EDITORIAL

Gentlemen, damn the sphenoid bone!

R. SHANE TUBBS*
Editor-in-Chief Seattle, WA

Welcome to our first issue of 2016. This year, Clinical Anatomy will provide our readership with cutting edge publications that can be used for improved patient care as well as in the teaching of anatomy to future practitioners of medicine and the health related professions.

Oliver Wendell Homes (1809-1894) (Fig. 1), a true Renaissance man, is known for his famous opening line (and the title of this editorial) for his anatomy course at Harvard Medical School. This whimsical comment not only applies to the complexity of this single bone but to the deeper aspects of anatomy as well. Oliver Wendell Holmes, Sr. was a physician, dean of the Harvard Medical School, one of the best regarded American poets of the 19th century, father of a future United States Supreme Court Justice, inventor and — unknown to many — an anatomist. His friends included Ralph Waldo Emerson, Henry Wadsworth Longfellow, and Louis Pasteur. He trained with some of the most influential anatomists/surgeons of his day including Lisfranc, Larrey, Velpeau, Bigelow, and Dupuytren. As a teacher of anatomy, he had strong feelings regarding medical curricular reform and to some, was considered one of the best lecturers in the discipline. As dean, he pioneered social reform by admitting both white women and free black men to Harvard Medical School (Tubbs et al., 2012). The cover of this issue of our Journal takes one back to times when segregation was the norm between trainees of medicine.

Since these earlier controversial times, anatomical knowledge and teaching have come a long way. However, controversies are still around. For example, the ethics of anatomy is a timely topic and one that we are happy to bring to you in this Special Issue. Dr. Gareth Jones from the University of Otago has aptly put together an international group of authors who are expert in this field. Although conclusions cannot be drawn, bringing these topics to the light is an important first step in conversation and debate and one that we believe the readers of Clinical Anatomy will enjoy.

REFERENCES

EDITORIAL

Anatomy in Ethical Review

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When I became Head of my present Anatomy Department in the early 1980s, it was considered very strange to encounter someone who had an interest in anatomy and ethics. At best the two were seen as occupying quite separate intellectual compartments; at worst the two were incompatible. In practice, their separation was little more than an indication that the discipline of anatomy had no need of ethics. Obtaining the bodies of the dead was carried out in accordance with existing legislation (the then extant Anatomy Act), and as it happened the only bodies used in the Department had been bequeathed for the purposes of teaching and research. All procedures were legal (Jones and Fennell, 1991). What more could be asked of anatomists?

The Department also housed the skeletal remains of indigenous peoples, histology slides of human tissue, and a Museum containing human embryos and fetuses, as well as an impressive collection of preserved human parts. While many of these items had been in the Department for many years, they represented important teaching tools and raised significant ethical challenges (Jones and Telfer, 1995; Jones and Harris, 1998).

Responses such as these reflected the ethical climate of the time, and should not be unduly harshly condemned. They were not intended to conceal notorious activities, and I have no reason to suspect that any such activities were taking place. However, they failed to prepare the anatomists in the Department (or anywhere for that matter) for activities elsewhere with the potential for mistreating dead bodies. Neither these nor other anatomists were being trained to think critically about their practices, and were not being provided with appropriate analytical ethical tools (Jones, 1998).

The organ scandals that came to light in the 1990s in the UK were the result of the activities of pathologists and clinicians, rather than of anatomists, and yet they brought into the open a welter of ethical considerations as to what can and cannot be done to and with the dead human body, body parts, and organs. These scandals led to one commission of inquiry after another, with the subsequent formulation of crucial ethical values governing treatment of the bodies of the recently deceased, plus ways of approaching the bereaved family (Bristol Royal Infirmary Inquiry, 2001; The Royal Liverpool Children’s Inquiry, 2001; Retained Organs Commission, 2002).

However, anatomists were directly implicated in unethical practices during the Nazi era in Germany and occupied territories, and more recently there has been ongoing debate over the public display of whole dissected plastinated bodies (Hildebrandt, 2009a,b; Jones and Whitaker, 2009; King et al., 2014). While different ethical issues are raised in these two areas, they hone in on fundamental ethical considerations— informed consent on the part of all involved, treating the person who has died and their families with dignity and respect, and working toward a gift relationship with its emphasis on donation rather than retention (Department of Health, 2001).

Much of the debate in the anatomical literature has centered on the ethical thrust away from using unclaimed bodies toward a model based on donation and bequest (Jones, 1994; Jones and Whitaker, 2012). While this is not the only ethical issue of significance in relation to dead bodies and body parts, it encapsulates them since a willingness to override the interests of the deceased and their families in this way suggests that they will also be overridden in others. There is perhaps a parallel between this and the retention of organs without consent following post mortem. Both suggest a professional paternalism whereby that which is regarded as benefiting the profession overrides the welfare of the dead person and their family.

Valuable as these debates have been, they are exposed to the danger that they reflect the situation in Western countries and ignore the realities found in other societies (Winkelmann and Guldner, 2004; Lin et al., 2009; Subrasinghe and Jones, 2015). Unless great care is exercised the result is cultural and religious myopia, resulting in ethical generalizations that are unworkable in some societies and may actually stifle constructive ethical debate. As has been evident in Western societies, the development of ethical awareness has occurred gradually, so that ethical standards today differ substantially from what was regarded as ethical practice 50 let alone 200 years ago. Against this background those societies lacking a history of ethical debate, especially where there are long-standing cultural and religious considerations that have not been rigorously assessed, may well follow their own trajectories. This is not to suggest that

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Received 7 September 2015; Accepted 9 October 2015
Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/ca.22646

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they will end up with radically different ethical values from those in the West, but that the manner in which they manifest themselves will be different. It also follows that the West may have much to learn from these other experiences.

The one underlying message that emerges from tracing the history of anatomy (especially the donation of bodies for dissection) is that anatomists have to win the confidence of the population in which they are functioning. This has been hard won over many years in the West, and it could still be lost. For instance, the organ scandals, even though the province of pathology, could have had dire repercussions for anatomy. This does not appear to be the case, and yet it demonstrates the inevitable tension between science and ethics; what is best for scientific investigation may not be best for protecting the people involved—patients, research subjects, the recently deceased. Anatomy is not alone in this; for instance, stem cell research has been colored by ethical controversies, fraud, and extravagant claims regarding the efficacy of certain treatments.

The papers in this special issue touch on many of these topics. While the emphasis of most of the papers is on ethical issues, some trace the changing face of anatomy and its interest to a range of professional groupings, while others reflect on issues in medical education. Nevertheless, all of them in their various ways point to the need for ethical reflection. They also indicate that new dilemmas continue to arise as more and more ways are found of using human tissue, in line with increasing technological abilities, and as procedures once thought adequate to protect human subjects are no longer sufficient. The latter is the case with the burgeoning use of digital images, and will also emerge as increasingly significant with the emergence of 3D printing technology and increasing use of genetic analyses and biobanking (Cambon-Thomsen, 2004; McMennamin et al., 2014).

Consequently, this special issue is no more than the start of an invigorating conversation, that will continue for as long as anatomy, and with it use of the human body, body parts, and human tissue, is central to teaching about the human body and remains foundational for human tissue research.

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A GLIMPSE OF OUR PAST

Historical Perspective—Anatomy Down the Ages in Australasia; Lessons for the Future

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Is anatomy a dying discipline? This article explores the history and current state of human anatomy in Australasia, and considers the changing nature of the discipline, and possibilities for the future. A web-based search of all tertiary institutions in Australasia was performed to identify which taught anatomy. Those identified were invited to provide further information about postgraduate student numbers, external courses and public outreach. Forty-one institutions across Australasia teach anatomy. There are seven identifiable anatomy departments and nine disciplines of anatomy. From 1900 to 2014, the number of medical schools has increased (from 4 to 20), however a concomitant increase in the number of anatomy departments (2014, $n=7$) was not observed. Twenty-one institutions, without medical schools, currently teach anatomy but none have a stand-alone anatomy department. Anatomy is taught in more than 18 different undergraduate and postgraduate programs. From the 28 institutions that provided current data, 310 postgraduate research students were identified. Predominantly, they came from longer-established institutions with an identifiable anatomy department. Similarly, those with anatomy departments/disciplines offered external professional courses. Many institutions engaged in public outreach. The evidence suggests that anatomy is alive and possibly even growing in Australasia. However, the structures around the discipline and the students who are learning anatomy are changing. Our challenge is to prepare the next generation of anatomy faculty to be both researchers and teachers. Clin. Anat. 29:4–10, 2016. © 2015 Wiley Periodicals, Inc.

Key words: anatomy; Australasia; research; teaching

INTRODUCTION

When Anatomists talk about the future of anatomy there can be a tendency for an attitude of “doom and gloom”, but is this response justified? Is anatomy a dying discipline or is it just changing? In this article we explore the history and current state of Human Anatomy in Australasia and consider the changing nature of the discipline and possibilities for the future.

Historically, the first anatomy departments in Australasia were established by anatomists from England and Scotland. As in the UK, these anatomy schools and departments were established to assist in the training of medical and dental students (Williams, 1986; The University of Sydney, 2008). Four medical schools with professors of anatomy were established in the 19th century in Australasia. The first Professor of Anatomy in Australasia was Prof George Britton Halford who was appointed at the University of Melbourne in 1862. Prof Halford came from the Grosvenor Place School of Medicine in London to set up the medical school (The University of Melbourne, 2012). The University of Otago was the next medical school to be created and Prof Millen Coughtrey arrived from Edinburgh in New Zealand in 1874. His time as professor was short as he soon realized that he could make a more lucrative living as a clinician (Page,
2008) and he was succeeded by another Scot, Prof John H. Scott, in 1877 (Page, 2008). Prof Anderson Stuart was the next appointment in 1883 to the University of Sydney. Although the Faculty of Medicine was formally created in 1856 the decision to establish a medical school did not occur until 1882 (The University of Sydney, 2008). Three years later, Prof Archibald Watson was appointed to the new medical school in Adelaide. Prof Watson was born and bred in Adelaide but gained his first doctorate from Göttingen (1878), his second in Paris (1880), and trained for his English and Australian credentials in London thereafter. He was subsequently appointed as Professor of Anatomy at the new medical school in Adelaide and held the chair for an impressive 34 years (The University of Adelaide, 2013).

By today’s standards these early professors were young, in their late 20’s and 30’s (George Britton Halford 38, Millen Coughtrey 26, John H Scott 26, Anderson Stuart 27, Archibald Watson 36) and with the exception of Prof Halford [who had experience as a lecturer (The University of Melbourne, 2012)] they had received no formal training in anatomy teaching apart from their undergraduate learning. However, they had high aspirations for their discipline. “Anatomy is now beyond the days in which the various organs and structures of the human body were displayed as part of a landscape...... [its study is] one of the most powerful media for mental culture exacted of the student.” (Prof Millen Coughtrey 1875) (Page, 2008, p. 22). They also clearly recognized the need for research to inform their teaching; as noted by Morrow (1968), Prof JT Wilson (University of Sydney, 1890–1920) insisted that a high standard of teaching can be maintained in a university department only if its instructors are adding knowledge to the field.

In the 19th and early 20th centuries the subject of anatomy, focused on the macroscopic structure of the human body as revealed by the dissection of cadavers (The University of Sydney, 2008), and this comprised a large component of the curriculum particularly in the first years (Parker, 2002). The subject was a very literal interpretation of its Greek language derivative “temnein” meaning “to cut” (Drake et al., 2010). Histology and embryology were also included in the subject where it was necessary for a better understanding of the anatomy of a structure (Drake et al., 2010).

Over the last century we have witnessed a growth in the areas considered to fall within the discipline of anatomy. The subject now encompasses an extensive range of sub-disciplines and is not just restricted to human anatomy as revealed by dissection. This is reflected in the diversity of research that is being undertaken. For example, the teaching and research undertaken in the Department of Anatomy at the University of Otago includes neuroscience, neuroendocrinology, biological anthropology, embryology, and developmental biology as well as the more traditional gross, functional, and clinical anatomy. The increase in anatomy sub-disciplines and of other biomedical information that medical students are expected to learn has been accompanied by a reduction of time in the curriculum for formal learning of anatomy, from ~500 to an average of 171 hours in Australasia (Craig et al., 2010). Such substantial reductions in the amount of time afforded to teaching anatomy as well as the expansion of the field raises the question of whether the historical definition of what anatomy involves is being diluted, and whether it compromises the identity of anatomy as a subject?

However, at the same time that the number of hours of anatomy teaching in the medical curriculum has been decreasing there has been an increase in anatomy teaching in other health professional curricula and in undergraduate and postgraduate science degrees. With these changes, what is happening to the identity of anatomy in Australasia? Is it disappearing or evolving? And if anatomy’s identity is changing, does this matter and what are the consequences for the discipline in the future?

In this current investigation we have attempted to gather a snapshot of anatomical teaching and research students in the tertiary institutes across Australia and New Zealand to determine “the current state of anatomy in Australasia”.

**MATERIAL AND METHODS**

Initially a web-based search of all tertiary institutions in Australasia was undertaken to determine which universities included anatomy or anatomically related subjects in their teaching portfolios. The age of the various institutions and whether they had a distinct department of anatomy was also explored.

In June 2014, 41 Australasian universities identified as teaching anatomy were invited to participate in this research project. Each institution was asked to complete a small table regarding student number, public engagement, and postgraduate education (Table 1).

If in response to our invitation to participate, an individual asked for a definition of what constituted “anatomy research”, we would advise that we were interested in gathering data regarding research and teaching that included gross/clinical/functional anatomy (including neuroanatomy), embryology, and histology. Otherwise, the decision regarding which areas to include was left for their own discretion.

**TABLE 1. Table for Institutions to Complete Regarding Current Postgraduate Student Number, Community Outreach, and Postgraduate Courses Involving Anatomy**

<table>
<thead>
<tr>
<th>Postgraduate course</th>
<th>Number of students currently enrolled (2014)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honours</td>
<td></td>
</tr>
<tr>
<td>Masters</td>
<td></td>
</tr>
<tr>
<td>PhD</td>
<td></td>
</tr>
<tr>
<td>Community outreach?</td>
<td>Y/N</td>
</tr>
<tr>
<td>Postgraduate courses?</td>
<td>Y/N</td>
</tr>
</tbody>
</table>

If yes, please provide a brief description:
RESULTS

Deans, Heads of Schools/Departments or other relevant staff members from 28 (68% response rate) of the 41 institutions responded.

Medical Schools in Australasia

As described above only four medical schools existed in Australasia in 1900 (three in Australia and one in New Zealand). A further medical school was opened between 1900 and 1949 (University of Queensland, 1939). In the second half of the 20th century seven more medical schools (Australia, n = 6; New Zealand, n = 1) were opened (Fig. 1). Since the turn of this century another eight medical schools have been established in Australia, many of these being postgraduate, rather than the historically more common undergraduate schools in this part of the world.

Departments of Anatomy in Australasia

Despite the increasing number of medical schools, a similar rise in the number of departments of anatomy has not occurred. Indeed, the number of cognate departments of anatomy has decreased since 1999 (Fig. 2). Throughout Australasia, there were seven identifiable departments of anatomy in 2014. This was a reduction from eight departments in 1999. However, there were nine tertiary institutes with publicly identifiable disciplines of anatomy within a wider school. Of the remaining 25 (out of 41) institutions with no identifiable anatomy department/discipline, 18 had schools/departments of biomedical sciences/biosciences, or health (science).

Anatomy Teaching

While medical schools have traditionally been the site of anatomy teaching they are no longer the only places teaching anatomy in Australasia. Of the 41 institutions in Australia and New Zealand that were identified as teaching anatomy papers or programs (with the term “anatomy” in the title), just under half (n = 20) have medical schools. Of the remainder without a medical school (n = 21), four have identifiable disciplines of anatomy within a wider school structure, but none have a distinct anatomy department. A list of programs in which papers with “anatomy” in the title is taught, can be seen in Table 2.

In addition to teaching anatomy at an undergraduate level, in both science and health professional courses, there are a number of postgraduate qualifications available to health professionals throughout Australasia. As an example specific to anatomy, a graduate diploma in surgical anatomy (or similar) is offered by nine institutes, with another one developing a course for 2015. Of these, four have identifiable disciplines of anatomy and three identifiable departments of anatomy. The remaining three courses are from

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TABLE 2. Programs in Which Papers with “Anatomy” in the Title are Taught Within the 41 Identifiable Australasian Tertiary Institutes

<table>
<thead>
<tr>
<th>Bachelor of Applied Science</th>
<th>Bachelor of Speech &amp; Language Pathology</th>
</tr>
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<tbody>
<tr>
<td>Bachelor of Biomedical Science</td>
<td>Chiropractic</td>
</tr>
<tr>
<td>Bachelor of Clinical Sciences</td>
<td>Dentistry</td>
</tr>
<tr>
<td>Bachelor of Exercise Science</td>
<td>Medical imaging/Radiography</td>
</tr>
<tr>
<td>Bachelor of Forensic Biology</td>
<td>Medical Laboratory Science</td>
</tr>
<tr>
<td>Bachelor of Health Science</td>
<td>Medicine</td>
</tr>
<tr>
<td>Bachelor of Human Sciences</td>
<td>Occupational Therapy</td>
</tr>
<tr>
<td>Bachelor of Medical Sciences</td>
<td>Physical Education</td>
</tr>
<tr>
<td>Bachelor of Science</td>
<td>Physiotherapy</td>
</tr>
<tr>
<td>Bachelor of Sports Management</td>
<td>Radiation Therapy</td>
</tr>
</tbody>
</table>

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universities that do not identify as having anatomy departments or disciplines; rather they are run through departments or schools of a more general biomedical/health science focus: a medical school \((n = 1)\), a school of chiropractic \((n = 1)\), and a school of biomedical science \((n = 1)\).

A number of institutions also connect with health science professionals through workshops or courses that count toward continuing education programs (Fig. 3). Three departments and five disciplines provide anatomically related workshops, short courses, or continuing education programs for professionals. Four (three departments, one discipline) do not appear to offer short courses or workshops. Nine institutions with no identifiable anatomy department/discipline also offer anatomy related workshops, short courses or continued education for professionals. Three of these were from professional schools; a medical school \((n = 1)\), schools of physiotherapy \((n = 2)\), and a school of chiropractic \((n = 1)\).

**Postgraduate Anatomy Students**

Data informing this section were supplied from five anatomy departments and six disciplines of anatomy, with the remainder of responses \((n = 17)\) coming from institutes where anatomy was taught by staff who were part of a wider school structure.

Across the 28 institutes that responded to our survey, there were 310 postgraduate students enrolled in postgraduate anatomy research degree programs. The distribution across universities was not even. Universities with a medical school had more postgraduate students than institutions without a medical school (Fig. 4a) and more postgraduate students were present in older medical schools than those established in the last 65 years (Fig. 4b). Furthermore, medical schools with a distinct anatomy department had more postgraduate students involved in anatomical research than those where anatomy was taught in a combined school of biomedicine or equivalent (Fig. 4c).

**Anatomy and the Public**

Provision of education to the public and local community is increasingly important. Of the 41 universities identified as teaching anatomy, 17 were found to participate in public and/or community engagement that was anatomically focused. Largely, these public outreach engagements were contributions to University-run open-days for high-school leavers. Nine of these institutions were those that identified as having departments or disciplines of anatomy, however, there were four universities with anatomy departments/disciplines that did not report that they engaged with the public. Nearly almost as many institutions \((n = 8)\) that do not have departments or disciplines of anatomy were also identified as engaging in public outreach.

Although it was not part of the survey, we are aware that many medical schools provide learning opportunities about legal and ethical issues regarding the use of cadavers. At the University of Otago this includes large and small group work, accompanied by the showing of the film “Donated to science” (Trotman, 2009). Furthermore, at the beginning of each academic year, all students who will be working in the dissection room are invited to attend a “whakawatea” (clearing of the way) ceremony. This process was put in place to facilitate cultural competence and safety, and to help put the new students at ease in their study-working space (Martyn et al., 2013).

**DISCUSSION**

The state of anatomy in Australasia today is very different to that a century ago. There has been significant growth in the number of medical schools reflecting the changing population needs but also a growth in diversity of the courses where anatomy is taught and a concomitant increase in universities without medical schools teaching anatomy. On the face of it
this would appear a good situation and bodes well for the discipline of anatomy. However, within the data there are some positive and negative aspects.

Before discussing the data further it is important to remember that for the most part we have presented a single snapshot of the state of anatomy. While our data reflect the general trends of what is happening across Australasia in terms of anatomy teaching and research, the responses we received from the institutions are not exhaustive for the whole of Australasia and thus some of the data obtained for this article should be interpreted with caution. In particular the number of postgraduate students identified as studying anatomy may be variable because of the individual interpretation of what constitutes “anatomy”. For example, some of the universities that were contacted may have excluded projects with a neuroanatomy focus when informing us of PhD and Masters student numbers, while others were inclusive of this topic. This of itself is an interesting dilemma and perhaps reflects a lack of a common identity of teachers and researchers working in this field. Perhaps a wider discussion is required to determine a common understanding of which areas are considered to lie within the remit of the discipline of anatomy.

What was perhaps surprising was the large number of institutions that taught courses that contained anatomy. Unlike a century ago anatomy teaching is no longer the prerogative of medical schools. Furthermore, the programs where anatomy is taught are no longer limited to medicine and dentistry and now encompass most allied health professional programs as well as science-based degrees. This has led to increased teaching workloads and a much larger volume of students passing through departments/disciplines/schools. If we consider our own department at the University of Otago the change in the number of courses to which anatomy contributes and the number of students has increased almost 10 fold over the last 30 years with 72 effective

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**Fig. 4.** The total and mean number of research postgraduate students across different Medical Schools in Australasia. (a) Institutions with Medical Schools compared to those without a Medical School. (b) Medical Schools with an anatomy department compared to those without an anatomy department. (c) “Old” Medical schools (established prior to 2000) compared to “New” Medical Schools (established post 2000).

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**TABLE 3. Changes in the Teaching and the Number of Students at the Department of Anatomy, University of Otago (1983–2013)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of effective full time students</th>
<th>Programs/courses where teaching was delivered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>72</td>
<td>Medicine years 2 &amp; 3, Dentistry, Health Science First Year, BSc Anatomy, B Physical Education, Home Science degree, PhD</td>
</tr>
<tr>
<td>2003</td>
<td>483</td>
<td>Medicine years 2, 3, &amp; 5, Dentistry, Dental Therapy, Health Science First Year, BSc &amp; BSc Hons Anatomy, B Physical Education, Physiotherapy, B Biomedical Sciences, B Medical Laboratory Science, BSc Neuroscience, PG Diploma Ophthalmology, MSc, PhD</td>
</tr>
<tr>
<td>2013</td>
<td>710</td>
<td>Medicine years 2, 3, &amp; 5, Dentistry, Health Science First Year, BSc &amp; BSc Hons Anatomy, B Physical Education, Physiotherapy, Pharmacy, B Biomedical Sciences, B Medical Laboratory Science, BSc Neuroscience, Dip Ophthalmology, PG Diploma Surgical Anatomy, MSc, PhD</td>
</tr>
</tbody>
</table>
recently, it has been made evident that in order for an anatomy department to thrive, its staff (and students) must be actively engaging in research (Jones et al., 2002). We have used postgraduate research students as a surrogate marker for research activity in an institution. While, of course, it is possible to be research active in the absence of postgraduate students it does also reflect the potential to train the anatomists of the future. If new anatomists are not being trained then it is difficult to see how our discipline will flourish. Within the New Zealand context there is an added complexity. The NZ Education Act (Education Act, 1989, part 14, s 162) states that at university level teaching must be research informed. The two universities in New Zealand that teach anatomy are research active but if this were not the case then they would be in breach of the Act.

The realization that anatomy is being taught to undergraduates by teachers who may not come from an anatomy discipline raises other questions. These data suggest that anatomy still has a strong presence in Health Sciences but is being taught as a subject integrated into courses rather than as an individual program. Similarly, it appears that the subject of anatomy has evolved from its historical form and no longer just encompasses gross anatomy as revealed by dissection. It could also be postulated that the fact that more tertiary institutions are offering postgraduate certificate qualifications to professionals is a consequence of the reduction in hours spent teaching undergraduate anatomy, particularly in medical courses (Craig et al., 2010).

In the 19th century, public interest in anatomy was high. This was no doubt due, in part, to the financial commitments made by the government for the establishment and foundation of medical schools. There were also cases of financial support from some members of the community (for research purposes within the medical schools) (The University of Western Australia, 1958; Doherty, 1986) and at one university, the salaries of existing lecturers from Law and Civil Engineering were reduced in order to provide funds for anatomy (Russell, 1977). Public interest in anatomy was probably also because of the direct involvement of community members in the supply of specimens and bodies for study. It was common for anatomy professors, assistants and students to collect specimens to establish anatomy and/or pathology museums (Russell, 1977; The University of Sydney, 2008) and enhance their teaching, learning and research. In some cities, the public was encouraged to participate in the collection by donating “interesting and rare” specimens (The University of Sydney, 2008). Interest is likely to have been further bolstered by the “body-snatching” cases and other controversial methods of body attainment for anatomical dissections that were publicized (MacDonald, 2010).

It is difficult to determine whether the public is still as interested in anatomy as is documented historically. Although these data are limited with respect to properly understanding the amount of dedicated time and effort put toward public outreach, it is encouraging to see that engagement between the community and the
anatomical sciences still exists across Australasia, suggesting that the interest in the subject is still prominent. Interestingly though, the responses suggest that the source from which the engagement or the courses are offered is varied, and more importantly, may not require the identity of an anatomy department or discipline to be well received and successful.

It is, however, somewhat disappointing that Anatomy Departments are not more engaged with public outreach, especially given the recent controversy surrounding the use of cadavers in exhibitions. Since the launch of Body Worlds in Tokyo in 1995, a divide between the public and anatomists has become apparent. The exhibitions unconventional displays of cadavers have generated a considerable amount of uncertainty by anatomists, both to the exhibitions and their founder Gunther von Hagens (Jones and Whitaker, 2009). It has been the opinion of some anatomical societies that their display would be "to the detriment of medical education" [Boyd et al., 2002 (as cited in Jones and Whitaker, 2009)]. However, Body Worlds has been immensely popular with the public (Jones and Whitaker, 2009). If nothing else, a constant, open relationship between anatomy departments and the public may put to rest the natural curiosity the layperson may have about the human body, the goings-on in medical schools, and to ensure that "bad press" does not damage the discipline.

Even in 2014, some 150 years after the first medical school in Australasia opened its doors (Russell, 1977) there is a desire and a need for the teaching and learning of anatomy across Australasia. Many tertiary institutions are involved in community engagement, and more are developing postgraduate anatomy courses and offering anatomically related continuing education, indicating the important place that anatomy has in health science. This suggests that anatomy is still a strong and popular contender as a study and research option.

It does not appear that anatomy in Australasia is waning because of "the scant likelihood of any new discoveries" (Dyer and Thorndike, 2000) but the identity of anatomy has changed. Anatomy teaching is no longer restricted to discrete departments or disciplines bearing its title. The subject is more diverse, because of advances in scientific technology over the years that now allow the simultaneous investigation of structure and function. Although such diversity has been attributed to the closure of Harvard's Anatomy department in 1994 (Dyer and Thorndike, 2000), there is no evidence that this will happen in Australasia. Indeed it would appear that anatomy research and teaching is evolving to meet the various needs within the Australasian context.

To parody Captain Spock "its anatomy, Jim, but not as we knew it".

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Body Donations Today and Tomorrow:
What is Best Practice and Why?

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There is considerable agreement that the use of human bodies for teaching and research remains important, yet not all universities use dissection to teach human gross anatomy. The concept of body donation has evolved over centuries and there are still considerable discrepancies among countries regarding the means by which human bodies are acquired and used for education and research. Many countries have well-established donation programs and use body dissection to teach most if not all human gross anatomy. In contrast, there are countries without donation programs that use unclaimed bodies or perhaps a few donated bodies instead. In several countries, use of cadavers for dissection is unthinkable for cultural or religious reasons. Against this background, successful donation programs are highlighted in the present review, emphasizing those aspects of the programs that make them successful. Looking to the future, we consider what best practice could look like and how the use of unclaimed bodies for anatomy teaching could be replaced. From an ethical point of view, countries that depend upon unclaimed bodies of dubious provenance are encouraged to use these reports and adopt strategies for developing successful donation programs. In many countries, the act of body donation has been guided by laws and ethical frameworks and has evolved alongside the needs for medical knowledge and for improved teaching of human anatomy. There will also be a future need for human bodies to ensure optimal pre- and post-graduate training and for use in biomedical research. Good body donation practice should be adopted wherever possible, moving away from the use of unclaimed bodies of dubious provenance and adopting strategies to favor the establishment of successful donation programs. Clin. Anat. 29:11–18, 2016. © 2015 Wiley Periodicals, Inc.

Key words: anatomy; body donation; ethics; guidelines; plastination; surveys; unclaimed bodies

INTRODUCTION
Why Is Dissection for Anatomy Teaching Important?

Anatomy, the science of human biology, is a major basic discipline every student or professional has to learn when entering medicine or biomedical sciences (Korf et al., 2007). Reviewing the history of gross

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Published online 28 October 2015 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/ca.22641

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anatomy teaching, Moxham and Plaisant (2014) outlined how the presentation and dissecting of the human body evolved. They also showed that the approach to learning and exploring human anatomy by dissection was handled differently before and after the Renaissance (dissection is implicit in the term “anatomy”). Although several universities in the US and the UK have abandoned dissection during recent decades and have moved toward cadaverless anatomy teaching, a number of authors (Korf et al., 2007) argue in favor of dissection courses in medical curriculum. For those authors, dissection is a central tool for teaching macroscopic anatomy for the benefit of future physicians in light of the respect and honour guaranteed to every donor (Korf et al., 2007). They also argued against plastination and long-term preservation of well-prepared specimens. However, these latter arguments appear to have been offered mainly in the context of viewing plastination as a replacement for traditional cadaver dissections. Despite such arguments, plastinates constitute an additional teaching tool that enables prosected body parts to be used alongside cadaver dissection and serve as a complementary approach to gaining knowledge (Riederer, 2014). Therefore, plastination must be seen as an additional teaching tool for stimulating as many senses as possible to foster the acquisition of anatomical knowledge.

Several points underline the importance of dissection for anatomical teaching (Korf et al., 2007): The gross anatomy laboratory offers a unique opportunity to learn and practice the manual skills required for analytical “doctoral touching”. A hypothetical seeing and thinking - “When I cut at this site with a scalpel, I should normally see this or that” - leads to a mental image of the anatomy needed to practice surgery. It stands to reason that passive acquisition of knowledge (reading, hearing, observing) is far less efficient than active acquisition (acting, discussing, constructing, dissecting). Knowledge acquisition is most efficient when it involves many senses as possible. This is fully exploited by dissection. To be a physician entails occupying a particular orientation toward the patient as subject or object, and maintaining an objective view as the basis of sound diagnosis and valid therapy. Students need to learn this dual role of neutral observer and compassionate helper. In that context, the cadaver begins as an object, but as dissection progresses the body starts to unravel its history, which could include osteoporosis, muscle atrophy, or calcified arteries, allowing students to develop clinical skills and attitudes.

**Diverse Means of Obtaining Human Cadavers for Anatomical Teaching and Research**

In the absence of well-established donation programs because of cultural and/or religious hurdles, the only viable option is to use unclaimed bodies. Several reports highlight these differences, and conferences on the topic point to a need for guidelines and the exchange of information on how to set up and improve body donation programs. History reveals the need for bodies and shows that legalization of body donation is a slow process. It is not surprising that many countries today, faced with scarce or nonexistent body donations, use unclaimed bodies or the bodies of executed criminals (see Table 1).

In countries where body donations have been available for 50–80 years, including Europe and US, the process has evolved such that today there are well-defined ethical and legal frameworks for body donation programs. These have resulted in increasing use of bodies for medical education and research (Garment et al., 2007; McHanwell et al., 2008; Riederer et al., 2012; Biasutto et al., 2014). Against this background, one would anticipate that in countries lacking legal frameworks governing body donations, and with cultural traditions to honor their deceased, legal, cultural and religious traditions will not change overnight and the relevant authorities will not readily be convinced that body donations are important for the sake of medical progress and education. Change will only be promoted by developing well-established guidelines that oversee body donation and are the working-out of ethical and legal principles.

**BODY DONATION TODAY**

**Donation From General Public**

Many European countries have body donation programs: Austria, France, Germany, Malta, the Netherlands, Portugal, Spain, Switzerland, and UK. Several others have difficulties in obtaining sufficient numbers of donors: Italy, Romania, Serbia, and Turkey (McHanwell et al., 2008; Riederer et al., 2012). Turkey, with its cultural particularity, has few donations and unclaimed bodies are insufficient for effective gross anatomy teaching by dissection (Sendemir, 2014).

The situation in Italy may be worth mentioning. In 1970, the Italian Government allowed free access to medical school for applicants in their first year of medicine, and in consequence there was a substantial increase in admissions and a need to overhaul the mode of teaching. The most serious consequence for anatomy teaching was the closure of the dissecting room facilities, followed by a progressive loss of donation programs, along with a loss of staff able to teach gross anatomy on human cadavers (de Caro 2009).

Today, there is an attempt to restore some body donation programs, but donations are scarce and the general public believes that unclaimed bodies of homeless people are mostly used. A quality management ISO 9001:2008 was adopted in Padova to improve the image of body donation, and the Anatomy department now receives about 20 donations per year (Porzionato et al., 2012). Lately, donation programs have been put in place in several Italian cities and donations are starting to arrive. A couple of years ago the Nicola Foundation established the ICLO teaching and research center in Arezzo, where over 80 postgraduate courses and cadaver laboratories are organized each year. For the cadaver laboratories, body parts from certified donors are imported from the US at high cost (Riederer, personal communication). Needless to say, physicians who participate at these
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<td><strong>Austria</strong></td>
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<td><strong>Greece</strong></td>
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<td><strong>India</strong></td>
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<td>Biasutto et al., 2014</td>
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<td><strong>Malta</strong></td>
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<td><strong>New Zealand</strong></td>
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<td><strong>Nigeria</strong></td>
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<td>Unclaimed bodies</td>
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<td>Many universities have body donation programs</td>
<td>McHanwell et al., 2008; Riederer et al., 2012; Richardson &amp; Hurwitz, 1995</td>
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<td><strong>Uruguay</strong></td>
<td>Deceased patients without family claim</td>
<td>Biasutto et al., 2014</td>
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This is by no means an exhaustive list and some reports could have been omitted.
events are satisfied, since it is one of the few occasions on which the quality of medical procedures and the correct placement of prostheses and devises can be checked, followed by a dissection to identify structures at risk during surgical interventions.

Biaisotto and colleagues opened a debate on the availability of human bodies for teaching anatomy and the importance and procurement of cadaver donations. The debate has included contributions covering India, Uruguay, Austria, USA, Spain, South Africa, New Zealand, Brazil, Nigeria, Columbia, UK and Malaysia (Biaisotto et al., 2014). Individual contributions report on the experience of donations but also testify to cultural limitations in Asiatic and African countries.

A report from Serbia pointed out the necessity of changing the legal framework before establishing body donation programs. Meanwhile, unclaimed bodies are used, but with permission of next-of-kin when possible, and efforts are made to define a chain of order and responsibilities, body storage and related procedures, confidentiality of personal data and burial procedures (Stimec et al., 2010). All these point to good body donation practices, since unclaimed body donation should not be more than a temporary solution. It is essential to raise public awareness in order to increase the number of donations.

In Singapore, the National University is setting up a donation program. Currently, unclaimed bodies are released for medical sciences and research and cadavers are imported from the US (Ang et al., 2012; EwonuBari et al., 2012). Unfortunately, the future for body donation and anatomical dissection is uncertain in Singapore, and recommendations to include body painting and clay plastinc to facilitate learning are no more than stop-gap measures, since they are of limited value for ensuring high quality medical education. Additional possibilities include obtaining bodies from neighbouring countries that have well-implemented body donation programs, such as Korea, Thailand and Taiwan (Winkelman and Gülner, 2004; Lin et al., 2009; Park et al., 2011).

A survey from Nigeria reported that ~94% of schools had too few cadavers for gross anatomy study (Anyanwu et al., 2011). Ninety percent of those available were unclaimed cadavers of criminals who had been killed by shooting; fewer than 10% were unclaimed and unidentified corpses. The estimated ages of the cadavers were between 20 and 40 years. The promotion and funding of donation programs are, therefore, crucial for improving medical education in Nigeria as well as other African countries (Anyanwu and Obikili 2012). In India, the supply of donated cadavers available for dissection is also insufficient (Rokade and Gaikawad, 2012; Biaisotto et al., 2014). A lack of public awareness appears to be the main reason here, so awareness campaigns are needed.

In Japan, after the Meiji restoration, the use of executed prisoners changed to use of patients who had previously received free medical treatment, or of unclaimed bodies from elderly homes and prisons (Kozai, 2007). Quite recently, "kentai" or "voluntary body donation" has become the common method for obtaining cadavers. This reflects a change in the relationship between medical science and Japanese society. Sakai (2008) reported a steady and impressive increase in registered donors and donations received.

In some Chinese cultures, Confucianism could have a negative effect (Park et al., 2011; Zhang et al., 2008, 2014): "Our bodies—to every hair and bit of skin—are received by us from our parents and we must not presume to injure or wound them …" Donating the body for dissection goes against this belief, which could have a negative influence on potential body donors in Hong Kong (Chiu et al., 2012). However, the decision to donate can be influenced by family members’ donations, registration as organ donors or a good doctor-patient relationship.

