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Virtual dissection: An educational resource that improves medical students' learning?

Disección virtual: ¿Un recurso didáctico que mejora el aprendizaje de los estudiantes de medicina?

Artículo de revisión documental | Documentary review article

ABSTRACT

For centuries, the study of human anatomy has relied predominantly on cadaveric dissection. However, in the 21st century, anatomy education is undergoing a significant transformation driven by emerging technological innovations, including virtual dissection. This innovation can be repeated without the need for many cadavers, providing a safe environment, cost-effectiveness, and the opportunity to reassess complex concepts for undergraduate medical students. The educational value of virtual dissection tools depends on high-fidelity digital modeling and strategically designed clinical scenarios in anatomical instruction. Nevertheless, further research is required to determine the efficacy of virtual dissection and to evaluate its long-term impact on undergraduate medical students' learning and retention of anatomical knowledge.

KEYWORDS: cadaveric dissection, human anatomy, medical education, virtual dissection.

RESUMEN

Durante siglos, el estudio de la anatomía humana se ha basado principalmente en la disección de cadáveres. Sin embargo, en el siglo XXI, la enseñanza de la anatomía está experimentando una importante transformación impulsada por las innovaciones tecnológicas emergentes, entre las que se incluye la disección virtual. Esta innovación puede repetirse sin necesidad de utilizar múltiples cadáveres, proporciona un entorno seguro, rentable y la posibilidad de reevaluación de conceptos complejos a conveniencia del estudiante de pregrado en medicina. El valor educativo de las herramientas de disección virtual depende del modelado digital de alta fidelidad, y de los escenarios clínicos diseñados estratégicamente en la instrucción anatómica. No obstante,

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se requiere mayor investigación para comprender la eficacia de la disección virtual y evaluar su impacto a largo plazo en el aprendizaje y la retención del conocimiento anatómico en estudiantes de medicina.

PALABRAS CLAVE: disección cadavérica, anatomía humana, educación médica, disección virtual.

INTRODUCTION

The history of human anatomy teaching/learning, from the earliest examinations of dead bodies in ancient times to the high-level analyses of the human body carried out by modern anatomists, is characterized by a continually developing understanding of the functions of structures and organs of the human body. In the 21st century, human anatomy education has confronted challenges with traditional cadaveric dissection, leading to the emergence of new technological innovations, among them virtual dissection as an educational alternative. Current undergraduate medical students (belonging to Generation Z), those born around the 2000's is constantly hyper-connected to emerging technological innovations, which could change the profile of human anatomy teaching/learning process [1]. Present undergraduate medical students are the first generation to be born in a world of widespread access to the internet by computers, mobile devices, tablets, smartphones, smartwatches, smart glasses, smart rings, and other electronic devices. But undergraduate medical students are employing emerging technological innovations in studying and learning about medical topics [2]. This review aims to make an initial evaluation of the pros and cons of the virtual dissection tool.

CADAVERIC DISSECTION

The teaching of human anatomy has changed a lot from ancient times until now, since the first human being observed the anatomical parts of other human beings or animals, either during a healing action, a fight, or a hunt. Later on, the first documented systematic anatomical dissections on the human body were carried out around the third century B.C. in Alexandria, but were soon banned for about 16 centuries. During the late Middle and Renaissance ages, anatomical dissections were restored and improved during the following centuries [3].

Teaching anatomy is an essential component of basic medical sciences, providing a basis for procedural and clinical skills in patient care for medical doctors [4]. The basic subject of human anatomy in medical school is crucial in medical training. Cadaveric dissection has long been a part of anatomy education, providing undergraduate medical students with a practical way to learn about the complexity of the human body. Gross anatomy education is essential for developing the knowledge and skills necessary for clinical practice. The teaching of gross anatomy has traditionally relied on cadaveric dissection, providing students with tactile experience and a direct understanding of human anatomy. Anatomical dissection allows for the exploration of complex anatomical relationships and variations, fostering a deeper understanding of the human body. Cadaver-based methods, namely dissection, prosection, and plastination (in which water and fat have been replaced with plastics of dead bodies), have played, and continue to play, an important role in anatomy education and have been accompanied by favorable results concerning undergraduate medical students' knowledge [5].

A thorough understanding of human anatomy is vital in clinical practice as it forms the basis for medical examination, making diagnoses, performing surgeries, and performing other medical interventions. Historically, human body dissection, coupled with textbooks and atlases, has served as the bedrock of gross anatomy pedagogy and has provided hands-on experiences for the appreciation and comprehension of the macroscopic structural organization of the human body [6].

Human anatomy is no longer considered a dissection-based, research-led discipline. And circumstances such as the increasing number of medical students, limited resources, and lesser time devoted to the human anatomy teaching/learning process per the new curricula have compelled every anatomist to use new educational techniques 7. With an increasing number of students in anatomy classes, the availability of cadavers might be insufficient to meet the requirements of all students. Health education institutions encounter many obstacles and complexities when it comes to acquiring cadavers for educational use. Legal, administrative, cultural, religious, social, economic, and educational factors are among the most significant challenges they face [8].

