Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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EDITORIAL

Cadaverless anatomy: Darkness in the times of pandemic Covid-19

Cadavre sans anatomie : l'obscurité au temps de la pandémie Covid-19

KEYWORDS
Anatomy education;
Body donation;
Covid-19;
Pandemic;
Virtual classes

Summary The pandemic Covid-19 is responsible for a major education crisis globally and has a drastic impact on medical training as well. The objective of the present study was to envision the present and future impact of Covid-19 on anatomy learning and research. The virtual education is the only mode of teaching in current scenario. Every anatomist is unlocking technology to deliver best education however understanding of the subject without dissections or other practical teaching aids like bones, specimens, embryology models, microscopic slides etc. is challenging. This approach misses the feel and human visual impacts. Potential educational disruption is felt currently and will be experienced even after the pandemic is over due to scarcity of cadavers. As the body donor may be carrier or died of Covid-19 and there is no proven screening to rule out this infection in donor, so the acceptance of body donations is not advisable for the safety of medical students and health care workers. To conclude, anatomy education is cadaverless currently due to Covid-19 lockdown and it is prophesied that after the pandemic, real cadavers will be replaced by virtual cadavers because of paucity of cadavers. Research in the field of anatomy will also be adversely affected.

Résumé La pandémie Covid-19 est responsable d'une crise majeure de l'éducation dans le monde et a également un impact considérable sur la formation médicale. L'objectif de la présente étude était d'envisager l'impact actuel et futur de la Covid-19 sur l'apprentissage et la recherche en anatomie. L'éducation virtuelle est le seul mode d'enseignement dans le scénario actuel. Chaque anatomiste exploite la technologie pour offrir la meilleure éducation, mais la compréhension du sujet sans dissections ou autres aides pédagogiques pratiques comme les os, les spécimens, les modèles d'embryologie, les lames microscopiques, etc. est difficile. Cette approche manque la sensation et les impacts visuels humains. Une perturbation éducative potentielle se fait sentir actuellement et sera ressentie même après la fin de la pandémie en raison de la rareté des cadavres. Étant donné que le donneur de corps peut être porteur ou décédé de la Covid-19 et qu'aucun dépistage n'a été prouvé pour exclure cette infection chez le donneur Ainsi, l'acceptation des dons de corps n'est pas recommandée pour la sécurité des étudiants en médecine et des travailleurs de la santé. Pour conclure, l'enseignement de l'anatomie est privé de cadavres actuellement en raison du verrouillage de la Covid-19 et il est prophétisé qu'après la pandémie, les vrais cadavres seront remplacés par des modèles virtuels en raison du manque de cadavres. La recherche dans le domaine de l'anatomie sera également affectée.

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Introduction

Pandemics are nothing unusual but devastating. Human being have endured different pandemics like cholera, the Black Death, and the Spanish flu, among others. Pandemics have played a role in shaping human history throughout the centuries. Just think of that we are not the only humans to have experienced such trials and suffering and we will not be the last. The current pandemic Covid-19 is impacting the global population in drastic ways. Coronavirus has so far killed more than two hundred thousand and infected nearly three million since its origin in Chinese city of Wuhan in December 2019 [1,2]. Everyone must remember that ''anything and everything has an end'' so shall this Covid-19. Though presently no vaccine has been discovered for the treatment of Covid-19. However it is strongly believed that the modern science and medicines are the incredible forces which will surely find the treatment of this novel Coronavirus in the near future. Currently the strategies to address this devastating infection are physical distancing and quarantine measures [3].

The pandemic Covid-19 outbreak is responsible for a major education crisis globally as almost entire world is under lockdown and all educational institutions including medical colleges are shut down. The key reason is to decrease the risk of exposure for medical students, residents, faculty, and laboratory technicians to contain the spread of Covid-19, which is an understandable concern. As the modern medical curriculum already allows restricted time for each subject, and now this pandemic will further shorten the same [4]. The present study was proposed to envision the present and future impact of Covid-19 on anatomy education and research.

Anatomy is the cornerstone of medical education from which clinicians develop their clinical skills. Virtual classes is the only option at present for the anatomists. Theory lectures may be delivered effectively by online classes, however learning of Anatomy exclusively by this mode is challenging. Cadaveric dissection is considered the ''gold standard'' in the anatomy education [5—7]. Almost all the medical students, especially residents in surgery instigate their anatomy education by disassembling a human body.

Potential impact of Covid-19 on anatomy education

In the darkness of Covid-19, most of the medical students and residents lost access not only to cadavers ''The body of Knowledge'', but also to a number of other learning modalities like models, museum specimens, bones, microscopic slides and others in the present scenario due to lockdown, which may potentially impact their knowledge in anatomy. Though every anatomist is unlocking technology to deliver best education, however there is a sharp learning curve associated with using these programs for faculty as well as students [8]. As there are no face to face interactions with teachers and peers, many students find it difficult to manipulate models and focus on structures of interest, thus further bringing into question their usefulness in times as challenging as a pandemic [9].