Despite such beliefs prohibiting body donation, a unique fusion of Western and Oriental medicines had emerged on the Korean Peninsula by the end of the twentieth century, and this revolutionized traditional perspectives, leading to a dramatic increase in donations (Park et al., 2011). The factors leading to this change include the organization of donor-appreciation ceremonies in Catholic-based and Buddhist-based schools, and also in schools with no religious background. Building monuments to thank the donors has also proved helpful (Zhang et al., 2008). Another example involving Buddhist-based schools is provided by Sri Lanka, where donations are plentiful and the families of donors are intimately involved in many aspects of the program, through to the final farewell to the donor following dissection (Subarsinghe and Jones, 2015). This demonstrates that some cultures approve of donation because of their religious beliefs.

In 2008, China was faced with an ongoing shortage of cadavers for education and research. The main obstacles were superstitious traditional views about the body, the lack of legislation, and the lack of channels for body donations. New legislation and public education are necessary for removing cultural barriers and changing long-held views about body donation. However, setting up successful donation programs requires a multitude of inputs including regulatory frameworks, team building, infrastructure requirements, education platforms, ways of showing gratitude and respect to the donors, strengthening ethics and humanistic education, and commemorative events (Zhang et al., 2014). At Nanjing Medical University in 2001, 20 body donations were received, while in 2012 this had risen to 70 bodies, demonstrating the success of the actions implemented there.

The body donation program implemented at the Federal University of Health Sciences of Porto Alegre in Brazil shows a transition from unclaimed bodies to mostly voluntary donations. The use of unclaimed bodies dropped from 56.25% to 3.57% after the reform in 2008 (da Rocha et al., 2013). Three pillars have proved essential: informing the general public, donor registration, and donation itself. It seems evident that having a donation program greatly improves the quality of bodies for teaching purposes, alongside an increase in ethical awareness.

**Surveys to Define Donor Profiles**

Several surveys give helpful hints about the profile of donors and the reasons why they wish to donate
(Cornwall 2011). Such information can be used to target potential donors when setting up donation programs, to circumvent difficulties in finding donors, or to monitor changes in donor profiles.

In recent years the Netherlands has experienced a steep increase in body donations (Bolt et al., 2010). It is interesting to investigate the motivation and background of the donors, 98% of whom were native Dutch and 79% non-church-affiliated. A quarter of them were healthcare professionals and 11% were involved in education. Among motivations were a desire to be useful after death, a negative attitude toward funerals, and expression of gratitude. Only 8% admitted to being prompted by financial considerations. Many donors have a supportive social network and these results contradict the notion that donations are made because of loneliness; rather, they show donation to be an altruistic act.

An international and multicenter study from New Zealand, Ireland and South Africa showed that educational levels, ethnicity and national identification influenced donations, and a significant proportion of individuals had no religious affiliation (Cornwall et al., 2012). Public discussion, TV, and newspapers can have positive effects (Trotman, 2009). Donors are generally older than 60 years. Knowledge of donation programs comes from various sources, and many donors have discussed their decision with friends and relatives. A prime motivation for donation is to be useful to medical science.

The profile of body donors at the Otago School of Medical Sciences in New Zealand was reviewed by McClea and Stringer in 2010, following an earlier study by Fennell and Jones in 1992. Most donors in the program registered after the age of 50. Few were in healthcare occupations and none was a medical doctor. Ninety percent gave the main reason as a wish to aid medical science teaching and research. Word of mouth and literature were dominant in learning about body donation, and 40% came from families where other members had donated their bodies. A subsequent study investigated why potential body donors had decided against donating (McClea and Stringer, 2013). The main reason was the weight restriction of 90 kg (25%). Other reasons were objections by a family member or a potential prion disease. Several potential donors had lost their registration forms or had not made up their minds. A major recommendation was the need to keep in touch with potential donors and send follow-up letters. Twenty percent of potential donors included in this questionnaire have since registered in the body donation program.

Analysis of a cadaver population in South Africa between 1921 and 2013 showed that between 2000 and 2013 the number of donations of males from the black population decreased significantly. This highlights the changing political climate and socioeconomic status of the population (Kramer and Hutchison, 2015). It could have a long-term effect on teaching and research and raises concerns about the sustainability of dissection-based courses in South Africa, unless measures are taken to address the issue.

In Greece, the body donation rate remains low (Halou et al., 2013). The elderly tend to donate less. Those with strong religious beliefs are unwilling to donate. Efforts to encourage discussions about body donations should be implemented.

In Maryland, the willingness to donate remains low—among 385 participants in a survey, 49% reported they would consider whole body donation (Boulware et al., 2004). However, considering body donation does not mean that they will actually subscribe to a program. In a recent report in the canton of Vaud, Switzerland, with a population of 750,000 inhabitants, there are 1933 subscribed donors (0.38%) and 86 actual donations (0.011%) per year (Riederer and Bueno-López, 2014). These donations are sufficient to cover anatomical teaching at undergraduate and post-graduate levels, as well as continued education and research.

**Attitudes of Professionals: Anatomists and Medical Students**

In a survey of 40 first-year graduate-entry medical students in University College Dublin, these students were much more in favor of donating than their family members (Perry and Ettarh, 2009). Interestingly, they were not likely to change their attitude after exposure to the dissection of human bodies. However, mental preparation and knowing what to expect are essential before entering the dissection room for the first time.

A survey conducted at a meeting of the Dutch Anatomical Society showed that a quarter of respondents would consider body donation (Bolt et al., 2012). Half of the participants are registered organ donors, a percentage that exceeds the proportion of 2% registered organ donors among the general public. In Ireland, a survey of attitudes of the medical profession to whole body donation showed that among 41% of interns (53 respondents), half said they would encourage the public to donate and 40% would recommend body donation to family members (Green et al., 2014).

An international survey was carried out in 2011 during the “Joint meeting of Anatomical Societies” at the Uludag University Centre at Bursa (Turkey) with the participation of six anatomical societies (Swiss, Spanish, Italian, British, Irish and Turkish). There were 87 replies from respondents in 29 countries, and these indicated that most teachers see dissection as an instrument for training undergraduate students, for the development of professional skills, and as a means of controlling the emotions of the future doctor (Arráez-Aybar et al., 2014). The willingness to donate organs was 41%, the entire body 9%, and the whole body and organs 25%. Willingness to donate increased significantly with years of teaching experience. However, a statistical evaluation at international level is difficult, given the variety of countries and number of responses per country. Thus, an update is needed. Yet one conclusion is very important: that it is necessary to prepare undergraduate students emotionally before their first experience of human dissection. In the context of this review, the preparation of students could be even more important when approaching unclaimed human cadavers who have
been provided without consent, because of a criminal history, or with contagious diseases.

At the University of Lausanne, students and faculty are asked prior to the dissection course to indicate whether a family member has made a body donation, in order to avoid any traumatic confrontation (Riederer and Bueno-López, 2014). Lausanne does not accept donations from faculty and it seems unimaginable to dissect a family member, friend or colleague.

Ceremonies, Monuments

In the US, 95.5% of human anatomy programs hold memorial services. These ceremonies are mostly student-driven (Jones et al., 2014). The Convocation of Thanks, an annual ceremony commemorating the gift of body donation at the Mayo Clinic Bequest program, gives students, researchers, faculty and family members an opportunity to reflect on the immeasurable value of the gifts (Pawlina et al., 2011). At Chung-ah Park (Seoul, Korea), a charnel house was built to praise and thank the dead for their contribution to medical development (Park et al., 2011). Another example is the Forest of Life in the University of the Basque Country campus at Leioa near Bilbao (Riederer and Bueno-López, 2014). Impressive wooden pillars that form the Forest of Life serve as a place for urns of ashes and as a ceremonial ground for thanking donors and their families.

Ways of showing respect for bodies throughout the anatomy course has been implemented in dissection classes. Students also participate at commemoration ceremonies in communities (Zhang et al., 2014). The testimonies of respect seem to have a positive effect on donation numbers. In 2009, a monument for body donors was unveiled at the Radboud University, Nijmegen (Kooloo et al., 2010). Monuments are important since the body will not be available for a funeral and the donor’s kin remain empty-handed. This is also a place for holding ceremonies and for thanking donors and their families.

BODY DONATION TOMORROW

What transpires from the different reports is that setting up body donation programs appears to be the best way for obtaining sufficient human bodies for anatomy teaching and research. From an ethical point of view, it is the only acceptable way to go. However, setting up donation programs and attaining sufficient numbers of donors depends on many factors. We can learn a great deal from the various suggestions offered about how to improve the image of anatomy and dissection of bodies in anatomy teaching, and to increase the number of donations. The costs of setting up donation programs and inherent in running such programs on a daily basis are much less frequently addressed. This is a separate issue that goes beyond the present review, but it could have crucial consequences in changing from the use of unclaimed bodies toward the development of body donation programs, such as establishing appropriate infrastructures, transport, handling and fixation, storage and cremation.

For the future, we should attempt to harmonize body donations worldwide. Nevertheless, this seems wishful thinking, since what has developed into well-organized body donation programs over decades and even centuries in many countries cannot be achieved overnight in developing countries. The transition has to be guided by legal and ethical frameworks, together with an appropriate cultural mindset and readiness of the population to adhere to, and contribute to, a donation program, for either whole body or organ donations. It seems clear that the use of unclaimed bodies of dubious provenance, criminals, homeless persons, prisoners, or bodies obtained by grave robbing, are reminders of practices in the early years of anatomical discovery by dissection. These practices from half a millennium ago in Europe are sometimes called the dark ages or inglorious days of anatomy, dissection being stigmatized by its close association with the punishment of criminals (Moxham and Plaisant, 2014). Therefore, from an ethical point of view, the use of unclaimed bodies for anatomical teaching should be discontinued and body donations should be the only source of cadavers or body parts for teaching (Jones and Whitaker, 2012). Consider for a moment what it would be like to dissect the body of a murderer who has never underwritten an informed consent form. The ethical as well as emotional problems posed to teacher and students are legion.

In future, what is essential is harmonization of body donations worldwide on the basis of a set of generally accepted ethical guidelines. Many testimonies show that body dissection is an essential part of the educational and mental structure of a physician. It is also essential to have human bodies for continued education and validation of novel procedures in prosthesis placement and surgery. There are several arguments against the use of unclaimed bodies for anatomical education: (i) it is an ethically dubious practice, (ii) there is no written consent, since the bodies are often those of criminals or homeless people or prisoners, (iii) far fewer unclaimed bodies are usually obtained than via body donation programs built on trust, a sound legal system and an ethically acceptable base. Legal and ethical frameworks need to be put in place to establish directives and guidelines (McHanwell et al., 2008; AAA, 2009; Riederer et al., 2012; Riederer and Bueno-López, 2014; Jones, 2014). Financial resources and infrastructures need to be put in place to establish donation programs and keep them running, and also make them attractive to potential donors. This includes finances to cover costs for transport, preparation of cadavers and disposal by cremation of human remains. Unfortunately, several donation programs do not foresee how they can continue to cover costs of cremation and transport (Drake, personal communication).

To maintain donation programs, it is essential to gain a sense of public opinion and eventually to adopt strategies on how to improve donations. Several surveys have documented the variation in donor populations among countries, while opinions also differ with age. Hence, there has to be adaptation to local, cultural and religious customs. In order to increase public
awareness of the crucial role of body donation in the medical education of future physicians, it is essential to speak to the public by all methods possible. Different approaches such as TV, newspapers, testimonies, setting up monuments, reports on ceremonies, testifying to dignity to cadavers, and social channels can be used to raise potential questions about bequeathing one’s own body.

An important point that is often neglected is to talk about death and how to face it. This starts with the preparation of students for dissection courses. What is going through the heads of one of our students while approaching the dissection room, such as a particular smell, what will I see, how will I and my colleagues cope with it…? This issue is not well explored and needs more attention. At the University of Lausanne, discussion groups are organized to talk about issues related to death, patients and coping with one’s feelings. Another important point is to maintain contact with potential donors and make the process of donation “user-friendly” by counselling or responding to questions. As many donors already have someone in the family who has donated, it is preferable to guide families through the difficult times of a bequest.

**CONCLUSION**

The overall goal of medical education is to provide optimal training of physicians and technicians in human health care. Several countries engage with public opinion of body donation in order to make the notion of donation acceptable for medical research. This is a major challenge for the future. It remains to be seen how well-developed countries with working body donation programs can help other countries where no such programs currently exist. The goal is to help them as they seek to make body donation programs the only way to approach human body dissection. This is where national and international anatomical societies and associations have a contribution to make, harmonizing body donations worldwide for the benefit of medical education, improving the validation of surgical processes, and guaranteeing optimal anatomical training for future generations of physicians.

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The Use of Animal Tissues Alongside Human Tissue: Cultural and Ethical Considerations

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Teaching and research facilities often use cadaveric material alongside animal tissues, although there appear to be differences in the way we handle, treat, and dispose of human cadaveric material compared to animal tissue. This study sought to analyze cultural and ethical considerations and provides policy recommendations on the use of animal tissues alongside human tissue. The status of human and animal remains and the respect because of human and animal tissues were compared and analyzed from ethical, legal, and cultural perspectives. The use of animal organs and tissues is carried out within the context of understanding human anatomy and function. Consequently, the interests of human donors are to be pre-eminent in any policies that are enunciated, so that if any donors find the presence of animal remains unacceptable, the latter should not be employed. The major differences appear to lie in differences in our perceptions of their respective intrinsic and instrumental values. Animals are considered to have lesser intrinsic value and greater instrumental value than humans. These differences stem from the role played by culture and ethical considerations, and are manifested in the resulting legal frameworks. In light of this discussion, six policy recommendations are proposed, encompassing the nature of consent, respect for animal tissues as well as human remains, and appropriate separation of both sets of tissues in preparation and display. Clin. Anat. 29:19–24, 2016.

Key words: human and animal tissues; ethics; intrinsic and instrumental values; altruism; medical education

INTRODUCTION

Teaching and research facilities often use human cadaveric material alongside animal tissues. This is to enable comparative observations to be made, and to better illustrate both anatomic and physiological similarities and differences. However, there is a stark contrast between the handling, treatment and disposal of human cadaveric material compared to animal tissue. This raises the question of whether our ethical obligations to human tissue are greater than those toward animal tissues, and also whether having cadaveric material alongside animal tissues in allied teaching and research facilities diminishes the respect given to the dead human body. The aim of this study was to analyze cultural and ethical considerations and provide tentative policy recommendations on the use of animal tissues alongside human tissue.

COMPARING THE STATUS OF HUMAN AND ANIMAL REMAINS

An understanding is needed of the ethical and cultural complexities that underlie what it is about animals that could influence or potentially diminish respect for the human cadaver. If that is the case, what impact does this have on the respect we show for animals? Does the amount of respect given to...
various animals during life translate to their bodies after death? Ultimately, is the respect given to animals the same as the respect shown to humans? Analysing these ideas will help to decipher whether there are ethical and cultural implications in having animal tissue in the same location as human tissue. However, one needs to enquire further into the extent to which we distinguish between different kinds of animals, for example, pets versus laboratory animals. The former evoke an emotional response from those who interact with them, usually resulting in a distinct relationship, sometimes akin to that of a family member. On the other hand, laboratory animals are disposed of as waste once they have fulfilled their designated purpose. What ethical principles dictate these actions and why?

Animals may have both intrinsic and instrumental values. The intrinsic value of the animal lies in the degree to which its identity is recognized and valued after death. Its instrumental value results from an individual’s emotional response based on the perceived value of the animal when alive. The instrumental value is also based on the social and emotional connections it makes. When animals are purchased, they become the possession of a human “owner”, who exercises a right over them by making decisions regarding what is done with and to the animal during its lifetime and death. Hence, it is the owner who is able to provide consent to any procedure that the animal undergoes. This is in some respects analogous to the donation of the human cadaver or organs as the individual and/or their family provide consent.

Animals, from pets to laboratory animals, whether living or dead, are treated as tradeable commodities. This human centric view is supported by the logic of Kant’s philosophy (1779; see Rachels, 1986), namely, that “But so far as animals are concerned, we have no direct duties. Animals … are there merely as means to an end. That end is man”. This does not lead to the mistreatment of laboratory animals, since they should undoubtedly be treated with ethical integrity. There are many reasons behind this stance, for instance, mistreatment of animals may indirectly cause human suffering (Rachels, 1986), while the mistreatment of animals may be viewed as being part of the mistreatment of other living beings in general (BBC Animal Ethics Guide, 2014). Ultimately, animals are living creatures that feed, interact, and reproduce, and are of scientific significance to humans. In line with these thoughts, many teaching/research institutions have strict ethical protocols and procedures to ensure that animals in their care are not mistreated (Streba et al., 2012).

Laboratory animals also have extrinsic value, in that they serve as a commodity. When this is coupled with the sterile environment of the laboratory and the fact that research has the power to manipulate animals, it becomes easy to view animals in reductionistic terms and thereby neglect to fulfill our obligations toward them. This is problematic since respect for the laboratory animal and its environment is respect for the practice of science and scientific discovery, since ideas and concepts emanating from animal research are of potential value to humanity and in some cases to the animals themselves (Baumanns, 2004). Experiments conducted on laboratory animals and tissues contribute to human good (Korsgaard, 1983), in such a way that the welfare of animals and that of humans is interlinked.

These considerations point toward the interdependence of humans and at least some animals. But how does this influence our views of the treatment of the dead remains of humans and animals? On the one hand, there are compelling grounds for treating the dead human with respect, and it is this that has led to seeing the bequest of bodies as ethically preferable to the use of unclaimed/unwanted bodies (Jones and Whittaker, 2012). Consequently, it is generally considered inappropriate to throw human bodies and tissues away, as so much rubbish or refuse. They were once integral to the lives of people just like us, with as much significance as us. Hence, cadavers and their parts have intrinsic value, capable of evoking a range of emotions and grief. The death of an individual is the death of a person, and that person’s remains represent much that the person when alive stood for. It follows that when an individual’s body has been donated for teaching and/or research, there is a strong altruistic intent associated with it, altruism that stems from the values and wishes of that individual when alive. While these feelings, connotations, and responses vary from one individual to another, and while there are cultural and religious differences, they all point to the emphasis generally placed upon the autonomy of humans.

The dead laboratory animal, by contrast, represents a means to an end. None of the values associated with human life (and death) apply to animals—laboratory or otherwise. It is an acceptable practice to throw away the remains of the once living animal. Laboratory animals are disposed of in biohazard waste bags, which are incinerated. This is acceptable, as long as the animals have been treated in an ethical manner when alive, and as long as the experiments conducted on them can be justified in terms of their scientific utility and legitimacy.

Consequently, there is a distinct difference in the amount of “respect” shown to the living laboratory animal and one that has been killed. Using the example of the laboratory rat, the treatment provided by human interaction exceeds the standards of care the animal would get in the wild. Laboratory rats are housed in warm, sanitary, and controlled conditions to ensure that very little is compromised in the experiments for which the rats are designed. Research has shown that the negative connotations of rats exist regardless of whether reference is made to a laboratory rat, desert rat, diseased, or nondiseased rat (Batt, 2009). These connotations of the animal do not change, regardless of the difference in the type of environment in which it is found. This could be explained by the idea that their unsanitaryness is inherently ingrained within humans, and hence the association of rats with the idea of uncleanliness (Batt, 2009).

Why, then, is there a distinction between laboratory rats and sewer rats? The predominant factor is the benefit that any particular animal has for human
good, and that this human good is of more value than the good of the animal (Korsgaard, 1983). This reasoning is based on the fact that the intrinsic value of a human is perceived as greater than that of an animal (Korsgaard, 1983). In other words, the intrinsic value of the laboratory rat is secondary to that of the human good that may emanate from its use in laboratory experiments. Laboratory rats are bred and sacrificed in order to provide useful scientific information and for furthering our understanding of disease (O'Sullivan et al., 2014). In spite of this perceived difference between the two groups of rats, each is thrown away when dead, even though in some research projects postmortems may be carried out. However, even these are to serve human ends. Since the laboratory rat is a means to an end, once its utilitarian purpose has been maximized, it is appropriately disposed.

In light of this discussion, it can be seen that the status of the dead human body differs markedly from that bestowed upon the remains of animals (principally laboratory animals in this case). From a human perspective, there is a moral compulsion to improve the conditions of human life (Jones and Whitaker, 2009) and to ensure that this applies even after death. This is in order to uphold the idea of human dignity and integrity. It is within this framework that laboratory animals are to receive optimum care when alive, yet this has only very limited relevance after death. The outcome of this is that far less value is attached to the remains of the dead animal compared with that ascribed to the dead human. Therefore, does placing the remains of these two side by side lower the value placed on the human tissue? Would this amount to denigration of the human remains and the dead human body?

What of the use of organs from animals sourced from abattoirs, for example, ox heart, that has not been bred for use in laboratories? In instances such as these, prior ethics consent would not have been gained in order to ensure that little harm is done to the animals, although one imagines they will have been bred appropriately for human consumption. This source of material also best utilizes and maximizes the human good that may be obtained from the death of the animal. In these terms it is difficult to see what additional problems are created by their use as an adjunct to the teaching of human anatomy.

**COMPARING THE RESPECT BECAUSE OF HUMAN AND ANIMAL TISSUES**

In 2006 the Bavarian High Court censored one of Gunther Von Hagen's controversial displays, titled "Rearing Horse with Rider", in Body Worlds. A dissected plastinated horseman was placed on the back of a dissected plastinated horse, charged for action. The court ruled that the display was morally inappropriate considering it had little educational impact. Why is this controversial? How is this any different to a human riding a horse in real life? In this real life situation, a human individual would have a degree of control over the horse and the direction in which it moves. However, in the plastinated version, both the animal and the human are dead, and it is the team of plastinators that manipulated the horse and cadaver to maximize the impact of the plastinated remains of both. Because of the sheer size of the horse and rider, the dissected human body could not be observed close up, nor was this exhibit aimed at those with veterinary interests. According to one commentator, it was derogatory to the value of human dignity as the man was viewed at “the level” of the beast (Barilan, 2006). This is because this display in effect creates a new beast, that of a “human-horse” hybrid, as tissues from the two specimens are interlinked upon contact, making it difficult to distinguish where the human ends and the horse begins. Furthermore, this hybrid has an unnatural, vicious and vulgar feel to it.

This example illustrates the proximity of human and animal far more poignantly than in situations where human and animal parts or organs lie on adjacent tables in a teaching laboratory. Nevertheless, it highlights the conceptual challenges. If there is nothing amiss with displays of human and animal material alongside one another, is there nothing amiss with the horse and rider? The differences it seems to us is that displaying parts alongside one another is not intended to merge them whereas the horse and rider has that intent. The hybrid description of the horse and rider clinches the difference by viewing its two facets as different faces of the one.

**Legality:** Another factor influencing respect between humans and animals are the strict legal frameworks in place, which stress the importance of protecting humanity and in particular human dignity. These frameworks are influenced strongly by ethical reasoning, to ensure that autonomy of an individual is respected, and that beneficence and nonmaleficence prevail during human interaction and ultimately have a sense of justice. For example, both the United Nations Universal Declaration of Human Rights (1949) and United Nations Educational, Scientific and Cultural Organization (UNESCO) Universal Declaration on Bioethics and Human Rights (2005) place emphasis on maintaining autonomy. The regulations surrounding animals are not as stringent as humans and as a result influence human attitudes toward animal tissues. The UNESCO Declaration of Animal Rights (1978, updated 2011) proposes that animals have equal rights to existence and should not be ill-treated or subjected to cruelty; have the protection of the law, and that dead animals must be treated with decency. This implies that there is an obligation to treat animals ethically to ensure that harm to them and humans (though indirectly) is minimal. This last statement is open to interpretation based on different cultural beliefs on the weight placed on decency. In contrast, articles 7 to 12 in the Universal Declaration on Bioethics and Human Rights focus on the treatment of human beings without the capacity to consent. Though neither Declaration is legally binding, many member nations use them as reference points in guiding legislation on the handling of human tissues and animal tissues.
**Cultural considerations:** The essence of respect is culturally driven and derived from traditions, customs, and religion. The ideals of an individual also affect their perception of whether or not respect for human tissue is affected when animal tissues are placed alongside human tissues. Respect requires the recognition of human value between individuals, particularly those with similar ideals and beliefs (Beach et al., 2007), therefore if these views and behavior spread to a wider group of people, this would be interpreted as the norm. For example, individuals who are passionate about animals would argue that animal rights are of equal importance as human rights, therefore these individuals would treat animal tissue with the same degree of respect as human tissue. This would not lessen the respect for the human tissue; it would merely increase the perceived respect given to the animal tissues.

Cultural influences behind the marking of respect for the deceased are strong. For example, at the beginning of the academic year, the Department of Anatomy at the University of Otago hosts a “Whakawātea” or clearing of the way ceremony (Martyn et al., 2013). This is a traditional Māori custom, which places emphasis on the raising of the tapu (sanctity) that is placed on the cadaver (Martyn et al., 2013). Lifting of the tapu allows for dissection to take place in a respected environment, as the ceremony involves paying respect and cleansing the hands to wash away the tapu. This is performed in the dissection room and allied facilities, and the facilities into which animal tissues may also be brought. Everything has tapu to some degree; however the amount of tapu that is placed on a human life is the highest and far greater than that of any animal (He Hinatore ki te Ao Māori, Mana and Tapu, 2001). Therefore, the placement of animal tissue which may have tapu next to human cadaveric material that has had the tapu raised from it could be viewed as a cultural breach, hence disrespectful to the donor (He Hinatore ki te Ao Māori, Mana and Tapu, 2001). While this conclusion may not be generalizable to other cultures, it serves as a reminder of concerns that readily arise in this area.

An allied scenario is provided by the following. Consider this scenario: a body donor identifying with Muslim traditions and customs donated their body to a medical school for altruistic reasons. The donation was on the basis that the individual wanted to give back to the community and aid in the training of future physicians. The individual’s body is prepared as a wet specimen and is used for anatomical teaching within the same laboratory where specimens from a pig are used. Pigs are regarded as dirty, “haram” (sinful) within the Muslim culture and should not be touched or consumed (Al-Baqarah, Quran 2:173). During life, the individual would not have consented to touching a pig, let alone being within the vicinity of the animal alive or dead. Consent, therefore, would not have been provided for this procedure and by having the animal specimen there it would be viewed as insensitive to the donor’s values when alive and may even violate the individual’s customs and traditions. This clearly demonstrates the tension between beneficence toward future medical professionals in training, and the individual’s autonomy. Such a situation could of course be avoided by the donor specifying the conditions under which their body was to be displayed. This is where well-articulated policies come into play.

**POLICY RECOMMENDATIONS**

We have been able to find little in the literature on the placement of human and animal tissues although some anatomy safety plans touch on this in a very peripheral manner (San Francisco State University Anatomy Safety Plan, 2007; Camden County College Department of Biology Guidelines, 2013). However, the rationale behind the plans is not evident, and the ethical drivers have not been elucidated. The following recommendations outline a first attempt at marshaling the ethical considerations into policy format. As the commentaries indicate some of the recommendations may be idealistic.

**Recommendation one:** Body donors should be made aware that their tissues could be used for comparative anatomy teaching and research purposes. They need to consent to displays of this type when deciding upon how their body will be used. The feasibility of this policy statement may be questionable because it is difficult to determine what the cadaver may be used for especially when demand outstrips supply. Other constraining factors include limited storage facilities to keep tissues separate, the logistics of transport and sharing of cadavers between different teaching disciplines (e.g. medicine, dentistry, anatomy). Since it is imperative to maintain the autonomy of the deceased by respecting their posthumous wishes, body donors who are hesitant to interact with animals during life should be made aware of comparative anatomical teaching and research. Culturally, some would find it unacceptable to have their remains near an animal as it could be perceived as undignified.

**Recommendation two:** Prior to the commencement of activities within the teaching and research laboratories, an outline of what is expected from the students/teaching staff should be provided. The outline includes but is not limited to (1) information regarding the ethical practices required when handling human tissues, (2) information regarding the ethical practices regarding human and animal tissues, and (3) importance about showing respect for the learning environment.

**Recommendation three:** The scientific and educational significance of animal tissue makes it obligatory for students and researchers to respect animal tissues. This environment is strictly controlled hence creates the need for respect. Mutilating animal tissue without a distinct end goal should be perceived as disrespectful, because of the value placed upon scientific resources.

**Recommendation four:** Preparation of animal and human tissue should be conducted separately in the preparation area and be transported to the destination separately. Thus, a number of measures should be taken. For example, tools that are used on cutting human tissue and
animal tissue should be adequately washed down and sterilized between tissue types. All materials required to handle human tissue must be kept in a separate area to those that are required for handling animal tissue. In the area where animal tissues are being used for teaching or research purposes, instruments for each set of tissue should be kept separate and be clearly marked for their specified purpose. If this recommendation is accepted, it is inappropriate for dissecting tools used on human bodies to be used for the dissection of nonhumans, e.g., dolphins. This would threaten the dignity of the donors and show lack of respect for those who have donated their bodies as well as their families.

**Recommendation five:** Human cadaveric material should be displayed, stored and disposed separately from animal specimens. Separate areas on shelves should be designated for human and animal specimens. Separate biohazard bags should be provided for appropriate disposal of both sets of tissues. This is because the destination of the human tissues is different from that of the animal tissues. The donor bequest program specifies how human tissue is collected and buried/cremated, and the way in which the remains of individuals are kept separate and disposed of separately. By contrast, best practice for animal tissues is usually incineration of the biohazard bags, in line with animal ethics protocols.

**Recommendation six:** There should be no cross contamination when transitioning from handling animal tissue to human tissue and vice versa. Hands are thoroughly washed and gloves are changed between the handling of animal specimens and human tissues. There is cultural significance in handling human material with clean hands; in most cultures it is a mark of respect.

**Further recommendations for the handling of plastinated body components:**

1. Plastinated tissues should be treated similarly to wet specimens, and emphasis should be placed on the fact that plastinated organs are not models.
2. Plastinated specimens should only be used in a restricted setting and controlled environment.
3. Plastinated specimens should be handled with clean hands and kept in an area separate from plastinated animal organs.
4. In spite of the degree to which they have been modified, plastinated specimens should be stored in a manner that will show respect for human dignity since they still represent the remains of human beings.

**CONCLUSION**

The discussion above has been mainly within the context of using human remains as well as those of animals for teaching and learning purposes. However, the context is that of human anatomy and the structure and function of the human body. As a result, any use of animal organs, such as the heart or lungs, or animal tissues in histology slides, is to throw light on human anatomy. By definition, therefore, interest lies in human structure and organization and not in that of any other species. It is also far easier to obtain animals than humans, since it is only the latter that are donated altruistically. Consequently, the interests of human donors are to be preeminent in any policies that are enunciated, so that if there are any reasons why donors find the presence of animal remains unacceptable, the latter should not be employed.

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The Business of Bodies: Ethical Perspectives on For-Profit Body Donation Companies

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Human cadavers are a scarce resource that have educational, research and clinical value. While the tissues have great value, it is illegal in many countries to pay for them. In the United States, a number of for-profit body acquisition companies have been established over the past decade. These companies obtain bodies which were freely donated by the individuals or their families. The companies distribute the specimens to surgical training organizations, researchers and educational institutions. These businesses do not charge the receiving organizations for the bodies; they do, however, charge a fee that covers the transport, handling and other services which creates a profit for their companies. These types of businesses are described and analyzed as to whether they constitute an ethically appropriate mechanism to obtain and distribute bodies. The role of organizations and governments in establishing policies and regulations for the appropriate treatment of human remains is addressed. Recommendations are given for best practices in the ethical use and regulation of willed bodies. Clin. Anat. 29:25–29, 2016.

Key words: Willed body programs; for-profit donation programs; not-for-profit donation programs; regulations

INTRODUCTION

Willed bodies have been used for medical education and research for many decades. The bodies are generally obtained by university or state-based anatomical boards which run willed body programs on a non-profit basis. In the United States, for-profit body distribution companies have been established that solicit body donors and then distribute these bodies or parts of these bodies to clients for a price. In addition, there are plastination companies that solicit body donors for use in for-profit exhibitions or to sell the plastinated parts to educational institutions. In the United States, these companies have been established in the absence of detailed regulations and with little consideration of the ethical implications.

TYPES OF BODY DONATION ESTABLISHMENTS

There are three types of donated body establishments in the United States: (1) state or university-based willed body programs, (2) not-for-profit organizations and (3) for-profit body donation companies. The most common form is the university or state-based willed body program; there are approximately 100 U.S. programs, several of which are over 50 years old. Examples of state-based programs are found in Colorado, Florida, Maryland, Nebraska, Texas and Virginia. These anatomical boards regulate and control the use of willed bodies in their state. Some may actually run the willed body programs while

Abbreviations used: HIPAA, Health Insurance Portability and Accountability Act; UAGA, Uniform Anatomical Gift Act.

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Received 1 October 2015; Revised 7 October 2015; Accepted 15 October 2015

Published online 23 November 2015 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/ca.22643

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others provide oversight of locally run programs, usually at specific universities within the state. In addition, some of the state-based programs are concerned with all uses of willed bodies in the state (imported bodies from other states, travelling body exhibitions), while other state programs merely oversee the use of bodies that are donated within the state. Information about each state’s anatomical board can be found on their corresponding websites. The website for the State of Florida’s Anatomical Board contains a list of the body donation programs in the United States (http://old.med.ufl.edu/anatbd/).

University-based willed body programs generally acquire and use willed bodies within their specific region. They may run their program based on individual state regulations or by oversight from a state anatomical board. Some university programs have, in the past, committed ethical and criminal transgressions (Broder, 2004). The University of California System has recently established an anatomical specimen management process; a system-wide policy and management program that includes human specimen oversight committees (Schmitt, et al., 2014). This certifies that all anatomical specimens used within schools in the University of California system are accounted for and treated appropriately.

There are two not-for-profit body donation organizations in the United States (Anatomy Gifts Registry in Hanover, Maryland, and LifeLegacy, in Tucson, Arizona) both of which were started in the 1990s. These organizations were established to provide bodies or body parts to educational or research institutions, especially to those that do not have their own willed body programs. They encourage individuals to donate their bodies through advertising at funeral homes, hospices and nursing homes. These organizations prepare the bodies, often sectioning them into smaller parts, ship them to the recipient and then they charge the recipient for shipping and handling. Their not-for-profit status requires that they charge only enough to sustain their operations. Anatomy Gifts Registry is the largest not-for-profit organization that ships willed bodies and body parts throughout the United States and internationally (http://www.anatomygifts.org/).

There are at least eight for-profit body donation companies that have started in the last 15 years. All, but one, of these are in the United States. The oldest and most established of the United States for-profit companies is Science Care with offices in Arizona, California, Colorado, Florida, Nevada, Pennsylvania and Texas. They advertise in local newspapers and visit local nursing homes and hospices to encourage individuals to donate their bodies. They state that they have over 80,000 individuals in their registry (http://www.sciencecare.com/). Like the not-for-profit organizations, they offer to handle all of the paperwork associated with the death of a loved one and state that they will return the cremated ashes within a few weeks. They, too, generally dismember the donated body and ship the parts to different clients for education or research. They charge the clients a fee that covers the handling, preparation and shipping of the parts. The amount charged is greater than the costs from administration, preparation and shipping which results in a profit for the company.

Other for-profit body donation companies include MedCure (in Oregon, Florida, Nevada, Missouri and Rhode Island); LifeQuest Anatomical (Pennsylvania); BioGift (Oregon); LifeScience Anatomical (Nebraska) and Northern California Surgical Innovations Center (California). All these companies operate in a similar manner as Science Care; advertising for donors, charging clients for shipping and handling fees and returning the ashes to the families. Since these for-profit companies have branches in large metropolitan areas, they can access local nursing homes and hospices, advertise for local donations and supply these donated bodies within the same region. This reduces shipping and handling costs allowing them to compete with the more distant not-for-profit organizations. In addition, a number of these for-profit companies have a surgical training facility associated with their body donation business. This provides the lecture and lab space as well as the human specimens necessary to host profit making surgical training courses. This provides another mechanism for the body donation businesses to generate profits.

These body donation companies are governed by various rules and regulations including the Uniform Anatomical Gift Act (UAGA), which is described in detail below. As an example, the BioGift website (http://biogift.org/index.php) states:

“BioGift abides by the UAGA, the National Organ Transplant Act, prohibiting the buying or selling of human organs or tissues, the Health Insurance Portability and Accountability Act (HIPAA), and the U.S. Code of Federal Regulations Title 45, Part 46, protecting donor confidentiality.”

“As a service organization, we operate on a cost recovery system whereby researchers and educators provide us reasonable reimbursement for the services of procurement, preparation, storage, and placement of the organs, tissues or specimens.”

Other for-profit body donation businesses attract donors who consent to having their bodies or organs plastinated for use in travelling shows or for education. The best known company in this field is Body-Worlds Donation, in Heidelberg, Germany. According to their documentation (http://www.koerperspende.de/en/body_donation.html), they have over 15,000 donors who have willingly consented to have their body plastinated after death. These plastinated bodies are used for educational and entertainment purposes in for-profit travelling exhibitions. Another company that solicits donors for willed body plastination is Plastination Arts in Arizona. This company collects willed bodies, plastinates them and then sells the plastinated parts to educational institutions for teaching purposes. Plastinating human tissues raises complex and interesting ethical questions (Jones, 2000; Tanassi, 2007).

