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Review Article

The evolution of teaching methods of human anatomy – a systematic integrative review of the literature

A evolução dos métodos de ensino da anatomia humana – uma revisão sistemática integrativa da literatura

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Abstract

Objective: presenting the temporal evolution in the teaching of human anatomy, in addition to analyzing the impact and effectiveness of new teaching methods on student learning. **Materials and Methods:** this is a systematic review of the integrative type based on the standards of the *Preferred Reporting Items for Systematic Reviews and Meta-Analyzes* (PRISMA). The study was built from the key question: "What is the temporal evolution of the teaching methods of human anatomy", by searching the electronic databases Medline and LILACS, using the association of descriptors and their synonyms "teaching", "education techniques", "Teaching materials", "teaching methods", "anatomy", "evolution". **Results:** twenty-one articles were included in this review. The teaching of human anatomy has changed over time, associated with the need to incorporate more modern methods to make learning more effective. In the temporal evolution, models such as cadaveric dissection, integration with the environment, body painting, problem-based learning, technological resources, 3D representations and assisted surgical procedures were identified. **Conclusion:** the studies suggest that the new alternatives enable students' interaction and autonomy, allowing a better understanding of them with the contents covered, and evidence the benefits of combining these methods in traditional anatomy teaching to facilitate the understanding of information.

Keywords: Dissection. Problem-based learning. Image 3D.

Resumo

Objetivo: apresentar a evolução temporal no ensino da anatomia humana e analisar o impacto e a efetividade dos novos métodos de ensino no aprendizado dos alunos. **Materiais e Métodos:** trata-se de uma revisão sistemática do tipo integrativa baseada nas normas da *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA). O estudo foi construído a partir da pergunta-chave: "Qual a evolução temporal dos métodos de ensino da anatomia humana", mediante busca nas bases eletrônicas Medline e LILACS, por meio do uso da associação dos descritores e seus sinônimos "teaching", "education techniques", "teaching materials", "teaching methods", "anatomy", "evolution". **Resultados:** foram incluídos vinte e um artigos nesta revisão. Com o tempo, o ensino da anatomia humana sofreu alterações devido à necessidade de incorporação de métodos mais modernos os quais visam ao aprendizado mais efetivo. Na evolução temporal, foram identificados modelos, como dissecção cadavérica, integração com o meio ambiente, pintura corporal, aprendizagem baseada em problemas, recursos tecnológicos, representações gráficas 3D e aplicação em procedimentos cirúrgicos assistidos. **Conclusão:** as novas alternativas possibilitam interação e autonomia dos estudantes, permitindo-lhes compreender melhor os conteúdos abordados, e evidenciam os benefícios da combinação desses métodos no ensino tradicional da anatomia para facilitar a compreensão de informações.

Palavras-chave: Dissecção. Aprendizagem baseada em problemas. Imagem em 3D.

INTRODUCTION

Human anatomy is an important basic science in the curricula of health sciences for the construction of structural, functional and physiological knowledge of the human body, which enables the understanding of pathological processes and clinical conditions[1]. The changes that occurred in medical education over the years, especially after the preparation of the Flexner Report in 1910, brought changes in the teaching methods of anatomy[2].

This science is traditionally studied by professionals and students through the methodology of systemic, topographic and radiological anatomy, using texts, atlases and cadavers. These methods present limitations, such as difficulty for the reader to visualize anatomical relationships, limitation to certain illustrations presented and difficulty in obtaining and conserving cadavers[3]. The obstacle to anatomical learning has relationships with broad terminology, inadequate preparation of the pieces, lack of attention, lack of motivation and the fear or fear of contact with human cadavers[4].

In turn, the advancement of medical technology and the consequent development of procedures, such as endoscopy and high-definition imaging, have made anatomical knowledge even more important[3]. Such advances required changes in the curricula of medical schools and provided the insertion of new teaching methods[5].

