



WESTERN NIGERIA JOURNAL OF MEDICAL SCIENCES (WNJMS)

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CHALLENGES OF CADAVER DISSECTION FOR ANATOMY TEACHING AND LEARNING DURING COVID-19 PANDEMIC IN A DEVELOPING COUNTRY: A REVIEW

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ABSTRACT

The infectious nature of the severe acute respiratory syndrome coronavirus SARS/COV-2 (COVID-19) poses serious challenges to anatomy education in higher institutions with migrations to the virtual environment. Cadaveric dissection involves the use of human remains for learning purposes in anatomy education therefore there is a need for regular supply. The major source of supply for human remains is from unclaimed bodies, body donation and imported cadavers from other countries. To sustain anatomical dissection, actions need to be taken by key stakeholders to ensure the continual use of cadaveric material in the dissemination of anatomical education. This article narrates the challenges encountered as part of effective teaching and learning of anatomy during the COVID-19 pandemic and also explores actions that need to be taken by key stakeholders to ensure a safe and effective cadaveric dissection learning environment in the face of a pandemic.

Keywords: Cadaver dissection, COVID-19 pandemic, Challenges, Anatomy Education

INTRODUCTION

Coronaviruses can cause serious health challenges and sometimes death in humans.¹ They have existed in animals long before they became a public health concern to humans.^{2,3} In recent years, different epidemics caused by

coronaviruses have afflicted humans such as the severe acute respiratory syndrome coronavirus (SARS-CoV) and the Middle East respiratory syndrome coronavirus (MERS-CoV) reported in 2003 and 2012 respectively.^{4,5} The SARS-CoV2 or Covid-19 with symptoms that range from fever, dry cough, pneumonia, renal failure, myalgia, and fatigue to death is plaguing the world.^{6,7} Coronavirus disease (SARS-CoV-2) is caused by a microorganism that exists in the form of positive-strand RNA viruses known to cause highly infectious respiratory diseases in humans.^{8,9} It presents with an atypical form of viral pneumonia and was first identified in Wuhan, China, in December 2019.¹⁰

The origin and exact mechanism of action of SARS-CoV-2 is currently not completely clear and there is insufficient scientific evidence to support its host species source though there are postulations about it originating from birds, reptiles and/or mammals.^{2,11} The SARS-CoV-2 appears to be more infectious than the SARS and MERS viruses with patients presenting with symptoms such as dry cough, fever, asthenia, nasal congestion, and diarrhoea.¹² The disease can result in atypical interstitial pneumonia, severe acute respiratory syndrome, acute renal failure and death.¹³

Transmission occurs from respiratory and oral aerosols through saliva, close contact or contaminated hands/or surfaces, for which hand hygiene, maintaining a safe distance and

avoiding touching the eyes, nose and mouth are highly recommended by the World Health Organization (WHO) and the Center for Disease Control (CDC).^{14,15} Although pandemics are not new, some of them have been documented to span long periods, for example, the Spanish flu spanned about 2 years.^{16,17} Since it is not certain when COVID-19 disease will end or be sufficiently controlled, it is important to continue to look for ways to safeguard the future of cadaver dissection without putting the lives of handlers such as anatomists, students, demonstrators and prosectors, especially in developing countries at risk.

The degree of transmissibility of the coronavirus disease from an infected cadaver or human remains to the handler has presented important questions on procedures that must be put in place for human anatomy educators, medical, dental and allied health science students as well as forensic scientists and pathologists who work with cadavers and human remains so that risks of exposure can be minimized or eliminated. A report on a forensic practitioner's demise after handling the body of COVID-19 corpses in Thailand highlighted the degree of risks that handlers and dissectors of cadavers face in carrying out their duties.¹⁸ It is currently not known how long the coronavirus survives in cadavers and human remains, nor is it possible to estimate the percentage of transmission in cadaver handlers. Available evidence from the literature on some viral infections implies that the body could potentially be infectious even after many days of cold storage.¹⁰ Fixatives were presumed to be effective in the inactivation of infectious agents but studies have shown that cadavers with infectious pathogens may still pose infection hazards to those who handle them.¹⁹

There have been a lot of debates about the suitability of delivering anatomical knowledge without cadaver dissection.²⁰ Moreover, the rapidly expanding literature on COVID-19 brings to the fore the highly infectious nature of the pathogen hence the need to scrutinize and safeguard the practice on the use of cadaver dissection in training and learning of anatomy especially in post-

secondary education. This article narrates the challenges encountered in training as part of effective teaching and learning of anatomy during the COVID-19 pandemic and also reviews measures taken by key stakeholders to ensure a safe and effective cadaveric dissection learning environment in the face of a pandemic.