**REGULATION OF DONATED BODIES IN THE UNITED STATES**

There is little specific regulatory guidance in the United States on donated body procurement and
distribution. The UAGA provides modest direction as do guidelines from tissue, transplant and anatomical organizations (like the American Association of Anatomists and the American Association of Clinical Anatomists). These are primarily concerned with who can legally donate, the health status of the donors and liability issues. All states also have basic regulations dealing with the use and distribution of unclaimed bodies. In addition, the funeral industry has regulations for the care and handling of the deceased.

Great Britain, Australia and New Zealand have national laws which cover the use of human tissues, but, in the United States, this topic is regulated by each state. The UAGA, like many uniform acts in the United States, was developed so that there could be conformity in rules and regulations across different states. These measures were developed by legal experts and then approved on a state-by-state basis. The UAGA was established in 1968 and regulates organ donations as well as body donation. The Act provides that the donor, the donor’s spouse, or, in the absence of a spouse, a list of specific relatives can make the organ or body donation. It also limits the liability of health care providers who decide that a deceased patient meant to make an anatomical gift. The Act prohibits trafficking in human organs for profit. Updated in 2006, it is currently adopted by 46 of the 50 states.

Interestingly, the human remains of Native Americans have special legal status in the United States that is not afforded other groups or individuals. The burial grounds of Native Americans are not allowed to be developed and anyone caught possessing Native American remains can be fined and imprisoned (Department of the Interior, 1990).

As was pointed out by Charo (2006), the rules and regulations guiding the use of human tissues in the United States are not uniform and should be standardized. She elegantly stated:

“Ultimately, the debate is less about whether the management of human tissue should be governed by property laws or by a more robust regulatory scheme than about the proper balance between respect for persons and the collective interest in promoting research involving human tissue.”

“But whichever system is chosen, it is long past time for the country to choose. State laws vary, federal regulations do not apply to all privately funded research, and a patchwork of rules cover the myriad laboratories and biobanks in the United States. Our tissue may be scattered. Our laws ought not to be.”

An international committee (as a standing committee of the International Federation of Associations of Anatomists) has developed standards on the ethical use of willed bodies (FICEM, 2012):

“There should be no commercialization in relation to bequests of human remains for anatomical education and research. This applies to the bequest process itself, where the decision to donate should be free from financial considerations, and also to the uses to which the remains are put following bequest. If bodies, body parts, or plastinated specimens are to be supplied to other institutions for educational or research purposes this may not yield commercial gain. However, charging for real costs incurred, including the cost of maintaining a body donation program and preparation and transport costs, is considered appropriate. Payment for human material per se is not acceptable.”

While this statement has no legal force, it is apparent that for-profit body donation and plastination companies are in conflict with the spirit of this policy (FICEM, 2012).

**NOT-FOR-PROFIT ORGANIZATION VERSUS UNIVERSITY-BASED WILLED BODY PROGRAM**

Anteby and Hyman (2008) compared a not-for-profit cadaver procurement organization (Anatomy Gifts Registry) with a university-based willed body program (University of Maryland) in the same geographic region. The authors found that the time from donation to acceptance of the body (bequest interval) was longer in the university-based willed body program (approximately 131 months) compared to the not-for-profit organization (approximately 2 months). This means that individuals donating their bodies to the university-based program had made the designation as much as 10 years before their death and generally were consenting to their own donation while in good health. On the other hand, individuals donating to the not-for-profit organization had done so only two months prior to their deaths with the majority knowing of their terminal illness. In some cases, the donations were made by the families and not by the actual donor.

Another point made by the authors is that body donation organizations have become a business and, therefore, business principles can influence the success of the programs (Anteby, 2010). As they stated:

“Irrespective of whether a legal market for cadavers might be considered a reason for sorrow or joy, market dynamics around whole-body donations de-facto operate in the United States.”

(Anteby and Hyman, 2008)

**DISCUSSION**

The establishment of for-profit body donation companies highlights the need for public debate about the ethical status of deceased human beings. Do deceased individuals have unique ethical or moral status or are they merely property? Based on a strictly legal view, the director of a willed body program in
California was found guilty of selling parts of donated bodies, since he had damaged or destroyed university property; the donated bodies (Leonard, 2009). This points out that, legally, the donated bodies were nothing more than university-owned property.

Most individuals, especially family members, when asked about the status of a deceased individual, will likely say that their loved one’s body has specific rights and holds an ethical status above that of property. They believe the deceased should be treated with respect and dignity.

A representation of this discussion point attempts to locate the ethical status of deceased humans on an ethical continuum from a discarded appliance to a healthy human being.

This continuum could begin with an old non-working appliance that is merely property to be bought, sold or parted out. It could continue with something that is not alive, but engenders care and consideration, like a famous painting. While this object could be bought or sold, it would be treated with a greater level of respect than the old appliance. Further along this continuum could be living entities, such as insects, birds or mammals. Individuals may place more ethical respect and dignity on these living beings than they would on a piece of property. Finally, at the other end of the continuum would be a living human. Where along this continuum would a deceased human be found? When asked, most individuals place a deceased human at the end of the continuum near a living human. This could be one reason that the majority of cultures have funeral and burial rituals. However, in the United States, the legal use of bodies falls closer to the other end of the continuum (property).

Another question concerns the ethical appropriateness of “parting out” or making aliquots of deceased individuals. If donated bodies deserve a level of respect and dignity, is this being followed if the bodies are sectioned into selected parts and distributed to different institutions for use? Can different parts or organs from donated bodies be plastinated and sold as educational tools? Is this a respectful and dignified use of the human body? These questions again illustrate the issue of tension between what individuals perceive as the proper respect afforded to bodies versus the established rules and regulations for the use of donated bodies.

Many of these questions can be addressed by appeal to the ethical and legal concept of informed or valid consent. If the bodies of donors do not themselves have interests, living humans have legitimate interests in what happens to their body after death. These interests are often culturally reflected, for instance, in preferences for burial or cremation as well as in legal prohibitions against “abuse of a corpse” and necrophilia (Troyer, 2008). Acquisition of human tissues and solid organs is governed in jurisdictions by anatomical laws that, at a minimum, require the consent or stipulation of the individual before death, or by the permission of surrogates after death. The preference of a living person that his or her body be used for medical practice, education or research provides, if appropriately informed, ample justification for such uses. An individual who gives permission for his or her body to be cut in pieces for such uses, or to be plastinated for educational or entertainment purposes, may have provided all that is necessary for the ethical use of those parts (Wilkinson, 2014).

Perhaps a greater challenge to the ethics and legality of using willed bodies revolves around whether profit should be generated from individuals who have willingly donated their bodies. Is it acceptable to make a profit from a body that was donated? It is presently illegal to profit from organ donation, yet profit can be made on blood, hair, sperm and ova in the United States. Profit can also be made on the sale of human bones, and body donation companies are profiting from willed bodies. In one Florida legal case, families protested that corporate requests for tissue donation did not make clear the requester’s for-profit status (Pinkham, 2004). Even if it were permissible to profit from donated tissue, it is important that, during the consent process, the donor be made fully aware of the motives of the business requesting the donation.

Thus, if individuals who donate their body are made fully aware that profits would be made from the donation and in light of this they willingly consent, then this should be allowed. On the other hand, it could be countered that some forms of for-profit commerce are inherently unethical and should therefore be illegal, irrespective of consent (for example, slavery or organ sales) (Cohen, 2012; Rippon, 2014) and that the use of human remains could fall into this category. Still others may posit that having the profit motive associated with an altruistic behavior (body or organ donation) could create substantial conflicts of interest (Delmonico, et al., 2015).

There still exists an inherent tension between for-profit body procurement companies and the altruistic act of body donation. If for-profit businesses are allowed, they should operate under specific principles: their status must be transparent, criteria must be set for governing the profits that can be made, and these criteria must be explicit to those willing to donate their bodies or those of their loved ones, to these businesses. The necessity of for-profit companies alongside already existing not-for-profit organizations should be widely discussed in the United States.

**CONCLUSION AND RECOMMENDATIONS**

Human tissues, donated bodies specifically, have value and deserve special treatment. They are not merely property to be bought and sold. They deserve the respect and dignity we would afford any of our deceased loved ones. They should not be “parted out” and sold like disposable property.

To encourage the proper treatment of donated bodies, anatomical organizations, such as the American Association of Anatomists or the American Association of Clinical Anatomists, should offer certification or accreditation for all entities dealing with donated bodies. This certification would ensure that both procedural and ethical standards are followed. This would establish a process in which the certifying organizations...
set high standards and the entities visibly demonstrate to the public that they meet these expectations. This would provide a mechanism for the public to know that donations are being used appropriately and that remains are treated with respect and dignity. In addition, institutions could develop Human Tissue Use committees that could oversee the proper and ethical use of all human tissues in their jurisdiction (Champney, 2011). This could be similar to an Institutional Review Board (IRB) or an Institutional Animal Care and Use Committee (IACUC) and could be modeled on the type of committee at the University of California (Schmitt, et al., 2014).

Another suggestion involves the development of national or state-based regulations that would cover the minimum ethical and procedural standards for the use and treatment of willed bodies due to their unique status. This would provide a lower limit for the proper care of human remains and could make it a crime if individuals mistreated these remains. These regulations could be fashioned in a similar manner as the current laws that criminalize the abuse of Native American remains (Department of the Interior, 1990).

In the United States, there are few rules and regulations governing the proper treatment of willed bodies. The few rules that exist differ between states, are difficult to enforce and do not directly address the issue of respect and dignity. It is important for all stakeholders to address these issues and to come to conclusions that foster the proper care and respect that are due those who have altruistically donated their bodies for medical education and research.

ACKNOWLEDGMENT

Dr. Kenneth Goodman’s editorial and philosophical contributions to an earlier version of this manuscript are greatly appreciated.

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Ethical Issues Surrounding the Use of Images From Donated Cadavers in the Anatomical Sciences

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Body donor programs rely on the generosity and trust of the public to facilitate the provision of cadaver resources for anatomical education and research. The uptake and adoption of emerging technologies, including those allowing the acquisition and distribution of images, are becoming more widespread, including within anatomical science education. Images of cadavers are useful for research and education, and their supply and distribution have commercial potential for textbooks and online education. It is unclear whether the utilization of images of donated cadavers are congruent with donor expectations, societal norms and boundaries of established public understanding. Presently, no global “best practices” or standards exist, nor is there a common model requiring specific image-related consent from body donors. As ongoing success of body donation programs relies upon the ethical and institutional governance of body utilization to maintain trust and a positive relationship with potential donors and the community, discussions considering the potential impact of image misuse are important. This paper discusses the subject of images of donated cadavers, commenting on images in non-specific use, education, research, and commercial applications. It explores the role and significance of such images in the context of anatomical science and society, and discusses how misuse - including unconsented use - of images has the potential to affect donor program success, suggesting that informed consent is currently necessary for all images arising from donated cadavers. Its purpose is to encourage discussion to guide responsible utilization of cadaver images, while protecting the interests of body donors and the public. Clin. Anat. 29:30–36, 2016.

Key words: cadaver; images; willed body program; body donation; photograph; ethics

INTRODUCTION

The increasing use of digital technology in society has brought with it many challenges. Information can now be shared instantaneously, between millions of people, on a variety of digital platforms. In many instances, the information that is made available in a digital format will neither be taken down nor cancelled—once it is available on the internet, a digital “footprint” exists that can be difficult to erase. This includes digital images.

The ethical and social issues surrounding images arising from donated cadavers—by default, now

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Received 31 July 2015; Revised 8 August 2015; Accepted 9 October 2015

Published online 28 October 2015 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/ca.22644

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including digital images—have not previously been explored in detail. How images of cadavers need to be handled in an ethically appropriate manner has not changed with the advent of digital technology, but the risk of inappropriate use has increased, and with this increase in risk comes the responsibility to ensure potential issues are dealt with in a timely and effective manner. With digital images, the magnitude and scale of distribution are new issues that increase the risk of potential misuse; given the development of such risks there is a requirement to review current practices and policies, and to take into account both donor expectations and public perceptions to deal with any new questions or challenges. An exploration of such issues would help ensure a robust and balanced ethical framework that can guide the responsible utilization of images from donated cadavers.

This article explores issues with respect to images acquired as photographs from bodies donated to donor programs. It does not seek to deal with the issue of real ism (the issue of mimetic or artistic representations or drawings), nor does it include the subject of images taken as part of healthcare procedures (normally acquired pre-mortem, autopsy images not withstanding). In addition, it centers on the subject of non-identifiable images (both macro and micro), given the likely agreement from the academic community that the use of identifiable images (i.e., those that could lead to an individual being positively identified) would be unethical. The aim of this article is to examine the subject in an attempt to explore and identify the potential issues affecting ethical use of images from donated cadavers, and to promote discussion to inform sustainable and responsible uses of cadaveric resources for medical science education and research. It is hoped the information provided will stimulate discussion and the development of appropriate ethically sensitive frameworks to manage the use of these images.

THE IMPORTANCE OF APPROPRIATE ETHICS AND GOVERNANCE

Ensuring ethical access to cadavers for the purpose of medical training was the stimulus for the development of the first Anatomy Act in 1832 in the United Kingdom. Since then, the acquisition and use of human bodies for education and research has remained a cornerstone of both medical training and research in the medical sciences (Dluzen et al., 1996; Gunderman, 2008; Gangata et al. 2010). The development of appropriate ethical standards and anatomy governance can often lead to controversy, with such circumstances frequently providing the impetus for development of regulatory control. In a number of contexts related to the use of human tissue for research, many controversies have arisen internationally involving improper uses of human tissue. They include the unconsented acquisition and use of Henrietta Lacks’s cervical cancer cells (Skloot, 2010; Greely and Cho, 2013), and the case of Moore v Regents of the University of California (51 Cal. 3d 120; 271 Cal. Rptr. 146; 793 P.2d 479) where cancer cells were wrongly acquired for research and commercialization; legal cases have followed inappropriate use of donated human tissue (Conroy v Regents of the University of California 45 Cal. 4th 1244, 203 P.3d 1127, 91 Cal. Rptr. 3d 532; Melican v Regents of the University of California 59 Cal. Rptr.3d 672). Other controversies have also involved misuse of bodies donated to science (Tward and Patterson, 2002; Roach, 2003; Davis, 2004; Harding, 2004; Armour, 2006; Anon, 2010; Willson et al., 2012). In New Zealand, the incident of a fake medical student gaining improper access to donated cadavers (including undertaking dissection) at the University of Auckland Medical School sparked a media storm and public disquiet that demanded institutional action (Jones, 2014).

These incidents generated considerable public interest regarding what is socially acceptable practice and the appropriate use of human tissue, substantiating the need for suitable governance of matters that deal with socially sensitive issues involving death, dying and consent. These cases also reinforce the necessity to strengthen public confidence and trust to protect donor programs against potential exploitation (Champney, 2011). In the United States, a prominent university (University of California, Davis) recently published policies on how donated bodies or body parts may be utilized clearly and responsibly according to the law, ethical standards and best practices (Schmitt et al., 2014); this timely publication highlights international academic concerns that warrant immediate initiatives to clarify and justify current practices. At the University of Otago (Dunedin, New Zealand), sixteen different courses rely on access to cadavers (Cornwall and Stringer, 2009), while significant numbers of research projects are undertaken utilizing cadaveric tissue. Downstream effects of limited or poor cadaver access, as a result of controversy affecting a donor program, could adversely impact on anatomical science education and research opportunities across many courses and programs. Appropriate governance is therefore essential for all aspects of the utilization of donated cadavers on account of the potential for misuse or unethical behavior. This includes the use of images.

TECHNOLOGY, BODY DONATION, AND RESPONSIBLE USE

As technology is developed, acquired and utilized, so also does the necessity to integrate such technologies into society in a socially acceptable and appropriate manner. Robust and responsive regulatory control should take into account the social, cultural and technological impact of new and emerging technologies within the community, encourage adherence to ethical standards, and sensitively allow the diffusion and transfer of these technologies within cultures.

The widespread adoption and use of digital technology and the internet have increased connectivity and revolutionized mass communication. In education and research, images – in particular, digital images - are being utilized more frequently and widely as learning aids and tools (Choi-Lundberg et al., in press; Meyer et al., in press). Digital technology allows information to be transmitted across the world with relative ease, with the internet allowing images and programs to be
shared and distributed freely, quickly and widely. The impact this technology might have on the dissemination of images from human body parts was flagged as a potential issue over a decade ago, in a report by Thomas (2002) that signaled potential predicaments with such technological advances: “The development and application of technologies will arguably be the driving force for the evolution of the world society over the next few decades. However there is apprehension about the potential risks of new technologies. Present legal concepts, procedures and structures are insufficient to keep pace with technological advances. ... Such discourse involves consideration of societal rights as contrasted with individual rights.” (p19).

The relationship between body donors, body donor families, the community, and the donor programs is complex (Cornwall and Schafer, 2014). While many aspects of these relationships remain unclear, it is likely that the continued success of programs involves a substantial reliance on trust between those donating their bodies and those donor programs that receive them. This is likely to involve the understanding that donor programs behave in an appropriate manner while overseeing use of bodies in a way acceptable to body donors, body donors’ families, and society in general. In this regard, the information provided to guide the donor prior to providing informed consent—information that is given as part of the registration process—outlines to potential donors what may occur after death. The amount of information provided should include a reasonable level of detail, at least enough to allow an informed decision to be made. A small survey of potential donors in Pennsylvania has indicated people want to be able to make informed decisions about what happens to their body after death should they become body donors (Larner et al., 2015). Presently, no empirical evidence is available to support current practice or positions in relation to the acquisition and use of images; the level of information provided by schools of anatomy is, therefore, based on an assumption of what potential body donors wish to hear (or know) about the use of their body, or what would be reasonable for donors to expect during the time their body is held by the institution or donor program.

IMAGES AND SOCIETY

Before discussing how images of donated cadavers should be considered, it is worth reflecting on the wider role of images in society. Humans are visual animals, negotiating the world through what is seen, including interaction with images distributed throughout public spaces (posters, signage, advertising) and via access to the world through digital technologies (Berger, 1972). Before the advent of film or the internet, people largely saw what was around them. Nowadays people live in a world bombarded by images of things they have not seen directly, will never see directly, or which are impossible to be seen directly (e.g., voyaging into interstellar space). Increasingly, our first experience of anything is through the virtual reality provided by technology. We expect everything to be visually available: from every street in the world to an image of every product.

The visual cannot not be significant in the way we process everything, and yet there can be discrimination among different types of images. Something which we may see and potentially touch will impact upon us in a way something which is seen on a screen may not, yet this does not mean that virtual images are not significant. Such images are a part of our experience, and accordingly contribute to shaping our opinions, valuations and attitudes (Berger, 1972). In the light of research which confirms search engines’ sociopolitical biases (Diaz, 2008), despite Google’s efforts to persuade the public otherwise, image searches may articulate social values in ways that are difficult to quantify. They are important as they help shape public attitudes and lend weight to determining what is socially acceptable; they influence our perceptions and color our future interactions. The availability or existence of images is therefore highly significant.

IMAGES AND CADAVERS

With the increasing utilization of technology, digital resources, and information distribution, it is no surprise that controversy involving the distribution of unethical (and unauthorized) images of donated cadavers has already arisen. A recent instance in the United States involved a student taking a “selfie” with a donated cadaver (Anon, 2014), while in Switzerland university staff were disciplined for posting pictures of body parts on Instagram (Bond, 2013). Such examples highlight the risk and ease of image acquisition and distribution, and potential for abuse of position, in relation to donated bodies. Worldwide, there is now increasing scrutiny of the legal and ethical uses of human bodies and of how the wishes of the individual are to be respected (McHanwell et al., 2008; Hildebrandt, 2010; Champney, 2011; Schmitt et al., 2014). This suggests that existing standards and guidelines should be extended to include the acquisition or use of cadaveric images.

At present, there are no evidence-based guidelines or global standards for the acquisition and use of images of cadavers, and there remains a paucity of guidelines relating to image acquisition or use based upon empirical research. There has been a suggestion that the origin of cadaver images in publications needs to be declared (Strkalj and Pather, 2014). However, despite this there remains no global framework to guide whether or how images arising from donated cadaveric tissue should be acquired, used, retained or destroyed. There is also no statement from the world governing body of anatomy (the International Federation of Associations of Anatomists) that comprehensively addresses this topic.

In the healthcare and education sectors, standards for the acquisition and use of images from human tissues vary widely throughout individual countries and institutions. While the (UK) Human Tissue Act 2008 is silent on specific standards for the taking of images in the dissection room and subsequent uses of those images, relevant professional guidance from the (UK) Anatomical Society indicates it is good practice to
obtain consent (Anatomical Society, 2009). This approach is supported by other institutions such as Macquarie University in Australia. Some schools of anatomy, including the University of Otago (Dunedin, New Zealand) have their own codes of conduct for student behavior in the dissection room that include restricting the use of cameras and mobile devices.

Clearly, the issues require consideration and thoughtfulness in developing guidelines that would help establish a responsible code of practice, yet it is difficult to address the issue without knowing what questions to ask and answer. The robust development of ethical, appropriate guidance requires us to ask: what are the expectations of body donors in relation to how cadavers and cadaveric tissues are acquired and used? What independent and empirically generated findings and evidence exist to support and strengthen the regulatory framework? What legal and policy measures would be essential or desirable to enable responsible and sustainable body donation practice in anatomy and the biomedical sciences? Further, many questions need to be ascertained: what are the risks that images may facilitate? Do they impact upon society? What do they stand for? What is the value of body donation, and how could this be undermined by the indiscriminate use of images? Many of these factors are unknown or remain unexplored, requiring an in-depth assessment in order to provide the information required. Given the rapid and unpredictable evolution of technological advances in the area of global connectivity, it is imperative discussions are forthcoming in relation to the use of images in connection with cadavers.

THE IMPORTANCE OF CADAVER IMAGES IN A SOCIOCULTURAL CONTEXT

Little research has been undertaken assessing the impact on society of images from donated cadavers, in particular those images of donated cadavers that are available on the internet. In an effort to explore this topic further, Cornwall and Callahan (2014) examined Google Images in order to determine what images about body donation are presented to the public in Australia and New Zealand, and how the results might be interpreted. Images without visible text included pictures of dissection being undertaken by students, while other images included images of plastinated cadavers, various images of 3-D anatomy models, and sentimentalized images whose implicit focus is on the ethical approval of the act of body donation.

The resulting interpretation of the use-value of such searches by potential body donors, and their influence on the latters’ decision to donate, remain unexplored, but given Google’s significance these may be hypothesized to be factors in the decision-making process with respect to body donation. Key themes include medicine, death and science. The graphic images of dissected cadavers and dissection raise questions regarding respect for donors, freedom of information, and - perhaps more importantly - informed consent. This small exploration of available images on the internet includes cadaver dissection and donated cadavers, but did not examine the influence of these images on donor decisions. However, it did highlight the potential for misuse and distribution that already exists in relation to images from donated cadavers.

Given that images bestow value on an object (Cragg, 2012), it is worth considering how images of donated cadavers may affect the view of society on body donation programs, and whether this is likely to impact on the individual’s decision to register in a donor program. It is reasonable to suggest that allowing anatomy students to post (on the internet) pictures of their own cadaver dissections would have an impact on society; potentially, this would undermine the trust between the donor program and the donor community. It may also affect how individual communities view donor programs, and possibly their collective view on those individuals who donate to such programs. This leads on to a consideration of which aspects of this relationship require more robust management. Such images need to be managed in a sensitive and informed manner to maintain the integrity of the relationship between donors, donor families, donor programs, and the community.

THE DIFFERENT CATEGORIES OF CADAVER IMAGES IN ANATOMY

Images play an important role in anatomy, in many different contexts. There is strong and growing demand for the use of images from cadavers in a range of educational and research contexts for use in classrooms, in laboratories, and over the internet (e.g., via distance learning). Some universities have even allowed smart phone applications to assist with dissected specimen identification during anatomy courses. As “smart technology” expands further into biomedical education and research, the risks of misuse or abuse may increase in sensitive areas. It has been embraced by the academic community (Stewart and Choudhury, in press; Choi-Lundberg et al., in press), so much so that the use of images arising from cadavers is likely to be an ongoing topic for consideration. This includes reflecting on the demographic, cultural, and social factors that will affect their acquisition, and the authority to do so. Broadly, images of donated cadavers in the field of anatomy can be categorized into four distinct areas: non-specific, research, education, and commercial application.

Non-Specific Images of Donated Cadavers

This category of images includes those acquired within no specific context, such as those images that would not obviously be utilized for research, education, or commercial application. Such images could include those taken of cadavers in a dissecting room, or during any time while the body is in the possession
of the donor program. This may include pictures while students or staff are undertaking authorized activity, such as research, dissecting or embalming, or unauthorized activity such as being located in a dissecting room without permission. Many such images are already available on the internet.

Images in Anatomical Research

Research is one of the two primary utilizations of bodies donated to medical science, and is a key motivator for people to register as body donors (Fennell and Jones, 1992; Cornwall et al., 2012). Images arising from research on donated cadavers are important, as they allow detailed examination of research findings, allowing a visual representation of material that may otherwise be difficult to describe in words. They provide a clear interpretation of human anatomy, and may provide proof that the stated work has been undertaken.

But should the definition of “research” include the acquisition of images? Within the study and practice of anatomy, it is routine to acquire images that will facilitate the distribution of and dissemination of findings. Such images are normally taken by a member of the investigating team, and likely stored securely on a personal computer. They are probably not widely distributed, and are generally used for presentation and publication. Within the wider anatomical community, it would be reasonable to suggest that the acquisition of images from donated cadavers is a standard part of the research process. However, what is uncertain is whether potential body donors understand what “research” involves (Larner et al., 2015), and whether registered donors explicitly understand that images may be acquired as part of this process.

Images in Anatomy Education

Many registered body donors become involved in donor programs because of their motivation to aid medical education (McClea and Stringer, 2010; Cornwall et al., 2012). Images of donated cadavers are acquired and utilized during or for the purpose of education, although it is unclear whether potential donors understand that this is a possibility. It is plausible that many donor programs provide no indication of whether or how they will store images, for how long they will use them, or in what form they will use them (e.g., online or print). It also remains unknown whether consent would be given by donors for their use or distribution outside the location of donation. This is an important consideration given that the act of donation may be a community-motivated decision (e.g., giving back to the community) (Cornwall and Schafer, 2014). This raises a challenge for those institutions that run distance-based anatomy programs, where images may be viewed by individuals far removed from the institution. There is also the separate issue of how to manage teaching resources that could be transferred between institutions when academics and researchers take new jobs in locations removed from the site of the body donation program.

Images and Commercialization

Commercialization involving images is perhaps the most urgent issue, with some companies already selling and distributing educational resources that include modules with images arising from donated cadavers (e.g., Smart Sparrow, https://www.smartsparrow.com/research/). The need for clear and publicly acceptable guidelines for the acquisition and use of images from cadavers is particularly relevant to institutes and companies involved with developing educational resources and products. This category has the greatest potential for exploitation and for damage to the relationship between donors, donor families, the community, and donor programs. All the issues raised in considering the issue of image utilization in education are relevant to commercialization. In addition, the issues of financial consideration and legislation need to be taken into account.

Many legislative frameworks strictly prohibit profit being made from donated bodies or body parts (Champney, 2011). There are parallels between the sale of bodies or body parts, and the utilization of images from bodies or body parts in online educational resources or textbooks. Both involve commercial application and involvement of private companies. However, it is unclear what sort of legal and ethical processes apply in such a scenario.

Potential Solutions and Considerations

For all the instances outlined above, it is unclear whether any of these scenarios would be acceptable to individual donor populations in relation to the acquisition and use of images. This highlights the fact that little is known about what practice is acceptable to body donors, and that many current practices (e.g., information presently in consent forms for donor programs) are likely to be based on the assumption of what might be acceptable. As already outlined, the decisions by donors about whether acquiring and using images are acceptable will almost certainly be multifactorial, and will probably differ by donor location and socio-cultural profile (e.g., ethnicity, background). Underpinning any decisions regarding the development of frameworks to safeguard images should be transparency regarding how images may be acquired, stored, used, and destroyed.

In many instances, institutions consent to retention of body parts for a long period of time (e.g., for plastination, or permanent preservation), and they endeavor to return remains to families once the body has been utilized. Thought should be given to whether it is reasonable to treat images arising from donated cadavers in the same fashion: that is, consent is provided to acquire and retain images for a specific purpose and duration, and for research or education. Donor programs should also consider destroying original images once the body is returned to the family unless permission is granted to retain such images. Also needing to be covered is consent to the distribution of images to locations removed from their
DISCUSSION

It would be naive to believe that issues surrounding images taken of donated cadavers are not important or will not become so in the future. At present, donated cadavers can be tracked in many medical schools via systems that identify the use of individual body parts; any use of bodies or parts could therefore be scrutinized at some point in the future. It is feasible that images acquired for use in textbooks or as educational resources could be retrospectively identified by family members who request information on how bodies were utilized - and compensation argued for unconsented use or for a proportion of any profit generated. One only has to reflect on the unfortunate case of Henrietta Lacks to be reminded of the potential for this scenario to occur (Skloot, 2010).

This article has discussed many of the factors surrounding images of cadavers. It is suggested that the relationship between the donors, donor families, community, and donor programs is complex and based on trust; successful maintenance of this relationship is viewed as essential to the ongoing success of donor programs (Fennell and Jones, 1992; Gunderman, 2008). This trust involves oversight of the management of donated bodies in a way that is ethically sound and primarily in keeping with the wishes and expectations of the donors themselves. At the very center of such good practice and governance is the necessity of having publicly informed and consulted regulatory measures that are responsive to the wishes and expectations of society. However, the difficulty lies in assuming knowledge about that which is unknown—in this instance, the use of images arising from donated bodies. While some may argue that requiring body donor programs to outline postmortem practice in detail is excessive, the simple statement from a donor family saying “you didn’t ask” is an effective counter against withholding appropriate pre-donation information in an age of informed consent.

Hence, images from cadavers have the potential to affect society and the public perception of donor programs to be distorted, thereby influencing the nature of the relationship between the public and the donors (respect, empathy, understanding), all of which are crucial to the perceived value of the program in society. It is a mistake to treat images of donated bodies in the same way as images of a living person on account of the nature of the complex relationship between the parties involved. In addition, the variety of purposes for which images may be gathered require appreciation of the motivations and rationale for each of them. All must be considered according to characteristics specific to each, as well as in the contexts of different socio-cultural and religious realities.

Finally, there are also a variety of cultural beliefs and acceptable practices concerning death and last rites for the body, beliefs and practices that require sensitivity in how they are approached and managed with respect to this issue. Individuals can also diverge from what might be predicted from their cultural profile, requiring further finessing on the part of professionals. Such cultural contexts will need to inform the development of robust models that could be applicable to a global anatomy audience.

CONCLUSION

At present, there is no empirical evidence available to guide the utilization of images arising from donated cadavers. With ever-increasing use of digital and smart technology, the risk associated with image misuse has grown exponentially. To this end, the subject of appropriate governance of such images needs to be considered, in order to protect the relationship between donors, donor families, the community, and
donor programs. To effectively regulate the acquisition, use and retention of images responsibly and sensitively, the perspectives, expectations and wishes of donors, their families and the wider public should inform the development of updated guidelines and standards, including definitions of what “informed consent” may entail in respect to image utilization. It is also suggested that informed consent is required for all images that include or are derived from donated cadavers or their tissue until evidence supports an alternative position. Given the sensitivity with which issues surrounding death and use of the dead are viewed by society, the subject of images arising from donated cadavers requires immediate attention so as to maintain acceptable ethical practices and decrease the likelihood of potential misuse. Such discussions will guide responsible practice, inform future developments, and provide a benchmark for the appropriate utilization of images arising from cadavers donated to medical science.

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While questions of ethics in body procurement have become a focus of attention in many medical schools around the world, the recent report by a medical student regarding disturbing incidences in an anatomical dissection course (Terry, 2014) underlines the importance of a discussion of ethical practices in anatomical education. Here thoughts on core elements of instruction are proposed which are based on the premise that both, ethical body procurement and ethical anatomical education, are the foundation for a humanism-based professional training of students in medicine. As the anatomical dissection course presents an exceptional situation for students, practical guidelines for a curriculum founded on ethical considerations are essential. They include a preparatory phase before the start of the course in which students are asked about their expectations and fears concerning anatomical dissection; an introduction to the history and ethics of anatomy; a time for reflection in the dissection room before the start of dissection; a regular opportunity for reflections on dissection in parallel to the course with students and faculty; and a memorial service for the donors organized by students for faculty, students and donor families. Finally, anatomical faculty should undergo training in ethical educational practices. Many anatomy programs have incorporated various of these ideas, while others have not done so. Guidelines for ethical anatomical practices can strengthen the foundation of a humanistic approach to medicine in future physicians and health care workers.

Key words: anatomical education; ethics in anatomy; body donation; memorial service; reflection on medicine

"It is commonly known that medical students dissect the bodies of the dead; it is less commonly known that these same dead do a great deal of cutting, probing and pulling at the minds of their youthful dissectors."
Allan Gregg, 1957
(quoted after Bertman, 2007)

INTRODUCTION
Anatomy’s classic purpose is to provide insight into the structure and function of the human body. Today it is also seen as a “vehicle for moral and ethical education,” as formulated by medical students George Dyer and Mary Thorndyke (Dyer and Thorndike, 2000). The anatomical dissection course is now recognized as one of the first situations during medical education in which students are introduced to the professionalism of their chosen field (Pawlina, 2006). Coincidentally, a wide range of ethical topics in the

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Published online 19 November 2015 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/ca.22645

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scientific field of anatomy has been explored in the last years, with a focus on ethical body procurement (for reviews see Jones and Whitaker, 2009, 2012; Satyapal 2005, 2012; Garment et al., 2007; Riederer and Bueno-López, 2014). In general, willed body donation programs are seen as the best ethical standard for body acquisition at medical schools, but many countries are still dependent on the use of unclaimed bodies for various reasons (for a recent short review see Subasinghe and Jones, 2015).

While body procurement has been at the center of the debate on ethics in anatomy, the recently published report of disturbing incidences in an anatomical dissection course in the US highlights the lack of a discussion on ethical standards in anatomical education. In a letter to his body donor, medical student Michael Terry describes a dissection course scenario reminiscent of the “Nazi gas chambers” (Terry, 2014). He writes about anatomical educators who called him “prudish” when he tried to cover up the parts of the donor’s body which were not being dissected, and faculty who did not intervene when other students showed gross disrespect to the donor in word and deed. His instructors also told him that it was impossible to learn more about the history of the donor when he voiced his interest in the donor’s life. These anatomists not only failed to listen to this student’s questions, but also contributed to his traumatic experience. A “Viewpoint” publication in “Clinical Anatomy” written in response to Terry’s plight has remained without comment so far (Hildebrandt, 2014). However, this student’s outcry cannot remain unanswered by anatomists concerned with ethical questions in their field of work. Of course one could argue that this student’s experience was an unfortunate exception in an otherwise perfect educational environment. However, most anatomical educators have anecdotal knowledge of failures in ethical educational practices, either because of their own occasional mistakes or by witnessing the blunders of others. Rather than assuming that Terry’s experience is a negligible “glitch in the system,” his essay should serve as an incentive for a vigorous discussion on standards in ethical anatomical education. The current discussion on the “modernization” of anatomical instruction (Sugand et al., 2010) needs to focus on these questions.

Recent reviews of the history, philosophy and ethics of anatomical education have centered on questions of a core curriculum, body procurement, pedagogical tools and strategies, and learning assessment (Louw et al., 2009; Sugand et al., 2010; Moxham and Plaisant, 2014; Riederer and Bueno-López, 2014; Stabile, 2015; Brenner et al., 2015). Some authors spell out the contents of a socially and ethically conscious anatomical curriculum that includes the medical humanities, sex/gender-specific, population/ethnicity-specific and age-related anatomy (Brenner and Pais, 2014). However, none of these reviews discuss the necessary practical aspects of an ethical anatomical education designed to introduce medical students to their profession in a meaningful and non-traumatic fashion. Only Anja Böckers has recently touched on some of the issues discussed here (Böckers, 2015).

This proposal argues that both, ethical body procurement and ethical educational practices are the necessary foundations for a humanism-based professional training of students in anatomy. As the dissection course presents an exceptional situation for all involved, anatomists need to be aware of, and to be trained in, professional ethical practices so that students can receive an education that is founded on ethical considerations. Here potential practical core elements of an ethical anatomical education are discussed. Among them is the opportunity for reflection on the course and all it implies, for students as well as faculty. At the center of anatomical learning has to be the educators’ care for students and donor.

**PROPOSAL FOR ETHICAL PRACTICES FOR AN ANATOMICAL DISSECTION COURSE**

A general proposal on ethical practices for anatomical education has to consider the difference in dissection courses established not only within countries but also globally. Programs vary in body procurement, dependent on religious, cultural and political background, as well as in size of student body. Thus the individual core elements of an ethical anatomical education discussed here may have to be modified according to the local reality (Table 1). However, none of these differences should prevent the beginning of an open discussion on the subject, and ultimately the care for the students and their successful anatomical education can be seen as a universal goal in all programs.

First of all, it is important to realize that any dissection course starts before it starts, meaning: students know they will be studying anatomy and they have certain expectations about it, which need to be addressed before the course.