Gradually active learning methodologies are being inserted in the teaching of human anatomy, which expand and facilitate the environment for the teaching and learning process, by recognizing the student as the protagonist of the process, stimulating criticality, autonomy in the study, the development of social, ethical and technical awareness, besides encouraging the student to intervene in day-to-day problems, which are addressed in classes[5]. These methodologies include problem-based learning, project learning, case learning, team and game-based learning and technological resources[5]. They allow the stimulation of creativity and, consequently, break the passive transfer of knowledge that happened with traditional teaching methods, such as exhibition classes[6].

Thus, the analysis of teaching methods in anatomy is necessary in view of the learning difficulties of students and the very transformation of medical education in the years to go. The present study aimed to conduct a systematic integrative literature review to present the temporal evolution of the teaching forms of human anatomy.

METHOD

This is an integrative systematic review study, elaborated from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology[7]. This study was constructed from the key question: "What is the temporal evolution of the teaching methods of human anatomy?" With this questioning, we sought to identify the possible changes in the teaching of human anatomy.

The search occurred on August 18, 2021, in the following databases: Medline, LILACS and PubMed and, for the search, the descriptors “teaching”, “education techniques”, “teaching materials”, “teaching methods”, “anatomy”, “anatomy, cross-sectional”, “anatomy, comparative”, “anatomy, regional”, “clinical evolution”, “cultural evolution”, “evolution” e “biological evolution”. From these descriptors and association of Booleans, the following algorithm was used in the PubMed platform: ((((((clinical evolution [Title/Abstract] OR cultural evolution[Title/Abstract]) OR Biological Evolution [Title/Abstract]) OR evolution[Title/Abstract])) AND ((((teaching materials

[Title/Abstract]) OR teaching[Title/Abstract]) OR teaching methods [Title/Abstract]) OR educational techniques [Title/Abstract])) AND ((((anatomy [Title/Abstract]) OR anatomy, cross-sectional [Title/Abstract]) OR anatomy, regional [Title/Abstract]) OR anatomy, comparative [Title/Abstract]).

Inclusion criteria were articles in English, Spanish and Portuguese, which related to the key question. The exclusion criteria considered were articles not found in full and articles related to the history of anatomy that did not address teaching methods. The reference lists of the articles were examined to identify other relevant papers. The studies were evaluated and critically compared by five researchers, considering the agreement and disagreement between them from the reading of the titles and abstracts and, after considering them pertinent, fully evaluating the articles chosen. This full process is described in Figure 1.

The analysis of the articles allowed the extraction of variables, based on an instrument elaborated for this collection, containing information about the studies, such as type, year of publication, drawing, methodological summary, results found and level of evidence. This allowed the evaluation of all variables obtained in the data and analysis of the results. The studies were evaluated for the level of evidence, using, for this, parameters of the Oxford Centre Evidence-Based Medicinetool8 updated in 2011.

RESULTS

The initial search resulted in 318 articles, which were submitted to the analysis of titles and abstracts and to the application of inclusion and exclusion criteria. A few 259 papers were excluded because they were not related to the key question or because they were in duplicates, with 59 articles read in full, of which 21 met the inclusion criteria. A summary of the electronic search and the respective results for inclusion are presented in Chart 1.

The included studies were characterized as action research studies published from 2004 to 2021, and 2018 was the year with the largest number of papers included (five articles). Most studies were conducted in the United States of America (six articles), and anatomy teaching tools were evaluated, cadaveric dissection and 3D resources. They were also analyzed for the level of evidence and were evaluated at level 4. The results are shown in Chart 1.

The selected studies emphasize the influence of technology as the main method to aid students' learning today.

Of the analyzed studies, seven[9-15] refer to the application of content from computers and 3D printing of the parts used in laboratories, as well as the importance in learning due to the more detailed visibility of structures from instruments such as video classes, clinical cases and interactive tools online. Of these, only four[11,13-15] reinforce the association between dissection and the use of technology as support, to keep traditional anatomy teaching. Students were advanced in the discipline with this applied methodology.

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Figure 1 - Flowchart of identification and selection of articles for the systematic review on the evolution of teaching methods in human anatomy, 2021.