Adaptability and determination are attributes during this time of challenge that medical students can prove more enthusiastically. As each student has a personal experience of how Covid-19 has impacted his/her education, and certainly the impacts of this pandemic will be felt on widespread level. The anxiety in the community is palpable and every individual is confused by how to proceed in the wake of Covid-19. This is no different for medical students and faculty. The questions that arise regarding medical education and their future careers are not answerable [10].

Pre-pandemic encroachment of real cadavers as technology advances

It has already been quoted even before the pandemic that ''Anatomy education has been resistant to change for almost millennium'' what is happening now is a sign of a possible historic transition and we are at the beginning of a paradigm shift. It was further predicted that anatomy education is going to be cadaverless in a decade. Traditional anatomy will be encroached by alternative modes like virtual dissection, medical imaging, living anatomy and multimedia resources [11,12]. In the present scenario of pandemic Covid-19 darkness, this prediction is going to be true in near future.

Post-pandemic anatomy

There are some practical issues in anatomy education to consider as a result of pandemic Covid-19. Currently students and residents of surgery are not able to access cadavers due to social distancing reasons, however future students and residents may not have this provision due to paucity of cadavers. There is already scarcity of cadavers in most of medical colleges globally and most of the institutes are reliant on the body donation program. Many medical institutes have denied accepting bodies during this pandemic. The donor may be carrier or infected with Covid-19 and it is not feasible to test the cadaver as screening kits are not enough even for all live suspected cases in the present scenario. Moreover negative results of laboratory screening may not rule out Covid-19 infection [13].The optimal approach to donor screening may change over time as more data will be collected.

Impact of cadaverless anatomy on education and research

Anatomy education without cadavers has its own shortcomings. It may be hard to develop a perception of real in a virtual body as spatial orientation and visualization of relationships between neurovascular structures will not be as clear as in cadaveric dissection The medical students especially residents in surgery will not be able to appreciate the natural anatomical variations, according to Hoffman. As cadavers are considered as doctor's first patient, students may lose the emotional impact of working on a cadaver [12]. Dissection trains the fingers and hands of future surgeon, thus the cadaverless anatomy may impact the clinical skills of a budding surgeon. Any novel surgical technique is mastered on the cadavers before operating on patients. The

research in the field of anatomy either its surgical anatomy, microscopic or molecular research is based on cadaver. The medical device research community also heavily depends on cadavers for developing new products and manoeuvres. They use the cadavers to make relevant measurements between different anatomical structures for the development of new medical devices and to train clinicians for execution of these novel procedures. The postgraduate research degrees in anatomy and surgery also usually involve dissection of cadaver. Thus presently as students and residents are not able to attend dissection laboratories, their cadaveric learning and research is paused.

Is to abandon the idea of accepting body donations is the only way-out at present?

As per guidelines issued by health ministry regarding safe handling of dead body, no Covid-19 infected body will be embalmed and autopsy should be avoided if possible. Ministry guidelines do not allow the body to be taken home, if the patient dies in hospital and there are clear instructions to cremate the body or deep burial to avoid any form of infection [14]. As this situation may continue for unknown period of time, family of donors should ensure that they have substitute funeral plan, as their body donation will not be accepted [15]. This information should be displayed on website by every institute which has body donation program, to avoid any inconvenience to donor's family during this pandemic crisis.

Conventionally infectious risks from cadavers are lesser than those from living individuals who have active disease or who are carriers of infectious agents. To prevent the transmission of infectious disease health workers are advised to avoid direct contact with blood and other body fluids, particularly to mucous membranes or broken skin [16]. Use of appropriate personal protective equipment and safe procedures are instructed for the same. According to WHO, the leading mode of transmission of Covid-19 is through fomites, droplets and close contact with possible spread through faeces [17]. This is a novel virus and the risks related to coming into contact with people who died from Covid-19 are unclear. It has been reported that in many countries, elderly males are facing the most threats and challenges of Coronavirus with maximum mortality. To this concern, literature says that bodies received in body donation program are predominantly of males with average age of 75 years [18—20]. This factor further discourages the acceptance of body donation in the current scenario, as the safety of health care professionals and medical students is the priority.

Conclusions

Traditional cadaveric dissection has already been partially encroached by technological advances before this pandemic. As now body donor pool is shrinking due to pandemic Covid-19, the question that comes to every anatomist mind is ''If digital learning will completely replace the real cadavers.'' The answer is ''Yes'', at least for current scenario because of lock down and in near future due to affected body donation program and shortened course time. The scarcity in the cadavers may impact research in anatomy as well. It is uncertain if digital cadavers will be suitable enough to replace real ones.

