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The study of human anatomy through cadaveric dissection facing new technologies: A reflection during the Covid-19 pandemic

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ABSTRACT

Introduction: Innovations in the pedagogical environment and new technologies have been put in check about the teaching of anatomy compared to cadaveric dissection (CD) facing the pandemic context. A recent review of the importance of teaching anatomy through CD and its difficulties during the Covid-19 pandemic were our objectives. A comparison was made on possible alternatives to CD and its further effects on the proper formation of future professionals. This review was conducted in three databases (PubMed, SciELO and Web Science) selecting articles from 2008 to March 2021. The inclusion criteria were studies on CD, other practices with corpses, new technologies, methodologies related to teaching, educational topics in basic or applied anatomy and the Covid-19 pandemic. Studies that did not discuss dissection as a teaching methodology or articles that used dissection only as an exploratory method were excluded. 34 articles were selected. 22 recommended CD, 10 indicated the use of CD combined with other methodologies, other technologies or have an indefinite conclusion, and 2 had no positive indication. New teaching methodologies and technologies do not replace CD but collaborate for the development of a more integrated curriculum, adapted to different realities and might be good alternatives during, and after, a pandemic.

Keywords: cadaveric dissection; anatomy; teaching; covid-19; anatomy education

INTRODUCTION

Cadaveric dissection (CD) is a practice that has existed for a long time. It started in 300 B.C, and during the 15th century, it was considered an essential tool for the studying of the human body and its structures (Memon, 2018). After the globalization period, new practices have been used and adapted by students, such as models and creative ideas for the study of anatomy. Thus, the curriculum structure and teaching methods have gone through a very significant evolution process. The inexorable tendency of teaching in faculties of health is characterized by a change combining future clinical practice with basic disciplines, such as anatomy, histology, and embryology. (Ghosh, 2017).

The use of human corpses for teaching purposes in various health specialties is a practice that has been maintained throughout history. Studies state that "the dead human body remains in a dark area where emotions prevail" and, although the deceased person has no legal personality, "the corpse is like a being with its rights and duties, in which relevance has oscillated in time between the social, religious, legal, and scientific levels" (Pontinha and Soeiro, 2014). In a pandemic scenario, in which mandatory stay-at-home orders were issued in several countries to mitigate the spread of the coronavirus (Covid-19), teachers and

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educators were forced to make a rapid transition from their teaching methods to distance education. (Harmon et al 2020).

The pandemic context brought a lot of negativity and divergences regarding anatomy teaching patterns, but at the same time, an opportunity to create an adapted environment in health courses. Thus, the work in favor of the discovery and introduction of new teaching-learning and assessment modalities allows for a reflection, aiming at a comprehensive and empathic approach for both students and teachers. Although part of students and educators analyze remote education negatively, it has shown its benefit-cost ratio in contrast to classroom teaching, due to the need for social distancing and health security measures during the pandemic (Patra et al, 2021; Evans and Pawlina 2021). The anatomical dissection not only familiarizes students with details but also with anatomical variations since the practice itself consists of systematic exploration of the preserved human corpse. (Estai and Bunt, 2016; Kumar and Rahman, 2017; Nobeschi et al., 2018)

There is a debate about whether CD is still an experience with as much learning value for the students in this digital era as it used to be since nowadays learning can come from digital resources, textbooks, prospection, and plastinated specimens (Flack and Nicholson, 2018). Currently, these innovations have been incorporated as undergraduate and graduate courses, which were presented in certain obsolete ways allowing students to employ technologies used in current clinical practice (Hu and Wattchow, 2018).

These may expand the three-dimensional perspective creating a link between interface and volume dimension, commonly referred to as digital dissection. Through these methodologies, there is a way to supply the need for the clinician and anatomist to see the body through modern tools. An integral and indispensable part of most current health courses curricula is the use of 2D, 3D, and film imaging exams, allowing the visualization of living anatomy. Applied to the specific health areas there was great progress and impact on the professional training, as well as their clinical reasoning (Hu and Wattchow, 2018).

Due to its great impact in the academic field, the pandemic has caused debates about what will be its potential effects on the discontinuance of body and organ donations, as well as in anatomy teaching in the universities. During the pandemic period, students might be able to learn through different methods. However, they will miss the opportunity to learn anatomy through dissections, failing to enjoy a wide range of benefits that only this method is able to provide (Ooi and Ooi, 2021).

