Gross anatomy laboratory education: The importance of cadaveric dissection in medical school during the COVID-19 pandemic

Karim Sidhom BSc[†]

Abstract

The role of cadaveric dissection for medical education has been subject to scrutiny in recent years. Questions around its effectiveness compared to other modalities for gross anatomy education were further potentiated by the COVID-19 pandemic. The objective of this commentary is to describe the ongoing importance of cadaveric dissection for medical education. A brief history of gross anatomy education is described as well as the contemporary approaches to anatomy education for medical learners. The current role of cadaveric dissection as a unique and effective resource for learning is examined in comparison to other modalities. Anatomical instruction at the University of Manitoba Max Rady College of Medicine is used as an example to discuss gross anatomy education before and after the onset of the COVID-19 pandemic. Adaptations made because of the pandemic, and considerations therein, are explored based on discussions with current anatomy laboratory instructors at the University of Manitoba. Overall, cadaveric dissection is demonstrated to be a valuable learning tool for early-years medical students and continues to be safely incorporated into coursework in the context of a pandemic. Expanding the availability of gross anatomy education for senior-years medical students, as well as postgraduate medical education, should be strongly considered.

Keywords: medical education, cadaver, dissection, COVID-19

Conflict of Interest Statement: None to declare.

Introduction

In December 2019, cases of an unknown viral pneumonia cases were in Wuhan, China.[1,2] This virus was later identified as a novel strain of coronavirus.[3] By March 11, 2020, the World Health Organization (WHO) declared the COVID-19 outbreak as a pandemic.[4] Given the circumstances, prevention strategies were, and still remain, a mainstay approach to manage the pathogen until mass immunization could be achieved.[5] Social distancing became one of the foremost prevention methods around the world.[6] On March 23, 2020, the province of Manitoba declared the closure of all universities and schools.[7] Similar closures of medical schools around the globe resulted in a massive shift in medical education, with significant impacts on teaching gross anatomy.[8,9]

Gross Anatomy at the University of Manitoba prior to the pandemic

Anatomy laboratories ("labs") in the University of Manitoba Max Rady College of Medicine Undergraduate Medical Education (UGME) program are predominantly a first-year endeavour taught in conjunction with lectures and adjunct note packages. In pre-pandemic times, labs and relevant lectures are held in-person. Students are separated into groups, and each group conducts dissections on a given body donor (a person who donated their body to medical science after they were deceased). Groups dissect body donors to completion by the end of the academic year in parallel with their modular coursework. Labs comprise of dissections, as well as a combination of prosection and electronic resources (such as relevant radiological imaging and note packages). During certain modules, groups rotate through multiple stations presenting a different aspect of anatomy under guided teaching by a preceptor, each with a separate body donor. Given the intensive nature of medical school training and faculty commitments respectively, guided time in labs can understandably be limited. However, access to labs is made available outside of class hours for students' independent learning. Unfortunately, the COVID-19 pandemic forced educators, both within and outside of medicine,[10] to adapt by cancelling in-person labs and/or restricting student access.[11] This resulted in the

*Correspondence to: sidhomk@myumanitoba.ca
[†]Max Rady College of Medicine, University of Manitoba

anatomy labs at the University of Manitoba, and many others across the world,[12] to focus on ways to adapt to the corresponding shift to online learning.

Gross Anatomy through the ages: Its history and importance

A thorough understanding of human anatomy is integral to medical education. Medicine is grounded in its physiological and pathological underpinnings, both of which are related to human anatomy. As such, anatomical education allows medical students to understand the link between function, structure, and the relation to disease process. Cadaveric dissection has long been a gold standard instructional method in medical school.[13] Indeed, centuries of history describing cadaveric dissection pedate even the United Kingdom's Anatomy Act of 1832 and the Murder Act of 1752, demonstrating that cadaveric recruitment and dissection are long-embedded within medical education.[14] Both of these acts legitimized the medical supply of human cadavers via legislature in one form or another. For example, the Murder Act stated that the bodies of criminals were to be given to the Surgeon's Hall in London for dissection and education. Nowadays, schools have instead developed ethically-rigorous standards for body donation that allow for the continued dissection of body donors for the purposes of medical learning.[15] Nevertheless, the development of this modern ethical framework is rooted even further back in time, stemming from a legendary professor, Galen of Pergamon, and a curious student, Andreas Vesalius.