**Phase A: Before the Course**

The importance of the phase before the course as a time of preparation and reflection for medical students was recently emphasized by Böckers: “During the preparation of the dissection experience, teachers have to support the initial habituation process and assist students in developing the professional skill of ‘detached concern’ and encourage students to reflect on their work and emotions […] The habituation process needs a preparatory period ahead of the course” (Böckers, 2015, p.197-198). Indeed, this notion of the preparation of students for their first encounter with the reality of the dissection room is as old as the practice of anatomical dissection by students itself. William Hunter had not only identified the development of “a kind of necessary inhumanity” in the dissector, but also the need to introduce students gradually to the task, lest anatomical dissection “might even create disgust to a study from which [they] ought to receive pleasure and advantage” (Hunter, in his 1775 lectures, quoted after Payne, 2007, p.110-111). Of course, Hunter had ample time in his course of 112 lectures to prepare his students
TABLE 1. Overview: Practical Core Elements of an Ethical Anatomical Education

**Phase A: before the course**
- Faculty: training concerning ethical practices
  - Contact students and ask them about fears and expectations for the course
  - Identify “at risk” students
  - Team-building: selection and pre-course meeting of dissection teams
  - Pre-course anatomy encounter for at-risk students

**Phase B: during the course**
- Welcome by instructors and body donation staff
  - Overview course content and ethical concepts
  - Explanation of body donation program
  - Explanation of “respect for the donor”
  - Questions from students
  - Lecture or seminar “History and ethics of anatomical dissection”
  - First visit of the dissection labs with faculty and M2 or M3 students as peer instructors, starting with a minute of silence in gratitude for the donors
  - Role modeling of respectful behavior in the labs by faculty and senior students
  - Regular opportunity for reflections on dissection in parallel to the course
    - Team reflection in lab with faculty feedback
    - Group discussions outside lab
    - Optional artistic activities: drawing, painting, theatre, writing, reading, music
  - Conclusion of lab sessions:
    - Pathology visit, discussion of “dissection-log”
    - Minute of silence in gratitude for the donors, leaving the bodies of the donors as “intact” as possible

**Phase C: after the course**
- Memorial service organized by students for faculty, students and donor families
- Reflection opportunity for students to reconnect with each other or faculty

for anatomy by encouraging self-observation. But even in the typical abbreviated contemporary anatomy course faculty and students can and should be given time for structured pre-course preparations.

**Faculty.** As Terry reported, one of his main problems with the dissection course was the behavior of the faculty. Indeed, the importance of the role played by educators cannot be overestimated, and most anatomists embrace this responsibility willingly (Bourguet et al., 1997). Thus faculty training needs to be a basis for the development of ethical standards in anatomical education. Such training should start before the course and be maintained through regular faculty meetings throughout the course. Topics of discussion can include a listening and open attitude toward the students, as this can help identify students at risk through emotional stress and potential conflict in a dissection group. Faculty also needs to be aware of their function as role-models in respectful behavior not only toward colleagues and students, but also toward donors. This may start with the way they address the bodies to be dissected, e.g., as “donors” or “bodies,” but not “cadavers,” as this term tends to have the connotation of “something found by the wayside.” Also, the term “cadaver” could be interpreted as a way to deny the former personhood of the donor, as expressed, e.g., by Katharine Treadway. In her contemplation of the start of developing “detachment” in medical school she traces this “detachment” to her anatomy class, when the body was “conveniently called a cadaver, as though that made it something different from a person who had died” (Treadway, 2007, quoted in Curlin, 2011, p55). Whichever way a team of faculty members decide to call the donors, there should be an agreement on the expected standards within the individual program. This includes proper dissection technique and waste disposal and the avoidance of unnecessarily mutilating dissection techniques, i.e., removal of body parts for the sake of “easier access” without additional gain of anatomical knowledge. For example: the removal of a hand to “ease access” to the plantar surface is an unnecessary mutilation, while the sagittal sectioning of the head is the only way to gain detailed knowledge about the oral and nasal cavities. Faculty also need to realize that students may be aware of their professional work outside the dissection course, thus thanking donors in word and deed, e.g., in anatomical publications, is important. Finally, it is essential to maintain a culture of innovation through reflection on possible problems and improvement based on previous course evaluations by students. Through all this anatomical educators can show their active interest in the care for donors and students.

**Students.** Excitement and anxiety are some of the more common reactions of incoming medical students when faced with the prospect of the anatomical dissection course, as is documented in Sandra Bertman’s collection of students’ artistic responses to dissection (Bertman, 2007). This may have to do with the fact that the anatomical dissection course has often been called a “rite of passage” for medical students (Fitzharris, 1998), thereby describing a formative experience in which the student “begins to transition from layperson to physician” (Bourguet et al., 1997, p.264), a process otherwise called professionalization. However, the term “rite of passage” recalls visions of brutal hazing exercises, and implies the potential for harm to the person undergoing this “passage.” Also, for many of the younger students the dissection course is often the first encounter with a dead body, and the potential for emotional disturbances is great (Ropars et al., 2011).

Bockers endorses an emotional preparation of students before the course, but states that, based on her personal experience, “anticipatory fears” of students “do not allow a reflective conversation beforehand” (Bockers, 2015, p.199). However, at the University of Michigan Medical School an early correspondence with students about the complexity of the dissection course
was successfully practiced over many years. Students were contacted via electronic mail by the anatomical faculty several weeks before the start of the dissection experience and invited to express their fears and expectations of the course in any manner suitable for them. This offer was eagerly accepted by medical and dental students, who created responses in various artistic media, including letters, poems, paintings, and music. These were shared during the formal introduction to the course, together with letters from the donors to their future dissectors (Hildebrandt, 2010a). This exercise gives students the opportunity to realize that they share many of the same emotions with their fellow students, even if they themselves might not be ready to admit their own anxieties (Grochowski et al., 2014). Several studies have shown that the anxiety levels of students vary greatly (Dinsmore et al., 2001; McGarvey et al., 2001; Grochowski et al., 2014), and generally decrease over the course of the dissection "pre-course" like the one in Ulm may not be possible, with ample time to answer students’ questions. Usually the course outline and content are given and the willed body program explained. If unclaimed bodies are used a possible ethical rational for this practice should be given (Wilkinson, 2014). The special role of the donors and their generous gift to the students should be emphasized, as well as the donors' roles as teachers or first patients (Bohl et al., 2011, 2012). This result coincides with the experience at Harvard Medical School, where students were given the opportunity to visit the dissection labs and encounter donors on an individual basis together with a faculty member before the course. They later reported that this experience had alleviated their anticipated distress during dissections substantially. While the introduction of a special "pre-course" like the one in Ulm may not be possible at every medical school, the offer of an individual visit to the labs before the course can easily be extended to students at all dissection programs, even in larger student populations. Of course, these approaches rely on a self-identification of students who feel the need for a preparation.

Other schools have created different pre-course encounters, some of which are mandatory for all medical students. At the University of Oklahoma a donor luncheon has been established in 2000, where families of donors meet the future student disectors and tell them about their loved one's life (Crow et al., 2012). At the University of Central Florida College of Medicine a video "Anatomy and Humanity" with statements by donors, anatomical faculty and medical students, is used in preparation for the course, and has been shown to elicit complex responses in the students (Dosani and Neuberger, 2015). In other countries a more formal approach was chosen: at the Tzu Chi College of Medicine in Taiwan the pre-course activities include the students' home visits to the donors' families and a Buddhist memorial blessing in the presence of students, faculty members, donors and the donors’ families in the dissection labs (Lin et al., 2009; also: on the history of Tzu Chi: https://www.youtube.com/watch?v=oOS-pm4xHe0 and pre-course activity: https://www.youtube.com/watch?v=Dn2jBaL3FQ8). A similar dedication service to honor the donors and their families is an established custom at the Naresuan University in Phitsanulok in Thailand (Winkelmann and Güldner, 2004). At the University of Otago in New Zealand a Maori "clearing the way" ceremony was introduced to aid the students of Maori descent to "come to terms with death" (University of Otago, 2014). The anonymization of donors in classical anatomy has thus been replaced at some medical schools with a conscious contact between students and donors and their families. At the University School of Medicine-Northwest in Gary/Indiana the acquaintance with the donor's identity and history begins before the course, with students viewing videos of donors and their families, and the students’ responsibility for the physical admission of the bodies to the anatomical department (Talarico, 2013).

Phase B: During the Course

Course introduction. A formal course introduction gives students the opportunity to meet all faculty members and the staff responsible for the body donation program. This session should be as interactive as possible, with ample time to answer students’ questions. Usually the course outline and content are given and the willed body program explained. If unclaimed bodies are used a possible ethical rational for this practice should be given (Wilkinson, 2014). The special role of the donors and their generous gift to the students should be emphasized, as well as the donors’ roles as teachers or first patients (Bohl et al., 2011, 2013). The concept of “respect for the donor,” e.g., as resulting from the donor’s death as part of his or her biography (Winkelmann and Schagen, 2009), should be introduced as a guiding principle for the course, including its meaning for personal behavior in and outside the dissection rooms. This deduction of respect for the dead is easily transferrable also to unclaimed bodies.

In addition, the students’ potential fears and expectations of the course should be addressed by sharing their previously submitted responses to the faculty’s inquiry. The students should learn to
understand that the dissection course is not a “rite of passage” or a “hardening exercise,” but rather an opportunity to learn a clinical detachment which is balanced with empathy. This balance will enable them to become neutral observers and compassionate helpers at the same time (Hildebrandt, 2010b). Students often express the fear that the experience of the dissection exercises might alienate them from their own personhood and result in a certain coldness or overly great detachment from the fate of donors and later patients. This concern is addressed by Fountain in the following manner: “Yet rather than see detached concern as depersonalization, I contend we should view this phenomenon as a sensitization, a trained perspective that puts the science and the personhood of the body in constant and productive tension. This […] sensitizes participants to the simultaneous biological value and humanity of the body […] to understand […] all anatomical bodies as medical and personal” (Fountain, 2014, p.20). Students should be encouraged to be aware of their emotions during the course, as this will facilitate their ability to balance detachment with empathy in the way described by Montross: “Yet I also believe that the lesson of anatomy is that we do not need to overcome all our emotion or conquer all difficulty in order to be good clinicians. In fact, in light of the important balance that clinical detachment requires, I should perhaps feel encouraged by my inability to always emotionally disengage” (Montross, 2007, p.287).

In order to place the students’ personal experience in the framework of the discipline’s history, the introduction to the dissection course should include a lecture or seminar on the history and ethics of anatomical dissection. While ethics in anatomy is a relatively new field of exploration, there is already a wealth of literature to provide discussion material in a seminar (for a review see Jones and Whitaker, 2009). Topics can range from philosophical questions about death and dying to the history of ethical or abusive body procurement in anatomy, and current global practices in anatomy. Modules for such seminars are available through the open access website http://reflectionsnonmedicine.org and can help introspection at the beginning of the course. Then a first visit by the students to the dissection rooms should follow, which ideally does not yet include a dissection assignment. Instead, this visit will provide the opportunity to enter the labs together with teammates and simply take in the atmosphere, the sights, the smells, and the awareness of the presence of the dead. Once the students have found their assigned tables, faculty will officially thank the donors for their gift, followed by a moment of silence and contemplation. Students who have already gone through the course should accompany the new students, as it has been shown that the presence of experienced peers significantly decreases physical and emotional distress in the beginners of dissection (Houwink et al., 2004). The experienced students can then help each dissection team to proceed with the process of acquainting themselves with the bodies they will dissect, at their own pace. This approach has aided students at the University of Michigan Medical school and at Harvard Medical School with the initiation to dissection in a quiet and self-directed way. Some teams start to explore the bodies, others remain in silent contemplation. It gives students time to gauge their emotional reaction and find a certain equilibrium.

**Anatomical educators as role models.** Little has been written about anatomical educators as role models, a surprising fact given the prominent position of most dissection courses at the beginning of the medical curriculum and the emotional impact of dissection. However, it is without doubt that anatomical educators do indeed serve as role models for medical students (Rizzolo, 2002). Böckers speaks of the need for anatomical course directors to “guide” their faculty colleagues “to an understanding of a uniform role model” to be represented for the students (Böckers, 2015). Anecdotal evidence testifies to the gratitude many students feel for dedicated anatomical educators, but also, as in the case of Michael Terry, of anatomists who deepened the trauma experienced by students during dissection. Anotomy faculty members have indeed a great responsibility as they “may influence the style of interaction that future physicians will adopt toward patients […]” as the authors Bourguet, Whittier, and Taslitz formulate, and then continue to state that “much of this process of influence will occur implicitly through the behavior of the faculty toward the student and the cadaver” (Bourguet et al., 1997, p. 264-265). The educators’ attitude toward the students has been discussed above, also the appropriate handling of the donors’ bodies. In addition, it should be mentioned that newer approaches to anatomical dissection, especially those based on clinical procedures, can be more suitable for a respectful handling of the donor’s body than some of the more traditional dissection strategies. At Harvard Medical School a dissection guide has been developed which is based on clinical procedures. It uses very few skin cuts, which are modeled after surgical incisions, and introduces the students to surgical rather than anatomical dissection techniques (Van Houten, manuscript). This approach is particularly suitable for abbreviated dissection courses, as it facilitates a quick and relatively non-traumatic access to the deeper structures, which are revealed with a minimum of potential “mutilation” of the donor’s body. But even if a traditional dissection procedure is chosen, faculty can model appropriate respect for the donor’s body, including during such invasive procedures as decapitation, if the educational nature of the procedure is emphasized and the body is handled in a dignified manner. Finally, respect for the donor can be demonstrated in practical exams, where whole bodies should be used for the practical questions, rather than severed body parts. Ultimately, the foremost duty of the anatomical educators is to care for the students as well as for the donors, and to clearly demonstrate this attitude in their daily practice. In all these practices instructors can remind themselves and their students on a daily basis that the bodies they are handling are not “things” but remains of the former person the bodies had once been, just like the patients’ bodies the students will lay hands on are not “things” but human beings.
Reflection on dissection during the course. The anatomical dissection course should have a scheduled time for reflection on the course. This can take place in at least two ways, firstly in time set aside inside the lab for "team-reflection," which may be supervised by faculty and include feedback by the student team and by the faculty, and secondly in optional extra time for meditation and reflection on dissection outside the dissection labs. Reflection sessions outside the labs can have many different forms. At Harvard Medical School open discussion sessions for students and faculty were offered by Dr. Martha Katz, using contemplative live music as an aid for reflection. Dr. Katz also organizes drawing sessions with live models. These offer students the opportunity to observe the human body as a whole and from another, an aesthetic point of view. Similar approaches have been taken by other medical schools and often include journaling and essay writing. At Yale Medical School guest discussion leaders such as chaplains, social workers and nurses were invited to reflection sessions (Rizzolo, 2002). The Mayo Clinic at Rochester has explored a unique mode of reflection with the students’ creation of a drama based on Robert Louis Stevenson’s “The Body Snatcher.” For this the students researched the history of anatomical body procurement and discussed their findings with respect to the ethics of anatomy (Hammer et al., 2010). At Otago Medical School/New Zealand the film “Donated to science,” in which donors relate their life stories (Trotman, 2009), has been effectively used as a medium for students to reflect on dissection. Based on this experience the University of Michigan Medical School developed a similar project with videos of donor interviews for student reflection (Bohl et al., 2013). All of these activities can aid the students’ introduction into their future profession in a manner that addresses the shared humanity of medical practitioner and patient.

The last day of dissection. The last day of dissection can provide a chance for closure. Even though students tend to find the dissection course challenging, this final encounter in the labs is often accompanied by a certain wistfulness in consideration of the end of a challenging part of their education. This situation can be addressed in various ways. At Harvard Medical School students maintain a donor logbook, in which they record unusual findings during the dissection process. On the last day of the course, students present their findings to a consulting pathologist who helps them reconcile their anatomical findings with the reported cause of death. This practice has been introduced in 2009 by the anatomists Dr. Trudy van Houten and Dr. Cynthia McDermott. It reinforces the role of the donor as “first patient” and provides a sense of order and closure for the students at the end of the course (van Houten, personal communication). Even very informal “dissection logs” can be discussed with faculty and among peers. Thus the “donor as teacher” will indeed become the “donor as the first patient” for these students (Bohl et al., 2011). In addition, the last day in the labs should be used for another sign of gratitude toward the donors. The bodies can be reassembled as much as the dissection status allows, and a minute of silence in contemplation of the donors’ gift should follow. At Tzu-Chi Medical School the students sew the bodies back together at the end of the course and leave letters with reflections on their experience with the donors’ bodies. The students then serve as coffin bearers on the donor’s way to the crematory (Lin et al., 2009).

Phase C: After the Course

Most medical schools with willed body programs have implemented memorial services in honor of their donors. Recent reviews by Pawlina and colleagues show that these ceremonies are performed in anatomical departments around the world (Pawlina et al., 2011; Jones et al., 2013). While Western medical schools have introduced the services relatively recently with the establishment of functional body donation programs in the later 20th century, the custom is much older in Japan, with ceremonies for dissected executed persons in the 17th to 19th century, and in Taiwan since the beginning of the 20th century (Pawlina et al., 2011, p.139). In the US, a survey found that 95.5% of all responding medical schools held a memorial service (Jones et al., 2013), and in Germany the number was similar (Pabst and Pabst, 2006). Anatomy faculty and medical students are involved in the organization and also constitute the audience. Donors’ family members are invited at 70% of medical schools in the US, but apparently not at all in Germany. While in the US the services are non-denominational or secular, in Germany the services are rooted in the Christian religion, and in Thailand, Taiwan and Sri Lanka Buddhist ceremonies prevail (Winkelmann and Gulden, 2004; Lin et al., 2009; memorial service at Tzu chi college: https://www.youtube.com/watch?v=SvpBfRCugHU; Subasinghe and Jones, in press). Common to all of the ceremonies is the students’ active involvement in the program design and performance, including such diverse creative elements as poetry, music, dance and personal essays. The inclusion of the donors’ families in the memorial services gives students the opportunity to once more reflect on the reality and impact of the donors’ lives on those around them.

While these memorial services are well established, there is little information on additional post-course opportunities for students to reconnect with each other or faculty for reflections on the dissection course. One module for such a reflection session was developed by medical students Peter Kahn and Tova Gardin Kahn and aims to address “the dualism and cognitive dissonance experienced in the anatomy lab” and “help guide students to reflect on their time in the lab and see if their feelings have changed” during the course (http://reflectionsonomedicine.org/modules.html). Students can contemplate the development of their emotions during the course, especially in terms of clinical detachment and empathy, and discuss possible resulting strategies of achieving a constructive emotional balance in their future clinical work. Ideally, such opportunities for reflection would be part of a longitudinal practice throughout all years of medical education.
If anything about the discipline of anatomy is constant, it is the continuous need for innovation in anatomical education in the face of increasingly shorter anatomy courses (Drake et al., 2009, 2014). Coincidentally, the literature on anatomical education has become vast (recent examples of reviews: Paulsen, 2010; Moxham and McHanwell, 2014; Chan and Pawlina, 2015). Major current topics of debate are the need for anatomical dissection by students (McLachlan et al., 2004, 2006; Rizzolo and Stewart, 2006; Korf et al., 2008; Winkelman, 2007), different educational technologies and learning approaches including digital teaching aids (Benninger et al., 2014; Moxham et al., 2014; Saltarelli et al., 2014; Topping, 2014; Hortsch, in press), and the anatomical core curriculum, i.e. the minimum of anatomical education deemed necessary for students to succeed in their medical training (Berman, 2014; Louw et al., 2009; Orsbon et al., 2014).

The prospect of dissection fills many students with conflicting emotions ranging from excitement to anxiety, including the previously mentioned fear of losing their empathy for their future patients (Böckers et al., 2010a,2010b,2012; Bernhardt et al., 2012; Limbrecht et al., 2013; Grochowski et al., 2014). Whereas during the 19th century the “art of medicine”- including the emotional responses of the practitioner- was part of anatomical training in the US, this changed during the early 20th century with the emphasis on the scientific method in the perception of anatomy as a basic science, and any attention to the students’ emotions came into disrepute (Warner and Rizzolo, 2006, p. 409). This understanding of anatomy was transformed again in the later 20th century, when a self-interrogation in medical education, including Hafferty’s study of the emotional socialization of medical students in the anatomical dissection course, refocused the anatomists’ attention on the students’ affective and professional development (Hafferty, 1991; see also special issue of Clinical Anatomy on Professionalism and Anatomy: Pawlina, 2006). Since then anatomy has undergone a further change in its perception by medical students and faculty toward the concept of anatomical education as an introduction into medical ethics and the development of humanistic attitudes and behavior (Dyer and Thornridge, 2000; Gregory and Cole, 2002). Indeed, “the self-identity of anatomy has changed in the [last] 40 years” to include the teaching of “compassion, respect and clinical ethics,” thus making it a “beachhead to have other courses join in anatomy’s effort to move beyond ‘the subject at hand’ and begin to explore how the entire and truly integrated educational enterprise (which extends far beyond the formal curriculum) can be devoted to creating better doctors in the service of the public” (Hafferty and Finn, 2015, pp.347-348). Hafferty and Finn also point out that there is a distinct gap between the claims of the curriculum and the lived reality of the hidden curriculum, and that such a gap can lead to students’ failure to learn (ibidem, p.340).

As most medical schools use human bodies in anatomical education, the central topic of discussions on ethics in anatomy so far has been the body procure-
Western medicine since the beginning of the 20th century (Roelcke, 2014).

Anatomists themselves have a duty to reflect on and remember the importance of care for donors and students. Ethical practices in anatomical education can strengthen the foundation of a humanistic approach to medicine in future physicians and other health care professionals.

ACKNOWLEDGMENTS

The author is grateful to her colleague Dr. Trudy van Houten for constructive discussions on the topics of ethics in anatomical education and thorough editing of this manuscript. She also thanks Dr. D. Gareth Jones for his detailed review of the text.

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The Public Display of Plastinates as a Challenge to the Integrity of Anatomy

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Anatomy has been thrust into the public domain by the highly successful public displays of dissected and plastinated human bodies. This is anatomy in modern guise, anatomy as perceived by the general public. If this is the case, the message it is giving the public about the nature of anatomy is that it is an impersonal analysis of the human body of value within a medical and health care environment. While this is in part true, and while it reflects important aspects of anatomy’s history, it fails to reflect the humanistic strands within an increasing swathe of contemporary anatomy. These are manifested in growing recognition of the centrality of informed consent in the practice of anatomy, awareness of the personal dimensions and relationships of those whose bodies are being dissected, and manifested in thanksgiving ceremonies involving staff and students. The notion that the bodies undergoing dissection can be students’ first teachers and/or patients is gaining ground, another indication of the human dimensions of the anatomical enterprise. Exhibitions such as Body Worlds ignore these dimensions within anatomy by dislocating it from its clinical and relational base. The significance of this is that loss of these dimensions leads to a loss of the human face of anatomy by isolating it from the people whose body bequests made this knowledge possible. What is required is greater transparency and openness in the practices of all who deal with the dead human body, trends that owe much to the writings of scholars from within a range of humanities disciplines as they have responded to the public displays of dissected plastinated bodies. Anatomists have much to learn from these debates. Clin. Anat. 29:46–54, 2016.

Key words: plastination; plastinates; body worlds; body bequests; contemporary anatomy; immortality

INTRODUCTION

The dead human body, with its reminder of what we will one day become, and the memories it enshrines of loved ones who are no longer with us, is inevitably an object of fascination. Whether it is regarded as an object of veneration or pity, whether forbidding or macabre, a reminder of death or an educational tool, the dead human body invites attention. Consequently, anatomists are not alone in their interest in dead bodies, others coming from spheres of interest that span sociology to science, feminist theory to art history, and religious studies to law and ethics. Scientific approaches to the study of the dead body, its organs and separated parts, although undertaken by anatomists (and pathologists), raise a host of questions that have become increasingly pressing as the visibility of dead bodies has increased among the public by the exceptionally successful exhibitions of whole plastinated, dissected human bodies, the so-called plastinates.

The thesis of this article is that the public display of dead bodies as epitomized by Body Worlds, and replicated by a host of other exhibitions, is having profound effects upon the way in which anatomy as a

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Received 7 September 2015; Accepted 9 October 2015

Published online 18 November 2015 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/ca.22647

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discipline is perceived. While these are not universally negative, the end result will depend upon the manner in which anatomists respond to the exhibitions and the plethora of wide ranging discussions that have followed in their wake. Many of these discussions emanate not from anatomists or other biomedical scientists, but from scholars in the humanities who are raising questions about the human body and how bodies of the deceased are treated. In other words, a great deal of the debate is not confined to a critique of Body Worlds and the like, but to the scientific and mechanistic environment within which anatomists have traditionally operated. It is this aspect of the growing debate that should be of immediate interest to anatomists.

Additionally, these exhibitions have not arisen in a cultural vacuum. They raise issues about how dead bodies are obtained, how they are treated, how much we are at liberty to transform them technologically, the extent to which we accede to the requests of donors, and whether dead bodies should be used for entertainment as well as education. This is confronting anatomists with questions they are not well equipped to answer, and yet they are questions anatomists need to address if they do not wish to relinquish their integrity as scholars prepared to understand and defend their core discipline.

THE EMERGENCE OF PLASTINATION AND BODY WORLDS

In approaching any new development within a discipline, it is instructive to look back a number of years to ask whether this particular development was foreseen. Were anatomists discussing this possibility in the mid-twentieth century, since bodies had been on public display in earlier centuries? Were they envisaging a return to such practices or were these practices confined to a disreputable past? It is likely that the latter was the case, since the technique of plastination did not burst upon the scene until the late 1970s and 1980s (patents were taken out between 1977 and 1982) leading to the initial publications on the potential of the technique (von Hagens, 1979; von Hagens et al., 1987). However, a technique for the preservation of human tissue of immediate interest to anatomists and other biomedical scientists for teaching purposes, is far removed from a procedure that would be used to transform public perceptions of the human body.

The first public exhibitions took place in 1995 to 1997 in Tokyo, with subsequent exhibitions in 1997 to 1998 in Mannheim in Germany and slightly later in other European countries. Following the Mannheim exhibition, an extensive catalogue Anatomy Art was published (von Hagens and Whalley, 2000), containing analyses of the technique, with commentaries on the feedback from the exhibitions, issues raised by the display of death in this manner, questions around human dignity, as well as legal and ethical assessments. These exhibitions, together with the interest and controversy surrounding them, ensured that they had entered into public consciousness. Further controversy erupted in the UK with the first London exhibition in 2002 to 2003, and then with the first American exhibitions in 2004 to 2005. Before the first American exhibition, the California Science Center instituted a review process looking closely at the ethical issues raised. The consensus reached was that the exhibit had considerable educational value and was appropriate for the Science Center (California Science Center, 2004/2005).

RESPONSES TO PLASTINATION AS A PUBLIC PHENOMENON

Initial responses from anatomists varied from stringent opposition (Boyde et al., 2002; Kuhnel, 2004) to quiet acceptance (Morriss-Kay, 2002). The opposition was to the manner in which dissected bodies were being displayed rather than to plastination as a technique in anatomical education. Among other opinions expressed, the displays were regarded as mere spectacles, and that the viewing of dissected bodies should be restricted to health science students in appropriately designated educational institutions. However, later in 2008 The American Association of Anatomists officially supported the Body Worlds exhibitions as long as there had been informed consent for the body donations (Burr, 2008).

Over subsequent years few contributions have come from anatomists. Even an edited book with the provocative title of Controversial Bodies: Thoughts on the Public Display of Plastinated Corpses, had only one anatomist among its contributors of clinicians, religionists, bioethicists and an art historian (Lantos, 2011). This paucity of anatomical responses has been surprising for a topic as close to the core commitments of anatomists as the public display of dead bodies. Nevertheless, there have been exceptions. Charleen Moore, an anatomist, along with Mackenzie Brown, a professor of religion, have engaged seriously with a number of aspects of Body Worlds (Moore and Brown, 2004a,b, 2007). Similarly, Jones has written extensively from an anatomist’s perspective (Jones, 2002, 2007; Jones and Whitaker, 2007, 2009a,b).

Beyond the domain of anatomy, the literature on plastinates has burgeoned. It is not my purpose to retrace the central arguments of these contributions, but it is worth recalling the many disciplines from which they have come. These include ethicists (Barlan, 2006; Campbell, 2009), feminists (Kuppers, 2004; Deller, 2011; Scott, 2011), and anthropologists (Walter, 2004a,b; Linke, 2005; vom Lehn, 2006).

King et al. (2014) in endeavoring to summarize a range of the major themes developed by humanities scholars, emerged with a central contention that the human body as depicted in these exhibitions cannot be categorized using standard cultural binary categories of interior or exterior, real or fake, dead or alive, bodies or persons, self or other. The plastinates are disconcerting in that they elude any of our normal descriptions, so that it is not surprising that anatomists find them bewildering. In seeking to make sense of these unsettling conclusions, these writers suggested that it may prove possible to bring them together using Noel Carroll’s structural framework for
horrific monsters (Carroll, 1990). However, even this attempt at reconciling their disparate features proved illusory since plastinates differ from horrific fictional monsters. This underlines the problematic and unsettling nature of plastinates, and it is this impression that is having repercussions for what is the public face of contemporary anatomy. By contrast, the plastinated body parts and organs used in the dissecting room and for undergraduate teaching pose no such disconcerting challenges.

While much in the humanities literature may appear to be foreign territory for anatomists, it has a considerable amount to offer them. It reminds anatomists that practices lying at the heart of modern anatomical endeavor have ethical and social consequences. While there is disquiet in some anatomical circles over the public display of dissected plastinated dead bodies, there is little if any concern over the use of plastination as a teaching tool. The relationship between the two situations needs to be spelled out more explicitly than is generally the case, since elements within the current debate in the humanities cast doubt on the whole of the anatomical enterprise (Barilan, 2005; Scott, 2011). Anatomists have to consider to what degree they isolate the body from the person, and concentrate on body parts and regions at the expense of the body as a whole. They also have to reflect on whether and why scientific anatomy is wedded to the "normal" (Barilan, 2005), and whether this has consequences for the ethical framework they construct.

Without these exhibitions and the writings of von Hagens et al. (2000) it is unlikely that scholars in disciplines far removed from anatomy and the biomedical sciences would have ventured nearly as deeply into what is done to and with the dead human body. This exposure of the dissected body to public scrutiny has reawakened scholarly interest in the clinical gaze epitomized by anatomical dissection and exploration of the dead body. While this is not a re-run of the unsavory ventures of the early nineteenth century and before (Richardson, 2001), it casts a spotlight onto anatomy—the type of spotlight from which it had been shielded for many decades. While there is no reason to suspect that there has been any intention to hide questionable activities, practices carried out in secret are at odds with the increasing social awareness of the importance of transparency and openness.

ETHICAL AND SOCIAL RESPONSIVENESS OF ANATOMISTS

Before considering the public's view of anatomy in the light of Body Worlds and similar exhibitions, we need to assess whether anatomists are becoming more aware of their responsibility for the bodies they receive—how they come to be in an anatomy department, and how they are treated when there.

Underlying every other consideration is a fundamental ethical one, and that is the nature of the bodies available for dissection. Over recent years there has been a major move in the direction of using the bodies of those who have bequeathed them for teaching and research purposes, as opposed to the use of unclaimed ones (Jones and Fennell, 1991; Richardson, 2001; McClea and Stringer, 2010). While this move commenced in the 1960s in some jurisdictions, it is only since the 1990s that anatomists have begun to actively debate the importance of informed consent as the dominant ethical driver of their practice (Jones and Whitaker, 2012). While there will continue to be difficulties in some countries in obtaining bodies for dissection on cultural and religious grounds, the stance that it is preferable ethically to use bequeathed bodies is gaining acceptance within anatomical circles (McHanwell et al., 2008; Riederer et al., 2012; Riederer, 2014). This trend is of considerable significance since it indicates an ethical awakening by anatomists, in that the source of bodies is to be taken seriously, and that it is not acceptable to obtain bodies from any available source. The tragic episodes during the Nazi era, so eloquently brought to our attention by Hildebrandt (2009a, 2009b, 2011), underscore this lesson with alarming poignancy.

If the use of bequeathed bodies is the ethically preferable mode of operation for anatomists, the foundation has been laid for accepting that human relationships are important within anatomy. Bodies to be dissected are not mere tools to be used and disposed of at will, as one might do with inanimate objects. They represent the remains of once living people, equal in value to living anatomists and students. While now dead they once had lives and interests, relatives and friends, wishes, hopes and fears, loves and expectations. Their place in the dissecting room should stem from their wish to be there, to help medical education and perhaps scientific research, or even to help their spouse's finances. Regardless of motives, they consented to this use of their body after death. This establishes a mutual relationship between departmental staff and students and those who were once alive and are now being dissected. No matter what framework one uses to understand this relationship, it signifies a move away from an unfeeling mechanical use of human material.

Against this background, other ethical indicators are to be expected and welcomed. For instance, the doors (of the dissecting room) are being opened, as depicted by the film Donated to Science (Trotman, 2011) with its integration of an actual dissection program with students’ subsequent responses to interviews with the donors of the bodies before their deaths. In covering these dual aspects of the program, it cast light on the human side of dissection both for the students and the donors. While ethical issues were not specifically discussed, they were inherent in the process of donation and the social and emotional responses of the students. Also of note are books that follow various aspects of the dissecting room experience and reflect on what its effects are on the medical students involved (Hafferty, 1991; Carter, 1997; Montross, 2007). Interestingly, only one of these authors, Christine Montross, wrote as an insider, a medical student, and none of them was an anatomist. The other two were from humanities disciplines, Comparative Literature and Sociology. Once again, one has to ask why there is such a dearth of anatomists writing along these lines?
While these books were not written in response to the *Body Worlds* phenomenon, they provide much needed insights into the human side of dissection, and help bridge the gulf between the allegedly arcane world of the dissecting room and that of normal human existence. They, along with films like *Donated to Science*, are highly relevant to the ongoing debate on the public display of dissected bodies, since they throw light onto the forces at work when medical students are dissecting bodies as part of what is commonly regarded as the highly scientific and mechanistic ethos of anatomy.

These comments have centered on Western experiences, but there is growing knowledge in the West of bequest practices strikingly different from generally encountered Western ones. Most commentary to date has been on certain Buddhist practices in Taiwan (Lin et al., 2009; Guo-Fang and Yueh-Jan, 2014) and Sri Lanka (Subasinghe and Jones, 2015) with their involvement of the families of donors and students. While these undoubtedly represent specific religious beliefs and practices, they illustrate the way in which anatomical practices have been adapted within different cultural situations.

Alongside increasing interest in the place of bequests, there has been increasing emphasis given to the role of ceremonies, both before and after burial or cremation of the remains, with their recognition of the altruism of the donors and the support of their families. While these ceremonies take a number of forms, they are a means of providing spiritual help for the medical students to dissect cadavers during their medical studies (Martyn et al., 2013), and also of thanking the donors for their selfless action (Pawlina et al., 2011).

The notion of cadavers as teachers has gained currency in recent years. One of the early publications to verbalize this term was that of Winkelmann and Guldner (2004) based on their experience in a Thai Medical School. Working in a Buddhist context, donors are bestowed with a highly regarded status, that of ajarn yai, great teacher. Although the specific elements within these ceremonies cannot be applied directly to other societies, they point toward the importance of recognizing the person in the cadaver. This is at odds with the tradition in the West of anonymizing the cadaver, a tradition that is in need of reassessment. In seeing the cadaver as their teacher, students begin to attribute a social role and status to it (Winkelmann and Guldner, 2004).

A related move is for students to regard cadavers as their first patient (Bertman and Marks, 1985; Segal, 1988; Ferguson et al., 2008). This is part of the growing realization that the experience of the dissecting room extends far beyond the boundaries of learning the essentials of anatomical structure and organization. It raises questions about death and dying, about how these bodies came to be in the dissecting room, what the people may have been like during their lives, and whether students should be dissecting them at all. These are all questions far more familiar to those in the medical humanities than in anatomy. The message that shines through is that anatomists are gradually moving toward a realization that these humanistic considerations are far more central to their discipline than has traditionally been the case.

**REVISITING BODY WORLDS**

Throughout the previous sections there have been strong hints that anatomy is far less sterile and mechanistic than frequently assumed. While many of these developments are recent ones, they are gaining momentum. It is now possible to compare *Body Worlds* with contemporary anatomy as I have been portraying it.

The argument provided by those associated with *Body Worlds* is that it is the modern face of anatomy. It has it is claimed moved away from the sterile world of the dissecting room, and von Hagens’s numerous allusions to the Renaissance era, and the plastinated mimicking of Renaissance works of art, bears this out (von Hagens and Whalley, 2000). But is this the case? Is the contrast nearly as unequivocal as this? I shall argue that it is not and that this is misleading.

In its advertising, *BODY WORLDS:*PULSE (Destination: You), the 2015 exhibition in Discovery Times Square, New York City sets out to present the story of the human body in the 21st century. It is described as a breakthrough in anatomy, in which visitors will learn about the human body, described as a scientific marvel and an artistic wonder, and as an epic of form and function, power and potential, vulnerability and resilience. The event is marketed as “an inspiring immersive multimedia exhibition about health, wellness, and living to the beat of life in a vibrant, fast-paced city” (*Body Worlds*, 2015). Visitors are promised that it will change the way in which they see themselves and the way in which they live. This is because it “chronicles the effects of our biology, lifestyles, and the environment on our physical and mental wellbeing.”

Of particular interest is the statement that “body donors who willed their bodies, after death, for plastination and the education of future generations, act as guides and teachers on this unforgettable journey of discovery” (*Body Worlds*, 2015). This appears to create a direct link between this exhibition and education, although it is not clear whether this is education of the general public alone or of the general public and health science students.