METHODS

We explored major databases such as PubMed MEDLINE, Ovid MEDLINE, Web of Science, and Science Direct from January 1992 to June 2019 using selected keywords ("COVID-19"; "cadaver"; "anatomy"; "dissection") to identify and extract articles relating and peculiar to Anatomy education in Nigeria. Search terms were updated according to the requirements of each electronic database where required. The literature obtained was exported into the Mendeley reference management software. Title and news content screening were performed independently by two researchers. No author or institution was contacted to verify the source of information. Published reports written in English were identified through the searches.

Relevance of Cadaver Dissection in Medical and Dental Education

Human cadaver dissection, demonstration and the use of prosected specimens were adjudged essential by medical and dental students as well as allied health science students to help them better visualize different organs of the human body.²¹ These hands-on learning methods were strongly supported by several authors who maintained that the use of cadaveric materials offers the best way to teach anatomy.²²⁻²⁷ The use of cadaveric dissection and prosection as the sole means of teaching anatomy was strongly supported by medical schools in Europe and the United States.^{22,24,26,28-35} Several studies argued that the benefits of learning with cadaveric dissection and prosected materials are many, ranging from bestowing on learners the practical proficiency needed to fully understand the human body, and their anatomical variations, to the teamwork, skills

and peer interaction enjoyed during dissection sessions.^{26,36–39}

Reports from medical students in Africa on the use of human cadaver dissection in learning human anatomy also revealed that it was considered an important and indispensable component of their study.^{40,41} Perspectives from the UK on anatomy demonstrations imply that the removal of cadaveric dissection from medical education could likely have lasting impacts on anatomy education because it is considered a learning tool without which anatomy education would be less than optimal, and could inhibit future development of Anatomists.⁴² Franchi also raised concerns about the impact that reduced exposure to cadaveric dissection could have on students during their clinical training as it could lead to inadequate preparation of students when they enter clerkships and residency programs.⁴² Aside from these, studies have also extolled the role of cadaveric dissection skills in the preparation of competent clinicians particularly surgeons, who need a deep understanding of anatomy for safe clinical procedures as well as for developing innovative surgical skills.^{20,43}

Cadaver Dissection prior to COVID-19 pandemic

Before the COVID-19 pandemic, some authorities have argued that cadaver dissection is dispensable.^{44,45} Some studies have shown that students can learn anatomy without a cadaver and purely through textbooks and online resources, and indeed several medical schools no longer use cadaver dissection.^{46,47} It is obvious that even before the COVID-19 pandemic, medical schools in developed countries were increasingly abandoning what they described as “costly and time-consuming dissection-based instructions” in favour of alternative methods of instruction including the use of prosected specimens, medical imaging, and multimedia resources.²⁰ However, in many developing countries, anatomists still depend on the supply of bodies that do not stem from voluntary donations by the deceased but from unclaimed bodies from hospitals and mortuaries, while some medical schools resort

to importing cadavers from abroad, and others utilize executed persons given to Anatomy Departments.^{48–50} The instability in supply has necessitated the application of alternative sources to meet the demand for bodies for anatomy education.^{40,51}

Challenges to cadaver dissection in countries with limited resources during COVID-19 pandemic

In Africa, 90% of medical schools use cadaveric dissections.⁴⁰ Although, cadaveric dissection helps in properly understanding the human body's structures, the COVID-19 pandemic has made it necessary to migrate to virtual teaching and learning platforms that involve the use of technologically advanced software devices, and innovative pedagogical approach.^{52–57} There are schools where dissection classes are still on hold as the institutions have made little or no investment in virtual teaching and learning. In the majority of these schools, access to donor-based dissection in laboratories is limited or nonexistent. Some studies have stated that dissection classes were cancelled earlier in the pandemic in the UK but have since resumed.^{58,59} In some African institutions, cadaver dissections are still suspended, and this could affect the delivery of teaching anatomy in the future. Most universities that have reopened, have opted for mostly virtual teaching and some have adopted limited face-to-face teaching as well as hybrid teaching. There has been a defense on the resumption of cadaver dissection during covid-19 pandemic as being essential even in the face of reduced numbers of donor bodies when compared to pre-covid-19 cadaver-to-student ratios.⁵³