In the almost 1500-year gap between the time of Galen and Versalius respectively, the culture surrounding medicine changed immensely. While Galen was limited by access only to animal dissections for education, Vesalius was able to use human cadavers.[16] Though Galen is commonly hailed as the founder of physiology and one of the most celebrated anatomists in history, Vesalius is specifically said to be the "father of modern human anatomy".[17] The revolutionary progression of anatomical knowledge illustrated by their research established that, if limited to books and animal dissection, understanding of the human body was inaccurate.[18] The modern debate however is no longer between animal versus human dissection, but rather between human dissection versus none whatsoever. Whether or not body donation is needed in current medical education is a highly-debated subject.[19] In contrast to the times of Galen and Vesalius, modern-day medical schools have access to technology that can act as a substitute to deceased animals and body donors.

Although new equipment may increase the number of modalities through which to teach anatomy, some physicians still believe that cadaveric teaching is an important element of medical curricula.[20] However, many physicians contend that it is possible to practice their current specialty without learning human anatomy via adaveric dissection.[20] Assuming goal-directed learning towards evidence-based medicine, if the intervention (i.e. cadaveric learning) does not alter the outcome compared to non-cadaveric learning, the benefit it offers would therefore be up for question. The problem with this statement is the outcome being measured. Depending on how teaching methods and subsequent learning is evaluated, assessing whether cadaveric teaching is beneficial or not may be unclear due to imprecise measurement. Most medical students do not know what specialty they will end up practicing at the end of their undergraduate education.[21] Rather, their goal through anatomy labs is to develop professionally, emotionally, and technically as future medical professionals.[22] This development is reflected by more than what is deduced from the application of semantic knowledge during bell-ringer examinations or similar assessment methods.[23–26]

Comparisons to contemporary gross anatomy

Regarding pedagogy around anatomical teaching itself, it can be argued that little has changed in the present day compared to previous centuries. In the past, most anatomical instruction occurred in-person at anatomy theatres where groups of students would learn from a teacher who would describe the human anatomy of a cadaver on display.[27,28] In the present, didactic anatomy teaching still occurs in lecture theatres and laboratories where one or more preceptors presents anatomy via a cadaver to a group of students. However, learning now also occurs via online class tutorials, video lectures, hands-on dissection,[29] and new computer software.[30] To this end, the pandemic has highlighted the importance of anatomical education, placing the spotlight on its novel technological adjuncts.[31]

Resources such as assigned study packages or three-dimensional modelling are not equal substitutes for cadaveric dissection. Yet, referring to the resources created for the past academic year at the University of Manitoba UGME anatomy labs as adjuncts would undercut their value. Medical students who used these resources during the pandemic achieved a thorough understanding of gross anatomy. The use of such packages offers a significant positive impact to students' performance and are well-received by learners.[32] However, cadaveric learning is a unique teaching resource that not only offers education on gross anatomy, but also serves to improve students' surgical,[24] communicative, and collaborative skills.[33] In Manual of Anatomy, Jacobus Sylvius noted that learning anatomy is to "learn the manner of cutting by eye and touch than by reading and listening. For reading alone never taught anyone how to sail a ship, to lead an army, nor to compound a medicine, which is done more so by the use of one's own sight and the training of one's own hands"[34]. Cadavers thus present a unique visceral experience to students that is not to be replaced by other resources, but rather supported.

The role of cadaveric dissection

In addition to the advantage it offers for developing surgical skill, the introduction of cadaveric dissection early in medical school may act as a differentiating factor concerning a student's choice between surgery and medicine-based practice.[26] At an even deeper level though, the tangible experience of cadaveric dissection elicits a response from students that does more than just direct them toward or away from surgical specialties.[35] Students go through the experience with their cadavers as one of their first "patients". This promotes their respect and appreciation for the body donor, which instills greater compassion for future living patients.[36] The process of cadaveric dissection teaches not just anatomy and surgical skill, but a fundamental sense of professionalism and humanism.[22,31,37,38]. As students progress through anatomy lab education, their perspective of the body donor may also evolve from cadaver to patient. As the encounter progressively more patients in-person, so to do they come to understand that their body donor was given to them by a once-living person who had a name, family, and life history. Indeed, the University of Manitoba holds an annual burial ceremony for the families of those that elected to participate in the body donor program. It allows students to present at this ceremony and thank the families for the contribution of their loved ones. This allows for the early development of an emotional and empathic understanding for patients in medical students.

