implemented, and only in 1976 was a program integrating theory and practice introduced. At the present time, laboratory practice is taught mainly with dissection, although there are other resources available, such as multimedia programs (Elizondo-Omaña et al., 2004), bones, and plastic models.

DISSECTION VS. OTHER EDUCATIONAL TOOLS

Technological innovations and other resources created in the last 30 years have stimulated a discussion about the role of dissection as a teaching tool, leading to a number of questions: What is the advantage or disadvantage of cadaver dissection? What is the difference between dissection and other technological resources as teaching tools? These questions were discussed recently in a debate forum published in this journal (Guttmann et al., 2004). The many different opinions on these topics can be divided into two points of view.

The first maintains that dissection is the best way to teach anatomy (Ellis, 2001; Aziz et al., 2002; Cahill, 2002; Rizzolo, 2002; Granger, 2004; Pawlina and Lachman, 2004). Those who feel that the cadaveric dissection is the key to teaching anatomy present a number of reasons why its use must continue. From this point of view, there are two method proposals for laboratory practice: dissection (Cahill and Dalley, 1990; Jones, 1997; Monkhouse and Farrel, 1999; Marks, 2000; Miller, 2000; Ellis, 2001; Cahill et al., 2002; Granger, 2004) and prosection (Sinclair, 1965; Nnodim, 1990; Skidmore, 1995; Topp, 2004). There are studies comparing both teaching methods (Alexander, 1970; Nnodim, 1990; Dinsmore et al., 1999) and both of them are used in some universities in Europe (Heylings, 2002) as well as the United States and Canada (Collins et al., 1994).

The second point of view maintains that dissection is dispensable (Finkelstein and Mathers, 1990; Millar, 2000; Sterling et al., 2000; Dinsmore et al., 2001; Hubbell et al., 2002; McLachlan, et al., 2004). However, studies comparing the effectiveness of cadaveric dissection versus multimedia programs for learning anatomy have yielded results that often support retaining dissection supplemented with multimedia learning (Galván et al., 1999; Carmichael and Pawlina, 2000; Elizondo-Omaña et al., 2003, 2004; Van Sint Jan et al., 2003).

As this line of thought has developed, some medical schools have substituted their traditional anatomy laboratories with computer rooms (Drake, 1998; Plack, 2000; McLachlan, 2004) while some have returned to dissection (Clark, 2003). This debate presages an important change in the teaching anatomy and also in medical education.

A PROPOSAL: INTEGRATION

The debate on how to teach human anatomy in the most effective manner continues, and there is not yet a practical integration of both lines of thought that resolves the discrepancies between the two approaches.

We consider that cadaveric dissection and the technological resources represent different approaches to learning anatomy, and some characteristics of each to develop necessary

practical and theoretical skills. We feel that the student should use both traditional and technological approaches in order to acquire skills and anatomical knowledge. Using traditional and technological resources, students should develop skills that fall into three categories: theoretical, practical, and bioethical.

There is no doubt that the physician should have skill in each of these three areas. We propose that students should learn clinical anatomy by computational resources that integrate information about the clinical case (such as medical imaging, superface anatomy, and other necessary data), so that they can then identify the anatomical bases of the case (technological resource). Students acquire skills and practical knowledge by using instruments in the anatomy laboratory and by participating in some basic surgical procedures on the cadaver (a traditional resource). The bioethical considerations derive from discussions in classes before and after the dissection course.

CONCLUSION

The previous discussion begs the following question: What is the future of dissection as a tool for teaching anatomy? In our opinion, dissection is, and will continue to be, an important tool in the anatomy laboratory. Dissection has survived many historical periods, cultural changes, and teaching trends, and it will continue to evolve, as new teaching technologies are added to the curricula.

The changes in culture, society, and the medical curriculum have altered the environment, the focus, and the trends in teaching anatomy. However, as this discussion has shown, dissection of cadavers in the laboratory has survived as a teaching tool and will continue as a fundamental approach to learning anatomy. History is the way we understand the present and predict the future. Understanding the history of dissection allows us to understand its present role and predict its future course.

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