To What Extent Is Cadaver Dissection Necessary to Learn Medical Gross Anatomy? A Debate Forum

GEOFFREY D. GUTTMANN, RICHARD L. DRAKE, AND ROBERT B. TRELEASE

In this Olympic year of 2004 in Athens, Greece, which is considered the birthplace of modern Olympics, controversy was inescapable. Whether it was the points awarded by the judges for gymnastics, Paula Radcliffe dropping out of the women’s marathon, or drug-testing scandals, controversy swirled. So, too, we find there is controversy within the arena of anatomical education for medical students. Athletes performed their tasks “just in time”; anatomical sciences educators, however, may have the luxury of time to contemplate the controversial issues they face today or they may have change thrust upon them—administratively, or through the fiat of best medical education practice.

The controversial issue for this year’s educational debate is to what extent is cadaver dissection necessary to learn medical gross anatomy. One of the moderators (G.D.G.) proposed a debate on whether dissection is necessary for learning medical gross anatomy for publication in The Anatomical Record (Part B): The New Anatomist. The question was refined to our current title. We bring this debate to the anatomy community through the pages of this journal and also through an online virtual issue on dissection and medical education, available at www.wiley.com/anatomy/dissection.

The format of this debate forum was designed to be similar to a formal debate. The moderators invited several anatomists to present and defend their positions on the topic. There were two proponents: one pro, arguing that dissection is necessary to learn medical gross anatomy, and one con, arguing that dissection is not necessary to learn medical gross anatomy. The proponents stated their positions independently. There were also two rebuttal debaters, one pro and one con. The rebuttal writers had the opportunity to review the proponents for each position and then present a response supporting their own position. The authors were allowed only limited space to make their arguments and were encouraged to provide data and references in support of their positions.

Dr. Noelle Granger, from the University of North Carolina School of Medicine, was the proponent for the pro position and presented arguments based on her and her students’ experiences (Granger, 2004). Her position was supported by many references. Dr. John McLachlan from the Peninsula Medical School (Plymouth, U.K.), where cadaver dissection is not part of the anatomical education program, supported the con position and described the rationale for their institution’s gross anatomy teaching program (McLachlan, 2004).

The rebuttal for the pro aspect was coauthored by Dr. Wojciech Pawlina, from the Mayo Clinic College of Medicine, and Dr. Nirusha Lachman, of the Durban Institute of Technology in South Africa. Pawlina and Lachman (2004) expanded on some of the ideas discussed in the proponent papers and drew a link between dissection in the gross anatomy laboratory and the acquisition of clinical skills, as well as the development of professionalism and professional attitudes for medicine. Dr. Kimberly Topp, from the University of California, San Francisco, authored the rebuttal for the con aspect. Topp (2004) made a point-by-point rebuttal to the pro arguments presented by Granger (2004) and indicated where she believed cadaver dissection may not be necessary in medical education.

It is worth noting that anatomy is not only the study of morphology or the structure and function of the members of the zoological or botanical kingdom, but also the geography of a biological entity. In this case, the human anatomist is actually a geographer of the human body. As geographers of the human body, we use atlases to find our way around. Many of us use exploratory learning such as dissection with other clinical resources like images generated by medical imaging modalities both to teach anatomy and to expand the anatomical knowledge base. After a number of visits, we become familiar with the places we have visited, just like one becomes familiar with a new town once one has driven around it. Value judgments aside, it is inescapable that the extent we experience hands-on and personal or emotional aspects of this educational journey directly affects not only how we teach the geography of the human body but also how and what our students learn. This also affects the knowledge they take with them into clinical practice as physicians.
As more than one author has noted, though, many anatomists may now be faced with implementing new curricula with little or no dissection, regardless of the educational arguments the faculty present. Unfortunately, in this context, the points of this debate may seem moot or even inconsequential to deans committed to downsizing course hours in the face of budget cuts and expanding curriculum goals. Deans will also claim “BME” (best medical education) practice as justification for devaluing dissection in the curriculum. However, the ethical and personal challenges for anatomists remain because as educators, we like to believe that we are doing the right things the right way, and for the right reasons. That belief may become a forgotten luxury as the number of teaching anatomists, training programs, and available secured academic programs continues to decline.

