Practical Applications of Teaching Methodologies in Human Anatomy

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Authors' contributions

This work was carried out with collaboration among all authors. Author PFT designed the study, wrote the protocol and wrote the first draft of the manuscript. All authors contributed in editing the manuscript and read and approved the final manuscript.

Original Research Article

ABSTRACT

The aim of this study is to underscore the significance of utilizing cadavers, artificial anatomical models, and innovative methodologies in Human Anatomy education, such as digital tables and 3D glasses. Additionally, it seeks to highlight the most effective approach for studying the female pelvis anatomically.
Materials and Methods: To achieve this, 600 questionnaires administered between March and October 2023 were analyzed.

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Results: Anatomical models emerged as the predominant practical teaching method in Human Anatomy, accounting for all 600 cases (100%). Cadavers were utilized in 504 cases, representing 84% of the studies. The digital table was employed in 312 cases (52%), and 3D glasses were referenced in 144 cases (24%). When assessing the method most conducive to studying the female pelvis, the majority of respondents cited cadavers (82%), followed by artificial anatomical models (11.5%), the digital table (5%), and 3D glasses (1.5%).

Conclusions: The popularity of anatomical models can be attributed to their accessibility, ease of handling, and durability. However, cadavers were deemed the most beneficial for studying the female pelvis due to their ability to provide a comprehensive three-dimensional perspective, facilitating understanding of the spatial relationships between genital structures and other pelvic organs. Furthermore, practical anatomy sessions utilizing cadavers offer valuable emotional preparation for future clinical encounters, fostering a deeper appreciation for the human body beyond mere academic study.

1. INTRODUCTION

Human anatomy is the science that studies the human body through a macroscopic modality. The centrality and commitment to understanding the importance of this science for health-related degrees have been fundamental and varied throughout history [1]. Since ancient times, the variations and different ways of studying human anatomy have been evident [2]. Some of these methods have been listed here. The Renaissance period provided a scientific consolidation in the teaching of anatomy, marking a watershed between ancient and modern anatomy. Andrea Vesalius' work, titled "De Humani Corporis Fabrica," redefined concepts and descriptions, elevating the teaching of anatomy through widespread cadaver dissection. More than an anatomy book, the work introduced new study methods and questioned misconceptions. His text proved to be innovative in anatomical investigations, strongly associating images with agents of anatomical knowledge. He was the first anatomist to dare to publicly dissect the human body [3,4].

Anatomical knowledge is essential for the professional practice of anyone in the healthcare field, who will deal with the human body throughout their professional life. Human Anatomy is a prerequisite and biological foundation for other disciplines, such as Histology, Embryology, Semiology, and Physiology, among others. It can be said that Human Anatomy, throughout the history of academic study, has refined its centrality, emphasizing the urgency and commitment to quality education in healthcare [5].

Over the centuries, cadavers were the only practical study method in the Human Anatomy discipline. Numerous possibilities for studying body areas emerged after the 1990s. This allowed for a reevaluation of the use of cadavers, investigating its advantages and disadvantages, and reflecting on practical study methods in Human Anatomy. It is widely accepted that the process of dissecting human cadavers helps students understand the 3D relationships between anatomical structures and reinforces the content of textbooks and lectures [6,7].

The aim of this paper is to highlight the value of cadavers, artificial anatomical models, and new methodologies in the teaching of Human Anatomy, such as digital tables and 3D glasses. Additionally, it aims to showcase the practical method that most benefits the anatomical study of the female pelvis.

2. MATERIALS AND METHODS

A descriptive study was conducted based on data collection through the administration of a questionnaire containing exclusively objective questions related to the methodologies applied in the teaching of human anatomy, directed towards professionals and teachers of human anatomy. The questionnaire was sent via email to participants between the months of March and October 2023. Professionals were queried about whether they used cadavers for study in their practical classes, what auxiliary teaching materials they employed, and whether their instructors utilized any technology in the classroom. Lastly, participants were asked about the method that most favored the study of the female pelvis. The development of the research

followed the Regulatory Norms for Research involving human beings, as established by the resolution of the National Health Council.