Gross dissection afforded by body donors also offers a unique visuospatial perspective to learning that students would otherwise not obtain. Simply put, the human body has more to offer than what is offered by the sagittal, transverse, and coronal planes. In-person observation of organs and systems gives students a greater understanding of the proportion, scale, and relationship between structures. While these relationships can be emulated in three-dimensional computer-generated models of the body, those models lack reality. The human body is not perfect, and too often learning materials present them as if they were. Real people get old, have had a cholecystectomy, have atherosclerosis, break bones, develop renal cysts, etc. This reality is not necessarily encapsulated by a computer-generated model, or even corresponding pages in a medical textbook with structure and function listed. Examining multiple body donors in-person fosters an appreciation not only for the variety within "normal" human anatomy, but also for a wider understanding of numerous pathologic processes that affect normal structure and function. No other opportunity allows a student to appreciate the very texture of human tissue in order to contrast normal against abnormal, young against aged, and healthy against pathological. Cadaveric learning offers a gestalt of anatomical education that is unmatched even by combinations of other modalities.[26,39] Despite this, after March 23, 2020, the University of Manitoba UGME anatomy labs were forced to adapt their in-person gross anatomy labs to the COVID-19 pandemic.

Gross anatomy at the University of Manitoba during the pandemic

Videos, e-book readings, cadaveric images, simulation applications, online learning tools and Zoom videoconferencing were some of the resources used by the University of Manitoba's UGME anatomy labs to adapt to the pandemic. Many of these were specifically developed to facilitate anatomical learning at a distance. The resources allowed students to progress in their medical education by completing their required anatomical learning in isolation without cadavers. Given that students were able to learn gross anatomy during the pandemic without cadaveric dissection, does this mean that cadaveric dissection is unnecessary? Not likely. There exist no resources or accessory technologies that can fully replace the enhanced learning that students experience with real cadavers. In his book, When Breath Becomes Air, neurosurgeon Paul Kalanithi states:

> "Cadaver dissection is a medical rite of passage and a trespass on the sacrosanct, engendering a legion of feelings: from revulsion, exhilaration, nausea, frustration, and awe to, as time passes, the mere tedium of academic exercise. Everything teeters between pathos and bathos: here you are, violating society's most fundamental taboos... Eventually, as you complete your assignments by dissecting the median nerve, sawing the pelvis in half, and slicing open the heart, the bathos supersedes: the sacred violation takes on the character of your average college class... Cadavers reverse the polarity. The mannequins you pretend are real; the cadavers you pretend are fake. But that first day, you just can't." [40]

By the beginning of the 2020-2021 academic year, gross anatomy labs in the UGME program were able to adapt in-person sessions to allow for socially distanced learning. Compared to past years, first-year medical students were divided into three rather than two groups. Justifiably, this was done in order to minimize the size of the "bubbles", optimize social distancing, and reduce class contacts. However, this also meant that each group was allotted less time because the overall number of hours given to lab instructors to teach the material was unchanged. Students were also unable to visit the anatomy laboratories outside of supervised time. Limitations on time with cadavers correspondingly restricts the utility of dissection.[41] In contrast, prosection and interactive didactic teaching are of greater value for learning when time is limited.[42] Although time-consuming, dissection is still a necessary resource within an ideal multi-modal approach to anatomical education in medicine.[26,43].

Beyond academic benefits, the practice of dissection also delivers social benefits. In the context of a "Code Red" critical pandemic response, medical stu-

dents could hardly see anyone outside of their household, let alone their classmates. As a result, anatomy classes became one of, if not their only, social engagements on a day-to-day, or even week-to-week basis. Here, the relative value of group learning increases: students may favourably associate anatomy labs due to their sociality in an environment that is otherwise typically conducive to burnout.[44] Certainly, the medical community constitutes a large portion of a physician's academic and non-academic life. With extracurricular events, club meetings, classes, and clinical skills sessions cancelled due to new weekly outbreaks, the anatomy lab may represent the single reliable social outing for medical students. Hence, the gross anatomy lab has the potential to become a new community-building environment for students.