There are two strands running through the *Body Worlds* literature, as demonstrated by the Institute for Plastination’s ([IfP] Booklet: *Donating Your Body for Plastination* [Institute for Plastination, 2008]. On the one hand there is the artistic and historic view that “the public display of human bodies represents the resurrection of the anatomical theatres of the early modern period, albeit in a completely new form” (p8). Alongside this von Hagens in his postscript: “Ensuring the Future of IfP’s Body Donation programme,” writes that donors can make “a very special contribution both to the training of future physicians and other medical professionals and to the education of the general public” (p30). Since IfP produces plastinated anatomical specimens for sale to recognized institutes as well as part of public displays, it is correct in stating...
that some of them will aid in the education of future health professionals. And yet the major emphasis still appears to be on the well-known public displays. These, after all, provide the source of the donors.

In addition to the Pulse exhibition, other Body Worlds exhibitions running at much the same time are "Animal Inside Out," "The Cycle of Life," "Vital," and "The Happiness Project." Additionally, there is now a permanent exhibition in Berlin at the Menschen Museum. There are undoubtedly a variety of conceptual strands running through these diverse exhibitions, and yet they are characterized by the display of whole body plastinates, and by a medical/health-centered view of anatomy.

A further contrast with contemporary anatomy is the public/private dichotomy. This forces us to ask whether there is anything inherently wrong (ethically and/or culturally) with putting plastinates on public display? When discussing Body Worlds, there are no issues with prior consent for the donations. Incidentally, there are many anatomy departments worldwide that use bodies without consent. These are the unclaimed bodies so well known throughout much of the history of anatomy (Richardson, 2001), and while vigorously rejected today by some anatomists (Jones and Whitaker, 2012) they have not disappeared completely from anatomy departments worldwide. It appears that Body Worlds cannot be faulted on these grounds. What is it then that creates so much angst in some quarters (including the world of anatomy) at the display of these dissected plastinated bodies? Putting aside questions regarding the commercial elements associated with the Body Worlds phenomenon, anatomists are left with fundamental queries.

What if the bodies on display were much like those found in dissecting rooms, some undissected, some partially dissected, and some even displayed in slightly elevated as well as horizontal positions? If education was the main object of the exercise, one could argue that with appropriate descriptors, such a display could be effective. Whether it would prove attractive to a lay audience is another matter. Since plastination is a viable technique one would expect some of the exhibits to be plastinated, most of which would be of organs and body parts rather than of whole bodies. However, none of the exhibits would be displayed in acrobatic or sporting modes. Such a display would probably elicit far less ethical concerns than any of the Body Worlds productions, although by concentrating on the mechanistic aspects of scientific anatomy they would fail to highlight the beauty and attractiveness of the human body. Moreover, they would prove more useful for demonstrating relationships between organs, vessels and nerves, so important for a role within a health sciences environment.

With this speculative (and unlikely) example in mind, is it the environment and expectations that constitute the substantial distinction between the general public and the health science student, and therefore between public exhibitions and the traditional dissecting room? There can be no doubt that plastination in the guise of whole body plastinates serves as an entrée to the public arena, since without it there would be no way in. Plastination in that context is not an end in itself, but a way into an appreciation of the dead (and living) body. Much of the story told by Body Worlds appears to be about the living body rather than the dead one. Plastinates are serving as inviting and welcoming real human ‘living models’. By depicting them as being alive and capable of a wide range of sporting feats, the organizers succeed in appealing to a wide cross section of the public including young people.

This is death made attractive. But is it death they come to see, or is it the dead packaged as though young, alive, and healthy? The bodies will be largely those of old people, but most of them are depicted as virile young people. There are, of course, exceptions as with the frail elderly man with his walking stick. But this is an exception to the general rule where “youth” dominates.

These are no more than observations, but they raise a question for anatomy, namely, whether there is anything inherently problematic for anatomy as a discipline in the mounting of these public exhibitions. On the surface it is difficult to see why this should be the case. Anatomy will continue as an academic discipline regardless of what Body Worlds or any of the other exhibitions mount, nor how commercially successful they may be. Ultimately, they stand or fall on their own merit using criteria far removed from the confines of anatomy and anatomists. But can the two be so neatly divorced as this suggests? I have my doubts on the ground that there are profound philosophical differences between the two. In order to explore this assertion I shall consider first the Body Worlds displays, and subsequently turn to contemporary anatomy.

THE AMBIGUITY OF PLASTINATES

Plastinates are ambiguous because we cannot readily slot them into familiar categories. Their nature is what has been referred to as transgressive (King et al., 2014). These categories have already been touched on (see Responses to plastination as a public phenomenon), and force us to ask disquieting questions: Are these “people” real, indeed are they still persons? Are they mortal or have they taken on a hint of immortality? While they look like us, is this deceptive and misleading? And finally, are they dead in the sense in which ordinary corpses are dead, since they seem to possess some of the characteristics of the living? These queries never surface in relation to the cadavers in a dissecting room. Do such questions point toward a fundamental difference between Body Worlds and the world of anatomy?

The Body Worlds exhibits give the impression of participating in the living world (Skulstad, 2006); they are smiling, content, have open eyes, and seem to be going somewhere and doing something. While dead, they are also very much “alive,” participating in the sports that appeal to us as living people; perhaps they are neither dead nor alive (Stern, 2006; Bates, 2010). Lizama (2009; p 21) thinks they project a “melancholic sadness over the loss of both life and death.” No one would ever consider this a possibility.
when viewing bodies in a dissecting room. Not only this, plastinates are virtually indestructible unlike those in the dissecting room. This gives them the feel of immortality, something that has major significance for von Hagens who sees them as joining the ranks of mummies and skeletons all of which have a form of post-mortem physical existence (von Hagens, 2001, p 259, 2000, p 36). For him plastinates are “post-mortal” (PRNewswire, 2006), thereby protecting them from physical decay and taking them into a realm beyond the mortal. While this may seem like an exaggeration, for von Hagens it has profound significance. He claims that plastination is “able to satisfy the desire for immortality, which until now has been monopolized by the church, in a way that is commensurate with our times” (von Hagens, 2001).

This ambivalence over what constitutes being alive and being dead is deliberate, since its philosophical significance for von Hagens enables him to replace religious beliefs about immortality with a form of ongoing existence based on the mortal body now transmuted into an indestructible plastinated body. Plastination has become more than mere technique, since it is capable of replacing religious notions of resurrection with a new kind of “fleshliness” (Fischer, 2000; Moore and Brown, 2004b; Linke, 2005; Preuss 2008, p 28).

No matter what views individual anatomists may have on Christian notions of the resurrection and the resurrected body, anatomy as a discipline has no reason to view plastination in quasi-religious terms. There is no temptation even to do so when using plastinated organs and body parts, rather than complete bodies. Herein lies a major contrast between plastination in the hands of anatomists and the plastinators responsible for iconic Body Worlds plastinates, such as the runner, the javelin thrower or the swordsman.

This may be immortality of a particular genus, but it is a “uniquely secular, material form of immortality” (Stern, 2003). However, the impression of imparting biological life after death is illusory and artificial (Linke, 2005). Whatever the impression given by plastinates, they are as static as any cadavers in a dissecting room. Regardless of the terms employed, “post-biological existence” amounts to nothing more than “a synthetic afterlife, unable to ever attain organic death or incorporeal resurrection” (Lizama, 2009, p 26). In clinical terms they have as little awareness as anyone in a persistent vegetative state (PVS) and their hope of even a modicum of “recovery” is infinitely less. The person once recognized as John or May, Douglas or Sally, has irretrievably gone; no hint of personal life remains. True, there is a beautifully dissected and plastinated dissection, but even this bears little resemblance to the external bodily features by which the individual was known and by which he or she would usually be remembered (King et al., 2014).

Even if Body Worlds does provide a reflective space to meditate on mortality, it does this by converting the corpse into plasticized remains. It is true that Body Worlds has made the dead body more accessible than it has generally been in societies that rarely come face-to-face with death, and yet the transformation of these plastinated bodies into “replicas” of the living alters the context within which death is presented and approached. This presentation differs significantly from more recent moves in anatomy to humanize dissection and students’ relationships with the bodies they are dissecting (Montross, 2007). It is difficult to imagine any student having a relationship with a plastinate, even the ones that are depicted as having life and vitality. Self-evidently, it is impossible for students to dissect plastinates, any more than they are able to dissect plastinated body parts. Plastinated material, valuable as it undoubtedly is as an adjunct to dissection-based teaching (Riederer, 2014), is no substitute for dissecting bodies.

Throughout this discussion there has been an underlying assumption that plastinated bodies are “real” in the sense that they accurately represent the individuals who once lived. And yet this is deceptive, in that they are substantially plasticized remnants of that once living, breathing and thinking individual. The plastinators have artificially modified the bodies to produce an exhibit that is made to appear life-like, and yet these very interventions serve to distance the bodies from their natural state.

The fundamental changes to the composition of the bodies ensure their presentability, structural integrity and longevity, and are of major significance for anatomists studying these human remains. But it detracts for their alleged “realness.” While substantial elements of the individuality of the individual continue to be present, these are far from self-evident to an observer.

For some commentators the bodies are chemically, surgically and artistically modified to such a degree that the intrusion of the artificial makes them “hyper-real” (Stern, 2006; Desmond, 2010). This leads to the contention that what is presented are representations of real bodies (van Dijck, 2001). The end result is an artificial representation of perfected nature (King et al., 2014).

These considerations enhance concerns about the ambiguity of plastinates. It may be that they have elements of both death and life, of the real and the fake. Their perplexity lies in their profound difference from anything normally encountered, whether in the public sphere or in the anatomists’ dissecting room. They seem to constitute another human species, Homo plasticus, different from us, no matter how much they are presented as being similar to us.

**ANATOMY AND BODY WORLDS**

The selling of Body Worlds as the public face of anatomy has been largely accepted both within and beyond the anatomical community, not always by way of approval but as an acknowledgment that this is the case. The perception that Body Worlds represents a more exciting face of anatomy, one that appeals far more to the general public, has also been widely accepted and with some justification. However, what is not clear is how anatomy is being represented. The impression that comes through is that it is solely a scientific approach to the structure of the human body. To the extent that this is correct, Body Worlds is indeed anatomy writ on a large
multimedia scale. However, this depiction of anatomy is incomplete and even misleading.

It has emerged in previous sections that anatomists are seeking to humanize anatomy and the study of the human body. This emerges repeatedly in discussions of how students (and medical students in particular) should approach the process of dissection, based on gratitude for the donations, and an understanding of the family relationships of the donors. However, Body Worlds appears to distance itself from the people who have been plastinated, thereby objectifying the body. While this may have some similarities to the anonymization of bodies in the dissecting room, the desire to treat the bodies as first patients and teachers is a move away from this ethos, while commemoration ceremonies aim to link the dead with their living relatives. In light of these trends, it needs to be asked whether Body Worlds and the like represent an outmoded view of the body by dislocating it from a clinical and relational base.

Current emphases within some of the Body Worlds exhibitions are health related and yet these are accomplished using anonymized bodies in artistically attractive ways. Regardless of the educational goals of these exhibitions, they are dependent upon dehumanizing the bodies, no matter how well dissected they have been, nor how aesthetically attractive many of them are. But this has been accomplished by removing them from the environment that nurtured them and of which they were a part. This is even more obvious if the ballet dancer, baseball player or chess player were not competent at those activities when alive.

Plastinates do not represent the bodies of somebody, but have been generalized to represent bodies in general. This parallels the manner in which scientists generalize bodies in order to learn more about them scientifically. Surprisingly, therefore, Body Worlds has far more of a scientific thrust than claimed. Alongside this it has far less of a humanistic thrust than one might imagine, in that the depersonalized elements tend to dominate.

Against a background of his earlier involvement in the commissions looking into the retention of organs scandals in the UK in the 1990s, Campbell (2009) comments that, even when dealing with the living, “distancing and objectifying of the body has detrimental effects on health” (p 99). In terms of retaining body parts after death, he reminds us that the physical body of the person is fully part of the love the parent feels for the child or the wife for her husband. In these discussions he links the dead body with the person, leading to the view that care has to be taken that scientific medicine does not become separated from the thoughts and responses of patients and lay people. What can be a useful source of information to the clinician may be interpreted as a violation of the dignity and integrity of the recently deceased. His fundamental thesis is that “to ignore the bodily aspects of ourselves, or to treat them in a merely instrumental way as a source of income or of social esteem, is ultimately threatening to the integrity of ourselves as individuals and as members of a human community” (p 103).

If bodies are dealt with instrumentally, even following donor consent, there are implications for the human community, simply on the ground that death and life are intertwined (Campbell, 2009, p 115). Who were these people? What were they during life? What did they do? What were they interested in? They may be dead but there are memories associated with them (what Campbell describes as “the gift of memory”), and while these will principally exist in the minds of their loved ones, any attempt to dissociate bodies from their background is to reduce them to impersonal objects. Anatomists have been guilty of this in the past, and undoubtedly remnants still exist, although attempts are being made to humanize what historically was at times a relatively uncaring profession (Richardson, 2001). For Barilan (2006) human remains should never be treated as mere raw material, with its indication of a lack of respect for the individuals concerned. He also advocates that Body Worlds has a duty to participate in the medical care of needy donors, a principle one imagines would also apply to anatomy departments in their dealings with donors before death.

Body Worlds shows no indication of avoiding this pitfall, since no attempt is made to link the plastinates with living individuals. This may be accentuated by the claim that plastinates display evidences of immortality (von Hagens and Whalley, 2000). Speaking in more general terms, Campbell (2009) comments that when faced with myriad attempts to defeat ageing what is urgently required is wisdom and humility to accept our earthbound state (p 125). Within the context of Body Worlds one would like to see acknowledged the limitations of plastinates, in that they fail to throw light on the human condition since they have been isolated from the histories of the donors as once living people. A related limitation stems from the artificiality of their presentation that further isolates plastinates from some of the anatomical realities of the human body. These criticisms in no way downplay the technical excellence of the dissections, nor of the anatomical intricacies displayed; that is, anatomy in its classical form. But this has been achieved at the expense of the human face of anatomy and of the people whose body bequests make this knowledge possible.

CONCLUSIONS: MODERN TRANSGRESSION OR ANATOMY MODERNIZED?

The transformation of dead people into plasticized representations of living people can be viewed either as a stunning technological achievement or as a disturbing example of scientific and cultural reductionism. It probably elicits elements of both. The transformation inherent within the plastination process stems from the work of those who carried out the plastination, who emerge as the creators of the final product. This is not anatomy modernized, which is moving in a humanistic direction through a range of pedagogical and ethical trends. It may be too strong to describe the public exhibitions as modern transgressions of anatomy, but their ethos has little that is
sympathetic to anatomy as a discipline. This is not the pubic face of anatomy; rather, it is the public face of what some perceive to be anatomy.

Plastination, especially the production of plastinates, compels anatomists to think more deeply about what can and cannot be done with dead human remains. The techniques at the anatomist's disposal have the potential for displaying these remains in novel ways, giving them a hint of physical immortality, and forcing a reconsideration of the ethical underpinnings of body donation. Foundational to any reconsideration is a view of anatomy as multidisciplinary, with ethical and cultural strands as well as the better known scientific ones. It is at this point that academic anatomy diverges from the vision of anatomy put forward by any of the public exhibitions of dissected plastinated bodies.

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Good practice recommendations for the donation of human bodies and tissues for anatomical examination have been produced by the International Federation of Associations of Anatomists (IFAA). Against the background of these recommendations, the ethical values underlying them were outlined. These were the centrality of informed consent, their non-commercial nature, and the respect due to all associated with donations including family members. The latter was exemplified in part by the institution of thanksgiving services and commemorations. A number of issues in the recommendations were discussed, including the movement of bodies across national borders, donor anonymity, taking images of bodies and body parts, and the length of time for which bodies can be kept. Outstanding questions in connection with body donation included the availability of bodies for research as well as teaching, allowing TV cameras into the dissecting room, and the display of archival material in anatomy museums. Future prospects included whether IFAA could be formulating a position on the public exhibition of plastinated human material, and in what ways IFAA could assist countries currently dependent upon the use of unclaimed bodies.

IFAA RECOMMENDATIONS

A number of articles in this issue have made reference to the International Federation of Associations of Anatomists (IFAA) "Recommendations of good practice for the donation and study of human bodies and tissues for anatomical examination." These were produced by me in consultation with others at the request of the executive committee of the IFAA and appeared first in Plexus, the newsletter of the IFAA, in August 2014 (IFAA, 2014). They were produced in order to outline what are regarded as good practice guidelines. They are reproduced here in full.

The study of human cadavers is essential for teaching, advanced training, and research in medical and anatomical sciences. Institutions1 rely on the donation of bodies by the general public, and are immensely grateful to donors. However, it is imperative that institutions follow procedures of the highest ethical standards in order to give donors full confidence in their decision to donate. Transparency regarding the use of human material and institutional procedures increases public trust and in turn increases public support of body donation.

1. Informed consent from donors must be obtained in writing before any bequest can be accepted.2 Consent forms should take into account the following:

1The term "institution" is intended to refer throughout to a university, medical school or anatomy department as appropriate.

2This excludes the use of unclaimed bodies.

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a. Donors must be entirely free in their decision to donate, this excludes donation by minors and prisoners condemned to death.
b. Although not essential, good practice is encouraged by having the next of kin also sign the form.
c. Whether the donor consents to their medical records being accessed.

2. There should be no commercialization in relation to bequests of human remains for anatomical education and research. This applies to the bequest process itself, where the decision to donate should be free from financial considerations, and also to the uses to which the remains are put following bequest. If bodies, body parts, or plastinated specimens are to be supplied to other institutions for educational or research purposes this may not yield commercial gain. However, charging for real costs incurred, including the cost of maintaining a body donation program and preparation and transport costs, is considered appropriate. Payment for human material per se is not acceptable.

3. There needs to be an urgent move toward the establishment of guideline regulating the transport of human bodies, or body parts, within and between countries.

4. Specimens must be treated with respect at all times. This includes, but is not limited to, storing and displaying human and non-human animal parts separately.

5. The normal practice is to retain donor anonymity. Any exceptions to this should be formally agreed to beforehand by the bequestee and, if appropriate, the family.

6. Limits need to be placed on the extent to which images, or other artifacts produced from donations are placed in the public domain, which images, or other artifacts produced from donations are put following bequest. If bodies, body parts, or plastinated specimens are to be supplied to other institutions for educational or research purposes this may not yield commercial gain. However, charging for real costs incurred, including the cost of maintaining a body donation program and preparation and transport costs, is considered appropriate. Payment for human material per se is not acceptable.

7. A clear and rigorous legal framework should be established on a national and/or state level. This legal framework should detail:
   a. The procedures to be followed in accepting bequests of human remains for anatomical examination, including who is responsible for human remains after death.
   b. The formal recognition of institutions which may accept bequests, which in some jurisdictions may involve licensing.
   c. The safe and secure storage of human remains within institutions.
   d. The length of time such remains will be retained by the institution.
   e. The procedures to be followed in disposing of remains once the anatomical examination is complete and they are no longer required for anatomical education and research.

8. Institutional procedures should be formally established by an oversight committee, which shall review the body donation program at regular intervals. Such procedures should include the following:
   a. Copies of the bequest should be retained both by the donor and by the institution for whom the bequest is intended.
   b. Records should be kept for a minimum of twenty years from the date of disposal to ensure that human material can be identified as originating from a specific donor.
   c. Good conservation procedures should be employed throughout the entire period during which the human remains are retained to ensure that the most effective use is made of any bequest received.
   d. Efficient tracking procedures should ensure that the identity and location of all body parts from an individual donor are known at all times.
   e. Facilities where cadavers are used must be appropriate for the storage of human remains and secured from entry by unauthorized personnel.

9. There needs to be transparency between the institution and potential donors and their relatives at every stage, from the receipt of an initial enquiry to the final disposal of the remains. The clear communication of information should include but not necessarily be limited to the production of an information leaflet (hard copy and/or digital), which could also help publicize anatomical bequests and increase the supply of donors. This should set out the following:
   a. The procedures relating to registering bequests, acceptance criteria, the procedures to be followed after death (including under what circumstances a bequest might be declined), and the procedures relating to disposal of the human remains. Sufficient grounds for rejection could include, but need not be limited to:
      - the physical condition of the body
      - the virological or microbiological status of the donor in life
      - the existence of other diseases (e.g., neurological pathology) that might expose staff or students handling the body to unacceptable risks
      - body weight or height over a specified limit
      - the possible over-supply of donations at that institution at that time
      - place of death outside the designated area from which bodies are obtained.
   b. The range of uses of donated bodies at that institution.
   c. Possible costs, if any, that might be incurred by the bequestee's family in making a bequest, and the costs to be met by the institution accepting the bequest.
   d. Whether the donor's anonymity will be preserved and whether their medical history accessed.
e. Whether the body or body parts might be supplied to another institution.
f. The maximum length of time the body will be retained, including any legally sanctioned possibility of indefinite retention of body parts. The relatives of the donor should be given the option of being informed in due course of the date when the remains will be disposed of.
g. Anatomists should be strongly encouraged to discuss their intentions with their relatives to ensure that their relatives are familiar with their wishes and that as far as possible those wishes will be carried out after death.

10. Special lectures/tutorials in ethics relating to the bequest of human remains should be made available to all students studying anatomy. This is to encourage the development of appropriate sensitivities in relation to the conduct and respect that is expected of those handling human remains used for purposes of anatomical education and research.

11. Institutions should be encouraged to hold Services of Thanksgiving or Commemoration for those who have donated their bodies for medical education and research, to which can be invited relatives of the deceased, along with staff and students.

COMMENTS ON THE RECOMMENDATIONS

These Recommendations stand as an illustration of good practice; one could say ideal practice. They were drawn up against a background of practice already in existence in a number of countries in the West, and reflect what might be considered underlying ethical values that should, and frequently do, motivate body donation. Their underlying premise is that all bodies are donated, on the ground that the alternative, use of unclaimed bodies, represents an ethically dubious practice that has on a number of occasions in the past placed anatomists in untenable predicaments (Jones and Whitaker, 2012). This, however, raises a legitimate query: if the use of unclaimed bodies represents a dubious path ethically, where does this leave countries and societies where bequests are rare or non-existent (regardless of the reason)? How are anatomists to act in this situation? In an attempt to address issues of this nature, it is important initially to re-visit the fundamental ethical values that underlie these Recommendations.

Ethical Values

The one value of pivotal importance to these Recommendations and that suffuses most of the articles in this special issue of Clinical Anatomy is that of informed consent. Once anatomists take this as a bedrock value for the use of human remains, the bodies routinely used in teaching and research will be those donated specifically for these purposes. The use of unclaimed bodies will be viewed as ethically compromised.

It should be noted that this statement reflects an ethical rather than a legal position. In many jurisdictions the use of unclaimed bodies remains legal, but this does not abjure anatomists from arguing that a more appropriate ethical path is that of bequests. Anatomists should never rest easy in the knowledge that they are acting legally, regardless of the nature of the legal position. Ultimately, they are moral agents who have to take responsibility for the work they are doing and the resources they are using.

A second strand within the Recommendations is that the donation of bodies is to proceed within a non-commercial context. Human bodies and body parts are to be donated altruistically. For-profit companies are not to be involved, since human material is not to be sold (Champney, 2015). While charging for real costs raises no ethical strictures, the distinction between real costs, payment and profit is a vexed area. Expectations will vary enormously and negotiations between parties that are not based on trust and honesty may degenerate into little more than a morass of profiteering. This, in turn, is a recipe for public distrust of anatomists and the anatomical profession, and distaste for what they are suspected to be involved in. Without scrupulous oversight of all anatomical procedures, both administrative and academic, anatomists could find themselves depicted as outlaws of respectable society, as was the case in some instances in the early-mid nineteenth century (Richardson, 2001; MacDonald, 2010). That would do a great disservice to the cause of anatomy in both the dissecting room and the research laboratory, and would also denigrate the efforts of most anatomists who function according to impeccable ethical standards.

A third strand stemming from these values is that all involved in the donation contract are to be treated with respect. This has implications for the way in which the families of donors are brought into the negotiations from the earliest stages through to the death of the donor and the burial or cremation of the remains and possibly return of the ashes. The details will vary depending upon cultural requirements and legal stipulations. What matters is that there is transparency so that families know what is happening. This will include providing criteria for rejecting bodies, what bodies will be used for, and the length of time body parts will be retained. There may also be demanding situations where immediate family members disagree on the donation or on return of the ashes. Care is required that the anatomy department and its representatives are seen to be acting in accordance with the Human Tissue Act under which they are operating, but also with due care for the feelings and grief of close relatives even when the problem stems from family disharmony.

These concerns for the family of the loved one have led to the institution of thanksgiving services and commemorations. While these take a myriad forms reflecting vast divergences in culture, religious stance and worldview, they share common ground in their desire to acknowledge the inestimable gift of the donations. In doing this students and staff who have benefitted
show their respect for this gift, and join with those responsible for providing it—the families and friends of the donors as they reflect on the donors themselves. The wider community is also involved, from the institution that assists financially in making the donation process possible, to the surrounding society in providing a suitable legal context for the donation of bodies for teaching and research. It is appropriate, therefore, that students are instructed in the ethical reasoning behind donations, and the ways in which they are to behave when dissecting and dealing with any human material. There should be no question about students (and staff) behaving inappropriately in the dissecting room if they have been inducted into seeing dissection as an ethical activity in which all are responsible participants (Kahn and Gardin, 2015).

**Points Requiring Further Deliberation**

Body bequests have generally been thought of in terms of providing bodies for use in the region where they were donated. While the “region” may vary considerably, it has usually been within the country in question or within the state. It is often assumed that those donating their bodies wish to assist those with whom they have dealings. While this may apply most obviously to the training of students, even research uses appear to be on the part of researchers working locally. It may be objected that restrictions along these lines are over interpreting donors’ motives, and are reading more into them than can be justified. However, until this is shown to be the case, care needs to be taken to ensure that bodies are not distributed more widely than provided for by the consent of the donor and the expectations of family members. Care is also required to check that legal stipulations are not breached, particularly where bodies are transported across national borders.

The latter raises interesting ethical questions for anatomists and anatomy schools where bodies from other countries are being used in the dissecting room. What is the provenance of these bodies? How much is known about them, whether clinical history, consent provided for the donation, and the donors’ expectations as to what will be done and with the bodies? These are not merely theoretical questions, but are seminal to involving the students in ethical discussions as developing health practitioners.

Donor anonymity has been central to dissecting room practice for many generations in many countries. The Recommendations continue to advocate this practice, and yet no rationale is provided. It is not accepted in some religious cultures where the family is integral to the dissecting process, in that they hand over their deceased family member whose relationship to the family is known and celebrated (Winkelmann and Guldner, 2004; Lin et al., 2009; Subasinghe and Jones, 2015). This has led to the concept of cadavers as teachers, a concept that is spreading to other cultures, where the notion of cadavers as first patients is gaining acceptance. In spite of these developments, there has been no substantial debate on the merits or otherwise of these concepts, nor on their ethical base. The breadth of informed consent would also have to be investigated to assess how it would function in this new environment within pluralist and secular societies.

A topic taken up in one of the articles in this collection is that of taking images of cadavers and body parts (Cornwall et al., 2015). While Cornwall has opened up what he views as a growing area of concern within the digital era, the Recommendations simply decree their inappropriateness in general. It is evident from Cornwall’s article that the opportunities for taking and spreading images have increased exponentially and in an uncontrolled manner over the last few years. This is a debate that has barely begun, and the in-depth discussion that needs to be held will have to be informed by serious ethical analysis of its features. Banning taking images will not, and should not, satisfy anatomists, unless supported by clear reasoning, and informed by the views of potential donors and their families. Ultimately, there is no way of separating the taking of images of bodies and body parts from knowing how the bodies were obtained in the first place. If the bodies were unclaimed, who is to object to taking and promulgating images since there is no one to contend for their remaining interests or those of their (unknown) families?

Even in well-regulated institutions there are frequently unclear aspects to the bequest process. How long can bodies or body parts be kept? Legislations vary, with some stipulating time limits and others being more openended. Regardless of the precise guidelines, issues arise with plastinated specimens and museum pieces, which may be intended to contribute to ongoing museum collections. Along with these issues there is the question of the disposal of such remains, especially plastinated ones. These raise questions around institutional procedures covering record keeping, conservation, and tracking of body parts and even tissue sections. Once again, there may be different ways of coping with these challenges, but the message of this special issue of Clinical Anatomy has been that their resolution has ethical dimensions.

**Outstanding Questions**

Discussions along the lines of this article as well as of most of those in this issue raise questions that have been little debated in the literature. While I have largely confined my attention to the IFAA Good Practice Recommendations in this article, a number of them lend themselves to ongoing analysis. These were touched upon in the preceding section. In addition to these, there are further issues that have featured to only a very limited extent in the anatomy/ethics literature. I shall do no more than outline these for future discussions.

First, should bodies bequeathed to Anatomy Departments be available for research as well as teaching? If they are to be available for research, should additional consent be required at the time the bequest is made? Assumptions are currently made that this is the case, and the public appears to have a very broad view of what constitutes “research” (Fennell and Jones, 1992), but clarity and transparency would be good practice.
How much should those interested in bequeathing their bodies be told about what will be done to their bodies in the Dissecting Room? In other words, should consent involve a detailed run down of the dissecting room processes? Is this unnecessary? Books and a film have specified what happens and there is no evidence that they have done any damage to the donation ethos (Hafferty, 1991; Carter, 1997; Montross, 2007; Trotman, 2011).

Should TV cameras be allowed into the Dissecting Room (with appropriate stipulations). If not, why not? This has been done (Trotman, 2011) and the resulting film was very favorably received. It is one means of breaking down the mystique of the Dissecting Room (and perhaps of Anatomy), and once again one needs to enquire whether there are convincing ethical reasons to keep it this way. This query is related to the question of the public display of plastinated and dissected bodies, about which there have been numerous responses (see Jones, 2015).

Should Anatomical museums continue to display specimens that were obtained many years ago without consent? This introduces the matter of the use of archival material (Jones et al., 2003). While there has been considerable debate on this matter, especially in relation to indigenous skeletal remains, it has not featured prominently in the anatomical literature.

In another article in this special issue, I have asked the question whether plastinates with all their various uses have improved the ethical standing of Anatomy, or have they done it ethical damage (Jones, 2015)? While the major spotlight has been placed on the public exhibitions of whole body plastinates, it is of more general applicability across anatomy. This is because plastinated material has a far more permanent character than material prepared using more conventional fixation techniques.

**IFAA Recommendations and the Future**

Against this background of some of the features of the IFAA Recommendations two questions emerge:

- Should the IFAA be formulating a definitive position regarding human exhibitions such as Body Worlds?
- Should the IFAA be considering the possibility of establishing guidelines to assist countries currently dependent upon the use of unclaimed bodies arrive at appropriate legislation regarding the treatment of human remains?

As attempts are made to address these questions, policy makers will be confronted with the question of how much compromise to accept on practices that are thought to be ethically substandard or unacceptable? What degree of pragmatism is in order on the path to more acceptable policies? These are questions for ongoing discussions by the IFAA and anatomy departments worldwide.

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A Student Proposal for Ethical Guidelines in Anatomical Education: Ethical and Policy Considerations

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The recent publication of a story regarding anatomical dissection in a medical school has revealed the need for increased attention to the ethical and policy aspects of anatomical education. While most of the attention devoted to these questions thus far has been focused on procedures before and after dissection, from the perspective of medical students, there are important considerations during the process of dissection itself. This proposal was developed by two third-year medical students through a review of the relevant published literature, reflection upon their personal experiences in anatomy courses in two separate institutions, and informal discussion of these topics with peers. The proposal is that basic ethical guidelines should be established and monitored by an independent committee tasked with reviewing them. The proposed guidelines include: First, a clear set of expectations about what the student is expected to learn with respect to anatomical knowledge and dissection technique; second, the establishment by schools or national bodies of minimal ethical standards regarding respectful behavior toward the donor bodies, and the communication of these standards to teachers and students involved in educational dissections; third, the use of materials that encourage students to view their donors with respect and ensure proper treatment of them; and fourth, the establishment of an oversight group (at each medical school and at national level) comprising students, faculty, community members, and staff, who will regularly review the anatomical education program and update these ethical guidelines as appropriate. While many of these proposals are already implemented in some anatomy departments, the establishment of clear guidelines at a national as well as a school-by-school level will permit students the freedom to participate fully in their education, knowing they have met the highest ethical standards as they prepare for a career as a humanistic physician. Clin. Anat. 29:60–64, 2016.

Key words: anatomical education; ethics of anatomy; donation; reflection on medicine; student perspective

INTRODUCTION

"Your death, I was told, provided a gift to others. Yet I hope your death will do even more. I hope it will awaken others to the need to cherish the dead. The dead are more than objects, cadavers or patients. You, my dear Joseph, are not..."
involved in anatomical education.

—"Dear Joseph" by Michael Terry (Terry, 2014a)

Why was it left to the student author to try to remind his fellow students of their duty toward the dead? Why was this course allowed to traumatize the student author to such a degree that the labs reminded him of the Nazi gas chambers—the ultimate symbol of death and destruction? Why was this medical student left alone in all of this?

—Sabine Hildebrandt (Hildebrandt, 2014)

In early 2014, an anonymous story appeared on the Pulse Magazine website. It had been written by a third year medical student, Michael Terry (Terry, 2014a). This story stimulated much discussion, as did its subsequent posting on another popular medical blog, where commentators addressed many of the same issues covered in the Pulse comments (Terry, 2014b). The theme of these two sets of comments was mostly supportive, expressing surprise at what had happened and generally revealing interest in developing proposals and programs to prevent future recurrences of such events. The present article is a direct result of this story and the call for proposals, an attempt by two medical students to suggest elements of a program that would not only prevent similar instances from occurring in the future, but also serve to ensure that student education does not suffer in the process.

Four core guidelines are proposed to serve as the basis upon which future work can be developed and expanded. These four principles are by no means meant to be exhaustive, but to guide discussion and further development of similar ethical guidelines from an interdisciplinary process including all those involved in anatomical education.

The guidelines we propose are:

1. A clear set of expectations regarding what the student is expected to learn with respect to anatomical knowledge and dissection technique.
2. The establishment by schools or national bodies of minimal ethical standards regarding respectful behavior toward the donor bodies and the communication of these standards to teachers and students involved in educational dissections.
3. The use of materials that encourage students to view their donors with respect and ensure proper treatment of the donor.
4. The establishment of an oversight group (at each medical school and at a national level) comprising students, faculty, community members, and staff, who will regularly review the anatomical education program and update these ethical guidelines as appropriate.

CURRENT STATUS OF ANATOMICAL EDUCATION IN THE US

In their surveys of anatomy courses, Drake et al. noted that the average number of anatomy course hours was 167 in 2002 but decreased to 147 in 2014, with a range of 55–252 in 2002 and 65–249 in 2014 (Drake et al., 2002, 2014). Interestingly, the 2014 figures show a decrease of 20 hours of time for the anatomy community, though the authors state this seems to have leveled off (Drake et al., 2014). While the wide variation might at first sight suggest little cause for concern from the student perspective, it actually represents a source of great concern. Students must gain a specific amount of knowledge from anatomy courses and there is limited time in which to do so (for some courses more than others), so the pressure to learn in this environment is often intense. This pressure by itself, or within the context of a first year medical student’s experience, would ordinarily be sufficient grounds for concern. However, when one considers that it is often coupled with an entirely new setting in which students are required to function, namely the dissection room, it is marvelous that stories such as that of Michael Terry are not more common. Indeed, this either represents the equally marvelous way in which all anatomy professors are able to cope with the decreased course hours and increased demands, or reflects the unwillingness or inability of students to share their concerns and stories. If the latter is the case, and proving a negative is always challenging, then the Terry story should be viewed as representative of others who are voiceless but find themselves in a similar position.

Indeed, these widely divergent attitudes and approaches to anatomy education can often create confusion for students as they begin their journey through the course. Through the establishment of ethical guidelines across all anatomy programs, students can gain an understanding of the expectations surrounding their anatomy course and be guided accordingly. Additionally, in the face of stories such as the one published by Michael Terry, potential donors and the public at large could begin to worry that anatomists are not sufficiently supervised, and as a result refrain from donating their bodies to anatomy programs. While this might seem insignificant at first sight, if cultural norms were to begin shifting away from donation owing to concerns about ethics within the anatomy laboratory (as the comments on the Terry story indicate), this would have adverse material effects on medical education in that fewer body donations would be available for dissection or other medical purposes.

Lest occasions such as these be written off as unfortunate and simply garner unwanted attention, the response to them, including that of the medical student story by Michael Terry, has been overwhelmingly negative (Nelkin and Andrews, 1998; de Bere and Petersen, 2006; Cheung, 2007). One such memorable instance was the book published by Norman Cantor outlining in unpleasant detail the way in which anatomists relate to donors (Cantor, 2010). In his
work, Cantor describes the process of anatomy as follows:

“Cracking open the chest cavity and extracting and minutely examining the viscera is just the beginning. In succeeding weeks a pelvic hemisection is performed, involving splitting the genital parts, sawing through the pelvis and pulling the legs apart from the trunk... As the legs are manipulated and pulled apart from the sacral vertebrae, a tearing noise is heard like that produced by the wrenching of a turkey leg from a holiday turkey” (Cantor, 2010).