Disclosure of interest

The authors declare that they have no competing interest.

References

[1] World Health Organization W.H.O. Novel Coronavirus (2019-nCoV): Situation Dashboard; 2020, https://covid19.who.int/ [accessed 28 April 2020].

[2] World Health Organization WHO. Novel Coronavirus (2019-nCoV): Situation report—1. 21 January 2020. 1st Ed Geneva, Switzerland: World Health Organization; 2020, https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200121-sitrep-1-2019- ncov.pdf?sfvrsn=20a99c10_45 p [accessed 28 April 2020].

[3] Newman T. Comparing Covid-19 with previous pandemics. Medical News Today 2020, https://www.medicalnewstoday.com/articles/comparing-covid-19-with-previous-pandemics #The-Black-Death.

[4] Warner JH, Rizzolo LJ. Anatomical instruction and training for professionalism from the 19th to the 21st centuries. Clin Anat 2006;19:403—14.

[5] Darras KE, de Bruin ABH, Nicolaou S, et al. Is there a superior simulator for human anatomy education? How virtual dissection can overcome the anatomic and pedagogic limitations of cadaveric dissection. Med Teach 2018;40:752—3.

[6] McLachlan JC. New path for teaching anatomy: living anatomy and medical imaging vs. dissection. Anat Rec B New Anat 2004;281:4—5.

[7] Washmuth NB, Cahoon, Tuggle K, Hunsinger RN. Virtual dissection: alternative to cadaveric dissection for a pregnant nurse anesthesia student. Health Professions Education; 2019, http://dx.doi.org/10.1016/j.hpe.11. 001.

[8] Doubleday EG, O'Loughlin VD, Doubleday AF. The virtual anatomy laboratory: Usability testing to improve an online learning resource for anatomy education. Anat Sci Educ 2011;4:318—26.

[9] Attardi SM, Choi S, Barnett J, Rogers KA. Mixed methods student evaluation of an online systemic human anatomy course with laboratory. Anat Sci Educ 2016;9:272—85.

[10] Ferrel MN, Ryan JJ. The impact of Covid-19 on medical education. Cureus 2020;12:e7492, http://dx.doi.org/10.7759/cureus.7492.

[11] Darras KE, Spouge R, Hatala R, et al. Integrated virtual and cadaveric dissection laboratories enhance first year medical students' anatomy experience: a pilot study. BMC Med Educ 2019;19:366, http://dx.doi.org/10.1186/s12909-019-1806-5.

[12] Gholipour B. 2019 URL: https://www.scientificamerican.com/article/med-school-without-cadavers/.[accessed 27 April 2020].

[13] Winichakoon P, Chaiwarith R, Liwsrisakun C, Salee P, Goonna A, Limsukon A, et al. Negative nasopharyngeal and oropharyngeal swab does not rule out Covid-19. J Clin Microbiol 2020, http://dx.doi.org/10.1128/JCM.00297-20 [in press].

[14] Government of India. Covid-19: Guidelines on Dead Body Management. 1st Ed New Delhi, India: Government of India, Ministry of Health and Family Welfare, Directorate General of Health Services (EMR Division); 2020, https://www.mohfw.gov.in/pdf/1584423700568_COVID19GuidelinesonDeadbody management.pdf 7 p.[accessed 27 April 2020].

[15] Human Tissue HTA, Authority. Body donations: Frequently asked questions. London, UK: Human Tissue Authority;

2020, https://www.hta.gov.uk/faqs/body-donation [accessed 27 April 2020].
[16] Morgan O. Infectious disease risks from dead bodies following natural disasters. Rev Panam Salud Publica 2004;15:307—12.
[17] World Health Organization W.H.O. Infection prevention and control for the safe management of a dead body in the context of COVID-19: Interim guidance 24 March 2020. 1st Ed Geneva, Switzerland: World Health Organization; 2020, https://apps.who.int/iris/bitstream/handle/10665/331538/WHO-COVID-19lPC_DBMgmt-2020.1-eng.pdf 6 p [accessed 28 April 2020].
[18] Bose A, Pandit VK, Jehan M, Marko RS. 11 years study of body bequest trends in a medical college. J Dent Med Sci 2017;16:130—3.
[19] Boulware LE, Ratner LE, Cooper LA, LaVeist TA, Powe NR. Whole body donation for medical science: a population based study. Clin Anat 2004;17:570—7.
[20] Dluzen DE, Brammer CM, Bernard JC, Keyser MR. Survey of cadaveric donors to a body donor program: 1978-1993. Clin Anat 1996;9:183—92.

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