VIRTUAL DISSECTION

A new era of medical education has been brought about by the development of emerging technological innovations, which have led to the inclusion of virtual dissection software in the anatomy curriculum. The significant challenges raised by this paradigm change are how ungraduated medical

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students view new digital tools and how they affect traditional instructional approaches [2, 9]. Virtual (or digital) dissection refers to the "anatomization" of a computer-generated 3D anatomical visualization to study the human body, its structures, internal systems, and cross-section, and enhance understanding of neighborhood relationships. Virtual anatomy is a fast-developing field, becoming increasingly accessible for undergraduate medical students. Many platforms and applications (for example: 3D Organon®, Visible Body®, Anatomage®, SECTRA-3D®,3D Organon®, Visible Body®, BioDigital®, Zygote Body®,) provide access to three-dimensional, interactive anatomy through a range of devices and from anywhere with internet access [1].

The medical education evolution has been demanded by the need for improved teaching/learning methods to understand the human body's complexities. Therefore, there is an increased need for the use of innovative technologies in anatomy education [8, 10]. Some of the reasons are: the challenges with acquiring bodies for dissection, difficulties in preserving acquired bodies, the laborious nature of body dissection, increasing educator-to-student ratios, evolving learning habits of students, and cultural reservations toward human body dissection. In recent years, advancements in technology have led to the development of digital dissection tools in the field of human anatomy, including virtual reality, augmented reality applications, and 3D anatomy software, which present an innovative approach to anatomy education employing sophisticated software to simulate the dissection process. These tools offer interactive and immersive experiences, allowing students to visualize and manipulate 3D models of anatomical structures without the ethical and logistical challenges associated with cadaver use [10, 11].

Virtual dissection can be repeated without the need for multiple cadavers, providing a safe environment, cost-effective, and customized to cater to different learning paces, enabling students to revisit complex concepts at their convenience. Virtual dissection tables (for example: Anatomage®, SECTRA-3D®, BioDigital, Zygote Body®,3D Organon®, Visible Body®), which comprise touch screens and have incorporated data of patient imaging modalities, have been proposed as a particular opportunity for professors of human anatomy to enhance their tool kit. Those tables based on 3D vectorial anatomical atlases, which use medical images to create authentic experiences for anatomy teaching/learning, can be loaded with digitalized cadavers, which are scanned via computed-tomography or magnetic resonance imaging and are three-dimensionally reconstructed, and may also have been affected by several diseases [12-14]. Thus, via the virtual dissection of those digitized cadavers, the user can explore not only normal but also abnormal human anatomy and be introduced into clinical practice.

The virtual dissection table allows undergraduate medical students to isolate different anatomical structures in 3D form, dissect, reconstruct, zoom in and out, and transect them in order to appreciate anatomical form and relationships. Pausing, rewinding, and revisiting different structures and systems by creating presets in a virtual dissection table is a unique feature that helps to provide personalization to the learners. [4, 15, 16]. Computer-based simulation materials offer a huge amount of supporting and reinforcing information to learners so that undergraduate medical students can work with them at their own pace.

DISCUSSION

Understanding the impact of cadaveric versus digital dissection on knowledge retention is essential for professors of human anatomy aiming to optimize syllabus curriculum design and enhance undergraduate medical students' learning outcomes. But the comparative effectiveness of these two modalities on knowledge retention remains a subject of debate. Some reviews [10, 17, 18] indicated that, while digital dissection can enhance initial understanding, cadaveric dissection tends to yield better long-term retention of anatomical knowledge. Similarly, other studies [2, 19, 20] found that students who engaged in cadaveric dissection demonstrated superior retention in follow-up assessments compared to those who used digital methods. But a possible disadvantage of Virtual dissection concerns the absence of tactile feedback. The usefulness of virtual dissection tools may depend on the quality of the digital models and the stages used to teach human anatomy. However, the expense and upkeep fees of virtual tools may prevent their widespread use in low-rate countries [9, 17]. More research is needed to realize Virtual dissection and examine its long-term impacts on undergraduate medical students' learning and retaining human anatomy.

CONCLUSION

Virtual dissection tools can help undergraduate medical students visualize anatomical structures in 3D and cross-section, improving student learning and perception. Nevertheless, it may not be as effective as hands-on dissection. However, little assistance is currently available to educators on how to incorporate virtual anatomy into their curricula and teaching practices, using approaches underpinned by pedagogic principles. This integration

will encourage undergraduate medical students' interest, anatomical knowledge, retention, and clinical relevance.

CONSIDERACIONES ÉTICAS:

El contenido es original y libre de plagio. Cualquier similitud con otros trabajos se relaciona con la conceptualización del tema realizada por los autores en distintas etapas del proyecto

CONFLICTO DE INTERÉS:

El autor declara no tener conflictos de interés.

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