As a spin-off from this debate forum, we moderators pose a couple of questions to the readers. Does BME practice mean that one can merely learn anatomy using an atlas or medical images and then be able to navigate on or around the human body effectively? Can the streamlined, non-cadaver-dissection-based teaching or training approaches used in anatomy and physiology courses for nurses and allied health professionals be effectively and appropriately used in the anatomical education of medical students? This new debate is now open to the readers and we encourage your comments.

**LITERATURE CITED**


New Path for Teaching Anatomy: Living Anatomy and Medical Imaging vs. Dissection

JOHN C. MCLACHLAN*

How should we best teach anatomy? For centuries, the answer has been through dissection. A few have argued that prosections can replace the experience of individual dissection. Until recently, no one has argued that the cadaver can be dispensed with altogether.

Peninsula Medical School, one of four new medical schools to open recently in the United Kingdom, has taken this radical step (McLachlan et al., 2004). So, what was behind our thinking? We asked ourselves how doctors encounter anatomy in clinical practice. The answer is through living and surface anatomy on the one hand, and medical imaging on the other. It therefore seemed to make sense to teach students anatomy in these contexts right from the beginning. This matches our desire for authentic experiences throughout the course. Students meet patients in community settings in their first days. They learn clinical skills from the first week, throughout the entire course. In teaching anatomy, we decided that we would rely on living anatomy delivered to the students through the extensive use of peer examination and life models and on medical imaging delivered by qualified radiologists.

This decision received comment in the media and has stimulated criticism and discussion. It was not, incidentally, based on costs. Our program is expensive in clinician time, especially for radiologists, and trained anatomists are still required as teachers.

ANATOMY TEACHING

Anatomy teaching takes place in tutor-led small groups (eight students per group; 80 sessions per student over years 1 and 2). Medical imaging (20 sessions) is led by clinical radiologists and features X-rays, ultrasound, MRIs, CT, and 3D imaging. Living anatomy (40 sessions) is studied through consented peer examination, supported by life models. Palpation and auscultation are covered, along with projection of still and moving images onto the body surface. Life-size full-color transverse cryosections and other imaging material are used with the living body, and high-verisimilitude body painting of underlying structures has proved useful. Portable ultrasound equipment is available to visualize structures in the living body. There are 24 integrated structure and function lectures in the first 2 years, although this is a problem-based learning course, which does not rely on didactic methods. Arts and humanities are integrated with anatomy learning as a core curriculum activity to help expand awareness of humane issues.

Our course has sometimes been misrepresented as the use of either plastic models or 3D computer models in place of cadavers. These are valuable adjuncts to anatomy learning, but not a substitute for working with the living human body.

A variety of benefits have traditionally been ascribed to the use of dissected or prosected material in anatomy teaching, some of which can be achieved by other means. For instance, self-directed learning and teamwork can be developed in a variety of settings, such as problem-based learning groups. Manual dexterity can usefully be practiced in clinical skills settings. Application of the scientific method is a slightly implausible benefit of dissection, but can be developed in more relevant ways by studying the application of scientific method to current topics.

It is a widely held view that dissection gives students a 3D view of human anatomy and reinforces knowledge acquired in lectures and tutorials. We believe that our students can achieve this 3D understanding by working extensively with living bodies in conjunction with projection of color images on the surface of the body, which can be dissected away layer by layer; by use of color transverse sections in association with the living body; and by extensive use of imaging. Indeed, modern 3D reconstruction and imaging methods give views of the internal structures of individual living patients during medical procedures that can be superior to those observed during dissection, and this may modify surgical practice in the near future.

Dissection is frequently seen as serving purposes of personal develop-
ment in promoting humanistic values, specifically as an introduction to death in a controlled manner. However, evidence on the benefit of such an introduction is mixed. Students may find the process stressful and it may encourage inappropriate attitudes toward human remains as students attempt to deal with this stress. Our students will encounter death in a much more natural setting, within communities, where the meaning of the death is clearly recognized. We do not wish our students to experience desensitization, which is sometimes proposed as a benefit. We wish them to remain sensitive while functioning effectively in their roles.

Study of human material may also be seen as an opportunity to appreciate the range of variability present in real human materials, as opposed to that described in the textbooks and in plastic specimens. This is a significant issue, which we are addressing through our extensive peer examination process and through the creation of an electronic surface anatomy atlas, which, instead of focusing on a few individuals (usually a young lean white male), enables us to represent the range of body morphologies observed in a variety of different subjects.