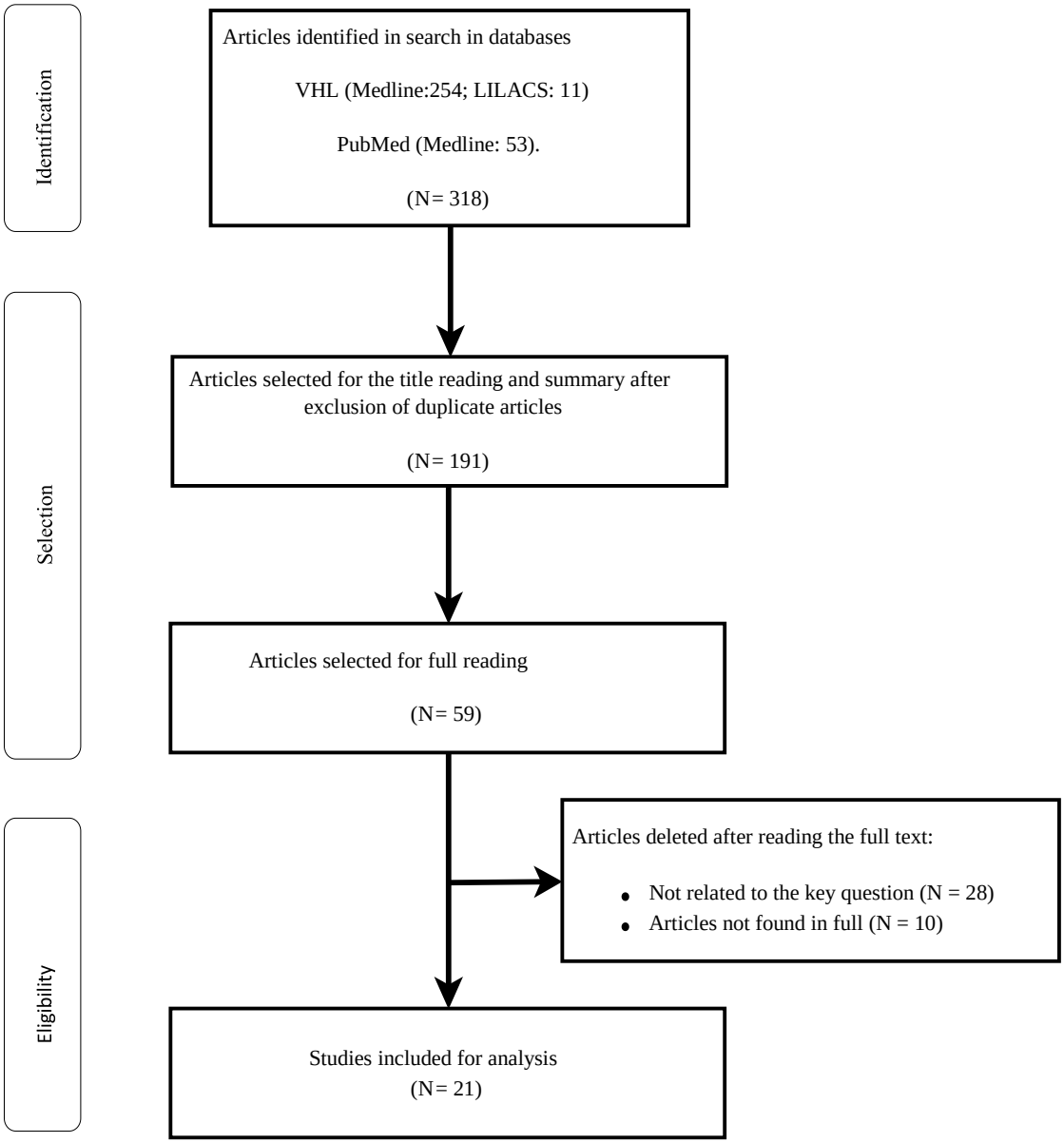

Chart 1 - Characteristics of studies on the evolution of teaching methods in human anatomy according to author, year, location, study design, methodological summary, results found and level of evidence. 2021.