On the other hand, even during this time, CD is feasible and essential in some contexts, since the risk of infection can be minimized with the appropriate means. Some institutions are prioritizing practical classes and clinics during a gradual reopening program, with a limited number of classes and students, making the likelihood of infection with the virus significantly lower (Ross et al 2020; Bond and Franchi, 2021).

Therefore, the objective of this article is to make a review on the importance of teaching anatomy in cadaverous pieces based on publications about CD and its possible substitutes. The study aims to discuss issues such as how the Covid-19 pandemic can affect this teaching process, and how it might interfere with future professional formation.

MATERIAL AND METHODS

This literature review was carried out in the PubMed, SciELO, and Web Science databases from 2008 to March 2021, based on the following combinations of descriptors: anatomy teaching AND dissection AND anatomical pieces AND anatomy classes Covid-19.

The studies were independently selected by 5 authors based on the following inclusion criteria: (1) literature reviews; (2) case studies; (3) observational/cross-sectional studies; (4) pilot studies; (5) cohort studies; (6) narrative reviews; (7) meta-analysis, (8) editorials and (9) letters to the editor. The group selected articles that carried out quantitative comparisons between different methods of teaching anatomy in relation to cadaveric dissection and studies that addressed the discussion of teaching anatomy and the use of cadaveric pieces in the pandemic. In the event of

any disagreement during the study selection process, there would be a debate by the group to reach the best conclusion. Studies that did not discuss dissection as a teaching methodology or articles that used dissection only as an exploratory method were excluded.

The following information was extracted from the studies by four independent reviewers: author and year of publication, title, country of origin, the methodology used, and main results.

Data analysis was performed descriptively. First, a general comparison of the researched article's methodologies was carried out, followed by an analysis of the conclusions and recommendations on the use and applicability of various anatomy teaching methodologies.

All material with information regarding the use of CD and its impact on the training of professionals was included and organized chronologically.

RESULTS

The following tables show the descriptive analysis of the selected studies in chronological order, including the type of research and their conclusions towards the use of CD (Table 1 - Articles where the authors recommend CD as a pedagogical tool; Table 2 - Articles where there is no definition about which methodology is superior; Table 3 - Articles that do not recommend CD as the best pedagogical tool).

The methodologies of the selected articles were: one meta-analysis, one pilot study, one method presentation, one research report, five case studies, four literature reviews, four narrative reviews, six letters to the editors, one editorial, and ten observational studies. It is worth mentioning that the largest amount of articles is composed of observational studies, whether cross-sectional or cohorts, and literature reviews, which are the ones that approach CD in a more incisive and pragmatic way. In addition, some letters to the editors were considered as they pointed to recent experiences related to teaching during the COVID-19 pandemic, but which have not yet been deeply documented in more complex studies.

The review methodologies (Memon, 2018, Estai, 2016 and Pontinha, 2014) and observational methodologies (Eppler, 2018 and Fornaziero et al 2009) were the ones that added more density to the discussion proposed by this study.

DISCUSSION

The suspension of academic activities started while students were still taking CD classes, and they still had a long period of practical teaching to complete. The blockades had many other implications, including the discontinuance of body donation programs since the institutions were unable to accept them because employees were being dismissed or obliged to work from home by government definition. As the pandemic continues, only a few universities have restarted their body donation programs due to uncertainties on new limitations and concerns over the ability to ensure that donated bodies are negative for Covid-19. Therefore, the Covid-19 pandemic might not only affect this academic year, but it may also cause significant problems for the subsequent years (Bond and Franchi, 2021).

According to Ramsey-Stewart et al. (2010), CD facilitates the understanding of the interdependence between body tissues, solving "clinical" problems with a real body, developing a three-dimensional mental map of the body, and divided into small groups with monitors. Although no comparisons were made with other methodologies, they concluded that the practices with cadavers are essential for the subsequent professional development.