Doctors encounter anatomy in clinical practice . . . through living and surface anatomy on the one hand, and medical imaging on the other. It therefore seemed to make sense to teach students anatomy in these contexts right from the beginning.

Cadavers may present a number of disadvantages. Their color, texture, and smell are not like real life, and cadavers cannot be palpated, auscultated, or usefully asked to change position. Their use may present health hazards and ethical/legal difficulties. While cost alone should not be the issue, the expense of maintaining a cadaveric facility means the cost-benefit ratio must be carefully considered.

Real evidence of the efficacy of different methods of anatomy study on clinical practice has always been lacking. Naturally, we are evaluating our program. However, our desired goal is to produce better clinicians, rather than better anatomists, and our first students will not qualify until 2007. It may therefore be some time before the best evidence arrives. The U.K. General Medical Council has been supportive of our approach so far.

This article is one of four invited papers that address the following question in a moderated debate format: “To what extent is dissection necessary in the learning of medical gross anatomy?” These articles were published in the November 2004 issue of The Anatomical Record Part B: The New Anatomist (Vol. 281B#1, pp 2–14). These articles can also be accessed online through our virtual issue on dissection and medical education (www.wiley.com/anatomy/dissection).

LITERATURE CITED
Dissection Laboratory Is Vital to Medical Gross Anatomy Education

NOELLE A. GRANGER*

The medical anatomy course has become a complex and complicated educational experience, in which dissection of the human body instructs not only in structure and function, but also in psychosocial areas critical to the development of the whole physician (Dyer and Thorndike, 2000; Gregory and Cole, 2002; Rizzolo, 2002). As the need to teach newer areas (such as molecular biology, cell biology, and medical genetics) has severely compressed the time spent in the dissection laboratory, and a generation of anatomists has reached retirement age without replacement (Marks, 1996; Fitzharris, 1998; Cottam, 1999; Parker, 2002), elimination of dissection is seen as one way to resolve these pressures. Can an anatomy course fulfill its objectives if it no longer includes dissection, using instead two- or three-dimensional virtual representations and computer-assisted learning programs? I would argue that it cannot.

I have listed the major reasons why I believe dissection is so important to the learning of anatomy and the creation of the mature physician, gleaned from my own experiences and that of many in the field more eloquent than I, including some of the thoughts of students at the University of North Carolina School of Medicine. Student quotations are taken from e-mails sent to me in response to the Los Angeles Times article “Cutting Out the Cadaver” (Zarembo, 2004). Roman numerals refer to the student’s medical school (MS) educational level.

Dissection teaches the following:

A MULTIDIMENSIONAL UNDERSTANDING OF THE ORGANIZATION OF HUMAN BODY

Patients are three-dimensional beings, changing as they age. It is in the dissection laboratory where students form their ideas and mental images of the structure of the human body at different levels over time (Marks, 2000). There is little educational research on how students learn three dimensionally, but it is clear that education on real cadavers allows them to recall this information on demand (Moore, 1998). “Although it is true that much of what we learn in our first 2 years has nothing to do with clinical medicine, dissection does . . . . The only way to truly know the body is to get up close and personal with it . . . . to feel the tendons and nerves, the fascia and the vessels. There are times when I have to do a femoral stick or an a-line or a central line and I remember the anatomy not from some picture but from what I saw during my own dissection” (MS IV student).

ANATOMICAL VARIABILITY

The dissection laboratory provides an introduction to the variability of the human body and the uniqueness of each cadaver. Discussions of variability have been dropped from many of the current textbooks, and lack of this information, or even of an awareness of variability, can lead to misdiagnosis and malpractice (Willan and Humpherson, 1999). “For me, one of the most important lessons I learned in anatomy was that a vast range of structures are considered normal (or at least will never cause dysfunction)” (MS III student).

BASIC LANGUAGE OF MEDICINE

Terminologia anatomica (Federative Committee on Anatomical Terminology, 1998) is the anatomical vocabulary used throughout medical training and practice, and the use of this terminology facilitates a common discourse about anatomy in both healthy and diseased patients (Whitmore, 1999; Rosse, 2001). It is in the dissection laboratory that this vocabulary is acquired and learned, not by rote.

Dr. Granger has taught human anatomy for 23 years in the University of North Carolina School of Medicine, where she directs the first-year medical course “Human Anatomy, Embryology and Imaging” and teaches histology. Her research has focused on invertebrate development endocrinology, but she now does educational research as well.