From the student perspective, such attention, be it in the form of public media, scholarship, or opinion, not only increases concern about the anatomy course generally but also can make students believe they are about to engage in an activity strongly sanctioned by the public. As a result of these concerns, the authors propose four guidelines with which anatomy programs can begin to develop more ethical and psychologically safe anatomy programs for students. While implementing each of these items alone would go a long way toward improving the experience of students, implementing all four guidelines together would greatly improve the ethical standards of education programs and in so doing ameliorate educational and ethical concerns shared by many students in each of these areas.

**THE FOUR GUIDELINES, EXPANDED**

**Guideline 1—Expectations**

Although anecdotal, the concerns we have heard expressed by students include the desire to develop clear expectations surrounding their experience in the anatomy laboratory. Unlike most courses where the material to be learned is fully encompassed by textbooks, slides, lectures, and PowerPoint presentations, an anatomy course, while making use of media resources, requires much learning to be done by physically dissecting a human body.

The actual dissection is certainly of value for discovering and understanding of the relationships of anatomical structures and organs to each other; merely memorizing lists of structures and pictures of organs is insufficient and inefficient, and medical schools that have experimented with eliminating the dissection portion of anatomy instruction have frequently changed course and reinstated it (Rizzolo and Stewart, 2006). While on the one hand dissection is often a rewarding experience, it can also be frustrating for students who experience challenges in dissection or in understanding what they have dissected. Owing to anatomical variations among donors and the differences among certain anatomy textbooks, the process of dissection and the anatomy course can often confuse students who are seeking “the” correct answer, as taught in other parts of medical education.

One mechanism to ensure standardization among courses, and thereby that students are clear about the knowledge expected of them, is to employ standardized syllabi developed by national bodies. Such an updated syllabus, developed through the American Association of Anatomists (AAA) or other similar association, would be the definitive template for the minimal amount of information students need to cover in dissection courses. This would enable medical licensing bodies as well as textbook publishing companies to prepare materials applicable to all medical students, thus improving the quality and experience of anatomical education. While this guideline may seem restrictive, it is important to emphasize that such a syllabus would represent the minimal information students are expected to glean from the course and instructors would be free to add additional material as time permits and in accordance with their expertise. Indeed, there are longstanding efforts in this area to develop standard curricula, but none have found full acceptance within the anatomy community (Louw et al., 2009; Berman, 2014; Orsbon et al., 2014). This points out to the need for educators not only to continue this discussion, but also to ensure that they are clear regarding the individual expectations in the course attended by students in their institutions.

Aside from a standard syllabus, students surveyed at King’s College London School of Medicine
Guideline 2—Standards

National ethical guidelines for the appropriate and respectful treatment of cadavers used in anatomical education by students, instructors and institutions are a crucial part of the student experience in anatomy. Unlike professionals who are more firmly fixed in the world of anatomy, students often experience their first and last exposure to anatomy during their anatomy course. The nature of this exposure is likely to be shaped by the contemporaneous values in the field, so students have a strong vested interest in having clear and universal ethical guidelines to protect their educational and ethical experience in anatomy. Some suggested components for the guideline include:

- Respecting the identity of the donor by not creating nicknames for them and not attempting to alter them in any unnecessary way such as providing inappropriate clothing, drawing on their body, or referring derogatorily to their medical conditions or history.
- Respecting the body of the donor by not insulting them, not cutting or dissecting unless educationally necessary, keeping the donor draped at all times unless dissecting that area, and keeping the anatomy room atmosphere professional and respectful as far as possible. It goes without saying that this suggestion would preclude eating and drinking near the donor in such a manner that they could be contaminated by food and drink, and would preclude removing and/or preserving portions of the body for non-course use.
- Respecting the process of anatomical education and the gift of the donor by honoring the body donor’s courage through remembrance programs, moments of reflection, and sharing the process of dissection with the next of kin should it be agreed to do so and should they wish to have this information shared with them. Respect for the process of education also entails (as above) eliminating inappropriate comments or conversation.
- Respecting the wishes of the family and donor with regard to privacy by providing the donor with their real name should the donor/family wish it, or by employing a pseudonym should they elect this option. Similarly, no photographs should be taken unless necessary for educational purposes, and if any are taken for such purposes they should not be distributed beyond the classroom.

These rules or something akin to them should be distributed to family members, students, educators, and prospective donors to ensure uniform adoption and adherence. Since they might not be appropriate for all settings, additional guidelines can and should be developed to suit individual institutions or cultures. However, it is crucial that any revision of them take place within the context of Guideline 4, with its broad oversight, to ensure that all concerns and considerations have been taken into account.

Guideline 3—Respect

The suggestion regarding use of materials to encourage the formation of a humanistic connection between the donor and student is not new (Marks et al., 1997; Dyer and Thorndike, 2000; Rizzolo, 2002; Granger, 2004) and has already been implemented in many institutions in which anatomy is taught. However, from the perspective of students engaged in anatomy, it is underutilized. An ideal model curriculum would include lessons on humanism and appropriate approaches to the donor to ensure that the values of humanism and professionalism are inculcated in students from the very start of the course and remain a key theme throughout medical training.

Additionally, as noted at the turn of the century, medical education has become far less interested in fostering curiosity about others, their history, and their personal stories (Fitzgerald, 1999). While this urgent need to know in the form of curiosity and the inquiry it generates may be disappearing from other areas of medical education, one area from which curiosity and the attendant humanism it engenders should never disappear is the anatomy course, where each donor is different and each day brings with it new challenges, both ethical and educational. Indeed, it is precisely at the start of the medical school curriculum when students have the essential opportunity to hone this ethically bounded curiosity, so that when they encounter patients, it will already be second nature. Through creative educational programs and methods, this type of curiosity can and should be leveraged by anatomy programs to develop a more robust humanism in which the stories, backgrounds, and humanity of others is a natural part of what it means to be a medical student or physician.

Guideline 4—Oversight

The suggestion to establish a group to oversee activities that represent areas in which extreme caution is warranted is not novel. Much as the world of medicine responded to the discovery of abuses within its walls by forming Institutional Review Board (IRB) panels, the authors propose that the world of anatomy similarly establish oversight panels. While instructor adherence to anatomical education standards is currently in the domain of academic departments in most
institutions, this wholly “in-house” approach appears to be inadequate as stories such as that of Terry continue to emerge. From the student perspective, oversight bodies such as the IRB are often tasked with paying particularly close attention to student protection, and the authors would anticipate that anatomy oversight bodies would do the same (Christakis, 1985; Prescott, 2002). While the authors strongly sympathize with the objection that IRBs dispense procedural ethics without attention to nuance or individual responsibility, it is their view that IRB-like panels are the best option in view of the lack of true and robust public oversight or any better alternative.

In developing this oversight body, all viewpoints and perspectives must be included. Such inclusion is important not only for the legitimacy of the body itself, but also to ensure that all ethical viewpoints and backgrounds are represented, such that the conclusions and policies recommended by this body can be trusted and viewed with confidence by those it supervises. To ensure this diversity, the regulatory body should comprise students, faculty, community members and anatomy or donation program staff, who will regularly review the anatomical education program and update these ethical guidelines as appropriate. This committee will also ensure that students and instructors alike have ready access to all such information regarding their donors as the donors wish to make available. A further goal of this committee should be to ensure that there is a safe and clear avenue for all concerns and questions related to the study of anatomy, particularly those of students. While in general students can approach their professors directly with concerns, particularly those of students. While in general students can approach their professors directly with concerns regarding their education, they might not always feel comfortable about approaching their instructors with ethical concerns or criticisms, as the anonymity of Michael Terry evidences.

CONCLUSION

From our perspective it is imperative that anatomists establish a set of guidelines to inform the conduct of medical anatomy education nationally and internationally. Given the near-impossibility of establishing a code of conduct that would be applicable in all circumstances in all locations, as students we propose the implementation of four guiding principles to be used as formative building blocks for any and all institutions that wish to establish a code of conduct for the anatomical community and thereby enhance the robust learning and practice of anatomy. These four principles pertain to key areas of the anatomy experience, with relevance to expectations, standards, respect, and oversight. Further, we advocate the implementation of these four guiding principles in all settings in which students function so that their anatomical experience can be educationally sound, ethically guided, and a source of personal growth. While these guidelines are undoubtedly an imperfect tool with which to improve the educational experience for students, they will we hope form an environment in which such discussion can take place openly, honestly, and with a genuine eye to ongoing improvement. At minimum, we hope they will help to prevent further traumatic experiences such as those of Michael Terry.

REFERENCES

Acknowledging Tissue Donation:
Human Cadaveric Specimens in Musculoskeletal Research

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Human cadaveric specimens are an important resource for research, particularly in biomechanical studies, but their use also raises ethical questions and cannot simply be taken for granted. It was asked how much information authors publishing musculoskeletal research actually give about such specimens and about how they were acquired. The aim was to formulate recommendations on how this reporting might be improved. Relevant articles published between 2009 and 2012 in four North American or European journals were scanned for information regarding the characteristics of the human specimens used, their institutional source and the ethical or legal context of their acquisition. While the majority of articles report biological characteristics of specimens (sex, age at death, preservation method), only 40% of articles refer to body donation, only 23% report the institution that provided specimens, and only 17% refer to some kind of formalized approval of their research. There were regional and journal-to-journal differences. No standard for reporting studies involving human specimens could be detected. It is suggested that such a standard be developed by researchers and editors. Information on the source of specimens and on the ethical or legal basis should be regularly reported to acknowledge this unique research resource and to preserve the good relationship between researchers and the communities, that provide the required specimens by body donation and upon which researchers depend.


Key words: anatomy; biomechanics; ethics of research; editorial guidelines

INTRODUCTION

Human cadaveric specimens are an important resource for medical research and teaching. In orthopedics and sports medicine, they are an invaluable basis for biomechanical research in particular. Nevertheless, this research resource is historically contentious. The ethical ambiguities of using either unclaimed bodies or bodies of executed prisoners without consent were reduced when body donation programs were introduced in the 1960s and 1970s (Garment et al., 2007). However, while the use of executed prisoners has been largely abandoned (Hildebrandt, 2008), unclaimed bodies are still used for research and teaching in many parts of the world (Gangata et al., 2010; Stimec et al., 2010). Moreover, the discussion surrounding the “Body Worlds” exhibitions (Jones and Whitaker, 2009), critical perspectives on the commercialization of human body
parts (Dickenson, 2009), and occasional scandals (Hunter, 2001; Schmitt et al., 2014) illustrate that the issue remains ethically fraught. Given these ethical uncertainties, the authors were surprised to find that many of today's scientific articles do not specify the source of cadaveric specimens used for research. This prompted the present empirical survey, which uses research on the musculoskeletal system as a case study. The intention of this systematic survey was to answer the following questions: How much information do authors provide on cadaveric specimens used for research and on the source of such specimens, and is there an—explicit or implicit—standard for reporting such research in the literature? To detect possible regional differences for such a standard, North American and European journals were included in the analysis.

MATERIAL AND METHODS

Four leading journals with a broad spectrum of research on the musculoskeletal system were included in the study, two of them from North America, two from Europe (see Table 1). Original articles from 2009 to 2012 (excluding supplementary issues) were included when they reported research involving gross anatomical specimens taken from recently deceased persons. This excluded research based on pre-existing osteological collections and on tissues taken from living patients (e.g., femoral heads).

All articles were scanned for relevant information following the list in Table 1. If the place of research was not clearly indicated, the home institution of the first author was assumed to be the place of research. Information on the “source of specimens” was understood as information on the institution or program that provided specimens. Reference to “donors or consent” was positively noted if any wording within the article (e.g., “donor,” “donation,” “anatomical gift”) suggested the consent of the deceased, even if use of the term “donor” alone does not necessarily guarantee a formalized written consent. Finally, reference to “formal approval” included any reference to ethical committees, institutional review boards, laws, or local guidelines, that is, to any kind of formalized approval of research on anatomical specimens.

As numbers generated by this survey are based on reported information that was sometimes ambiguous (see below), we refrained from statistical analysis, so that comparisons made must remain descriptive.

RESULTS

The main results are shown in Table 1. A total of 345 articles were analyzed. In most cases (78%) place of research and place of publication were within the same continent. There were no studies from Africa.

In general, information regarding specimen use was neither homogeneous nor always unequivocal. Information on the age of the specimens (i.e., age at time of death) was given as mean (with or without range) by 236 articles and as range only by 26 articles. The mean of all given means was 64.8 years (range, 27.6–92). In one exceptional case, a study included tissue “from five juvenile donors (each <1 year old)” (Adkisson et al., 2010). Specimens were used “fresh-frozen” (234 articles), embalmed (formalin, Thiel method, or unspecified; 36 articles), or “fresh” (25 articles). Few authors reported causes of

<table>
<thead>
<tr>
<th>Place of publication</th>
<th>USA</th>
<th>USA</th>
<th>UK</th>
<th>Germany</th>
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</thead>
<tbody>
<tr>
<td>Impact Factor 2012</td>
<td>4.4</td>
<td>3.2</td>
<td>2.7</td>
<td>1.4</td>
</tr>
<tr>
<td>No. of articles</td>
<td>156</td>
<td>65</td>
<td>40</td>
<td>84</td>
</tr>
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The lower half of the table differentiates results for the four investigated journals, not for place of research. Comparisons based on place of research rather than place of publication are reported in the text.
DISCUSSION

This survey looked for amount and quality of information authors give on cadaveric specimens used for research on the musculoskeletal system. It turns out that information is patchy and that none of the investigated journals seems to have a reporting standard for such research, not to mention an international standard. In general, much more information is given on biological characteristics of specimens (sex, age, preservation technique) than on sources of specimens and ethical context.

As for the former, most but not all authors provide information on biological characteristics (Table 1). Given the fact that tissue biomechanics may be influenced by sex (Lipps et al., 2012) and age (Woo et al., 1991) of the donors and preservation methods (Ohman et al., 2008), their full disclosure in all articles would improve the comparability of published data. In certain cases, like research on osteological collections, age and sex may be unknown to the researchers, but in institutional donation programs, traceability of specimens to individual donors is a desirable standard (International Federation of Associations of Anatomists, 2012; Schmitt et al., 2014).

More importantly, the survey found that information on the source of specimens and the ethical context of their retrieval is not common. Only 40% of articles refer to body donation, only 23% report the institution that provided specimens, and only 17% refer to formalized approval of their study. It appears that most authors either deem ethical questions of limited interest as long as legal and institutional requirements are met, or they take the availability of specimens and the providing institutions for granted. While this may be plausible within any local context, where all involved probably know the relevant regulations, we would argue that this approach within an international context and directed at an international audience, is inadequate. This is because the context of body procurement is diverse (Gangata et al., 2010; Stimec et al., 2010) and readers cannot be expected to know the adequacy or otherwise of local regulations. This diversity is confirmed by our survey, with its wide spread of possible sources for human specimens with some of them varying by geographical area. The same is true for ethical considerations and/or formalized approval procedures, relating to an obvious international diversity of cultural and legal contexts.

In contrast to research on living subjects, which is regulated internationally by the Helsinki Declaration (World Medical Association, 2013), this Declaration does not explicitly include tissues from deceased persons. Recommendations for research on the deceased developed by the International Federation of Associations of Anatomists (IFAA) (2012) are not widely known and do not have the status of accepted international guidelines. And although medical journal editors have developed guidelines for reporting research on living subjects, it remains unclear whether their notions of “human data” (International Committee of Medical Journal Editors, 2010), or of “human tissues” (World Association of Medical Editors Publication Ethics Committee, 2011) are meant to include tissues from deceased persons. While, for example, the “45 CFR 46” code of regulations on research subjects of the US American Department of Health clearly defines a “human subject” as a “living individual” (Department of Health and Human Services, 2009), the Helsinki Declaration and the above quoted editorial guidelines do not. Therefore, an accepted international standard for the reporting of such research is lacking.
What are the biological characteristics of the specimens (sex, age at death, preservation method)?
Was there written consent of donors during their lifetime?
Which institution provided the specimens?
Which was the legal/ethical basis for the availability of specimens (e.g., local laws or guidelines, approval by review boards)?

We see three reasons why more details should actually be reported. First, as stated above, authors should account for readers from different cultural and legal contexts. The international diversity of such contexts and of how specimens can be acquired makes it difficult to take one approach for granted. For example, the existence of non-profit or for-profit tissue banks organizing donation programs and distributing human tissues to institutions for research and teaching purposes may need no explanation among North American authors, but are largely unknown outside the United States.

Secondly, the impression should be avoided that cadaveric specimens are “freely available” to those working within a medical context. Such an impression could endanger researchers’ “relationships of trust with their local communities” (Jones and Whitaker, 2012) on whom they depend for future research (Schmitt et al., 2014). It is also important to demonstrate good practice in all our research endeavors. In this instance, good practice is the use of donated body parts and acknowledgement that this has been followed.

Thirdly, cadaveric specimens are not just “material.” While not part of a living person anymore, neither are they fully detached from a person. Just as people are interested in what happens to the body of their loved ones after death, the post mortal fate of a body becomes part of the person’s biography. An ethics of research involving the dead could be based on seeing such research as an intersection of two biographies (Winkelmann and Schagen, 2009), establishing a relationship between the living and the dead. Even if very unfamiliar and always asymmetric, this relationship can nevertheless be conceptualized as a relationship between two people, in this case between the researcher and the researched. Most medical students participating in dissection courses acknowledge this relationship by organizing memorial services for “their” body donors (Pabst and Pabst, 2006; Jones et al., 2014). Researchers dealing with isolated specimens will not usually develop such a “personal” relationship. Nevertheless, it seems appropriate that medical and science students as well as senior scientists acknowledge the ambiguity of this research resource and thus also pay respect to the donors, whose decision enables them to do such research.

We suggest that all publications regarding research on cadaveric specimens report the information listed in Table 2 and that journal editors make the inclusion of this information obligatory. Young researchers should be educated during their studies to adequately acknowledge specimens from body donors. In the following, we give a fictitious example to demonstrate that the necessary information, reported in the Methods section, does not need much space or elaboration: “Sixteen unpaired fresh-frozen knees were obtained from the Anatomy Department of XY University, which runs a body donation program based on informed consent under the local autopsy law. Six knees were from male, ten from female donors, the age at death ranged from 69 to 93 years (mean, 76 years).” We also suggest that editorial guidelines for medical journals clearly define whether their instructions regarding research on human subjects include bodies, organs or tissues of deceased persons.

Our suggestion does not intend to increase obstacles to important research, but to raise awareness for the ethical peculiarity of donated bodies and to preserve the good relationship between researchers and their communities, which provide the required specimens and upon which researchers depend.

In the same vein, we recommend two simple measures: to acknowledge the donors in the acknowledgment section—as has been recently suggested in this journal (Benninger, 2013) and since implemented in the instructions for authors—, and to replace the word “Material” in the conventional section title “Material and Methods” by either “Donors” or “Specimens”—as it is replaced by “Patients” in case of living research subjects.

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Consent and Consensus—Ethical Perspectives on Obtaining Bodies for Anatomical Dissection

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Biomedical research and education benefit from the use of human cadavers. These are usually acquired from donors who have willed their body to science during their lifetime. This concept of donation through “informed consent” respects the personal autonomy of the donor and the dignity of the dead body (extended from the dignity of the living person). The concept of informed consent is taken from research on living human subjects regulated in the Helsinki Declaration. This transfer to the domain of anatomical donation, however, has several problems. For example, the dead cannot speak for themselves and the ethical status of the human cadaver remains ambiguous. It is therefore suggested that an element of consensus is added to the concept of consent, a consensus between donors, relatives, anatomists, and the wider community. A consensus can give difficult decisions surrounding body donation and dissection a broader basis and can help bridge the gap between donors and families on the one side and anatomists, researchers and students on the other side. This approach can help to establish relationships of trust with local communities, on which body donation programs depend.

Key words: body donation; informed consent; consensus; human dignity; ethical theories; presumed consent

INTRODUCTION

In the biomedical context, the dead human body is an invaluable resource for research and teaching. In many if not most countries around the world, medical and dental students learn anatomy by dissecting a human body. Donated bodies are also increasingly used for postgraduate training, e.g., to practice surgical techniques, and are in widespread use for biomechanical and other research. Nevertheless, even if this medical use of the dead body can be called “common”, the availability of bodies for such uses cannot simply be taken as a given and the use for research and teaching still carries ethical and legal uncertainties. Therefore, the acquisition of bodies of deceased persons and their subsequent handling by authorized institutions requires careful ethical consideration. After explaining why such considerations are necessary, I shall discuss the ethics of anatomical use of dead bodies guided by ethical theory and by historical and cultural comparisons.

As is well known and extensively documented the history of performing dissections on dead bodies has been tortuous and the sources of bodies and the conditions of anatomical dissection have changed substantially more than once (Porter, 1997; Richardson, 2001). It is often assumed that the road to modern-day dissection in the “West” was constrained by religious objections, particularly during the middle ages (Elizondo-Omana et al., 2005), but it can also be argued that there is a more general “human” objection to dissection. This is particularly the case if the dissection is of the bodies of those close to the dissectors, be it by personal familiarity or by similarity of personal and social background. For example, in mid-15th century Bologna in Italy, one formal prerequisite for

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Received 15 August 2015; Revised 27 August 2015; Accepted 7 September 2015
Published online 4 November 2015 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/ca.22651
dissection was that the deceased came from a town at least 30 miles away (Park, 1994), i.e., was more likely to be a “stranger”. Over the centuries, the source of bodies developed from executions to “unclaimed” bodies to donated bodies. While body donation programs can be seen as the general rule today, albeit with exceptions (see below), they were not widely established before the 1960s and 1970s. To my knowledge, their history has only been written for a few countries so far (Garment et al., 2007; Jones and Fennell, 1991).

The ethical dilemmas of using “unclaimed bodies,” still the case in some anatomy departments, have been detailed elsewhere (Jones and Whitaker, 2012). But as mentioned above, even regulated body donation programs carry some ethical and even legal uncertainties. It is beyond the scope of this article to review the legal situation on an international scale, which is usually regulated by different local laws (cf. McHanwell et al., 2008). To give just one example: in Germany, anatomical dissection is regulated by regional burial laws that differ in some respects (as in the United States, cf. Champney, 2011), and there are even regions where body donation is practiced without any explicit law, but simply based “in analogy” on transplantation laws (Kleinke, 2007). One difference between these laws relates to the question whether or not relatives of the deceased should have a say in donation matters. Another question not always easy to answer is what kind of usages are actually legitimated by a confirmed body donation. Should the donor have detailed knowledge and/or leave detailed instructions as to what he or she deems appropriate? Would, for example, use for an art project be included? Would public dissection be included? As recent discussions about public dissections by Gunther von Hagens (Bruce-Chwatt, 2010) demonstrate, some argue that such use of a dead body would not be appropriate even if the donor has specifically agreed to it. The same applies to exhibiting cadavers in sexual poses, as has been the case in some plastination exhibitions. Finally, it should be mentioned that in contrast to research on living human subjects, research on human cadavers is not regulated internationally. The latest version of the Declaration of Helsinki (World Medical Association, 2013) does include “identifiable human material”, which however does not cover tissues or organs taken from a deceased person (cf. Winkelmann et al., 2015).

These questions demonstrate that body donation is far from straightforward and requires ethical analysis.

THEORETICAL APPROACHES

Academic discussion of ethical principles governing decisions in this field is vital for those who deal with body donation and use cadavers for research and teaching. Ethics cannot produce irrevocable truths, and the hypotheses offered here should be seen as illustrations and suggestions for ongoing debate. Some of these thoughts presented were first published in German as part of a habilitation thesis (Winkelmann, 2013). Questions regarding the ethics of anatomy belong to the domain of applied ethics, or more specifically to bioethics or medical ethics. Textbooks or compendiums of this field usually deal with research on living subjects or with ethical dilemmas related to the beginning or end of life, but rarely discuss the use of cadavers in anatomy (with the notable exception of Barilan, 2012).

Basically, ethical questions can be approached from two sides, deontological and consequential ethics. Deontological theories mainly trace back to the German philosopher Immanuel Kant (1724–1804) and relate to moral norms or obligations. Actions are not so much judged for their consequences, but for rules and principles, which motivate them. For Kant, such rules are based on reason, i.e., a universal a priori reason necessitates individuals to act rationally and thus morally.

As the name implies, consequential ethics, on the other hand, judge actions by their consequences, independent of good or bad motivations. The most prominent form of consequentialism is utilitarianism, which goes back to English philosophers Jeremy Bentham (1748–1832) and John Stuart Mill (1806–1873). According to utilitarianism, good actions are those that produce the maximum sum of well-being in all those involved. An obvious problem of this approach is that harm to individuals can be justified if only enough others benefit from an action.

As discussed in more detail below, there have been attempts in ethical theory to avoid recourse to Kant’s absolute reason as much as to the (utilitarian) individual pursuit of happiness by basing ethical principles on more “interactive” mechanisms. This includes discourse ethics (Habermas, 2009) and contractarianism, i.e., “morals by agreement” (Gauthier, 1986). Although all these ethical theories stem from a “Western” philosophical background. I shall attempt to keep the scope of the arguments as universal as possible.

THE MAIN ARGUMENT

Anatomists and other staff of anatomical institutes or body donation programs have to handle the dead body physically to serve intended research and teaching purposes. One might call their approach “pragmatic materialism”. If the human cadaver were “just material” in this context, as say a block of wood or a technical device, the situation would not need any ethical consideration. Most people, however, see a difference between the handling of a dead human body and a block of wood, on account of the dignity they ascribe to the dead body. In this way, human dignity extends from the living person to his or her mortal remains. It is a central tenet of the ethics of anatomical dissection, an ethical norm, and as such belongs to the realm of deontological ethics.

Kant specified dignity as follows: “In the kingdom of ends everything has either a price or a dignity.
What has a price can be replaced by something else as its equivalent; what on the other hand is above all price and therefore admits of no equivalent has a dignity” (Kant, 1998 [1785]). This can be applied to the human body, which is not replaceable and cannot (should not) be sold.

For those who find it difficult to accept the extension of the dignity of the human body to the human cadaver, it is good to remember that a person’s biography includes the fate of his or her mortal remains. For example, most people will know where deceased relatives are buried, and this burial place often has a special significance, not only in the lives of kings or queens. As another example, it is part of the “biography” of Hector, the hero of Greek mythology, that his adversary Achilles, after killing him, slits his heels, attaches the dead body to his chariot with a girdle and drags the lifeless body through the dust for twelve days. This is an example of a post mortal humiliation, and we have argued that the use of the bodies of Nazi victims by German anatomists could also be understood as an additional humiliation of the victims (Winkelmann and Schagen, 2009), even if, in contrast to Achilles, the anatomists at the time did not explicitly intend this humiliation but rather condemned it. On the other hand, the Catholic worship of relics demonstrates that remains can also be part of a post mortal veneration and thus of a valorization of a person’s biography.

The concept of human dignity as applied to the human cadaver thus establishes continuity between the living and the dead. It can be seen as an implementation of this perceived continuity and also as an increasing acknowledgment of personal autonomy (cf. Mackenzie, 2015) that body donation procedures were established and formalized in many parts of the world during the second half of the 20th century (Garment et al., 2007). It was thus established that living persons should be able to decide about the fate of their “own” cadaver after death. This historical development toward body donation can also be interpreted as a transfer of the concept of “informed consent” to anatomical dissection. Informed consent, i.e., the written consent of a potential research subject after information about involved risks, is the core ethical value of today’s medical research on living human subjects. It was globally established by the Helsinki Declaration of 1964, which goes back to the Nuremberg Code of 1947 (Carlson et al., 2004).

In the same vein, body donation implies that a living competent human subject consents in writing that his or her body may be used for anatomical purposes after death. Information in this case does not usually include “risks” for the donor, but rather an explanation of the purposes of the donation and of the eventual fate of the remains. From an ethical point of view, this concept of body donation based on “informed consent” was a major advance as it observes two important deontological norms: human dignity, and individual personal autonomy.

Nevertheless, there are three reasons why the concept of “informed consent” of the Helsinki Declaration is not as easily transferable to body donation. First, in their historical development, the above concepts of human dignity and personal autonomy mainly stem from a “Western” tradition. Without going into detailed comparisons, it must be assumed that cultures around the world have different concepts of the link between living people and dead bodies and also different approaches to strike a balance between personal autonomy and obligations to the community.

Secondly, in contrast to living research subjects, the dead cannot speak for themselves anymore. Even if they have clearly expressed their will during their lifetime, they need advocates who will see to the implementation of their will after their death—compatible to an executor of last wills or testaments.

Thirdly, despite specifications in last wills, the status of the dead body remains ambiguous and indeterminate—as Champney puts it “[t]he ethical status of cadavers (...) is difficult to define” (2011). Hafferty (1991) has fittingly called the cadaver in the dissecting room “ambiguous man”, because it bears aspects of an object and a subject, it (or he for that matter) is at the same time a material “remain”, accessible to physical manipulation, and a deceased person, a focus of bereavement, memory, and religious or other rituals. This ambiguity can cause anxiety as much as fascination and it is not easily resolved in either direction (cf. Robbins et al. 2008). To focus on the “object” qualities of the cadaver and to dismiss its “private” background would lead to a reification or even commodification of the body. As has been argued above, such a reductionist approach would ignore the dignity of the person and of his or her body. To focus, on the other hand, on the “subject” qualities and to dismiss the physical properties of a cadaver is difficult to maintain, at least in its extreme form, not the least because the human corpse has a tendency to remind its environment of its physicality when left to decay. This “immaterial” focus would certainly be at odds with modern biomedicine, where for example physical examination of patients, radiological diagnostics, or surgical treatment rely heavily on a physical approach to the human body. Thus, this irresolvable ambiguity of the body after death means that the post mortal status of the cadaver is not fixed, but subject to negotiations. For example, even if a donor agrees to the public display of “his” body after death, this wish might be contested either by his relatives, or by more general concerns of the wider community.

CONSENSUS AND CONSENSUS

I am suggesting, therefore, that the ethical principle of donor consent is broadened by adding an element of consensus, i.e. to include the perspective of the relatives and friends of the deceased and of anatomists and other “users”, but also of the wider community, into ethical considerations. Before taking this suggestion any further, I will first discuss the theoretical basis for this concept. The question theory has to answer is: Is a consensus of all those involved a good basis for ethical norms regarding anatomical dissection? I will discuss two theories in this context (see above): discourse ethics and contractarianism.
Discourse Ethics and Contractarianism

Habermas (2009) legitimates ethical decisions by a discourse among all those involved and thus contrasts Kantian morals, where individuals are guided by reason and the Categorical Imperative, with a more dialogical production of moral norms. He establishes rules for such a discourse in his elaborate “discourse theory”, the most important of which is that the discourse must be free of coercion. The resulting dialogue should not just seek input from others, but lead to an exchange of reasonable arguments. For Habermas, this discourse is not just a discussion that leads to an agreement, but a rational mechanism to establish the truthfulness of ethical norms. His theory avoids a Kantian “absolute” reason on the one hand, and individual self-interest on the other hand. It is more concerned with the process of producing norms than with individual persons’ motivations to act morally. Benhabib (1992) stresses that discourse ethics enjoins a “reversibility of perspectives”. Habermas’ concept can be criticized for being too idealistic. It requires an ideal communication situation that is difficult to achieve and individuals with an interest and a capacity for an ambitious rational dialogue, and it tends to ignore emotional aspects (Benhabib, 1992).

Another ethical theory involving agreements between people is (moral) contractarianism, based on the political theory of a social contract in the tradition of Hobbes and Locke. In Morals by Agreement David Gauthier, the main proponent of this theory, argues that people are guided by self-interest, but that prudence speaks against the maximization of this interest (Gauthier, 1986). As in political social contract theory, the motivation for such a prudential self-restriction is either fear of the malevolence of others or hopes for a benefit from cooperation. Gauthier requires a neutral starting point that has been reached by all involved without coercion, and sees the process leading to moral agreement as a kind of bargaining to achieve what he calls “minimax relative concessions”, which means that everybody tries to serve his or her own interest as much as possible without, however, compromising an agreement and to balance the amount of concessions everybody has to make. This theory comes closer to utilitarianism, but avoids the injustice of balancing harm to one person with luck for another by adding the element of bargaining a contract. Contractarianism requires that people “learn” in the process to cooperate rather than to focus on their self-interest—or otherwise, they will lose their motivation to keep the contract. It has been doubted, however, whether this can be achieved (Vallentyne, 1991).

Another serious critique of contractarianism warns that it offers no motivation to include powerless, vulnerable people into the contract (Attfield, 2012). I take from these theoretical considerations that to establish ethical principles by agreement or by discourse requires several cautions. It requires a willingness of those involved to enter into dialogue, which should be a dialogue among equals, and to take mutual perspectives. It also requires an environment free of coercion. At least the second theory aims to look at motivations behind, for example, donation or dissection. None of these theories explicitly deals with the question of how to handle the will of those who have died and who, after their death, cannot actively participate in any discourse or bargaining of a contract. This only demonstrates again the need for ethical considerations in this situation. In a way, the deceased can be compared to other vulnerable subjects, like minors or unconscious patients, who are a matter of ethical concern when involved in medical research (cf. World Medical Association, 2013).

Consensus as a Way Forward

I suggest that the addition of a consensus element to the principle of willed donation can help in two ways to alleviate some of these problems related to body donation. First, in the sense of a continuous discourse, a consensus can be understood as a process that includes the potential donor still alive as well as his or her will after death, making the loss of one of the contributors to the process less disrupting. It thus creates a network of people spanning the time before and after an individual’s death and may therefore help to protect these “vulnerable subjects” of research. And secondly, after the death of the donor; a consensus of all those involved can address the above-mentioned ambiguities in the consent of the donated cadaver and thus establish a broader ethical basis for body donation.

A consensus with mutual perspective-taking is particularly important in this field, as the perspectives of anatomists and “users” on the one hand and donors and their relatives on the other hand can be very divergent. This is illustrated by historical comparisons. During the Nazi period, for example, German anatomists benefited from the rising numbers of executions, bringing an increasing supply of cadavers to anatomy departments (Winkelmann and Schagen, 2009). Anatomists usually welcomed this supply as useful “material” for research and teaching and even made it a mark of quality of extracted tissues if they had still been warm for histological processing (Hildebrandt, 2013). This perspective on the bodies of the executed as mere material is at odds with a view on these executed persons as Nazi victims, usually tried for political reasons or for minor crimes. From the perspective of the victims and their relatives, anatomical dissection was usually not a useful research endeavor but a post mortem humiliation (see above). The same is true for earlier historical practices of dissection of executed prisoners, where dissection could even be an explicit tightening of the death sentence imposed by a court.

This gap of perspectives is additionally sustained by the fact that anatomical dissection as an academic approach to the human body is not primarily interested in biographies. Even if the body does show traces of an individual biography, anatomy as a discipline is interested in abstractions that are valid for all people and generate universal anatomical knowledge. In dissection for teaching, the cadaver usually exemplifies a more general “normal” human anatomy, while research on cadavers applies statistical methods to go from individual cases to general results. This is at
odds with the perspective of donors or relatives who will focus on an individual biography.

A consensus is necessary therefore to bridge these gaps, not only a consensus between an individual donor and an anatomical institution, as fixed in a donation agreement, but a broadly based consensus among persons and their communities. Following historical and cultural comparisons, I suggest that a congruence of the languages of those involved is a good indicator of the degree of consensus that has been reached. In the case of the dissection of execution victims, there is no common language for the description of the processes involved other than in terms of “punishment” (it remains difficult, however, to say whether Renaissance anatomists themselves perceived their dissection activity as part of a punishment). The advent of body donation programs constitutes progress in this sense, as the term “donation” can be used by both sides who are seen as “givers” and “receivers” of an “anatomical gift”. Thus, not only by a donation agreement but also by way of language, a closer link is established between the two groups.

A gift is nevertheless still an object, and this could be criticized from an ethical point of view for being too materialistic a perspective on the dead body. There is, however, a more recent tendency not just to call the process “donation,” but to call the actual body in the dissecting room “donor” instead of “body” or “cadaver”, thus acknowledging its (or his/her) subject qualities. In parts of Asia, students call the cadaver in the dissecting room “silent teacher” (Lin et al., 2009), “silent mentor” (Guo-Fang and Yueh-Han, 2014) or “great teacher” (Winkelmann and Güldner, 2004). US American students also find the donor as “teacher” a convincing concept (Bohl et al., 2011). In my view, this bridges the gap even better as the body/donor is given a social role well known from other contexts, that of a teacher. This is a position of high respect that defines a familiar relationship between donor and student.

DISCUSSION OF THE CONCEPT OF CONSENT AND CONSENSUS

I will now discuss the concept of “consent and consensus” and its theoretical implications as applied to pressing ethical questions of anatomical dissection: firstly, the legitimacy of certain uses of donated bodies, including public display, and their link to the motivation of donors and users, secondly the controversial use of unclaimed bodies, and thirdly some aspects of the IFAA recommendations (Jones, in press).

Legitimacy of Specific Uses of Donated Bodies

As mentioned above, even with an “ethically correct” bequest, it is not always clear, which uses of the donated body are appropriate. It seems generally accepted, at least as an ideal, that the use of donated bodies and tissues should not be for profit (Jones and Whitaker, 2009; Champney, 2011). This requirement arises directly from the Kantian perspective that the human body should have a dignity, but not a price. Many laws and guidelines pertaining to anatomical dissection therefore aim to exclude any commercialization of the human cadaver or its parts. Indeed, body donation programs cannot function without financial transactions, but neither should the donor be financially rewarded nor should body parts be “sold”. This means that processing fees must be distinguishable from purchase prices of body parts, even if this is not always a straightforward distinction (Dickenson, 2008; Hoeyer, 2009). The motivation of anatomists and others to use donated bodies should not be financial.