While students need the laboratory for academic learning and non-academic social benefits, the lab requires body donors to serve this purpose. The concept of body donation has long been a subject to scrutiny,[19,45,46] and therefore merits ongoing discussion, especially considering the transmissibility of a pandemic pathogen. There is still much to learn about SARS-CoV-2 and its pathogenicity. Questions around whether the virus is transmissible from the deceased to the living are allotted lower global priority compared to questions around vaccine development, transmission via fomites, etc.[47,48] However, for those who instruct and learn in anatomy labs, and whose conventional recruitment methods have been impaired due to the pandemic, these questions are important for the continuity of gross anatomy education. Typically, at the University of Manitoba, body donors can be recruited from funeral homes and hospitals with the help of emergency physician residents. There was a significant decrease in body donors over the past academic year due to the pandemic, its corresponding restrictions, and apprehension over transmissibility. This obstacle is both social and scientific: the community cannot currently answer questions about body donors acting as vectors for SARS-CoV-2 with scientific confidence.[49–51] It can neither market the body donor program for the purposes of recruitment due to dubious nature of, and ethical quandaries raised by, soliciting body donations during a pandemic that has resulted in the deaths of thousands in Canada alone.

Conclusion

The practice of cadaveric dissection was thought by some to be impossible due to the COVID-19.[52] In spite of this, the gross anatomy labs at the University of Manitoba have survived the pandemic. Not only has the program continued with dissections, but there are discussions underway to expand gross anatomy teaching using focus groups of 2nd- and 3rd-year medical students over the summer months to prepare for the upcoming academic year.[53] Expanding 4th-year gross anatomy electives and postgraduate training with the use of clinical grade cadavers is also under consideration.[54] Throughout the pandemic, the University of Manitoba UGME program demonstrated the high value of cadaveric teaching in order to provide future doctors with the necessary foundation to succeed in medicine. Medical learners' future patients are real people. This means that learning anatomy with real people, just as students do with clinical skills, is crucial. Body donors are among the first patients of young medical students. Ultimately, there are lessons beyond technical basics of gross anatomy that only a silent teacher can instill in learners.

References

[1] Amrane S, Tissot-Dupont H, Doudier B. Rapid viral diagnosis and ambulatory management of suspected COVID-19 cases presenting at the infectious diseases referral hospital in Marseille, France, - January 31st to March 1st, 2020: A respiratory virus snapshot. Travel Med Infect Dis. 2020;36(101632).

[2] Zu ZY, Di Jiang M, Xu PP, et al. Coronavirus Disease 2019 (COVID-19): A Perspective from China. Radiology. 2020;296(2).

[3] Coronaviridae Study Group of the International Committee on Taxonomy of Viruses. The species Severe acute respiratory syndrome-related coronavirus: classifying 2019-nCoV and naming it SARS-CoV-2. Nat Microbiol. 2020;5(4).

[4] WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020; 2020. [Cited 2021 July 12]. Available from: https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020.

[5] Randolph HE, Barreiro LB. Herd Immunity: Understanding COVID-19. Immunity. 2020;52(5).

[6] VoPham T, Weaver MD, Hart JE, Ton M, White E, Newcomb PA. Effect of social distancing on COVID-19 incidence and mortality in the US. medRxiv; 2020.

[7] Coronavirus: Manitoba schools to close for three weeks starting March 23 — Globalnews.ca; 2021. [Cited 2021 July 12]. Available from: https://globalnews.ca/news/6673744/coronavirus-university-of-winnipeg-suspends-winter-term-red-river-college-implements-study-week/.

[8] Brassett C, Cosker T, Davies DC, et al. COVID-19 and anatomy: Stimulus and initial response. J Anat. 2020;237(3).

[9] Pather N, Blyth P, Chapman JA, et al. Forced Disruption of Anatomy Education in Australia and New Zealand: An Acute Response to the Covid-19 Pandemic. Anat Sci Educ. 2020;13(3).