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memorization, but by conceptualization based on what is seen and felt.

**PRACTICAL SKILLS**

The routine performance of dissection provides students with training in spatial appreciation and orientation and in the use of instruments. Most of these are directly related to surgery, but the acquired skill in eye-hand coordination and manual dexterity is relevant in a variety of clinical settings (Moore, 1998; Newell, 1999; Ellis, 2001).

**LEARNING IN PEER GROUP AND FUNCTIONING AS PART OF A TEAM**

The normally small dissection groups force students early on in their professional education to communicate effectively, engage in cooperative interaction, and utilize “both self-directed and directed self-learning” (Newell, 1999). This establishes the routine by which they will continue to work, as a part of a medical team in many different practice settings (Moore, 1998; Aziz et al., 2002). In addition, the bonding of the dissection team fosters coping with the distress of the laboratory (Coulehan et al., 1995) and the stress of the first year of medical school. “I feel gross anatomy was like deriving the equation instead of being handed the equation” (MS III student). “Sharing the struggle of assimilating tons of information, learning a new 'language' and dealing with the implications and magnitude of dissecting a human being is, in my opinion, one of the more formative experiences in the first 2 years of medical school” (MS IV student).

**INTRODUCTION TO PHYSICIAN-PATIENT RELATIONSHIP**

Their first encounter with a cadaver establishes for the students the reality of a human life, connects them to their ultimate objective—the living patient—and confronts them with the tremendous responsibility they will assume in treating that patient as their physician (Coulehan et al., 1995; Aziz et al., 2002). The anatomy dissection laboratory is often where the process of professional acculturation is initiated, fostering knowledge, skills, attitudes, values, and behaviors that will enable physicians to function appropriately within their chosen discipline. “It is the only course in the first 2 years that makes explicit the privilege and challenge of being a physician, because only the anatomy lab teaches you to be intimate with the bodies of strangers” (MD graduate, class of 2004).

**INTRODUCTION OF CONCEPTS OF HUMANISTIC CARE AND COMPREHENSION OF DEATH AND DYING**

Introduction of the concepts of humanistic care in a medical curriculum is a formidable task in the face of increasing educational technology and procedurally based patient treatment. The anatomy laboratory is where this education can begin, with attention to end-of-life issues and to opportunities for student expression of their emotions and attitudes (Rizzolo, 2002). The students’ emotional responses to their cadaver and, for many, their first confrontation with death and dying present a true teaching opportunity. “Compassion and true understanding go hand in hand, and it is only with a hands on dissection (as messy and smelly and frustrating as it may get) that both may be maximized” (MS III student).

Memorial services for the donors are standard ritual in many curricula (Tchernig and Pabst, 2001). Thus, the dissection laboratory plays an essential role in “initiating a balanced attitude to death and dying in trainee medical doctors” (Tchernig et al., 2000). “I never want to dissect again. But I also recognize what an amazing experience this was. Someone gave herself to me. She forced me to confront death in a very real way, a way that I will have to contend with as a future physician . . . . Dissection was a critical part of my development of compassion towards my future patients” (MS II student).

It is interesting to note that the University of Washington discontinued full dissection in the 1970s and made the dissection laboratory an elective. Dissection returned to the curriculum 2 years later, when nearly 90% of their students signed up for the elective (Clark, 2003). Would this happen today, with the wealth of computer programs available to replace dissection? Perhaps so. A recent study at the Rush Medical School indicated that even the students who dissect little (30 h total) sense that this process is somehow important to their training (Dinsmore et al., 1999). A far better measure of the students’ anatomical knowledge than the United States Medical Licensing Examination (USMLE) part 1 score is the measure of the clerkship and residency directors who subsequently train them. In a recent study, a majority of the reporting residency program directors felt that gross anatomy was either extremely important or very important to the mastery of their discipline, and 57% of them felt residents needed a refresher course in gross anatomy upon arrival (Cottam, 1999). Is this situation only going to worsen if dissection is no longer part of an anatomy course?

This article is one of four invited papers that address the following question in a moderated debate format: “To what extent is dissection necessary in the learning of medical gross anatomy?” These articles were published in the November 2004 issue of The Anatomical Record Part B: The New Anatomist (Vol. 281B#1, pp 2–14). These articles can also be accessed online through our virtual issue on dissection and medical education (www.wiley.com/anatomy/dissection).