Uses for medical research and education are usually motivated by an advancement of medicine and science and the qualification of medical personnel. Even if researchers and teachers may not be entirely altruistic (for example, focused on their personal career), it is clear that their efforts should primarily benefit others. This brings a consensus of the wider community into play, as body donation can be regarded as a contribution to the community and, in particular, to its future medical care. For a community to support body donation in this way, it is probably important that the benefit is not too abstract, as in “medical progress” in general, but serves visible purposes and relates to the local community. For research on living subjects, the Helsinki Declaration stipulates—if only for vulnerable subjects—that the group involved in research should also “stand to benefit from the knowledge, practices or interventions that result from the research” (World Medical Association, 2013). An analogy can be seen in body donation: While body donors will not benefit from any ensuing medical advances themselves, they will often expect that members of their community—however this may be defined—are likely to benefit. If on the contrary, for example, only rich people benefit from research on poor people, the consensus about body donation in a given community may be endangered.

One of the most controversial issues is the use of donated bodies for public exhibitions of plastinated specimens. Is this use legitimate? Such exhibitions have been criticized for their orientation toward commerce, and if profit is their main purpose, they are ethically dubious. They have, however, also been criticized for serving egoistic purposes of the donors: Donors explicitly aim at being exhibited after death, and not at helping others “through education and research”; they therefore have egoistic rather than altruistic motives, which according to Jones and Whitaker (2012) disrupts the usual “link between donation and altruism”. However, this line of argument is difficult to maintain, not only because pure altruism is probably rare, but also because it is difficult to base an ethical judgment on individual motivations for body donation because such motivations cannot be known for sure. It is probably more realistic to assume a bargaining of different self-interests with the additional aim of benefitting from cooperation—the contractarian concept (see above). In the case of exhibitions of plastinated bodies, if the perspectives of donors and plastinators coalesce in their very materialistic view.
on the body, exemplified in some donors’ belief that by plastination they attain a kind of eternal post-mortem “existence”, this must be accepted in the first instance as a consensus legally covered by an informed consent. It can, however, be questioned by a wider community that argues against this materialistic perspective or against other aspects of such exhibitions (commercialization, sensationalism, questionable educational value, disregard of human dignity) and tries to reach a consensus, for example, to ban such exhibitions. In addition, it seems more important in the case of public displays, that the relatives of the deceased should have a say (Champney, 2011).

Use of Unclaimed Bodies

Secondly, I will look at the dissection of “unclaimed bodies”: this is the practice of allocating bodies to anatomy departments of those who die without known relatives or anybody else to “claim” the body for burial, but also sometimes of those who cannot afford burial, in which cases anatomy departments assume a right to dissect by bearing the costs of burial. The use of unclaimed bodies has been the rule for much of the nineteenth and twentieth centuries and is still legal and also practiced in parts of the world, particularly where body donation meets cultural and/or religious objections (Jones and Whittaker, 2012). The dissection of an unclaimed body does not necessarily have to be undignified. Nevertheless, it is not safe to assume that the person in question would have approved of dissection of his or her body, which means that, on an individual level, this practice must be seen as a violation of the personal autonomy of the deceased and his or her presumed last wishes. On a community level, use of unclaimed bodies often discriminates against the poor who cannot afford burial and/or do not have the means to care for or protect their dead (Jones and Whittaker, 2012). Even if there are no direct relatives, the mere awareness within a community that those who die without relatives may “end up on the anatomist’s table” can be disturbing and may endanger the trust a community has in its anatomists.

It may be argued based on utilitarian theories that dissection of an unclaimed body potentially benefits many people by advancing medical science while harming few people. This argument holds that the perceived benefit is so great that it justifies a more dubious practice in some cases and thus outweighs any harm done that way. This would be acceptable in Bentham’s ethical approach, which sees the “greatest happiness” of the greatest number of people as the overarching aim of moral decisions (Attfield, 2012). However, as argued above, it seems difficult to accept that some people should be harmed for the benefit of others, producing an obvious injustice. On the contrary, aiming at a consensus about what might be acceptable, for example in a society that has doubts about body donation, can be a way to address these problems, but only if groups of potential donors are involved in the process.

From an ethical point of view, the use of unclaimed bodies should be avoided in the long run. It might, however, be ethnocentric for a “Westerner” to ask all communities around the world for an immediate stop to the use of unclaimed bodies and the introduction of body donation programs based on informed consent, given that the latter concepts have taken many years to develop in Western culture. I would therefore like to express an option, even if controversial, which is taken from transplantation laws in some countries and which, from an ethical point of view, is between body donation and the use of unclaimed bodies: the establishment of “opt-out” regulations as they are in place for organ transplantation, for example in Austria, Spain, or Chile (MacKay, 2015; Zúñiga-Fajuri, 2015). Applied to body donation, this would lead to an assumption—after informing the population—that people do not object to body donation as long as they do not explicitly express this objection in writing during their lifetime. If somebody dies without having expressed such an objection, the body could then be used for anatomical purposes. It is of course possible to grant relatives of the deceased a right to veto such a donation. This is certainly not ideal as it ignores many of the ethical principles laid out above, but at least it replaces “no consent” by “presumed consent” and may therefore be an interim arrangement on the way to entirely voluntary body donation. For organ transplantation, such regulations have been introduced because a consensus within a community exists (or is assumed) that organ transplantation is of paramount importance and therefore justifies this approach. It will be a matter of debate (and consensus) whether the benefits of anatomical body donation are rated on a comparable level in any given community.

Code of Ethics

Thirdly, because of their ethical ambiguities, anatomical dissection and body donation need clear regulations. The IFAA recommendations (International Federation of Associations of Anatomists, 2012) should be seen as the gold standard for these matters and should be adopted by national associations of anatomists. I will only comment on some aspects of these guidelines in the light of the above theoretical discussions. The first and central claim of the recommendations is to require a formalized informed consent from donors who are entirely free in their decision. This respects the personal autonomy of the deceased and the dignity of his/her mortal remains and acknowledges a continuity between the living person and the dead body. The requirement of an entirely free decision excludes minors and other “incompetent” individuals, and also explicitly prisoners on death row. This is in line with what has been said above about ways toward a consensus that must be free of coercion.

The recommendations do not obligatorily include the relatives or even the wider community in the required consent, but they do encourage that “the next of kin also sign the form”, that donors discuss their wishes with their relatives, and ask for “transparency between the institution and potential donors and their relatives” for the entire process. A donation by initiative of family members—without the
CONCLUSIONS

To summarize, the backbone of the ethics of anatomy is body donation based on informed consent of the donor during his or her lifetime, an approach that respects the personal autonomy of the donor and the dignity of the human body. This approach is well regulated by the IFAA recommendations (International Federation of Associations of Anatomists, 2012).

To this basis of informed consent, I suggest the addition of an element of consensus, which will not be easily formalized in recommendations or guidelines, but can raise awareness of the needs of all those involved in anatomical body procurement and dissection. Such a consensus should aim to include the donors, their relatives and friends, the anatomists, researchers and students who work with a donated body, and the wider community. It is assumed that the establishment of trust between the involved partners can promote body donation as a concept.

The process of finding a consensus should be an interaction of equals and should include the taking of mutual perspectives. As such, this process differs from the dissection of "strangers" as in the case of Renaissance Bologna (see introduction), in the use of "unclaimed" bodies, or in the use of body parts shipped to other continents. In this vein, body donation should be promoted as serving the local community, not just an abstract universal progress of medical knowledge and skill. If the partners in this process are able to find a common language for what they are doing, this indicates a successful degree of consensus.

Finally, as the discussion of the use of unclaimed bodies shows, informed consent is an ideal that may be difficult to reach in communities with cultural or religious concerns about body donation. There is no question that this ethical ideal should be upheld, and, if conceivable at all, communities should be convinced about the value of anatomical dissection and the virtue of body donation. As Sendemir puts it, "The challenge for anatomists is to establish relationships of trust with their local communities" (Sendemir, 2014). The alternative of transporting donated bodies over longer distances to supply communities with a shortage of donated bodies is not convincing (Sendemir, 2014), not least because it comes close to the trade of body parts, and is also against the previous suggestion that donors should primarily serve their own community (are donors actually aware that their knees or shoulders may be shipped to another continent?). There are, however, examples of how donation programs were established against religious concerns as in Thailand, where support of the Royal Family and the bestowal of the highly regarded status of "Great Teacher" to donors has helped overcome religious concerns related to the belief in rebirth, or in Taiwan, where the integration of interaction of students and donors’ families into the curriculum helped to promote body donation (Guo-Fang and Yueh-Han, 2014). Such examples may not always be transferable to other communities, but discussion of them may help in finding other solutions and in promoting the importance of consent and consensus in matters of body donation and anatomical dissection.

ACKNOWLEDGMENT

The author is grateful for helpful comments by Claudia Kiessling and by discussants at the meeting of the International Federation of Associations of Anatomists (IFAA) in Beijing 2014.

REFERENCES


INTRODUCTION

With thyroid cancer fast becoming one of the most common endocrine cancers, the frequency of thyroid surgery has increased (Pellegriti, 2013). One of the more common but debilitating concerns with thyroid surgery is recurrent laryngeal nerve (RLN) paralysis, which can lead to glottal obstruction and airway compromise. Prevalence of temporary and permanent RLN injury post-thyroid surgery has been said to be between 0 and 11% (Dralle et al., 2008).

Anatomy of the Recurrent Laryngeal Nerve

First described by Galeno of Pergamo (Galen, 1962), the RLN is a branch of the vagus nerve, which carries motor, sensory, and parasympathetic fibers to the larynx. The thyroid gland is located in the lower neck, usually extending from C5 to T1 and has several important neurovascular structures running adjacent to it, of which the RLN is most frequently endangered during thyroid surgery due to its anatomical variations. Injury to the RLN can cause voice changes in

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Conflicts of interest: None declared

Received 27 July 2015; Revised 6 August 2015; Accepted 14 August 2015
Published online 5 October 2015 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/ca.22613

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mild cases, and glottal obstruction, leading to airway compromise in severe, bilateral RLN injury. Hence, it is important to recognize the anatomical variants of the nerve to preserve the nerve and its function.

The RLN runs a different course on each side: on the right, it originates at the level of the first part of the subclavian artery, loops below the subclavian artery, and ascends toward the transoesophageal groove before entering the larynx (Simon, 1943). On the left, however, the RLN originates from the vagus nerve at the aortic arch. It passes below the ligamentum arteriosum, hooks around the aortic arch and returns into the neck within the transoesophageal groove. It then enters the larynx posterior to the inferior constrictor, providing sensory and motor innervation to the intrinsic muscles of the larynx, except the cricothyroid muscles (Simon, 1943).

Conversely, the nonrecurrent laryngeal nerve (NRLN) is a rare anatomical variant of the RLN. First reported in 1823 by Steadman, it is most often found only on the right side. Similar to the RLN, the NRLN carries motor, sensory, and parasympathetic innervation to the larynx. Instead of originating from the aortic arch, however, the NRLN passes from the vagus nerve in the neck and enters the larynx directly, hence named “nonrecurrent” (Cannon, 1999).

In thyroid surgery, the most commonly used landmark to identify the RLN is the inferior thyroid artery (ITA), which is a terminal branch of the subclavian artery. The ITA comes off the thyrocervical trunk, which is the first branch of the subclavian artery. From there, the ITA travels upward in close relation to the RLN and provides blood supply to the thyroid gland. There are three variations of the RLN in relation to the ITA that are commonly used (Fowler and Hanson, 1929; Berlin and Lahey, 1929; Ziegelman, 1933; Berlin, 1935; Reed, 1943; Bachhuber, 1943; Simon, 1943; Armstrong and Hinton, 1951; Morrison, 1952; Bowden, 1955; Wade, 1955; Clader et al., 1957; Hunt, 1968; Kratz, 1973; Skandalakis et al., 1976; Papadatos, 1978; Chang-Chien, 1980; Steinberg et al., 1986; Al-Salihi and Dabbagh, 1898; Lekacos et al., 1992; Salama and McGarath, 1999; Campos and Henriques, 2000; Poyraz and Calguner, 2001; Sun, 2001; Monfared, 2002; Page et al., 2003; Ardito et al., 2004; Uen et al., 2006; Makay et al., 2008; Lee et al., 2009; Tang et al., 2012) and will be used in this study:

a. RLN anterior to ITA (Figure 1)
b. RLN between branches of ITA (Figure 2)
c. RLN posterior to ITA (Figure 3)

While there have been many studies regarding the anatomy of the RLN, most did not compare the
different anatomical variants of the RLN. The aim of this study is to systematically review the available literature on the relationship between the RLN and the ITA, summarizing the incidence of each variation and to make surgeons aware of the anatomical features of each variation, which may be useful in the identification of the RLN in thyroid surgery.

**METHODS**

MEDLINE, Web of Science, MEDITEXT, AMED, CINAHL, Cochrane, ProQuest, Pubmed, and ScienceDirect were searched using the search terms “inferior thyroid artery,” “recurrent laryngeal nerve,” and “anatomical variation.” No publication year restrictions were imposed. The reference sections of the articles found were searched for additional reports.

The following summarizes the selection criteria used:

1. The study must be a report of recurrent laryngeal nerve abnormalities, relative to the ITA, using a nominal scale similar to that described in this study, that is, anterior, posterior, or mixed
2. The study must have been written in English
3. No race, age, sex, journal, or publication year limitations were imposed

No efforts were made to search unpublished materials. Only case reports with ≥30 sides were included in this review.

Data extraction was performed by the authors with no masking. Due to the variation in the reporting process of each study, it was difficult to obtain certain characteristics about the race, age, sex, and laterality of the cadavers.

As a second task, a search was undertaken to identify the prevalence of a nonrecurrent laryngeal nerve variation. The searches included the databases mentioned above and were searched using the terms “nonrecurrent laryngeal nerve” and “anatomical variation.” The references of all articles were searched to find articles missed in the database search. To be included, the study must have reported the presence of the variant.

Statistics are presented as proportions and fisher exact confidence intervals (CIs) using OpenEpi Version 3.0.1.

**RESULTS**

The search retrieved 1,130 titles. After narrowing the search, 23 studies or datasets met the selection criteria. While reviewing the studies, a further 9 studies were found in the reference sections that met the selection criteria. A total of 32 studies were included.
in the final analysis, as shown in Table 1, comprising of 8,655 RLNs.

In most of the studies, neither gender nor ethnicities of the specimens were specified. Due to the lack of adequate records, comparison between the anatomical variations between genders and race was not feasible.

After the final pooling of data from all 32 articles, a total of 8,655 RLN sides were included in this study. Of those, 1,813 (20.95%; 95% CI 20.09, 21.82) showed a Type A configuration of RLN in relation to the ITA, 2,432 (28.10%) showed a Type B configuration and 4,410 (50.95%) showed a Type C configuration between the RLN and the ITA.

The second search on the prevalence of nonrecurrent laryngeal nerve returned 502 articles. After review the articles and eliminating irrelevant articles, only 21 remained. From the remaining studies, a total of 38,568 recurrent laryngeal sides were included in this study, as reflected in Table 2. Only 221 (0.57%; 95%CI 0.5, 0.65) NRLN were found.

### DISCUSSION

This systematic review and meta-analysis reviews the anatomical variation of the RLN in relation to the ITA from 32 studies of 8,655 sides. While most of the data collected in this study was based on cadaveric studies, assuming that cadavers are valid representations of the normal population, this study has shown that in 50.95% of cases, the RLN lies posterior to the ITA. This is consistent with the findings of many studies (Simon, 1943; Bowden, 1955; Wade, 1955; Steinberg et al., 1986; Al-Salihi and Dabbagh, 1989; Salama and McGrath, 1992; Sturniolo et al., 1999; Poyraz and Calguner, 2001; Hisham and Lukman, 2002; Ardito, 2003; Page et al., 2003; Uen et al., 2006; Lee et al., 2009; Tang et al., 2012; Carter et al., 2012), which have reported that the posterior configuration of nerve to artery is most commonly seen. This study also looked

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**TABLE 1. Characteristics of Articles Included in Review, Showing 8,655 RLN Sides Included in this Study**

<table>
<thead>
<tr>
<th>Author name</th>
<th>Year</th>
<th>N (sides)</th>
<th>Type A (anterior)</th>
<th>Type B (between)</th>
<th>Type C (posterior)</th>
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<tbody>
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<td>400</td>
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<td>34</td>
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<td>1943</td>
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</tbody>
</table>

One thousand eight hundred and thirteen (20.95%) showed a Type A configuration of RLN in relation to the ITA, 2,432 (28.10%) showed a Type B configuration and 4,410 (50.95%) showed a Type C configuration between the RLN and the ITA.
at the incidence of NRLN, and we found that it is present only in 0.57% of cases.

First advocated by Lahey in 1944, the exposure of the RLN has been a long-standing practice to prevent nerve damage and injury. Vocal cord palsy/paralysis is one of the major risk factors for thyroid surgery and can greatly diminish the quality of life of patients.

Though rare, the outcome is often poor, as reported in Hayward (2013), recurrent laryngeal nerve palsies occur in 0.3–8% of cases, as a complication of thyroid surgery. Hence, identification of the RLN is a vital step in preventing RLN injury and despite controversy, visualization of the RLN is still usually the proposed first step in thyroidectomy (Sun et al., 2002). Due to its importance in the outcome of thyroid surgery, the configuration of the RLN and the ITA has been studied extensively (Simon, 1943; Bowden, 1955; Wade, 1955; Steinberg et al., 1986; Al-Salihi and Dabbagh, 1989; Salama and McGrath, 1992; Sturniolo et al., 1999; Poyraz and Calguner, 2001; Hisham and Lukman, 2002; Ardito, 2003; Page et al., 2003; Uen et al., 2006; Tang et al., 2012; Carter et al., 2012). Some (Lee et al., 2009; Iacobone et al., 2008) have reported multiple variations—Yalcxin in 2006 reported 20 different variants and Makay in 2008 reported 16 varying configurations, but majority of the studies, as shown in Table 1, have classified the variants into three groups—the RLN anterior, between or posterior to the ITA.

Injury to the RLN is most frequent when a branch of the ITA is ligated, which often results in the nerve being clipped or resected with the arterial branch (Sturniolo et al., 1999). Although recent monitoring advances have allowed intraoperative neuromonitoring to reduce the incidence of RLN injury (Dralle et al., 2008; Randolph et al., 2011), visual identification of the RLN remains the gold standard for RLN injury prevention (Avisse et al., 1998; Page et al., 2008). Therefore, it is vital to determine the anatomical position of the RLN in surgery.

In terms of laterality of the variant, studies have reported varying arrangements (Berlin and Lahey,

### TABLE 2. Frequency of NRLN

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Sample size</th>
<th>Frequency of NRLN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wijetilaka</td>
<td>1978</td>
<td>203</td>
<td>2</td>
</tr>
<tr>
<td>Sanders</td>
<td>1983</td>
<td>1000</td>
<td>7</td>
</tr>
<tr>
<td>Friedman</td>
<td>1986</td>
<td>270</td>
<td>3</td>
</tr>
<tr>
<td>Henry</td>
<td>1988</td>
<td>6307</td>
<td>33</td>
</tr>
<tr>
<td>Proye</td>
<td>1990</td>
<td>6961</td>
<td>56</td>
</tr>
<tr>
<td>LeKacos</td>
<td>1992</td>
<td>109</td>
<td>1</td>
</tr>
<tr>
<td>Mra</td>
<td>1999</td>
<td>513</td>
<td>2</td>
</tr>
<tr>
<td>Rafaelii</td>
<td>2000</td>
<td>656</td>
<td>3</td>
</tr>
<tr>
<td>Stewart</td>
<td>2000</td>
<td>1776</td>
<td>6</td>
</tr>
<tr>
<td>Watanabe</td>
<td>2001</td>
<td>594</td>
<td>6</td>
</tr>
<tr>
<td>Hisham</td>
<td>2002</td>
<td>491</td>
<td>1</td>
</tr>
<tr>
<td>Hermans</td>
<td>2003</td>
<td>484</td>
<td>1</td>
</tr>
<tr>
<td>Toniato</td>
<td>2004</td>
<td>6000</td>
<td>31</td>
</tr>
<tr>
<td>Ardito</td>
<td>2004</td>
<td>1342</td>
<td>5</td>
</tr>
<tr>
<td>Page</td>
<td>2007</td>
<td>887</td>
<td>3</td>
</tr>
<tr>
<td>Iacobone</td>
<td>2008</td>
<td>741</td>
<td>9</td>
</tr>
<tr>
<td>Wang</td>
<td>2010</td>
<td>290</td>
<td>9</td>
</tr>
<tr>
<td>Lee</td>
<td>2011</td>
<td>6546</td>
<td>20</td>
</tr>
<tr>
<td>Dolezel</td>
<td>2014</td>
<td>725</td>
<td>4</td>
</tr>
<tr>
<td>Hong</td>
<td>2014</td>
<td>2187</td>
<td>15</td>
</tr>
<tr>
<td>Watanabe</td>
<td>2014</td>
<td>486</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>38568</td>
<td>221</td>
</tr>
</tbody>
</table>

This table shows that there were only 221 NRLN Found, in a sample size of 38,568 RLN sides.

at the incidence of NRLN, and we found that it is present only in 0.57% of cases.

First advocated by Lahey in 1944, the exposure of the RLN has been a long-standing practice to prevent nerve damage and injury. Vocal cord palsy/paralysis is one of the major risk factors for thyroid surgery and can greatly diminish the quality of life of patients.

### TABLE 3. Laterality of Variant

<table>
<thead>
<tr>
<th>Author name</th>
<th>Year</th>
<th>Sides</th>
<th>R (RLN)</th>
<th>L (RLN)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Type A</td>
<td>Type B</td>
</tr>
<tr>
<td>Berlin and Lahey</td>
<td>1929</td>
<td>48</td>
<td>18</td>
<td>NA</td>
</tr>
<tr>
<td>Ziegelman</td>
<td>1933</td>
<td>42</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Berlin</td>
<td>1935</td>
<td>140</td>
<td>28</td>
<td>11</td>
</tr>
<tr>
<td>Reed</td>
<td>1943</td>
<td>503</td>
<td>65</td>
<td>117</td>
</tr>
<tr>
<td>Bachhuber</td>
<td>1943</td>
<td>200</td>
<td>18</td>
<td>49</td>
</tr>
<tr>
<td>Amstrong and Hinton</td>
<td>1951</td>
<td>100</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>Bowden</td>
<td>1955</td>
<td>55</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Wade</td>
<td>1955</td>
<td>185</td>
<td>16</td>
<td>40</td>
</tr>
<tr>
<td>Cramer</td>
<td>1957</td>
<td>96</td>
<td>9</td>
<td>23</td>
</tr>
<tr>
<td>Al-Salihi and Dabbagh</td>
<td>1989</td>
<td>212</td>
<td>36</td>
<td>39</td>
</tr>
<tr>
<td>Salama and McGrath</td>
<td>1992</td>
<td>144</td>
<td>14</td>
<td>29</td>
</tr>
<tr>
<td>Lekacos</td>
<td>1992</td>
<td>191</td>
<td>38</td>
<td>19</td>
</tr>
<tr>
<td>Sturniolo et al.</td>
<td>1999</td>
<td>280</td>
<td>44</td>
<td>41</td>
</tr>
<tr>
<td>Campos and Henriques</td>
<td>2000</td>
<td>142</td>
<td>27</td>
<td>35</td>
</tr>
<tr>
<td>Poyraz and Calguner</td>
<td>2001</td>
<td>48</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Monfared</td>
<td>2002</td>
<td>40</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Page</td>
<td>2003</td>
<td>481</td>
<td>137</td>
<td>48</td>
</tr>
<tr>
<td>Ardito</td>
<td>2004</td>
<td>1856</td>
<td>113</td>
<td>256</td>
</tr>
<tr>
<td>Uen</td>
<td>2006</td>
<td>120</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>Makay</td>
<td>2008</td>
<td>477</td>
<td>61</td>
<td>9</td>
</tr>
<tr>
<td>Lee</td>
<td>2009</td>
<td>110</td>
<td>22</td>
<td>14</td>
</tr>
<tr>
<td>Kaisha</td>
<td>2011</td>
<td>146</td>
<td>31</td>
<td>7</td>
</tr>
<tr>
<td>Sun</td>
<td>2011</td>
<td>100</td>
<td>25</td>
<td>14</td>
</tr>
<tr>
<td>Tang</td>
<td>2012</td>
<td>160</td>
<td>60</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>5876</td>
<td>822</td>
<td>826</td>
</tr>
</tbody>
</table>
In conclusion, the RLN is most commonly found in the Type C configuration but its configuration is more variable on the right. The NRLN is a rare but important variant and extensive care needs to be taken to avoid damage to the nerve in surgery.

REFERENCES


Reed AF. 1943. The relations of the inferior laryngeal nerve to the inferior thyroid artery. Anat Rec 85:17–23.


Comprehensive Review of the Anatomy and Physiology of Male Ejaculation: Premature Ejaculation Is Not a Disease

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Human semen contains spermatozoa secreted by the testes and a mixture of components produced by the bulbo-urethral and Littre (paraurethral) glands, prostate, seminal vesicles, ampulla, and epididymis. Ejaculation is used as a synonym for the external ejection of semen, but it comprises two phases: emission and expulsion. As semen collects in the prostatic urethra, the rapid preorgasmic distension of the urethral bulb is pathognomonic of impeding orgasm, and the man experiences a sensation that ejaculation is inevitable (in women, emission is the only phase of orgasm). The semen is propelled along the penile urethra mainly by the bulbocavernosus muscle. With Kegel exercises, it is possible to train the perineal muscles. Immediately after the expulsion phase the male enters a refractory period, a recovery time during which further orgasm or ejaculation is physiologically impossible. Age affects the recovery time: as a man grows older, the refractory period increases. Sexual medicine experts consider premature ejaculation only in the case of vaginal intercourse, but vaginal orgasm has no scientific basis, so the duration of intercourse is not important for a woman’s orgasm. The key to female orgasm are the female erectile organs; vaginal orgasm, G-spot, G-spot amplification, clitoral bulbs, clitoris-urethra-vaginal complex, internal clitoris and female ejaculation are terms without scientific basis. Female sexual dysfunctions are popular because they are based on something that does not exist, i.e. the vaginal orgasm. The physiology of ejaculation and orgasm is not impaired in premature ejaculation: it is not a disease, and non-coital sexual acts after male ejaculation can be used to produce orgasm in women. Teenagers and men can understand their sexual responses by masturbation and learn ejaculatory control with the stop–start method and the squeeze technique. Premature ejaculation must not be classified as a male sexual dysfunction. It has become the center of a multimillion dollar business: is premature ejaculation—and female sexual dysfunction—an illness constructed by sexual medicine experts under the influence of drug companies? Clin. Anat. 29:111–119, 2016.

Key words: semen; ejaculation; bulbocavernosus muscle; orgasm; sexual dysfunction; dapoxetine

INTRODUCTION

Orgasm, a subjective experience of pleasure, is a normal physiological function of humans. Male ejaculation usually occurs simultaneously with orgasm. Ejaculation is used as a synonym for the external ejection of...
Semen, but it comprises two phases: emission, i.e. the ejection into the prostatic urethra of spermatozoa mixed with fluids secreted by accessory sexual glands (by smooth muscle fiber contractions in the epididymis, ductus deferens, seminal vesicles, and prostate); and expulsion, i.e., the ejection of semen from the urethra at the glands (by involuntary contractions of the striated perineal muscles). For sexual medicine experts, ejaculatory disorders are the most common sexual dysfunctions in males (McMahon et al., 2013). The aim of this review is to clarify the anatomy and physiology of ejaculation and to assess whether premature ejaculation (PE), the most common male sexual disorder, is really a disease.

**SEmen**

Semen contains spermatozoa secreted by the testes (Fig. 1) and the seminal fluids, mainly produced by the seminal vesicles and prostate (Fig. 2), which provide the medium and vehicle for the spermatozoa (Chiarugi and Bucciante, 1975). Human semen is a mixture of components produced by several different glands. These components are incompletely mixed during ejaculation, so the initial ejaculate is not entirely homogeneous. The first portion of it consists of secretions from the Cowper (bulbo-urethral) and Littre (paraurethral) glands. The second portion derives from the prostate. There follow small contributions from the ampulla and epididymis and, finally, from the seminal vesicles, which contribute the remainder, and majority, of the ejaculate (Masters and Johnson, 1966; Owen and Katz, 2005; McDougal et al., 2012).

On average, there are 2–5 ml of semen per ejaculation, but the volume is progressively reduced with each ejaculatory episode, and if more ejaculations occur at short intervals the semen contains few spermatozoa. On the other hand, if a male has been continent for several days, a larger volume of semen is generally ejaculated than after only a few minutes of continence. A larger volume ejaculate is appreciated subjectively as more sensually pleasurable than a lower volume. The concentration of spermatozoa is highly variable and also depends on the frequency of ejaculation. A count of 20–120 million per milliliter is considered normal, so there are 40–600 million spermatozoa in a single ejaculate; spermatozoa production slows down after age 40, but it continues into the 80s and 90s. Seminal vesicle secretions constitute 65–75% of the total volume, prostate secretions 15–30%, and bulbo-urethral and Littre glands secretions 1–5% (Mann, 1954; Masters and Johnson, 1966; Masters et al., 1988; Owen and Katz, 2005; Puppo, 2011; McDougal et al., 2012).

The spermatozoa mature in the epididymis, which secretes potassium, sodium, and glycerylphosphorylcholine. The ampulla of the ductus deferens secretes a yellowish fluid containing fructose, a sugar that nourishes the spermatozoa. Seminal vesicle secretions produce a yellowish viscous fluid that contains amino acids, citrate, phosphorus, potassium, enzymes, fructose, phosphorylcholine, prostaglandins, proteins, and vitamin C. The prostate secretion is a thin whitish fluid that contains acid phosphatase, citric acid, fibrinolysin, prostate specific antigen, proteolytic enzymes, and zinc. The bulbo-urethral gland secretion is thick and clear and...
contains galactose, mucus, sialic acid, and plasminogen activator (Mann, 1954; Owen and Katz, 2005).

The semen is ejaculated in liquid form and is typically translucent with a white, grey, or yellowish tint. It has a creamy, sticky texture, its consistency resembling mucilage or thin jelly. The later part of the ejaculated semen coagulates immediately, forming globules. Right after ejaculation the semen is rather thick, but it liquefies quickly. Liquefaction occurs over a period of 5 min in vivo. After 15–30 min, the prostate-specific antigen and plasminogen activator produced in the prostate and present in the semen cause decoagulation of the seminal coagulum. The liquefaction process allows the spermatozoa to be released slowly from the coagulum so they can be transported into the cervix and eventually upstream to the ovulated eggs. Overall, the process of coagulation and liquefaction allows for appropriate exposure of the spermatozoa to seminal fluid factors that stimulate their motility and enhance their fertilizing capacity, and then permits their orderly entry into the upper female genital tract (Mann, 1954; Masters et al., 1988; Balk et al., 2003; Owen and Katz, 2005; McDougal et al., 2012).

The bulbo-urethral glands are two pea-sized structures connected to the urethra just below the prostate gland. They produce a few drops of fluid, which sometimes appear at the tip of the penis during sexual arousal but before ejaculation. It is mucoid in character, usually totals no more than two or three drops, and escapes involuntarily from urethral meatus. Some men never notice this pre-ejaculatory fluid, while others can produce a teaspoonful or more of this slippery secretion. In some studies, pre-ejaculatory fluid secreted by the bulbo-urethral glands during sexual stimulation lacks spermatozoa so it cannot cause pregnancy after coitus interruptus (Masters et al., 1988; Fetissof et al., 1989; Puppo, 2011).

**Fig. 3.** Emission phase (contractions of the epididymis, ductus deferens, seminal vesicles, and prostate; expansion of the urethral bulb) and expulsion phase (bladder neck closure, penile/urethra/urethral bulb/perineal muscle contractions; expulsion of semen) (from Puppo, 2011). 1, Testis; 2, Bladder; 3, Ductus deferens; 4, Ampulla and seminal vesicle; 5, Ejaculatory duct; 6, Prostate; 7, Prostatic urethra; 8, Anus; 9, External anal sphincter; 10, Urogenital diaphragm; 11, Bulbocavernosus muscle; 12, Bulb; 13, Penile urethra; 14, Corpus cavernosum; 15, Glans penis.

**Emission Phase of Ejaculation**

Emission is the first phase of the male ejaculation. It is a sympathetic spinal cord reflex (T10–L2): stimuli from the genitalia, essentially those reflecting the degree of activation of sensory receptors mainly located in the glans penis (Krause–Finger corpuscles), are integrated at the spinal level and stimulate peristaltic contraction of the accessory sexual glands. The emission phase is initiated by contractions of the vasa efferentia of the testes. At orgasm, spermatozoa starting from the epididymis up the ductus deferens are propelled by its strong muscular coats; their bulky vehicle is acquired from the seminal vesicles along with reinforcements or emergency rations of spermatozoa that may be stored there. The ductus deferens contracts near-synchronously with the seminal vesicles: the contents of the ampulla (outlet of the ductus deferens) are discharged into the prostatic urethra accompanied by simultaneous emission of seminal vesicle secretions through the ejaculatory ducts (Fig. 3) (Dickinson, 1949; Giuliano and Clement, 2005; Motofei and Rowland, 2005; Palmer and Stuckey, 2008; Puppo, 2011; Rowland et al., 2010).

Ejaculatory ducts open in the seminal colliculus (i.e., veru montanum), which is a prominence of the dorsal surface of the prostatic urethra. Among them is the male vagina (i.e., the prostatic utricle (Fig. 4); “male vagina” is a more accurate term than “prostatic utricle” because it is the homologue of the female vagina). The ejaculatory ducts sometimes open into the male vagina (Puppo, 2011, 2013).

During this phase the prostatic fluid is also discharged into the prostatic urethra by regularly recurring contractions, which can be palpated rectally. The efficiency of the accessory sexual glands can become...
impaired during aging. Men over 60 years of age did not demonstrate contractions of the prostate clinically during ejaculation, and the amount of semen was reduced (Masters and Johnson, 1966; Puppo, 2011).

As semen collects in the prostatic urethra, there is simultaneously a two- to three-fold involuntary expansion of the urethral bulb. The rapid preorgasmic distension of the urethral bulb is pathognomonic of impeding orgasm and the man experiences a sensation that ejaculation is inevitable, that is, the feeling of having reached the limit of control. This subjective experience has been described by many men as feeling the ejaculation coming. The sense of inevitability is accurate because at this point ejaculation cannot be stopped. From the onset of this sensation there is a brief interval (2–3 sec) during which the male feels the ejaculation coming and can no longer constrain, delay, or in any way control it. This subjective experience of inevitability develops as semen is collecting in the prostatic urethra but before the actual emission begins (Masters and Johnson, 1966; Masters et al., 1988; Puppo, 2011).

In older men, the emission phase can be foreshortened to the extent that all sensation of ejaculatory inevitability is obliterated or lengthened. In this situation, the male’s ejaculatory process is one of sudden second-phase expulsion of semen through the urethral meatus without distinct first-phase warning contractions of the accessory glands of reproduction. In other word, instead of a two-phase, well-differentiated ejaculatory process, the elderly male may have a single-phase expulsion of semen, the accessory glands of reproduction contracting simultaneously with the explosive penile contractions rather than preceding them by 2–3 sec (Masters and Johnson, 1966; Masters et al., 1988; Puppo, 2011).

In women, emission is the only phase of orgasm. Jannini et al. in 2012 stated: “The phenomenon of female ejaculation is called similar or lengthened. In this situation, the female ejaculation is sudden second-phase expulsion of semen through the urethral meatus without distinct first-phase warning contractions of the accessory glands of reproduction. In other word, instead of a two-phase, well-differentiated ejaculatory process, the elderly male may have a single-phase expulsion of semen, the accessory glands of reproduction contracting simultaneously with the explosive penile contractions rather than preceding them by 2–3 sec (Masters and Johnson, 1966; Masters et al., 1988; Puppo, 2011).

In women, emission is the only phase of orgasm. In the vaginal vestibule, the external orifice of the urethra is seen with the paraurethral (Skene’s) ducts opening on both sides. The intraurethral (Skene’s) glands are regarded as the female “prostate.” Secretions from these glands are expelled through the urethral meatus or through the orifices of the paraurethral ducts into the vaginal vestibule, which corresponds to the dorsal wall of the male penile urethra (while the labia minora correspond to its ventral wall); female “prostate” secretion during orgasm corresponds to the emission phase of male ejaculation. From a physiological point of view, the term “female emission” is more accurate than “female ejaculation” (however, in a few women there is a powerful emission): it corresponds to the emission of seminal fluid into the prostatic urethra in the male. The lack of an ejaculation phase in the female could explain why women have no refractory period and are able to experience multiple orgasms (Puppo, 2011, 2013; Puppo and Puppo, 2015b).

**EXPULSION PHASE OF EJACULATION**

Expulsion is the second phase of the male ejaculation. The organs participating in the expulsion phase comprise the bladder neck and urethra as well as the perineal muscles, creating the physical force that propels the semen and accounts for the spurt of it during ejaculation (Fig. 3) (Masters and Johnson, 1966; Puppo, 2011).

Normal antegrade ejaculation is initiated by bladder neck closure; the internal sphincter of the bladder remains sealed to prevent semen from flowing backward into the bladder and to ensure that it moves forward, precluding any mixing of urine and semen. The external urinary sphincter is relaxed, which allows the seminal fluid to flow into the distended bulb, whence it is propelled along the penile urethra and from the urethral meatus (Masters and Johnson, 1966; Giuliano and Clement, 2005; Puppo, 2011).