3. RESULTS

A total of 612 questionnaires were received. Eleven were incomplete, and one was incorrect, thus excluded. Anatomical models were the most widely used practical anatomical method in the teaching of human anatomy, with 600 cases (100%). Cadavers were present in 504 cases, representing 84% of the studies. The digital table corresponded to 312 cases (52%), and 3D glasses were mentioned in 144 cases (24%). Table 1.

When asked about the method that most favored the study of the female pelvis, the results were as follows: cadavers in 82% of cases, artificial anatomical models in 11.5%, digital tables in 5%, and 3D glasses in 1.5% (Fig. 1).

Table 1. List of teaching method and cases

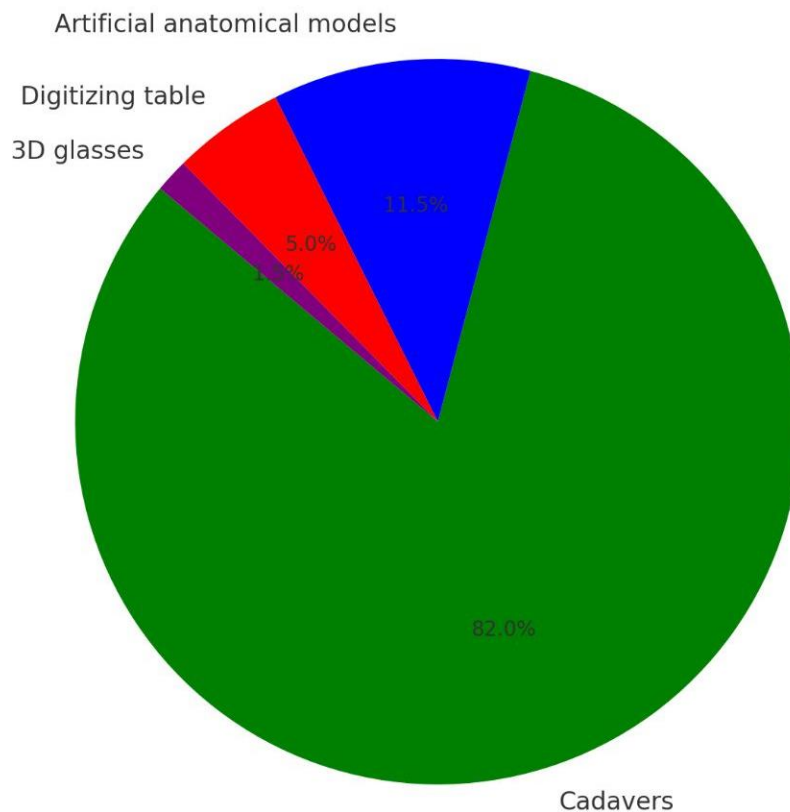| Teaching Method	Cases	Percentage
Anatomical models	600	100%
Cadavers	504	84%
Digitizing table	312	52%
3D glasses	144	24%

Fig. 1. Preferred methods for studying the female pelvis

4. DISCUSSION

Although technology has arrived to revolutionize the world, bringing more dynamism to the population, it seems less conclusive regarding the study of anatomy for the learning of healthcare students. Despite anatomical models allowing the production of multiple copies at any scale, being considered easy to use, having good long-term knowledge retention efficacy [8], it is a methodology that still distorts the proper and real spatial understanding of anatomy, making students feel disoriented and frustrated with the method [9,10].

Anatomical models offer a three-dimensional representation of the human body or specific organs, allowing students to visualize structures in their real forms, providing a more comprehensive and accurate understanding of anatomy compared to two-dimensional images in books or screens. Furthermore, the use of anatomical models provides a hands-on experience that helps students develop a deep understanding of body structures in various situations, such as serving as a foundation for learning to perform clinical breast examinations during undergraduate studies, which is an important yet complex activity due to its intimate nature [11,12].

Students can explore the location, size, relationship, and function of anatomical structures. Furthermore, it is possible to remove specific parts and study different body systems in isolation, which contributes even further to the enhancement of their students identification skills and spatial memory. Another very important factor is that anatomical models are often used as communication tools between healthcare professionals and patients [13,14]. They assist in explaining medical conditions, surgical procedures, and treatments in a clearer and visual way, allowing patients to better understand the procedure and their health conditions, with an emphasis on the study of the female pelvis, the subject of this article [15].