Dissection in Learning and Teaching Gross Anatomy: Rebuttal to McLachlan

WOJIECH PAWLINA* AND NIRUSHA LACHMAN

The notion that anatomy as a basic medical science should remain traditional in its learning approach and classic in its content can no longer be supported due to the recent advancements in electronic media. The development of more powerful computers, video cards, and 3D gaming technology has allowed medical educators to use high-quality imaging, sophisticated training tools, and interactive computerized programs projecting cross-sectional, radiologic, and living anatomy in the classroom. What were once considered advanced imaging methods and technologies are now considered routine.

It is unlikely, therefore, that an anatomy teacher would not want to take advantage of this modern technology. There is no question that the use of such techniques and tools in anatomy education is essential to the training of a medical student. There is no question that gross anatomy must be taught in relation to clinical practice and that students must incorporate principles of living anatomy in their learning. The question is simply, Where do we draw the line?

TO DISSECT OR NOT TO DISSECT?

The issue of dissection is ongoing and has been a topic of debate by anatomiasts, educators, and politicians for centuries. Those who advocate retaining this traditional learning exercise cite the value of the cadaver experience. Those who see the practice as redundant defend their position by pointing to recent technological advancements. While arguments remain within the confines of debate, it is evident that denying a medical student the privilege to dissect is undeserved. As Jacobus Sylvius (1555) remarked in his Manual of Anatomy: “For my judgment is that it is much better that you should learn the manner of cutting by eye and touch than by reading and listening. For reading alone never taught anyone how to sail a ship, to lead an army, nor to compound a medicine, which is done rather by the use of one’s own sight and the training of one’s own hands.”

DOES ACQUISITION OF CLINICAL SKILLS EQUAL ACQUISITION OF CORE KNOWLEDGE?

In attempting to frame a modern concept of gross anatomy education, it is necessary to shift the paradigm of tradition passed down over the centuries and integrate its foundation into clinical practice. However, the acquisition of clinical skills should not be confused with the acquisition of core knowledge. While the two are interdependent, they are separate educational entities whose distinctness must be preserved. The establishment of a foundation in basic science is mandatory for the successful performance of clinical skills, not the other way around (du Toit, 2003). The trend toward minimal-access surgery and the more frequent performance of interventional procedures within limited anatomical areas further necessitate a solid understanding of anatomical relationships. Anatomical details considered minor in the past have now become critical to the success of a clinical procedure. Dissection as an integral tool in the training of clinical experts cannot be subverted, nor can an acceptable substitute be found. Dissection defines anatomy and teaches essential skills that support the development of a student across the spectrum of medical education.

DOES ANATOMY LABORATORY PROVIDE VALUABLE EXPERIENCE FOR LEARNING AND TEACHING?

Standard anatomical teaching that does not include dissection provides the student with an artificially narrow experience in which one seldom-seen ideal state is recognized as the normal model. But does this normal educational model work? Often, when we have reviewed normal anatomy with senior medical students or residents, we have found that many of them...
have acquired only superficial and sometimes even misleading information about the orientation and structure of the human body. Before they can understand the true anatomy of these structures, they must unlearn information that they have already been taught. Dissection provides students with the opportunity to verify their learning, trust their observations, and appreciate the concept of variability as it presents itself and not as it is presented to them.

The case for maintaining dissection in the undergraduate medical curriculum rests on an appreciation that it involves more than routine physical investigation. If directed creatively, dissection provides the platform for the independent learning and independent thinking that underpins the development of diagnostic aptitude. Dissection can thus play many roles in the educational process.

**DOES CADAVER EXPERIENCE PROVIDE AN OPPORTUNITY FOR PSYCHOSOCIAL DEVELOPMENT?**

In addition to its academic merits, the dissection experience contributes to a student’s psychosocial development. While it is true that the very nature of dissection demands a level of desensitization, it also promotes greater sensitivity to issues involving death and dying. Students also learn to respect the act of body donation. The unnatural setting of the gross anatomy laboratory is fertile ground for teaching aspects of medicine that cannot be learned in any other setting. Far from being a stressful occasion, the dissection experience should be viewed as a valuable gift that every medical professional deserves.