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In older men, the emission phase can be foreshortened to the extent that all sensation of ejaculatory inevitability is obliterated or lengthened. In this situation, the male’s ejaculatory process is one of sudden second-phase expulsion of semen through the urethral meatus without distinct first-phase warning contractions of the accessory glands of reproduction. In other word, instead of a two-phase, well-differentiated ejaculatory process, the elderly male may have a single-phase expulsion of semen, the accessory glands of reproduction contracting simultaneously with the explosive penile contractions rather than preceding them by 2–3 sec (Masters and Johnson, 1966; Masters et al., 1988; Puppo, 2011).

In women, emission is the only phase of orgasm. Jannini et al. in 2012 stated: “The phenomenon of female ejaculation is called similar or lengthened. In this situation, the female ejaculation is sudden second-phase expulsion of semen through the urethral meatus without distinct first-phase warning contractions of the accessory glands of reproduction. In other word, instead of a two-phase, well-differentiated ejaculatory process, the elderly male may have a single-phase expulsion of semen, the accessory glands of reproduction contracting simultaneously with the explosive penile contractions rather than preceding them by 2–3 sec (Masters and Johnson, 1966; Masters et al., 1988; Puppo, 2011).

In women, emission is the only phase of orgasm. In the vaginal vestibule, the external orifice of the urethra is seen with the paraurethral (Skene’s) ducts opening on both sides. The intraurethral (Skene’s) glands are regarded as the female “prostate.” Secretions from these glands are expelled through the urethral meatus or through the orifices of the paraurethral ducts into the vaginal vestibule, which corresponds to the dorsal wall of the male penile urethra (while the labia minora correspond to its ventral wall); female “prostate” secretion during orgasm corresponds to the emission phase of male ejaculation. From a physiological point of view, the term “female emission” is more accurate than “female ejaculation” (however, in a few women there is a powerful emission): it corresponds to the emission of seminal fluid into the prostatic urethra in the male. The lack of an ejaculation phase in the female could explain why women have no refractory period and are able to experience multiple orgasms (Puppo, 2011, 2013; Puppo and Puppo, 2015b).
sperm is propelled from the prostatic urethra along the penile urethra mainly by the BC muscle, which covers the urethral bulb. It is situated in the anterior region of the perineum, i.e. penile region (Figs. 5 and 6) (Masters and Johnson, 1966; Chiarugi and Buczak, 1975; Puppo, 2006, 2011).

At orgasm, the BC muscle contracts rhythmically. It is suggested that the muscle helps ejaculation by acting as a ‘pump.’ On contraction, the muscle might compress and evacuate the contents of the bulbous urethra to the exterior. On relaxation of the muscle, the intraurethral pressure drop probably ‘sucks’ the semen from the posterior into the bulbous urethra. The intrabulbar urethral fossa might act as a ‘receptacle’ in which the semen pools to be ejected by BC muscle contraction. The rhythmic BC muscle contraction, with its pumping action, might result in ejecting the semen in jets. The BC muscle functions also to evacuate the urine that remains in the urethra at the end of micturition. When the bladder empties its contents, the urine remaining in the urethra seems to be evacuated by repeated voluntary contraction of the BC muscle. The latter compresses the bulbous urethra and probably empties the urethra of urine in spurts: the BC muscle can be considered the muscle of ejaculation (Shafik, 1995).

The urethral bulb also contracts regularly as an aid to the propulsive mechanism. The first two or three ejaculatory contractions of the penile urethra project the semen content under such pressure that the initial portions of the ejaculate can be expelled 30–60 cm from the urethral meatus if the penis is unencumbered by vaginal containment. The expansive penile contractions start at intervals of 0.8 sec. After the first three or four major expulsive efforts the contractions are rapidly reduced in both frequency of recurrence and expulsive force. Minor contractions of the penile urethra continue for several seconds in an irregularly recurring manner, projecting a minimal amount of seminal fluid under little if any expulsive force. The terminal intercontractile intervals are extended to several seconds (Masters and Johnson, 1966; Masters et al., 1988).

Men cannot have multiple orgasms or a rapid series of ejaculations: immediately after ejaculation the male enters a refractory period, a recovery time during which further orgasm or ejaculation is physiologically impossible. There is great variability in the length of the refractory period both among males and within individuals; it can last anywhere from a few minutes to many hours. Many males below the age of 30, but relatively few thereafter, have the ability to ejaculate frequently and are subject to only very short

Fig. 5. Ischiocavernosus and bulbocavernosus muscle (from Puppo, 2006). 1, Corpus cavernosum; 2, Corpus spongiosum of the urethra; 3–4, Ischiocavernosus muscle; 5, Bulbocavernosus muscle.

Fig. 6. Urethral bulb covered by bulbocavernosus muscles (from Puppo, 2006). 1, Ischiocavernosus muscle; 2, Bulbocavernosus muscle; 3, Houston muscle; 4, Fibrous septum.
refractory periods. Younger men typically recover more quickly than older men. Age affects the recovery time: as a man grows older, the refractory period increases. It can last for extended periods particularly after the age of 60, when there is less physical need to ejaculate (Masters and Johnson, 1966; Masters et al., 1988; Puppo, 2011).

With Kegel exercises, it is possible to train the perineal muscles ("pelvic floor exercises" is an incorrect term). Strengthening these muscles can be important for improving the oxygenation and trophism of all of them, so the muscle tone needed for their function is maintained. Kegel exercises are important for preventing urinary incontinence, and they can reduce the lengthening of the refractory period and prevent the weakening of the expulsive force of semen that occur in all men over 50 years of age (Puppo, 2006, 2011).

Orgasm without ejaculation is common in boys before puberty and can occur if the prostate is diseased or when certain drugs are used. Anejaculation is the inability to ejaculate despite an erection (McDougal et al., 2012; Meng et al., 2013; McMahon et al., 2013). Males experience nocturnal ejaculation, the highest incidence and frequency of this occurring during the late teens. Nocturnal ejaculation provides a physiological safety-valve for accumulated sexual tension that has not been released in any other fashion (Masters et al., 1988). Ejaculation can sometimes occur without orgasm, for example in certain types of neurological illness (Masters et al., 1988). In retrograde ejaculation, the bladder neck does not close off properly during orgasm so semen spurts backward into the bladder. This occurs in some men with multiple sclerosis or diabetes or after certain types of prostate surgery (Rowland et al., 2010; McDougall et al., 2012).

### PREMATURE EJACULATION IS NOT A DISEASE/SEXUAL DYSFUNCTION

Premature ejaculation (PE) has been defined as a male sexual dysfunction characterized by ejaculation that always or nearly always occurs prior to or within 1 min of vaginal penetration and the inability to delay the event, with negative personal consequences (American Psychiatric Association, 2013; McMahon et al., 2013; Tiefer, 2014).

Hatzimouratidis et al. in 2015 stated: "Erectile dysfunction and premature ejaculation are the two main complaints in male sexual medicine." Byun et al. in 2013 stated: "In men PE is more common than delayed ejaculation. Timed intercourse imposes a substantial degree of stress on men. Physicians and clinicians should acknowledge the potentially harmful effects of timed intercourse on the physical and mental health of men. The impact of impending timed intercourse on sexual dysfunction and the behavior of male partners have only recently been investigated." Jannini et al. in 2015 stated: "the term 'premature ejaculation' would be introduced later in 1917 by a psychoanalyst. In the beginning, PE was considered as psychogenic in nature. PE is considered as a psycho-neuro-endocrine and urologic disorder affecting the couple." Yang et al. in 2013 stated: "In spite of the increasing interest in PE in the field of sexual medicine, our knowledge about the prevalence, etiology, diagnosis, and treatment of PE is scarce." Buvat in 2011 stated. "Although the characteristics of PE are established, the exact etiology is largely unknown. Most of the proposed biological and psychological etiologies of PE are supported by little evidence."

### IS PE REALLY A MALE SEXUAL DYSFUNCTION/DISEASE?

Sexual medicine experts consider PE only in the case of vaginal intercourse. PE is limited to heterosexual men engaging in vaginal intercourse, as few relevant studies have been conducted on homosexual men or during other forms of sexual activity (McMahon et al., 2013).

Lee et al. in 2013 stated: “The epidemiology of PE has not been firmly established, and the lack of robust epidemiological studies renders its true prevalence unknown. PE males felt that they did not satisfy their partners in terms of the partners’ sexual satisfaction and frequency of orgasm, in comparison with non-PE males.”

Until a few decades ago, PE did not entail discomfort for males during vaginal intercourse because orgasm was not essential for female sexual satisfaction. Until the mid-twentieth century, many people (including some medical authorities) believed that women were not capable of orgasm. This belief undoubtedly reflected a cultural bias: sex was seen as something the man did to the woman for his own gratification. Women were told for centuries to do their wifely duties by making themselves available to their husbands for sex (Masters and Johnson, 1966; Masters et al., 1988).

PE is considered the cause of the partner’s failure to achieve vaginal orgasm, with negative psychological consequences for the male, but vaginal orgasm does not exist. The key to female orgasm are the female erectile organs, i.e. the clitoris, vestibular bulbs and pars intermedia, labia minora, and corpus spongiosum of the female urethra. Vaginal orgasm, G-spot, G-spot amplification, clitoral bulbs, clitoral or clitoris-urethra-vaginal complex, internal clitoris and female ejaculation (O’Connell et al., 2005, 2008; Rubio-Casillas and Jannini, 2011; Jannini et al., 2012; Buisson and Jannini 2013; Jannini et al., 2013; Oakley et al., 2014; Vaccaro et al., 2014; Graziotin and Gambini, 2015; Herold et al., 2015; Levin, 2015; Pan et al., 2015; Pauls, 2015; Vaccaro, 2015) are terms without scientific basis and should not be used by urologists, gynecologists, sexologists, sexual medicine experts, women, or the mass media (Puppo, 2013; Puppo and Puppo, 2015b).

If a woman has an orgasm through clitoral stimulation but not during intercourse, it does not meet the criteria for a clinical diagnosis of female orgasmic disorder. If the orgasmic difficulties are the result of inadequate sexual stimulation, these cases should not be diagnosed as a disorder of female orgasm
Female sexual dysfunctions are popular because they are based on something that does not exist, i.e., the vaginal orgasm. There are no medications for female sexual dysfunction because it is impossible to increase the desire of vaginal intercourse. Hypoactive sexual desire disorder is an example of a condition that was sponsored by industry to prepare the market for a specific treatment. Flibanserin is an antidepressant, but the mechanism by which the drug improves sexual desire is not known. Addyi has not been shown to enhance sexual performance, it was found to be modestly effective in improving sexual desire during clinical trials: women should fully understand the risks associated with the use of Addyi before considering treatment (Puppo and Puppo, 2015a).

The female sexual function index (FSFI) questionnaire is the most widely used measure of female sexual dysfunction; however, it does not assess female sexual function but primarily assesses vaginal intercourse. The FSFI must not be used to assess female sexual dysfunctions (Puppo, 2015). In all women, orgasm is always possible if the female erectile organs are effectively stimulated during masturbation, clitoral smear, or partner masturbation, or during vaginal intercourse if the clitoris is simply stimulated with a finger (Puppo, 2011, 2013).

Many men think prolonged intercourse is the key to orgasms, but it is not helpful for women. PE does not occur if both partners agree that the quality of their sexual encounters is not influenced by efforts to delay ejaculation, and some females may be grateful to get it over with quickly. Male ejaculation does not automatically mean the end of sex for most women. Touching and kissing can be continued almost indefinitely; non-coital sexual acts after male ejaculation can be used to produce orgasm in women (Puppo and Puppo, 2015b; Puppo et al., 2015).

As a matter of fact, the vaginal orgasm has no scientific basis, so the duration of penile-vaginal intercourse is not important for a woman’s orgasm. Sexual dysfunctions are conditions in which the ordinary physical responses of sexual function are impaired: it is important for men (and sexual medicine experts, endocrinologists, urologists, andrologists, and sexologists) to understand that in “premature” ejaculation the physiology of ejaculation and orgasm is not impaired, and that PE is normal in adolescent males especially during their first sexual encounters.

Sansone et al. stated in 2015: “It should be clear that PE is often associated with endocrine diseases.” Jannini et al. in 2015 stated: “PE is still far from being fully understood. All cases of PE thus are or become psychogenic, even where PE is a symptom of an organic etiology. The epidemiology of PE is dramatically influenced by its definition. Pharmaceutical industry-sponsored population studies, limited by the possible conflict of interest but with the merit of huge enrollments, show a 20% prevalence. Dapoxetine is the unique, first-line, officially approved pharmacotherapy for PE.” PE during vaginal intercourse is not a male sexual dysfunction/disease, therefore it cannot be associated with endocrine diseases and drug therapy must be not used.

Jannini et al. in 2015 stated: “E.A. Jannini has received personal fees from Menarini, Bayer, Ibsa, GSK, and Pfizer.” PE has become the center of a multimillion-dollar business: is PE—and female sexual dysfunction—an illness constructed by sexual medicine experts under the influence of drug companies?

Moon du et al. in 2015 stated: “Feasibility and efficacy of glans penis augmentation for PE. The pathophysiology of premature ejaculation is poorly understood.” The pathophysiology of PE is poorly understood because it is not a disease, so glans penis augmentation is not medically indicated. Men must be informed about the lack of data supporting the efficacy of this procedure and its complications. Clinicians who receive requests for glans penis augmentation, or for medical treatment for PE, must discuss with the patient the reason for his request and examine him for physical signs or symptoms that could indicate a need for surgical intervention or drugs. A patient’s concern regarding the appearance of his genitalia can be alleviated by a discussion of the wide range of normal genitalia and reassurance that the appearance of the penis differs significantly from man to man.

Human body functions must be studied in the subject: questionnaires about male ejaculation must assess masturbation, and the questions should not include the words “intercourse” and “satisfaction.” I warn colleagues to maintain a high level of professionalism: unscientific definitions and questionnaires must not be used. A new definition could be: PE is a sexual dysfunction when the ability to delay ejaculation during masturbation is diminished or lacking, and ejaculation occurs before the person wishes it, with negative personal consequences (Puppo et al., 2015).

Teenagers must understand that PE is absolutely normal at their age. Men with PE have no negative personal consequences during masturbation: there is no such thing as PE when orgasm and ejaculation are attained by masturbation. However, masturbation provides a safe means of sexual experimentation, improving sexual self-confidence.

Jannini et al. in 2015 stated: “From the early 1900s until the 1990s, PE was considered a psychological problem, and it was treated primarily with behavioral therapies such as the squeeze technique and stop–start technique.” Sexologists and sexual medicine experts must acknowledge two specific methods called the

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**Fig. 7.** The squeeze technique (from Puppo, 2011). A: Coronal squeeze. B: Basilar squeeze.
CONCLUSIONS

Sexual health is a fundamental and universal human right, and sexual pleasure, including autoeroticism, is a source of physical and psychological wellbeing that contributes to human happiness. Knowledge of the anatomy and physiology of male ejaculation is essential in the field of men’s sexual health. Men must also know the changes in their sexual response that occur physiologically with aging and train their perineal muscles with Kegel exercises. The man with PE is often embarrassed or depressed about his plight, which he regards as reflecting poorly on his manhood. Sexual medicine experts, endocrinologists, urologists, andrologists, and sexologists must acknowledge that PE is not a disease and must not be classified as a male sexual dysfunction, and that it is normal for any healthy adolescent man owing to his inexperience in sexual matters. Teens and men can understand their sexual response during masturbation and learn ejaculatory control with the stop–start method and the squeeze technique. They will then be able to gain better control during intercourse. Also, during lovemaking, the duration of vaginal intercourse is not important.

Sexual medicine experts and sexologists must know that vaginal orgasm does not exist and ensure that proper sex education is provided in schools and by the mass media. They must define having sex/making love as a situation in which orgasm occurs for both partners with or without vaginal intercourse: a definition for all human beings.

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stop–start method and the squeeze technique that help recondition the ejaculatory reflex during masturbation. In the stop–start method the male stimulates the penis manually until he feels that he is rapidly approaching ejaculation, and then he stops all stimulation until the sense of ejaculatory urgency disappears. Stimulation then begins again, and the stop–start cycle is repeated several times before the man is allowed to ejaculate (Semans, 1956; Glina et al., 2007; Puppo, 2011). In the squeeze technique the man puts his second and third fingers on the frenulum of the penis and places his thumb just below the coronal ridge on the opposite side (Fig. 7A). Firm pressure is applied for about 4 sec and then abruptly released. The squeeze technique reduces the urgency to ejaculate. It must begin in the early phase of masturbation and continue periodically, every few minutes. With the basilar squeeze, the squeezing is at the base of the penis (Fig. 7B) (Masters et al., 1988; Puppo, 2011).
The Subdiaphragmatic Part of the Phrenic Nerve – Morphometry and Connections to Autonomic Ganglia

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Few anatomical textbooks offer much information concerning the anatomy and distribution of the phrenic nerve inferior to the diaphragm. The aim of this study was to identify the subdiaphragmatic distribution of the phrenic nerve, the presence of phrenic ganglia, and possible connections to the celiac plexus. One hundred and thirty formalin-fixed adult cadavers were studied. The right phrenic nerve was found inferior to the diaphragm in 98% with 49.1% displaying a right phrenic ganglion. In 22.8% there was an additional smaller ganglion (right accessory phrenic ganglion). The remaining 50.9% had no grossly identifiable right phrenic ganglion. Most (65.5% of specimens) exhibited plexiform communications with the celiac ganglion, aorticorenal ganglion, and suprarenal gland. The left phrenic nerve inferior to the diaphragm was observed in 60% of specimens with 19% containing a left phrenic ganglion. No accessory left phrenic ganglia were observed. The left phrenic ganglion exhibited plexiform communications to several ganglia in 71.4% of specimens. Histologically, the right phrenic and left phrenic ganglia contained large soma concentrated in their peripheries. Both phrenic nerves and ganglia were closely related to the diaphragmatic crura. Surgically, sutures to approximate the crura for repair of hiatal hernias must be placed above the ganglia in order to avoid iatrogenic injuries to the autonomic supply to the diaphragm and abdomen. These findings could also provide a better understanding of the anatomy and distribution of the fibers of that autonomic supply. Clin. Anat. 29:120–128, 2016. © 2015 Wiley Periodicals, Inc.

Key words: subdiaphragmatic phrenic nerve; diaphragm; celiac ganglion; suprarenal gland; phrenic ganglion

INTRODUCTION

The nerve supply to the diaphragm has been studied and debated for decades, from the nerves that innervate it to the type of innervation they provide. Probably the best known of these structures is the phrenic nerve. However, there still appear to be several inconsistencies in terms of connections, distribution and composition, especially in its subdiaphragmatic portion. According to standard anatomical textbooks such as Gray's Anatomy (Clemente, 1985; Robinson, 1907;
MATERIALS AND METHODS

We examined 130 adult human cadavers, 88 female and 42 male, with an age range at death of 42 to 82 years (mean = 70 years). All cadavers were fixed in a formalin/phenol/alcohol solution and none revealed evidence of significant gross pathology, previous surgical procedures, or traumatic lesions to the diaphragmatic region.

To gain access to the right inferior hemidiaphragm the coronary and falciform ligaments of the liver were divided and the liver was retracted to the left. The inferior vena cava was cut and reflected to expose the right diaphragmatic pillar. On the left, the attachments of the greater curvature of the stomach were divided. The stomach was transected at the gastroesophageal junction and removed along with the transverse colon, duodenum, and pancreas. A complete dissection was performed along the course of the phrenic nerve entering the diaphragm from the thorax in order to follow its distribution, termination, and communications.

Following preliminary examination, images from all dissected specimens were recorded with a Nikon digital camera (model: D90) and studied using a computer-assisted image analysis system (ProgRes Mac CapturePro 2.8.8, Jenoptik AG). After a standard 1 mm scale had been applied to all the pictures, the program used this information to calculate pixel differences between two selected points such as the origin and termination of a given nerve. The purpose of the software was to allow pixel differences to be translated easily and accurately into metric measurements.

Distances were measured between the right phrenic ganglion and the celiac ganglion, suprarenal gland, aorticorenal ganglion, and right accessory phrenic ganglion (the name we decided to choose for an additional smaller ganglion). The distances from the left phrenic ganglion to the left celiac ganglion, aorticorenal ganglion and suprarenal gland were also measured. Furthermore, both right and left phrenic nerves were transected at their exits from the inferior surface of the diaphragm. Subsequently, each specimen was photographed and the diameters of the nerves were measured. Diameters were also measured for the right phrenic ganglion, right accessory phrenic ganglion, and left phrenic ganglion.

The results were analyzed using Student’s t test (SPSS) and differences between means were considered statistically significant when the values were $P < 0.05$.

For the purposes of this manuscript, all references to the phrenic nerve are meant specifically to indicate only those branches located inferior to the diaphragm. In addition, although their exact description is somewhat controversial, we have chosen to consider the ganglia of the celiac plexus as consisting of two parts (Stewart et al., 2004). As defined by Standring et al. (2005), the celiac ganglion usually comprises two separate identifiable masses. The superior mass, which is joined by the greater splanchnic nerve, is termed the celiac ganglion, while the inferior mass receives the lesser splanchnic nerve and is termed the aorticorenal ganglion. This aorticorenal ganglion lies anterosuperior to the origin of the renal artery and gives rise to most of the renal plexus.

In addition to gross anatomical analysis, all phrenic ganglia were sectioned for histological staining. The specimens were preserved in 4% neutral buffered formalin, dehydrated through a graded alcohol series and embedded in paraffin. Serial sections were cut at 5 μm and stained using the standard hematoxylin–eosin method.

Ethical Considerations

All specimens were handled in accordance with the laws and regulations of the country in which the study was performed.
was performed. The specimens used for this research were protected under approval for the use of human tissue in teaching and research by the IRB.

RESULTS

The criteria described in the materials and methods section did not allow the aorticorenal and celiac ganglia to be distinguished in 10 of the specimens. Accordingly, those 10 specimens were excluded, resulting in a revised total of 120 cadavers.

Right Phrenic Ganglion

The right phrenic nerve was present inferior to the diaphragm in 98% (118) of cases (Fig. 1). It traversed the caval foramen in 52% (61) of the specimens, while in the remaining 48% (57) it pierced the central tendon of the diaphragm within 2 cm lateral to the caval hiatus. In 2% (2) specimens, the phrenic nerve could not be identified grossly inferior to the diaphragm.

After the nerve emerged inferior to the diaphragm, a right phrenic ganglion was present in 49.1% (58) of specimens, and there was an additional smaller ganglion, the “right accessory phrenic ganglion”, in 22.8%. The remaining 50.9% of specimens had no right phrenic ganglion. Where only one ganglion was present, this was considered to be the right phrenic ganglion, so there were no specimens with only a right accessory phrenic ganglion.

The right phrenic ganglion was located close to the right inferior phrenic artery and right diaphragmatic crus and exhibited plexiform communications to the celiac ganglion and suprarenal gland. In one such example, it was unusually close to the suprarenal gland (Figs. 2 and 3). It communicated only with the celiac ganglion in 15.5% (Fig. 4), only with the suprarenal gland in 10.3%, and only with the aorticorenal ganglion in 8.6% of the specimens. However, the right phrenic ganglion most commonly (65.6% of specimens) exhibited plexiform communications with two (Figs. 2 and 3) or more (Fig. 5) of these structures (Table 1). The mean distances were: from the right phrenic ganglion to the celiac ganglion 3.6 cm with a range of 2.1–4.5 cm, to the suprarenal gland 2.1 cm with a range of 1.8–3.1 cm, and to the aorticorenal ganglion 4.1 cm with a range of 3.2–5.1 cm.

The right accessory phrenic ganglion also exhibited communicating branches to combinations of the celiac and aorticorenal ganglia and the suprarenal gland in 52.6% of specimens (Fig. 3). The right accessory phrenic ganglion communicated only with the celiac ganglion in 14.4% and only with the suprarenal gland in 11.1%. No specimens were found with a solitary communication between the right accessory phrenic ganglion and the aorticorenal ganglion (Table 1). The
mean distance from the right phrenic ganglion to the right accessory phrenic ganglion was 1.6 cm.

Of those specimens with neither right phrenic nor right accessory phrenic ganglia (n=60), the right phrenic nerve trunk branched to form communications with several ganglia in 70% (Fig. 6). In the remainder, the right phrenic nerve trunk continued as a single nerve to communicate only with the celiac ganglion in 13.3%, only with the suprarenal gland in 8.3%, and only with the aorticorenal ganglion in 8.3% (Table 1).

Overall, the right phrenic nerve exhibited plexiform communications to multiple ganglia either directly or via the right phrenic ganglion in 67.8% of specimens.

Furthermore, the right phrenic nerve communicated (either directly or via the right phrenic ganglion) only with the celiac ganglion in 14.4%, only with the suprarenal gland in 11.8%, and only with the aorticorenal ganglion in 8.4%. In 16% the right phrenic nerve did not communicate with any autonomic structure in the abdomen. The subdiaphragmatic connections of the right phrenic nerve were most commonly located anterior to the muscular portion of the right diaphragmatic crus.

**Left Phrenic Ganglion**

The left phrenic nerve was observed in 60% (72) of specimens. In the remaining cases, the phrenic nerve could not be identified grossly inferior to the diaphragm. The point of exit of the left phrenic nerve was more variable than that of the right, but was most commonly observed posterior to the central...

**Fig. 2.** A right phrenic ganglion in close association to the right inferior phrenic artery and right diaphragmatic crus with plexiform communications (indicated by the arrows) to the celiac ganglion and suprarenal gland. In this example, the right phrenic ganglion is unusually close to the suprarenal gland. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

**Fig. 3.** A right phrenic ganglion and right accessory phrenic ganglion with communications (indicated by the arrows) to the celiac ganglion and suprarenal gland. The close association between these two ganglia and the right crus of the diaphragm is clearly visible. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]
tendon and lateral to the esophageal hiatus. A single left phrenic ganglion was observed in 19% (14) of specimens. The remaining 81% (58) had no left phrenic ganglion and none had an accessory left phrenic ganglion. The left phrenic ganglion exhibited plexiform communications to multiple ganglia in 71.4%. It communicated only with the celiac ganglion in 21.4% (Fig. 7) and only with the suprarenal gland in 7.1%. No specimen had solitary communications between the left phrenic ganglion and the aorticorenal ganglion (Table 1). The mean distance from the left phrenic ganglion to the celiac ganglion was 4.3 cm, from the left phrenic ganglion to the suprarenal gland 3.9 cm, and from the left phrenic ganglion to the aorticorenal ganglion 5.0 cm.

Of those specimens lacking a left phrenic ganglion (n = 58), the left phrenic nerve trunk branched to form plexiform communications with multiple ganglia in 67.2%. The remainder of left phrenic nerve trunks communicated only with the celiac ganglion in 8.6%, only with the suprarenal gland in 10.3%, and only with the aorticorenal ganglion in 13.8%.

Overall, the left phrenic nerve exhibited plexiform communications (either directly or via the left phrenic ganglion) with several ganglia in 68% of specimens. The remainder exhibited communications only with the celiac ganglion in 11.1%, only with the suprarenal gland in 9.7%, and only with the aorticorenal ganglion in 11.1% (Table 1). From the left crus, the left phrenic nerve traveled inferomedially across the median arcuate ligament to communicate with the celiac ganglion (situated anterior to the aorta). In order to communicate with the left suprarenal gland, the left phrenic nerve coursed inferolaterally across the muscular portion of the left crus.

**Morphometrical Analysis**

Table 1 summarizes the frequencies with which the right and left phrenic nerves, and the right phrenic ganglion and left phrenic ganglion, connected to different ganglia. The right accessory phrenic ganglion was never observed without an accompanying right phrenic ganglion; the data confirming this are also depicted in Table 1.

The mean diameter of the right phrenic nerve at its point of entry into the abdominal cavity was 1.2 mm with a range of 0.9–1.5 mm, and for the left phrenic nerve, 1.0 mm with a range of 0.7–1.2 mm. The mean diameter of the right phrenic ganglion was 3.5 mm with a range of 3–3.9 mm, while that of the right accessory phrenic ganglion was 2.2 mm with a range of 1.9–2.4 mm. Finally, the mean diameter of
the left phrenic ganglion was 2.3 mm with a range of 2–2.6 mm. The mean diameters of the right and left phrenic nerves were not significantly different ($P > 0.05$). Also, no statistical differences were found between mean lengths or diameters among the various phrenic nerve connections, between left and right sides, or between age and sex ($P > 0.05$).

**Histology.** Histologically, the right and left phrenic ganglia are encapsulated with loose connective tissue in which neurons have a tendency to cluster as they do in prevertebral ganglia. A rich dendritic plexus was present between the neurons within the phrenic ganglia. Large neural cell bodies were arranged in the periphery of the ganglia and were multipolar, with vesicular nuclei and cytoplasm rich in Nissl substance.

**DISCUSSION**

Several previous studies have described phrenic ganglia communicating variably with the celiac ganglion and suprarenal gland. One study, by Rusu, described some variations in the morphology and

| TABLE 1. A Summary of the Communications Between the Left and Right Phrenic Nerves, their Ganglia (when Present) and Relevant Autonomic Structures of the Abdomen |
|---------------------------------------|-------------------------|--------------------------|---------------------|--------------------------|-----------------------|-------------------------|
|                                      | Right Phrenic Ganglion  | Left Phrenic Ganglion    | Right Accessory Ganglion | Left Accessory Ganglion | Right Aorticorenal Ganglion | Left Aorticorenal Ganglion |
| Prevalence                            | 98.4% (97)              | 100% (100)                | 14.5% (14)                | 14% (14)                  | 11% (11)                   | 9% (9)                   |
| Single Branch to Celiac Ganglion      | 14% (14)                | 14% (14)                  | 15% (15)                   | 15% (15)                  | 15% (15)                   | 15% (15)                  |
| Single Branch to Suprarenal Gland     | 11% (11)                | 11% (11)                  | 10% (10)                   | 10% (10)                  | 10% (10)                   | 10% (10)                  |
| Multiple connections to multiple ganglia | 70% (70)                | 70% (70)                  | 65% (65)                   | 65% (65)                  | 65% (65)                   | 65% (65)                  |

**Fig. 6.** An example of a right phrenic nerve trunk with no phrenic ganglia with communications to the aorticorenal ganglion and suprarenal gland. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]
topography of the phrenic ganglia (Rusu, 2006). In this study only 10 cadavers were dissected and examined. It described communications between the right phrenic ganglion and the celiac ganglion and with the suprarenal gland, but did not mention any communication with the aorticorenal ganglion. Using a much larger sample size we were able to identify several different patterns that had not been observed in earlier studies. However, we were unable to determine whether the apparent lack of left phrenic ganglia in previous studies was attributable to smaller sample sizes, individual cadaveric variations or different methods of detection.

Another challenge encountered in reviewing the literature was that of inconsistent nomenclature. For example, Rusu (2006) used different terminology within the same report to describe the phrenic ganglia. He referred to the phrenic ganglion, upper and lower phrenic ganglia, superior, middle, and inferior phrenic ganglia, the median phrenic ganglion, right inferior phrenic artery ganglion, phrenic plexal ganglia, right inferior phrenic artery plexus, periarterial ganglion, phrenic artery ganglion, the diaphragmatic nerve, the inner diaphragmatic nerve, and the diaphragmatic branch of the middle phrenic ganglion (Rusu, 2006). All of these terms apparently denoted to the same structure, but only “phrenic ganglion” is accepted by the Federative Committee on Anatomical Terminology (FCAT) as published in Terminologica Anatomica (FICAT, 1998).

The term “right inferior phrenic artery ganglion” was first used by Robinson (1907) to describe these “constant structures, always located along the course of the phrenic artery”. On the basis of our previous work, we disagree with the use of this term because the location with respect to the topography of the inferiorphrenic arteries is highly variable (Loukas et al., 2005a; 2005b). In fact, Robinson (1907) recognized this variability in his own dissections and reported that the origin of the phrenic artery varies considerably, thus altering the topographic relationships of the phrenic ganglion. More important than the nomenclature employed is the consistency of its application and the precision with which characteristics are defined. It is only through consistent terminology that we, as anatomists and clinicians, can communicate new ideas and concepts accurately and efficiently. For this reason, the present authors have decided to maintain consistency with the FCAT in using the term ‘phrenic ganglion’. By extension, it seems appropriate that this nomenclature be applied to both right and left phrenic ganglia when those structures are present. In addition, we have chosen to assign the term “accessory phrenic ganglion” to the variable structure located proximal to the right phrenic ganglion. Although this term is not found in the Terminologica Anatomica, it seems appropriate considering the variable topographic relationships described herein.

As mentioned by Hidayet et al. (1973) and Uzun et al. (2003), the presence of a classical phrenic ganglion in 50% of human specimens suggests that it constitutes a potential source of extraphrenic innervation. Furthermore, the communication between the phrenic nerve, phrenic ganglion, and celiac ganglion provides structural evidence for a flow of retrograde impulses via the celiac plexus and phrenic ganglia (peripheral control) for diaphragmatic function. The existence of these communications allows for the possibility of a viscerosomatic communication through which the respiratory function of the diaphragm can in part be controlled peripherally. Such “peripheral controls”, if present, could prove particularly active when the action of breathing is regulated by variations in autonomic tone, such as sleeping. In this regard, Tubbs et al. demonstrated sympathetic neural bodies in the phrenic ganglion immunohistochemically, strengthening the case for autonomic involvement (Tubbs et al., 2008).

Robinson first described the concept of peripheral autoregulatory functions in 1907 and used the term “Abdominal Brain” to describe the celiac plexus, including communications with the phrenic nerve. This idea is further supported by histological examination of the right phrenic and right accessory phrenic ganglia by Rusu (2006) and Tubbs et al. (2008). The presence of multipolar autonomic neurons within these ganglia suggests that these communications could provide autonomic innervation. In contrast, Balkowiec and Szulczyk (1992) have suggested that...
postganglionic sympathetic axons within the phrenic nerve could be involved in innervating blood vessels of the diaphragm.

In addition to gross anatomical and histological data, which suggest an extraphrenic autonomic supply to the diaphragm, a few studies have demonstrated this concept physiologically. For example, using a rat model, Zhou and Gilbey (1992) examined the discharge patterns of sympathetic preganglionic neurons in the lower thoracic and upper lumbar regions. These patterns were then analyzed in relation to phrenic nerve discharge. On the basis of differences in respiratory modulation patterns, Zhou and Gilbey (1992) suggested that pathways other than those arising from the rostral ventrolateral medulla could be important in influencing sympathetic preganglionic neuronal activity. Similarly, Lahiri et al. (1991) and Huang et al. (1989) analyzed the sympathetic respiratory patterns in cats. By analyzing preganglionic cervical sympathetic nerve fibers, phrenic nerve, and intercostal nerve activity, both studies demonstrated individual differences in their firing patterns. Specifically, sympathetic activity did not share the after-discharge of the phrenic nerve, which persisted beyond carotid chemoreceptor stimulation. One possible conclusion is that in addition to central control from the rostral ventrolateral medulla, there could be an accessory peripheral mechanism that allows for extraphrenic autonomic regulation. Taking into account the historical evidence and the known autonomic properties of the celiac plexus and suprarenal gland, communicating fibers between these two structures make it possible that the subdiaphragmatic segment of the phrenic nerve and the phrenic ganglion could indeed contribute to this mechanism. A follow-up study could analyze the electrophysiological properties of the phrenic nerve and attempt to correlate these with autonomic regulatory functions, and determine the direction of nerve conduction within those fibers.

Additional evidence for viscerosomatic regulation comes from reports describing neurogenic shock and respiratory paralysis following trauma to the epigastrium (Robinson, 1907; Furuya et al., 1979). By extension, if one considers the possibility of this viscerosomatic control, preservation of these fibers could prove particularly important during surgical procedures to the region. Owing to their location anterior to the diaphragmatic crura, the right phrenic ganglion, right accessory phrenic ganglion, and left phrenic ganglion could potentially be injured during operations for repair of diaphragmatic hernia and median arcuate ligament syndrome. Conversely, if there is indeed sympathetic innervation of the diaphragm and its crura within these fibers, as proposed by Tubbs et al. a highly selective sympathectomy of the phrenic ganglia could be explored as a potential therapeutic alternative in the treatment of median arcuate ligament syndrome (Tubbs et al., 2008).

CONCLUSIONS

We have found extensive interconnections between the phrenic, celiac, and aorticorenal ganglia as well as plexiform fibers to the adrenal glands. Together with results from previous studies, this indicates that iatrogenic injury to these fibers can have devastating effects, not only to breathing during times of reduced cortical output but also on the adrenal gland. Detailed knowledge of the anatomy of the subdiaphragmatic phrenic nerve could prove useful for surgeons performing adrenalectomy by making it possible to preserve some autonomic function. Although the significance of these communications is yet to be determined, it is hoped that our research will provide anatomists and surgeons with useful information, both in increasing their specific knowledge and in opening the possibility of new therapeutic procedures. Immunohistochemical study of these structures is now necessary to characterize them as either sympathetic or parasympathetic and to determine the extent of their influence.

ACKNOWLEDGMENTS

The authors wish to thank Jessica Holland, MS, Medical Illustrator, for creating the illustrations used in this article. The authors gratefully thank the individuals who donated their bodies to the Department of Anatomy. This study was made possible by the selfless gifts from donor cadaver patients.

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