[10] Dhawan S. Online Learning: A Panacea in the Time of COVID-19 Crisis. J Educ Technol Syst. 2020;49(1).

[11] Franchi T. The Impact of the Covid-19 Pandemic on Current Anatomy Education and Future Careers: A Student's Perspective. Anat Sci Educ. 2020;13(3).

[12] Kim D, Yoo H, Lee YM, Rhyu IJ. Lessons from Cadaver Dissection during the COVID-19 Pandemic. J Korean Med Sci. 2021;36(26):1–5.

[13] McLachlan JC, Patten D. Anatomy teaching: ghosts of the past, present and future. Med Educ. 2006;40(3):243–253.

[14] Bennett RE. A Fate Worse than Death? Dissection and the Criminal Corpse. In: Capital Punishment and the Criminal Corpse in Scotland, 1740–1834; 2017. p. 159–185.

[15] Siddiquey AS, Husain SS, Laila SZH. History of Anatomy. Bangladesh J Anat. 2009;7(1):1–3.

[16] Zampieri F, ElMaghawry M, Zanatta A, Thiene G. Andreas Vesalius: Celebrating 500 years of dissecting nature. Glob Cardiol Sci Pract. 2015;2015(5).

[17] Standring S. A brief history of topographical anatomy. J Anat. 2016;229(1).

[18] Markatos K, Chytas D, Tsakotos G, Karamanou M, Piagkou M, Johnson E. Vesalius criticism on Galen's musculoskeletal anatomy. Acta Chir Belg. 2019;119(4):267–271.

[19] Saha A, Sarkar A, Mandal S. Body Donation after Death: The Mental Setup of Educated People. J Clin Diagn Res. 2015;9(6).

[20] Ghazanfar H, Rashid S, Hussain A, Ghazanfar M, Ghazanfar A, Javaid A. Cadaveric Dissection a Thing of the Past? The Insight of Consultants, Fellows, and Residents. Cureus. 2018;10(4).

[21] Scott IM, Wright BJ, Brenneis FR, Gowans MC. Whether or wither some specialties: a survey of Canadian medical student career interest. BMC Med Educ. 2009;9(1).

[22] Parker E, Randall V. Learning Beyond the Basics of Cadaveric Dissection: a Qualitative Analysis of Non-academic Learning in Anatomy Education. Med Sci Educ. 2021;31(1).

[23] Miyoshi M, Mori T, Tanimura C, et al. Impact of Hands-on Experience of a Cadaver Dissection on the Professional Identity Formation of Health Sciences Students. Yonago Acta Med. 2019;62(1).

[24] Holland JP, Lorraine W, Alan H, Vinidh P, Deehan DJ. Cadaveric hands-on training for surgical specialties: is this back to the future for surgical skills development? J Surg Educ. 2011;68(2):110–116.

[25] Korf HW, Wicht H, Snipes RL, et al. The dissection course – necessary and indispensable for teaching anatomy to medical students. Ann Anat - Anat Anzeiger. 2008;190(1):16–22.

[26] Estai M, Bunt S. Best teaching practices in anatomy education: A critical review. Ann Anat. 2016;208:151–157.

[27] Martinez-Vidal A, Pardo-Tomás J. Anatomical Theatres and the Teaching of Anatomy in Early Modern Spain. Med Hist. 2005;49(3).

[28] Klestinec C. A History of Anatomy Theaters in Sixteenth-Century Padua. J Hist Med Allied Sci. 2004;59(3):375–412.

[29] Johnson JH. Importance of dissection in learning anatomy: personal dissection versus peer teaching. Clin Anat. 2002;15(1):38–44.

[30] Zargaran A, Turki MA, Bhaskar J, Spiers HVM, Zargaran D. The Role of Technology in Anatomy Teaching: Striking the Right Balance. Adv Med Educ Pract. 2020;11(259).

[31] Goss AL, Viswanathan VB, DeLisser HM. Not Just a Specimen: A Qualitative Study of Emotion, Morality, and Professionalism in One Medical School Gross Anatomy Laboratory. Anat Sci Educ. 2019;12(4):349–359.