A questionnaire was performed to inquire students about the importance of CD in medical school and the benefits of components of anatomy course to master the concepts of anatomy. They assessed the students perception of the advantages and challenges of CD. Most students had a positive perception, with statements such as: "dissections make learning more interesting" and "I would be at a disadvantage if I did not attend dissection classes". Non-regular attendance was associated with statements such as "I don't like the smell", "time-consuming" and "bored with the way it is done"

(Houser and Kondrashov 2018, Dissabandara el al., 2015).

Despite its limitations, anatomy training based on CD improves confidence and knowledge acquisition for doctors and, consequently, reflects on better patient safety (Kumar and Rahman, 2017). CD is a methodology that could also benefit students from other health courses, claiming that this tool would allow better consolidation and understanding of the anatomy that will inevitably influence the professional routine (Nobeschi et al., 2018). Studies in clinical contexts, on the other hand, show how the use of embalmed parts and corpses have an intimate application for withdrawing hypotheses that can be used directly in professional practice, in addition to improving the competence of an introductory clinical skill (Keim Janssen, et al., 2013; Martin, et al 2013; Meng, 2015).

Besides, CD is an essential part of education and an indispensable basis for other educational approaches, such as living anatomy, seminars on clinical aspects, problem-oriented learning, as well as computerized methodologies. A better understanding of the three-dimensional anatomy and the concept of biological variation stands out among the benefits of practicing CD. This practice also introduces students to teamwork and encourages communication skills individually and in groups. They also emphasize that CD brings students closer to the reality of death and teaches respect for the body (Korf et al., 2008; Ramsey-Stewart Et al., 2010).

A study focused on the perception of students regarding the learning obtained with CD concluded that students believe CD is not only a useful tool for learning anatomy but also it stimulates teamwork, improves professional development, and helps them face death. In addition, some stated they were able to gain a better understanding of the three-dimensional concept of the body and the interdependence of body structures (Flack and Nicholson, 2018; Ramsey-Stewart et al., 2010).

A study by Pais et al. also aimed to observe the satisfaction of medical students in contact with CD, and this group obtained similar results to the ones from Ramsey-Stewart et al (2010) and Flack and Nicholson (2018). The students mentioned that dissection courses brought more benefits in addition to those already specified in the objectives of the course. They mentioned the contact with death, and the possibility of a practical approach beyond what had been taught in general anatomy, which they considered closer to the clinical and surgical procedures taught in medicine (Pais et al., 2017).

With CD, students develop and improve several other skills besides the study of anatomy, such as teamwork, solidarity, empathy, improve the notion of depth, develop the perception of the textures of different tissues, and can see the body, in addition to being an active practice that can be beneficial for all health students in learning anatomy. Students who intend to pursue a surgical career develop their motor skills and other characteristics with the use of dissection, just as physiotherapy students improve their perception of biomechanics and the degree of elasticity of the different tissues of the body (Ogard, 2014; Darras et al., 2018). Teaching based on prospecting and plastination would be more suitable for students of dentistry, pharmacy, and other health sciences (Estai and Bunt 2016).

In a study conducted by Eppler et al, in which an optional dissection course was offered adapted to a 6-year medical curriculum, students who chose CD ended up performing statistically better than students who did not choose to do it (Eppler et al., 2018). An alternative proposal was to practice virtual dissection. However, there are several limitations to this, as students do not develop the sensory-motor experience, and they do not learn anatomy following the three-dimensional concept of the body (Darras et al., 2018).

When it comes to online teaching, a study conducted in China in 2020 concluded that the top three benefits of this type of classes were "diversity of teaching methods", "development of content materials for teaching" and "good opportunities to develop new teaching methods". On the other hand, the three main difficulties reported were "difficulty in understanding student progress and learning outcomes", "unstable online learning environments" and "insufficient online teaching resources". Although some anatomy teachers consulted in that study were very positive about online teaching, the majority of them emphasized the indispensability of practical sessions, and a quote summed up this

perspective: “No dissection, no anatomy” (Cheng et al., 2020).

Darras et al and Chytas et al., reported a positive learning experience with virtual dissection integrated with CD. Most students declared that this integrated curriculum was able to improve their understanding of cadaveric anatomy and the clinical applications of anatomy. This study corroborates with the principle that innovative alternative methodologies such as virtual anatomy should complement rather than replace CD. Although their findings suggest that the majority of students considered that the virtual dissection laboratories increased their anatomy understanding, they have also indicated that CD still seems to have an important role in this learning, which suggests that more research is needed to determine how much this integrated approach results in a significant change in anatomy knowledge. Although these studies have shown that 3D visualization led to better performance and of students' anatomy compared to traditional methods, this conclusion is not valid when compared to CD. There was no research showing that students have a better performance if they do not dissect, all studies show that CD results in superior understanding and performance.