The challenges of sourcing bodies for cadaver dissection still looms due to a reduction in the optimal delivery of goods and services as well as the provision of adequate testing, contact tracing and required Personal Protective Equipment (PPE) for staff and students. While some nations may easily find ways to amend their teaching and work to suit the evolving era using a hybrid of limited face-to-face teaching and technology, there is a real concern where resources and access to

technology are limited as observed in many African settings in order to ensure that cadaver dissection continues. How does one determine if the bodies of accident victims that are unclaimed or the bodies of armed bandits, prisoners etc. are COVID-19 positive without the provision of testing before donating to anatomical facilities? The sourcing, storage, and lack of adequate records on donated bodies pose serious challenges in developing countries.⁶⁰ This implies that infected bodies may easily find their way into anatomical body banks. There is also the challenge of accessing the online learning environment as a result of inadequate funding of tertiary institutions, insecurity, poor internet facilities, inadequate electricity supply and low income among other inherent socioeconomic problems.

Risk of transmission of infectious pathogens on cadavers despite fixation

The potential hazard of exposure to infectious pathogens is one of the risks associated with handling human cadavers during dissections despite the use of fixatives, disinfectants, glycerol, salts, and water.¹⁹ Winichakoon and colleagues were able to justify that a negative nasopharyngeal and oropharyngeal swab does not rule out COVID-19 infection.⁶¹ Moreover, studies have shown that microorganisms like *Mycobacterium tuberculosis*, hepatitis B & C viruses, HIV and prions cause transmissible spongiform encephalopathies when present in cadavers.^{62–67}

It is important to note and be cautious about the potential infectious nature of the novel COVID-19 especially because information on its infectivity rate in fixed human remains is evolving. A study reported the demise of a forensic practitioner following handling the body of COVID-19 corpses in Thailand.¹⁸ Another study has reported that SARS-CoV-2 has been detected in formalin-fixed paraffin-embedded samples following surgical resection of tongue squamous cell carcinoma of a patient who developed COVID-19 post-surgery. RNA of the SARS-CoV-2 strain was detected in the tumour and the normal submandibular gland samples using a real-time PCR-based assay although

viral RNA was not found in the metastatic and reactive lymph nodes, thus demonstrating that SARS-CoV-2 RNA can be detected in human samples even before COVID-19 disease develops.⁶⁸ For cytological experiments that involve COVID-19-positive human tissue, standard procedures (use of 2% or 4% paraformaldehyde, 50%–70% ethanol, 10% neutral buffered formalin) are required to fix tissues for pathological analysis and ultrafiltration through membranes with a molecular weight cut-off (MWCO) ranging from 3–30kDa, are effective for inactivating or eliminating SARS-CoV-2 to reduce infection risk and safe handling in Biosafety Level 2 facilities.⁶⁹ A study has also revealed that the SARS-CoV-2 transmission rate, which is affected by several factors, could increase or decrease the risk of transmission such as the viability of the virus within the blood and various organ compartments.⁵

Strategies that were adopted to teach Anatomy during previous disease outbreaks

1. Online problem-based learning

Online problem-based learning techniques were implemented to complete the curricula of an incomplete program in Hong Kong medical schools during the outbreak of SARS. Information technology was utilized for teaching via a problem-based learning methodology. Large numbers of students could not be gathered in lecture halls because of its risk tendency, so PowerPoint files were embedded with the lecturer's voice and put on the faculty website. Students reported that they found it useful and did not have to rush to attend their usual early morning class sessions.⁷⁰

2. Performing remote lectures and tutorials

Remote lectures and tutorial classes were organized for students to continue their education without the risk of exposure to infection with Middle East respiratory syndrome (MERS) in South Korea at Sungkyunkwan University School of Medicine (SKKUSOM). The school used a previously installed remote lecturing system that linked the hospital classrooms and

