A History of Gross Anatomy – Lessons for the Future

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The science of anatomy has a multitude of methods, goals and philosophies. For many medical students, including those at the University of Toronto, gross anatomy is the first real introduction to the study of medicine. In addition to providing the obvious structural and functional background for medicine, some have argued that dissection in the gross anatomy laboratory serves as a “vehicle for moral and ethical education”. However, gross anatomy is much more than a teaching tool. It has enjoyed significant success as a research field and has interacted historically with many clinical specialties as well as with the basic life sciences (e.g. microscopic anatomy, comparative and developmental anatomy). While many of these basic sciences are also part of the larger science of anatomy, the scope of this paper will be largely limited to gross anatomy.

Gross anatomy and dissection science have not always existed as we experience them today. Rather, the study of anatomy has shifted with changing scientific and medical priorities, historical events, cultural shifts and the resulting changes in social norms. The history of anatomy is an interesting reflection of these changes. This paper will offer an overview of the development of the science of anatomy over time and will provide a detailed account of a few specific (and sometimes notorious) events and individuals that stand out as historical examples.

Galen's Anatomy
Claudius Galen (130-200 AD) was both a physician and an anatomist. He published more than 130 medical treatises, most of which focused on anatomy. These treatises would form the basis for anatomical study for the next 1400 years, with students not dissecting, but rather studying Galenic texts. Anatomic discovery and research was also essentially stagnant during this time period, with Galen's writings accepted as truth. Ironically, Galen himself was a great advocate of direct observation in learning, although he had never dissected a human cadaver. His own work was based largely on the dissection of animals (because human bodies were denied to him under the Roman Empire), as well as a strong belief that human organs were perfectly adapted to their functions. These assumptions led Galen to make some false conclusions, such as the inclusion of the rete mirabile (a collection of blood vessels found at the base of the brain in pigs) in his description of human anatomy.

Galen's writings were fraught with these errors, which went uncorrected until the Renaissance. Indeed, until the work of Andreas Vesalius, very few dissections took place at all. However, a limited number of dissections took place in fourteenth century Italy under the direction of the Italian anatomist Mondino di Luzzi (1276-1326), usually in public places. Mondino himself did not perform the dissections, but rather directed them, using Galen's text as a guide, while medical students watched. The intent was not to further anatomical knowledge or study in detail the structures, but rather to illustrate what Galen had written.

The Renaissance
The Renaissance was a time of massive societal change. There was a significant separation of religion and culture, and the result was a radical new way of thinking, with support for progress and exploration of new ideas that had not existed before. Medicine in general, and anatomy specifically, was very much entwined in this revolution. Science, art and humanism were interconnected in a novel way. Anatomy came to reflect the prevailing cultural and spiritual issues of the time, while art became fascinated with the human form.

Andreas Vesalius, considered by many to be the first great anatomist, was the first to advocate for the direct observation of anatomy in medical education and research. There was still no legal source of cadavers, so Vesalius likely conducted his dissections on bodies that were obtained from graveyards. He was a master dissector and his work contradicted much of Galen's writings, which had dominated anatomical dogma for 1400 years. In 1543, Vesalius' De Humani Corporis Fabrica was published, the first anatomy atlas based directly on human dissections. Not only was the atlas the most technically accurate ever produced, the engravings were astoundingly artistic and often incorporated classical Roman scenery. The text of the atlas was not limited to descriptions of muscle origins and insertions or of the pathways of blood
vessels; it included Vesalius’ contemplative reflections on life and death. Although this interpretive portrayal of anatomy may not fit with the focused, concise methods of anatomy textbooks of today, it was very much a reflection of the intellectual exploration that fueled the Renaissance. It also reflected the inseparability of medicine and philosophy, an association that modern physicians may sometimes neglect.

Interestingly, although Vesalius was a physician, anatomy was certainly not the exclusive domain of physicians, and its relevance was not limited to medicine. The human form was a focus of much of the art and culture of the time. Many of the great Renaissance artists, such as Michelangelo and Leonardo da Vinci, performed dissections to improve their understanding of the human form. Da Vinci in particular reportedly dissected at least 30 human bodies. These artist-anatomists are credited with improving attention to detail in the study of anatomy. This valuable collaboration of scientist, physicians and artists continues even today, with significant contributions by biomedical artists to medical education and research.

Anatomy in the Modern Age
During the modern era, a time of massive industrialization, anatomy thrived as a research science, and dissection of cadavers became a vital scientific tool. In addition, the use of surgery increased and improved, due both to the advent of anesthesia (c. 1840) and to the use of sterile technique. Anatomy was thus essential, both in research and education, to further improve and develop surgical techniques.

After Vesalius’ time, the role of anatomy in medical education became clear, and most medical students had some exposure to human dissection during their training. Regrettably, the modern era, for all its advances, was a time of many ethical low points for gross anatomy.

Grave Robbing, Murder and Anatomy
As the interest in anatomy increased, so did the need for cadavers. However, Victorian attitudes imposed restrictions on the use of human remains. The only legal source of cadavers was executed criminals. In fact, US judges had discretion to add dissection to the death penalty for criminals. This meant that cadavers often had to be obtained through unscrupulous means. Grave robbing was rampant both in Britain and the United States. Its role in Canadian anatomy is less clearly documented, although it likely occurred, at least to some extent. The grave robbers were sometimes outside parties, sometimes friends, and sometimes students of anatomy, who then sold the bodies to their teachers to help defray the costs of their education. The wealthy often went to great lengths to protect their graves from robbers; cemeteries were guarded and stone slabs were placed over graves.