Regarding the importance of Problem Based Learning (PBL) Huitt et al. and Ghosh, have defined anatomy teaching as an integrated method of transmitting anatomical knowledge in combination with clinical information and skills. This methodology was incorporated into the curriculum to increase students' exposure to clinical issues and encourage them to conduct independent research, as well as to develop lifelong learning habits. They identified that Team-Based Learning (TBL) is an effective way to improve the traditional experience of the dissection laboratory. Students achieved better performance as part of their exams when TBL was used with the expository classes and the laboratory. They also concluded that TBL can improve the long-term retention of anatomical knowledge (Huitt et al., 2015; Ghosh 2017).

It is important to highlight that the acquisition of clinical skills should not be confused with the absorption of essential knowledge. The advanced teaching tools aim to focus on clinical aspects since the beginning of the medical course with the integration of alternative methods such as the inclusion of PBL in order to enrich the curriculum by adding clinically relevant materials, promoting interactive learning and cultivating a problem-solving approach. However, results obtained by Ghosh 2017 suggest that a solid knowledge of basic sciences is mandatory for the development of clinical skills. Educators from this study believe that the reduction in the number of hours allocated to CD in the curriculum due to reasons such as reduced availability of cadavers, increased operating costs of dissection laboratories and the higher emphasis on alternative skills had a negative impact on anatomy learning outcomes, raising questions about safety and competence of newly graduated students. Reports have emerged about doctors who are unwilling to undergo surgical training during their residency because of a perceived lack of knowledge in anatomy.

Although the "new versus old" paradigm divides the community of educators, anatomists and students, technological advances cannot be ignored and it is of great value to try to integrate the different approaches to comprehensively satisfy all the educational needs of the students. Education in surgical anatomy is unique, as it requires detailed and specific knowledge of structures in a specialized way and specifically requires a mixture of modalities that consolidate the basic anatomical knowledge with the clinical aspects (Hu and Wattchow, 2018).

Dissection does not simply serve to promote specific skills. It is an essential pedagogical tool in the consolidation of knowledge, preparing professionals for clinical practice, regardless of the area. With this tool, students can explore the contents given in the theoretical classes, associating them with the cadaverous pieces, by seeing the human body in a three-dimensional view, with all its possible similarities and peculiarities, anatomical variations, origin and insertion of muscles and a perception of how movements are triggered (Williams et al., 2019).

Although CD has remained the gold standard for learning anatomical knowledge for hundreds of years, it is considered, by some authors, as outdated, of high cost, requiring much time invested and being an approach that involves

risks to students. The transition from anatomy-focused courses to integrated and system-based curricula, in line with the reduction of the teaching staff, resources, and teaching hours, led many institutions to adopt more economical, less time-consuming, and up-to-date teaching alternatives, such as plastination, Challenge Based Learning (CBL), image exams and distance learning elements. These teaching practices should be incorporated into the educational paradigm to optimize efficient student time management, maximize future surgical skills, retain anatomical knowledge and increase academic success (Estai and Bunt 2016).

This idea is corroborated in a meta-analysis carried out by Wilson et al., in which the results obtained when comparing traditional dissection to other laboratory methods, such as prospecting, digital media, 3D models, and hybrid approaches, suggest little or no difference between the different methodologies. The authors suggest that future research is needed in three specific directions. First, a meta-analysis to explore the effects of more modern didactic pedagogies that were not addressed in their study such as team-based learning, problem-based learning, case-based learning, and computer-assisted learning. Second, study the effects of these approaches on the acquisition and improvement of anatomical knowledge specifically. Finally, study the effects of other pedagogical approaches on the retention of knowledge in anatomy in the long run (Wilson et al., 2018).