[32] Dawson AG, Bruce SAM, Heys SD, Steward IJ. Student views on the introduction of anatomy teaching packages into clinical attachments. Clin Anat. 2009;22(2):267–272.

[33] Palmer EG, Reddy RK, Laughey W. Teaching Professionalism to Medical Students Using Dissection-Based Anatomy Education: a Practical Guide. Med Sci Educ. 2020;311. 2020;31(1):203-213.

[34] Pawlina W, Lachman N. Dissection in learning and teaching gross anatomy: Rebuttal to McLachlan. Anat Rec Part B New Anat. 2004;281B(1):9-11.

[35] Selcuk I, Tatar I, Huri E. Cadaveric anatomy and dissection in surgical training. Turkish J Obstet Gynecol. 2019;16(1).

[36] Weeks SE, Harris EE, Kinzey WG. Human gross anatomy: a crucial time to encourage respect and compassion in students. Clin Anat. 1995;8(1):69–79.

[37] Swartz WJ. Using gross anatomy to teach and assess professionalism in the first year of medical school. Clin Anat. 2006;19(5):437–441.

[38] Escobar-Poni B, Poni ES. The role of gross anatomy in promoting professionalism: a neglected opportunity! Clin Anat. 2006;19(5):461–467.

[39] Older J. Anatomy: a must for teaching the next generation. Surgeon. 2004;2(2):79–90.

[40] Kalanithi P. When Breath Becomes Air. New York: Random House; 2016.

[41] Sugand K, Abrahams P, Khurana A. The anatomy of anatomy: A review for its modernization. Anat Sci Educ. 2010;3(2):83–93.

[42] Abdellatif H. Time Spent in Practicing Dissection Correlated with Improvement in Anatomical Knowledge of Students: Experimental Study in an Integrated Learning Program. Cureus. 2020;12(4).

[43] Kerby J, Shukur ZN, Shalhoub J. The relationships between learning outcomes and methods of teaching anatomy as perceived by medical students. Clin Anat. 2011;24(4):489–497.

[44] Cecil J, McHale C, Hart J, Laidlaw A. Behaviour and burnout in medical students. Med Educ Online. 2014;19(25209).

[45] Rokade SA, Gaikawad AP. Body donation in India: social awareness, willingness, and associated factors. Anat Sci Educ. 2012;5(2):83–89.

[46] Naidoo N, Al-Sharif GA, Khan R, Azar A, Omer A. In death there is life: perceptions of the university community regarding body donation for educational purposes in the United Arab Emirates. Heliyon. 2021;7(7).

[47] BMA — COVID-19: death certification and cremation; 2021. [Cited 2021, July 12]. Available from: https://www.bma.org.uk/advice-and-support/covid-19/adapting-to-covid/covid-19-death-certification-and-cremation.

[48] Guidance for care of the deceased with suspected or confirmed coronavirus (COVID-19) - GOV.UK; 2021. [Cited 2021 July 12]. Available from: https://www.gov.uk/government/publications/covid-19-guidance-for-care-of-the-deceased/guidance-for-care-of-the-deceased-with-suspected-or-confirmed-coronavirus-covid-19.

[49] Ooi SZY, Ooi R. Impact of SARS-CoV-2 virus pandemic on the future of cadaveric dissection anatomical teaching. Med Educ Online. 2020;25(1).

[50] Rajasekhar SSSN, Kumar VD. The Cadaver Conundrum: Sourcing and Anatomical Embalming of Human Dead Bodies by Medical Schools during and after COVID-19 Pandemic: Review and Recommendations. SN Compr Clin Med. 2021;3(4):924–936.

[51] McCumber TL, Latacha KS, Lomneth CS. The state of anatomical donation programs amidst the SARS-CoV-2 (Covid-19) pandemic. Clin Anat. 2021;.

[52] Saverino D. Teaching anatomy at the time of COVID-19. Clin Anat. 2020;.

[53] In conversation with Dr. A. Hyrniuk (Assistant Professor, University of Manitoba) and L. Clayton (Laboratory Instructor, University of Manitoba); 2020.

[54] In-text: feedback from ([faculty reviewer, name redacted for blinded review], University of Manitoba; 2021.