The digital table in anatomy is one of the most advanced technologies for 3D anatomy visualization and virtual dissection tools for teaching anatomy and physiology and it is being adopted by schools and medical institutions worldwide. It was featured in TEDTalks, PBS, Fuji TV, and various other magazines for its innovative approach to digital anatomy. The surgical table combined with the radiology software and clinical content from Anatomage, advances reading options compared to other Human Anatomy teaching methods [16].

The digital table is one of the fully segmented 3D anatomy platforms. Users can visualize the anatomy exactly as they would on a fresh cadaver. Individual structures are precisely reconstructed, resulting in an unprecedented level of accuracy, dissectible real anatomy in 3D. The anatomy of the female pelvis is presented as a fully interactive experience, in a life-sized tactile form, resembling an operating table.

The digital tables allow for the exploration and learning of human anatomy beyond what any cadaver could offer. There are no chemicals to handle, no unpleasant odors, no recurring costs for facilities, no regulations, and there is a higher adoption rate among students compared to traditional cadavers.

The revolutionary 3D glasses system allows the user to create various anatomical realities in a matter of seconds. Educators and students are able to dissect and manipulate anatomical structures while being fully immersed in virtual reality [17].

This software was developed using technological advancements adopted from gaming and graphics, as well as medical imaging and modeling methods that have only become available in recent years. The combined experience of engineering simulation, programming, and medical imaging has made 3D glasses fundamentally unique in the market [18].

The application contains all the body systems and can be taught through systemic or regional approaches. It encompasses an intuitive, easy-to-use method for dissection by simply 'peeling' away any structure. From the smallest ligaments to nerves and vessels, each structure is clinically labeled [19].

It is used for patient education and illustrative purposes. A user of the Med version, for example, can fully interact with the anatomy of the 'shell' muscles, follow nerve roots, examine skeletal anatomical landmarks, understand muscle insertions and origins, and look at minute details of organs. High school students in biology classes can better understand the various body systems in a fascinating three-dimensional way [20].

The Cyber Anatomy Med VR, for example, is available as a modular server-based solution for

content distribution over the web. It can be used on any type of web server, similar to how normal HTML pages or GIF files are served. A viewer is first downloaded to the client's machine and is used to dynamically interact with the 3D anatomy content. 3D anatomy components are streamed into the scene, allowing full interactivity with extremely small file sizes.

The Technological Revolution, which began in the 20th century, has provided great advancements for society, innovating in educational areas and enabling knowledge to be shared more quickly and efficiently. In this context, virtual reality glasses were created, which, although they favor health education and anatomical study, still have presents limitations [21,22].

Initially, virtual reality facilitated by glasses realistically allows students to interact with limbs and organs, often used due to the scarcity of human cadavers for dissection or the lack of adequate facilities. Moreover, in an interactive manner that generates greater motivation for learning, as it is a dynamic and attractive platform, learners have the opportunity to train new techniques by simulating various situations, simulate complications without putting any individual's life at risk, and perform emergency and surgical treatments. Furthermore, it enables future professionals to perform demonstrations and explanations more clearly, in order to convey security and comfort to the patient.

The high cost of the digital dissection table and virtual reality glasses makes them inaccessible to all socioeconomic niches, and the technology is not able to replace the sensation of touch provided by studying cadavers, lacking tactile feedback. The user may have difficulties connecting with reality, as they do not have true exposure to depth and color, which favors the process of humanization.

5. CONCLUSION

The reason anatomical models are the most practical method is, in our understanding, due to the ease of acquisition, handling, and preservation. It is understood that the cadaver was the method that most favored the study of the female pelvis because it allowed a three-dimensional view of the anatomical structure and a spatial view of the genital structures of the woman and their positional relationships and integration with other pelvic organs. Part of these

findings are also justified because practical human anatomy classes using cadavers provide emotional preparation for future interactions with patients, considering the encouragement to value the human body much more than just an object of study. On the other hand, valuing the process of humanization is possible from the beginning of higher education courses in the healthcare field.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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