Code	Authors (Year)	Country	Study Design	Methodological summary	Results	Evidence Level
1	Reeves et al. (2004)[15]	USA	Action search	Development of software for dissection and evaluation of alternating programming in practical performance in anatomy. Computer pool to dissection.	Significant improvement in student independence and proficiency, the efficiency of dissection time and quality of faculty lab instructions.	4
2	McWhorter et al. (2004)[16]	USA	Action search	Evaluation of alternating programming effects on the practical performance of the gross anatomy laboratory through dissection.	Dissection may be important in more complex cases and voluminous regions of the body.	4
3	McMenamin et al. (2008)[25]	Australia	Action search	Introduction of body painting in integrated clinical skills teaching sessions.	Kinesthesia nature and active participation, together with visual images of the underlying anatomy, contribute to the value of body painting as a teaching exercise. In addition, they can help end the apprehension regarding peer-to-peer examination. Based on the experience and feedback of students, the use of body painting as a complement to superficial anatomy and clinical skills classes is advocated.	4
4	Fornaziero et al. (2009)[26]	Brazil	Action search	Principles of action research were used, with the combination of different situations of dialogued teaching-learning, associated with the integration of the human body with the environment.	The results obtained were positive in the sense of combining the knowledge of a basic science, such as anatomy, to environmental knowledge, in a model of differentiated teaching-learning process.	4
5	Logan et al. (2011)[21]	USA	Action search	Application of tests with repeated questions to evaluate the improvement in anatomy teaching.	Showed that students really learned and remembered the material and improved their performance.	4
6	Brown et al. (2012)[14]	United Kingdom	Action search	It refers to the creation of a system that represents 3D anatomy and may be related to pathologies such as aortic aneurysm and trauma.	In the first-year result, the students indicated a positive response to the tutorial and the 3D system..	4
7	Khan et al. (2013)[18]	Pakistan	Action search	Evaluation of the physical and psychological effects of dissection of human cadavers in the graduation of medical students and observation of the role of counseling in this regard.	Physical and psychological problems associated with cadaveric dissection were found, but which can be reduced with counseling. But despite all the problems, students still prefer dissection to plastic models and other audiovisual resources.	4
8	Larkin et al. (2013)[19]	Australia	Action search	Medical students' perception of the experience of voluntary human dissection, scheduled at the beginning of the 2nd year.	Students' responses to the most beneficial component of the dissection experience were based on practical skills, anatomical education, learning process, and body donors.	4

9	Hammer et al. (2015)[27]	Germany	Action search	Surgical exposures demonstrating procedures in body donors. After the introduction, students practiced the exhibits in an analogous way to the operating room.	The overall result of the evaluation of surgical exposures was excellent, proving to be a better result when compared to the dissection course of the first year. The surgical exhibition workshop provided students with clinically relevant anatomy and manual dexterity.	4
10	Pais et al. (2016)[17]	Portugal	Action search	Two optional cadaveric dissection courses were introduced for the first two years of the medical school curriculum.	The students who took these courses rated them particularly important in terms of consolidating their knowledge of anatomy, preparation for other undergraduate courses and training for future clinical practice.	4
11	Cui et al. (2017)[9]	USA	Action search	Investigation of the efficacy of stereoscopic 3D models created from computerized tomographic angiography (CTA) data, through observation by medical students.	The use of stereoscopic 3D models can be particularly useful to improve anatomical performance in all students, particularly those with lower spatial capacity.	4
12	Perumal et al. (2017)[10]	New Zealand	Action search	Introduction of online supplementary resources (clinical cases of human anatomy) were developed and introduced into the regional and clinical anatomy module of the medical course.	Custom resources have promoted learning clinical anatomy outside of classroom hours and make supplemental learning a task.	4
13	Walrod et al. (2018)[22]	USA	Action search	Use of ultrasound as a complementary method of teaching skeletal muscle anatomy to aid in the physical examination skills of medical students.	The use of ultrasound provides an educational advantage when learning musculoskeletal physical examination of soft tissue landmarks.	4
14	Langfield et al. (2018)[11]	Australia	Action search	Offering short instructional videos for each of the firsthand classes.	Students who accessed all video sets had a higher learning gain compared to students who didn't use any or one of the four sets of videos. Potentially, videos represent a passive mode of teaching, while active learning has been shown to result in greater learning gains.	4
15	Perumal (2018)[12]	New Zealand	Action search	Production of an interactive online sectional anatomy learning tool (SALT) to learn the transverse anatomy of the spine, thorax, abdomen and pelvis.	SALT promoted independent learning, and improved students' learning experience and academic performance.	4
16	Lozano et al. (2018)[13]	Spain	Action search	Description of different modalities of obtaining anatomical images using different 3D scanning devices.	With 3D printing, different anatomical bone parts were able to detail the morphological aspects. The high-quality model allowed anatomy students to use it for better learning.	4
17	Silva et al. (2018)[29]	Brazil	Action search	Imaging exams were used as a teaching method and questionnaire application for students of human anatomy of the Physiotherapy course.	The imaging approach proved to be highly effective and feasible, with good acceptance, allowing to assimilate the contents studied in the classroom, enhancing the teaching and learning process.	4
18	Varsou (2019)[23]	United Kingdom	Action search	Incorporation of ultrasound teaching in undergraduate curricula, outside the field of opportunistic bedside learning, accompanied	Ultrasound is effective in terms of improving knowledge and increasing confidence among students, but it is still important to consider that ultrasound is an adjunct to be used alongside	4