Students have also reported that CD may provide coexistence with death at the beginning of their undergraduate courses, which can help more sensitive students to face this situation more openly besides providing teamwork, respect for the body, and familiarization between theory and practice with consequent preparation for clinical practice. Fornaziero et al., 2010, concluded that the use of technological methods does not put aside traditional practice. However, they point out that, depending on cultural conditions and educational institutions, adaptations must be sought according to each reality so that there is a sum of the instruments available to work in search of a better understanding of the contents

Ogard 2014, mentioned a few issues with CD, starting from the point where, as a pedagogical tool, it requires a high cost to maintain, leading to a decrease in the number of hours and time dedicated for this practice. When comparing overall course scores from year to year, there was no observed difference in student performance as assessed by written and practical exams. Therefore, the study concluded that methodologies such as the use of dissection videos and computers can be a viable alternative teaching tool.

Kinirons et al., 2019, divided students into two groups, one with practical dissection classes and the other with palpatory anatomy. Based on within and between subgroup comparisons, the result was that there was no statistically significant difference between the two groups and there was no difference in the academic performance of Physiotherapy and Occupational Therapy students in the General Anatomy course. The results suggested that it had no effect on written, laboratory practical, or palpation practical examination scores. Moreover, when resources are limited, teaching CD “in pairs” as an alternative way, is an effective method to teach macroscopic anatomy. However, in this study, the cadaver demonstrations were conducted entirely by teachers and there was no description about the students having practiced dissection and how it was performed or guided in detail in a study progression program.

The evidence to support that surgical competence is compromised if the surgeon has not been taught anatomy through dissection is not strong. The literature that supports this point of view is restricted to personal comments and opinions. It lacks studies that directly investigate the correlation between surgical competence and the presence of CD in anatomy training. More research is needed to compare CD with the continuous development of three-dimensional visualization technologies, in terms of effectiveness in improving anatomical knowledge and subsequent surgical competence. Therefore, it is too early to define which is the best method for teaching anatomy in terms of health benefits for future patients (Chytas et al, 2021).

In the pandemic scenario, body donation programs have been reduced or suspended in more than half of the medical schools surveyed, since

donated bodies may present potential risks of Covid-19 for students and health professionals. During a pandemic, fewer bodies will be donated to universities and therefore CD will have to be temporarily replaced by virtual dissection due to the scarcity of cadavers (Cheng et al., 2020).

Since the teaching of anatomy with CD is still being carried out in some universities, three main aspects are necessary to preserve safety: non-infectious corpses; mechanisms to meet the demands for social distance; and institutional commitment. Therefore, safe, non-infectious corpses are easy to obtain from anatomical donation organizations, which enforce policies to refuse donations from people with infectious diseases. Additional care ensures that the cadaverous material is extremely unlikely to transmit viruses to students, instructors and support staff, since they are more likely to contaminate each other than with cadavers and the likelihood of infection with these viruses is significantly reduced by the distance in the study environment and the use of protective equipment during teaching actions (Ross et al 2020).

The dissection carried out during the pandemic period should be encouraged by universities and analyzed by anatomy instructors, making them proactive in the development of plans and proposals for its realization. Methods with new digital technologies do not replace CD but collaborate for the development of a more integrated and adapted curriculum so that students can associate the different ways of learning and overcome possible limitations in the use of cadavers (Ross et al 2020).

There is no doubt that CD plays an essential role in the teaching process. Other study approaches and techniques are not able to provide everything that the dissection adds to the students beyond the theoretical content.

For new studies, we suggest comparisons between the new technologies available and the learning by CD concerning the fixation of anatomical knowledge, in the long term, and the performance in theoretical and practical activities. This would assess not only the performance itself but would also correlate the burden of not having a hands-on activity with cadavers, with activities carried out by technological means.

CONCLUSIONS

The absence of CD, or the choice to use only one teaching methodology, may generate a deficit in the development of essential skills for future health professionals. It is natural to inquire about the impact of the COVID-19 pandemic and the absence of practical learning through dissection on anatomy teaching. In an alternative learning context, using only digital methods, the proper skills needed by health professionals cannot be fully acquired the same way as in situations where different teaching methods are integrated into the whole curricula. This integration could provide a good adaptation to different realities and might be an alternative during, and even after, a pandemic period.

CONFLICTS OF INTEREST

Authors have no conflict of interest. The authors alone are responsible for the content and writing of the paper.

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