**DO HEALTH CARE CHANGES INFLUENCE TEACHING OF ANATOMY?**

The ongoing transformation of the world’s health care infrastructure as well as increasing pressures from insurance and managed care institutions threatens to undermine the values and attitudes that are the foundation of medical professionalism (American Board of Internal Medicine Foundation, American College of Physicians-American Society of Internal Medicine, European Federation of Internal Medicine, 2002). Erosion of professional values in the medical community has a negative impact on the professional development of medical students and residents. In the past, medical students, residents, and physicians modeled their professional behavior on those whom they most respected in their fields (Mufson, 1997). As health care delivery and the financial and societal issues that surround it have become more complex, it has become clear that traditional methods of instilling professional values in medical students are inadequate. An intricate world and a diversified society require the establishment of formal programs to teach professionalism in medical schools as well as residency programs ( Stephenson et al., 2001).

**DOES ANATOMY TEACH PROFESSIONALISM?**

Medical educators are responding to this changing environment by implementing innovative methods to provide such training. Currently, almost 90% of U.S. medical schools provide formal activities designed to teach medical professionalism, and some of them start from day 1 of the medical curriculum ( Swick et al., 1999). Courses that have traditionally offered only pure content are now being utilized to teach professionalism. The gross anatomy course is a perfect vehicle with which many aspects of professionalism can be addressed (O’Connell and Pascoe, 2004).

For most medical students, their initial contact with professional values occurs during the first-year gross anatomy course. Students in gross anatomy courses are asked to reflect on the altruistic gift of the human body for which they are assigned to care for ( Jones, 1997). Other important areas of professionalism exercised in the gross anatomy course include team-building, cooperative learning, and the development of leadership skills. These skills and competencies are essential for new physicians to function in the current health care system. In addition, ample opportunities exist to explore issues related to interprofessional respect, responsibility, confidentiality, self-policing, and interpersonal skills (Swick, 2000). In many gross anatomy laboratories, the members of a dissection group perform self- and peer evaluations and learn how to use formative and summative evaluations effectively in order to provide constructive feedback to the gross anatomy faculty (O’Connell and Pascoe, 2004; Pawlina, 2004). In many educational institutions, the gross anatomy course is being viewed not only as a way to teach the morphology of the human body but also as the first link in a long chain of events that teach new skills and competencies to tomorrow’s physicians.

In the dynamic continuum of global education, the future of gross anatomy as an inclusive component of the medical curriculum continues to be scrutinized. Will the decision to phase out dissection—a vital pedagogical component of anatomy education—be determined by curriculum committees? As this question continues to be debated, it will be important to keep in mind that clinical competency, good educational practice, and professionalism can only benefit the health care system and its consumers.

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LITERATURE CITED


Advances in science, medical diagnostics, and pedagogy have resulted in significant alterations in medical school curricula. Anatomy courses have reduced contact hours, reduced anatomical detail, and graying anatomy faculty members. Concurrently, there is a need to introduce clinical reasoning, physical examination skills, clinical imaging, and diagnostics much earlier in the curriculum than in years past. My learned colleague has presented thoroughly reasoned, articulate, and rational arguments for continuing the use of cadaver dissection in the teaching of anatomy to medical students. In this collegial debate, I will address individually the points advanced and question those that may not require the use of cadaver dissection.

**A MULTIDIMENSIONAL UNDERSTANDING OF THE ORGANIZATION OF HUMAN BODY**

It is true that dissection facilitates learning of three-dimensional organization of gross anatomical structure. As outlined by Marks (2000), three-dimensional learning requires perception of pattern and form, and imagery, which itself requires time for reconstruction, testing, validation, and modifications of the image. In a dissection approach, however, pattern and form are not immediately apparent. Dissection begins with a complex structure and reduces it in the process of dissection. It has been argued that to facilitate learning of spatial relationships, one should start with visually simplified fundamental lines and symmetrical patterns and build up to the more complex organization (Miller, 2000). This could be best accomplished in the anatomy laboratory by studying carefully crafted prosections.

Although it should not be the driving force behind curricular design, time in the anatomy laboratory is extremely valuable and must be used wisely. Based on student feedback and assessments, prosections are efficient learning tools (Alexander, 1970; Jones et al., 1978; Dinsmore et al., 1999; Leong, 1999). Although prosections are often used to demonstrate challenging dissections and provide alternative views, a recent study suggests that they may be better applied in replacement of simple, rather than complicated, dissections (McWhorter and Forester, 2004).