University lecture rooms. Instructors delivered lectures in the hospital classroom while students took classes at the main campus. The lectures were video-recorded, and students maintaining safe distances, simultaneously watched the recorded lectures on a screen thus instructors and students could interact as though they were in the same classroom.⁷¹

3. The video conference method

Here a lecturer utilizes a webcam and a microphone to give live lessons at designated times with up to 10 students whose email addresses have been utilized to create a workstation on the Google Hangout app. Students can see and hear the teacher in an empty classroom teaching on a whiteboard. Students can ask questions that are audible to the whole group. This method was designed to make up for the abrupt truncation of lessons performed daily on the board in the surgery department of Louis Mourier Hospital, Nord, University of Paris, France. Google Hangouts app, which is freely available on the application list for Gmail users was utilized to achieve this during the Covid-19 pandemic.⁷²

4. The Virtual Learning Platform

Recorded presentations and accompanying audio were uploaded to a Virtual Learning platform like Panopto (Panopto Inc., Seattle, WA). Live teaching and learning sessions as well as tutorials were conducted via platforms like Zoom (Zoom Voice Communications Inc., San Jose, CA), Collaborate Ultra (Blackboard Inc., New York, NY), and Big Blue Button (Big Blue Button Inc., Ottawa, Canada).⁷³

5. Use of digitized Anatomy practical and laboratory sessions

Practical sessions on anatomy were conducted using digitized cadaveric materials. 3D virtual resources such as Acland's Video Atlas of Human Anatomy are currently being used. Images from high-quality cadavers made from institutional collections as well as videos of prosected/ plastinated specimens were put on YouTube™ videos (YouTube, San Bruno, CA) for students to access easily. Other useful resources currently used in many medical

schools in the United States include the Visible Human Project (U.S National Library of Medicine, Bethesda, MD), Three-dimensional virtual resources included "Visible Body" (Argosy Publishing, Inc., Newton, MA), Complete Anatomy (3D4Medical/Elsevier, Dublin, Republic of Ireland), 3D models using Sketchfab (Sketchfab, New York, NY), "Anatomy TV" (Primal Pictures Ltd., Colchester, UK), Sectra (a virtual dissection table; Sectra AB, Linköping, Sweden). Practical tutorials are also being conducted via sessions using platforms such as Zoom (Zoom Voice Communications Inc., San Jose, CA) as well as <https://case.edu/holoanatomy/>.

CONCLUSION AND RECOMMENDATIONS

There is no doubt that the COVID-19 pandemic has serious implications for the progression of cadaveric dissection. The various methods being adopted in medical and allied medical schools around the world show the resilient nature of humans to surmount the crisis. However, one major factor that could help institutions with limited resources is the need to develop systems and policies that regulate records of donated bodies without which the bodies would not be accepted. Thorough and multiple screening as well as testing of bodies from donors or potential donors for diseases such as COVID-19 infection should be conducted before donation into Anatomical facilities. It is very important to screen bodies meant for dissection before use because asymptomatic or presymptomatic carriers may be presumed to have died of natural circumstances. This increases the level of risk to anatomists, embalmers and other handlers of human remains, hence the need to increase safety measures.

There should be provision and strict enforcement of the use of correct Personal Protective Equipment (PPE) when handling human remains. It is worthy of note that a negative result of laboratory screening may not rule out COVID-19 infection. Priority should therefore be given to handlers of

human remains, teachers and students of anatomy involved in cadaveric dissection during COVID-19 vaccine distribution. Periodic Training and retraining of handlers of human remains should be encouraged. Smaller-sized groups of learners as well as social distancing should also be encouraged with strict adherence to other COVID-19 protocols. While researchers are trying to find effective ways to defeat the virus, the healthcare systems and education agencies can strengthen their institutions to better protect anatomists from the dangers that stare at them.

Computer software companies and big technology companies can be approached for institutional support in the form of free access to their programs during the pandemic. Manufacturers of medical gadgets and devices should as a matter of urgency make donations that would help sustain the future of the age-long practice of cadaver dissection in developing countries. Though the COVID-19 pandemic presented major challenges in the study of anatomy as a subject, there abound immense opportunity for innovation, therefore, there should be a constant qualitative advancement approach to evaluate and implement these transformations, especially in developing countries.

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