The Burns Collection, a set of medical mummies brought to the United States from Glasgow, Scotland in 1819 and now housed at the University of Maryland, has somewhat questionable origins. The collection was accumulated by Allen Burns, a Scottish anatomist who died in 1813, and then acquired by Granville Sharpe Pattison, one of Burns’ protégés, in 1814. Although medical historians cannot be certain, it is speculated that the bodies came both from executed prisoners and from grave robbery. In fact, Allen Burns’ older brother John had been convicted of grave robbery and Pattison had been indicted, although not convicted.

With guarded cemeteries, and the need for fresh bodies, grave robbing was often ineffective. One of the most infamous tales of anatomical history is that of William Burke and William Hare in Scotland. Their story began when a resident at Hare’s boarding house died, leaving a small debt to Hare. Hare and Burke discovered that the body could be sold for more than the debt, and that body snatching, as it was known, was a lucrative business. Hare and Burke murdered 16 other people after luring them into the boarding house, and sold the bodies to a local anatomist, Dr. Robert Knox. In 1829, the two were caught. Burke was hanged, while Hare received immunity for testifying against him. So infamous was the tale, that body snatching became known as “burying”, in dubious honour of William Burke.

These events prompted legislation in both Britain (the Warburton Anatomy Act of 1832) and in the United States, allowing anatomists to use unclaimed bodies for research. In the US, legislation was state specific. Massachusetts was the first state to respond to the Burke and Hare case, passing the Anatomy Act in 1831. Other states followed suit slowly, but by the beginning of the 20th century all had enacted similar laws.

Nazi Germany and Pernkopf’s Atlas
The crimes of Nazi physicians are well documented. Jews and other “political prisoners” were routinely the victims of medical research. Recently, anatomists worldwide have expressed concern about the murder of Jewish and other Nazi prisoners for the purposes of anatomical research by Nazi scientists and physicians. To the credit of the anatomy community in previously Nazi countries, such as Germany and Austria, inquiries have been launched into these allegations and the results shared with the scientific and popular press.

One paper published in 2002 by anatomists at the University of Marburg in Berlin sheds some light on the atrocities committed by anatomists at their university during the Second World War. Although direct evidence is not available, circumstantial evidence is significant. The paper reveals that an increasing number of corpses were registered to the Department of Anatomy during the war years. By the authors’ own admission, the recorded causes of death for those cadavers are “imprecise, superficial, and sometimes deliberately false”. They assert that many German medical students trained during this dark period in German history almost certainly learned their anatomy at the expense of Nazi concentration camp victims.

Eduard Pernkopf, an Austrian physician and instructor of anatomy at the University of Vienna, published a 4-volume set of anatomy atlases between 1937 and 1960. Recently, the atlas has been subjected to some scrutiny from the anatomy community, with accusations that the cadavers on which the illustrations were based may have been Jews interred in Nazi concentration camps. There is
no question that Pernkopf was a Nazi supporter. When made dean of the medical school at the University of Vienna in 1938, he removed all non-Aryan faculty members from the school. He routinely made pro-Hitler speeches. The four artists who worked on the atlas were also reportedly Nazi party members or sympathizers, and incorporated the swastika into their signatures from time to time.\textsuperscript{12}

Still, the question of whether the cadavers were concentration camp prisoners is unclear. The University of Vienna conducted an inquiry between 1997 and 2000 to examine this issue in detail.\textsuperscript{13} However, many of the department’s records had been destroyed in allied air raids during the war, and discovering the source of the cadavers proved difficult. Certainly, many of the cadavers were people executed for political crimes against the Nazi regime, although only 6 out of about 1400 could be definitely identified as Jewish. In view of the lack of records, it seems unlikely that further light will be shed on this matter.

The question now challenging anatomists and physicians is what to do with Pernkopf’s atlas. Should it be used when the cadavers depicted in the illustrations are of unknown source? What is the relevance of Pernkopf’s known Nazi sympathies? Should Nazi symbols be removed? These questions have been highly debated by anatomists and ethicists alike. Some have advocated for the removal of the atlas from libraries and the cessation of publication. Some have argued that the atlas should remain in circulation, with a prologue revealing what is known and what is unknown about the author and the atlas itself.

Conclusions
Clearly, the history of anatomy and dissection is one of great accomplishments. We have learned a wealth of information about the human body and applied this information to great human gain. Unfortunately, the field is not without significant shame. Although some might argue that these shortcomings are the work of a few and that most anatomists and physicians are of the highest moral character, the problem has been broader than just a few “bad apples”. The historical cases presented in this paper are only examples of broader problems.

Thankfully, current legislation allows individuals to bequeath their bodies to the science of anatomy, for the purposes of research and medical education. In Ontario, this right is allowed under the Human Tissue Gift Act and similar legislation exists across Canada.\textsuperscript{14} The sale of bodies and tissues is expressly prohibited by the act, and subject to criminal prosecution.

Still, controversies associated with anatomy continue. In November of 2002, Gunther von Hagens, a German professor, carried out the first public dissection in Britain since 1830 on a man who had donated his body.\textsuperscript{15} Von Hagens also developed an art exhibit of dissected corpses and body parts which has been on display in Japan since 1995. Many of the bodies used in this display were obtained through an agreement with Novosibirsk medical school in Russia, which supplied the bodies in exchange for plastinated specimens to be used in medical education. Reports are now emerging that some of these bodies may be those of Russian citizens whose relatives have been told that they were cremated. A Russian coroner has been charged in connection with these reports but von Hagens has not.

As medical students, not only are we entrusted with the bodies of the patients we care for and learn from in life, but also those patients we are privileged to learn from in death. This responsibility is a significant one, and it is imperative that we be aware of the travesties of the past and of the present in order that we may maintain the highest degree of respect and gratitude for those who entrust their bodies to us.

References