Lastly, it behooves clinical anatomists to reflect on their own knowledge base, recognizing that although prosections seem like simplified anatomy to us, students may be equally challenged in learning anatomical nomenclature, structures, relationships, and concepts from prosected materials or through dissection.

**TOUCH-MEDIATED PERCEPTION OF BODY**

Several authors have spoken of the benefits of the multisensory learning environment of the dissection laboratory (Aziz et al., 2002) and cited particular structures that are best learned through dissection (Cahill et al., 2002). Few would argue that computerized haptic devices are quite at the stage of development to substitute for three-dimensional cadavers or prosections (Williams et al., 2004), although they are remarkable adjuncts to teaching. I suggest that one may obtain a multisensory experience and learn structures and relationships from an interactive exploration of carefully prepared prosected cadavers as well as from cadaver dissection. Students learning solely from dissection of embalmed cadavers may come away with distorted views of the biomechanical properties of tissues. Some structures, such as synovial sheaths, bursae, and joint cavities, are both altered by fixation and not well maintained due to desiccation during use. The physical properties of these structures, as well as those of fascial planes and fragile peripheral nerves, are more accurately represented in unpreserved cadavers than in embalmed cadavers. If
unpreserved cadavers are not available, these structures may be appreciated in video demonstrations.

**ANATOMICAL VARIABILITY**

It is true that the wide range of anatomically normal structural relationships may be made apparent in the anatomy laboratory. It is also true that few modern textbooks contain figures depicting normal variations, let alone the population frequency of each variation (Willan and Humpherson, 1999). Students working with prosections have the opportunity to view several variations, rather than the single variation that may be present in their dissection cadaver. Moreover, students moving rapidly through a dissection using a modern atlas may not recognize or preserve a variation. If the dissection is carried out in the process of developing a teaching prosection, the variation may be preserved for the education of many.

**BASIC LANGUAGE OF MEDICINE**

Anatomy vocabulary, which is so necessary for communication in clinical medicine, may be learned through interactive use of prosections and many other learning materials, as well as through dissection.

**PRACTICAL SKILLS**

The act of dissection may facilitate the skilled use of instruments necessary for some clinical tasks (Moore, 1998; Newell, 1999; Ellis, 2001). Potentially overlooked, however, is the valuable opportunity to teach manual palpation skills on live humans (Ellis, 2001). Teaching surface anatomy in the anatomy laboratory allows for simultaneous verification of relationships in dissected or prosected cadavers.

**LEARNING IN PEER GROUP AND FUNCTIONING AS PART OF A TEAM**

Self-directed learning, peer teaching, communication skills, and team-building can come from a prosection-based or dissection-based laboratory environment. Students working together to learn from prosected materials may spend more time focused on the learning objectives than students dissecting in a team with an entertaining colleague. As noted by numerous authors, the key is to make anatomy a quest for discovery. The inquiry-based approaches so eloquently described by Miller et al. (2002) could be used in prosection or dissection courses to make anatomy interesting and relevant.

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**Student learning is not dependent on performance of a full dissection. It is instead dependent on outstanding instruction, engaged inquiry, interaction with peers, continual self-assessment, and dissemination and testing of one’s newly acquired knowledge.**

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**INTRODUCTION TO PHYSICIAN-PATIENT RELATIONSHIP, CONCEPTS OF HUMANISTIC CARE, COMPREHENSION OF DEATH AND DYING**

Much has been written about the cadaver as the medical student’s first patient and first encounter with pathology and death and need not be expanded here.

Anatomy education should continue in an integrated manner with other disciplines throughout the 4 years of medical education and beyond. Our charge, however, is not to produce clinical anatomists. Dissection may be fascinating and even consuming to us, but it is one component in the training of a multifaceted physician. We will mold better clinicians if we pique students’ interest in anatomy. We should teach them to be lifelong learners, to apply a conceptual foundation to new problems, to identify, assess, and use resources, and to self-monitor judgment and clinical and communication skills. Student learning is not dependent on performance of a full dissection. It is instead dependent on outstanding instruction, engaged inquiry, interaction with peers, continual self-assessment, and dissemination and testing of one’s newly acquired knowledge.

**ACKNOWLEDGMENTS**

This article is dedicated to the memory of Dr. Hugh (Pat) Patterson, a devoted and innovative instructor and well-known proponent of prosection-based anatomical education at the University of California at San Francisco.

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