				by the consideration of ethical topics such as the management of incidental findings and careful evaluation of its cross-sectional and longitudinal pedagogical impact.	traditional approaches to teaching topographic anatomy and not as the only means for learning anatomy.	
19	Chew et al. (2020)[28]	United Kingdom	Review	A systematic review of the literature was conducted to evaluate radiology and radiological images in the teaching of medicine.	There has been a significant increase in articles published in radiology in the teaching of medical students in the last decade. Most articles remain exhibits and research - few are truly experimental. There is a tendency of non-radiologists teaching radiology - the adequacy of this in the 21st century is questionable. Imaging exams are increasingly being used in the teaching of anatomy.	4
20	Georgakarakos et al. (2020)[24]	USA	Action search	Active learning to perform peripheral vascular ultrasound and increase students' understanding of vascular anatomy and cardiovascular pathophysiology, collaborating in the review of knowledge of vascular anatomy during clinical activities.	Modern medicine has placed the vascular system at thecenter of minimally invasive techniques. In medical schools, a transdisciplinary teaching approach is ideal for providing practical, theoretical skills and efficient long-term retention of anatomical knowledge. Early exposure to surgical procedures, vascular exposures, and extracurricular practical training can help focus on the practical aspects of anatomy.	4
21	McWatt et al. (2021)[20]	Canada	Cohort	Examine the role of the laboratory environment in learning and comparison between the method of dissection and prosection in the teaching of human anatomy.	Both types of laboratory were effective in maintaining prominent levels of student satisfaction, learning approaches and similar performance in written and laboratory assessments. Although students in the dissection cohort performed better in oral evaluations, the results show that gradual prosection is also an effective method for learning anatomy.	3

Cadaveric dissection, alone, is analyzed in five studies[16-19,20] and showed a key role in the consolidation of the students' anatomical knowledge, which allowed improving their performance in the tests and optimizing the time of study of the discipline. The method that applies repeated tests was found in a study[21], through which questionnaires on anatomy containing different versions of the same question are applied to students.

The complementary use of ultrasound in association with traditional classes of human anatomy was analyzed in three studies[22,23,24] to verify if there was an improvement in the performance of semiological skills in the musculoskeletal physical examination performed by the students.

The introduction of body painting, as a teaching methodology of human anatomy, was analyzed by a study[25], which showed great acceptance by the evaluated students, consisting of an active form of study, in which the students themselves apply the knowledge drawing in each other.

A study[26] discussed an extension project that teaches human anatomy promoting the integration of relations between the human body and the environment. Another teaching method, analyzed from a study[27], highlights the learning in anatomy from the surgical exposure, composed of a team of anatomists and surgeons with the introduction of content together in a practical and theoretical way and demonstrating procedures in body donors.

The use of imaging and radiology tests in the teaching of human anatomy was evaluated in two studies[28,29]. The incorporation of a radiologist as a professor of the sessions, especially in the medical course, was analyzed in one of them[28].

DISCUSSION

The teaching of anatomy in health sciences has undergone changes due to the need to improve the effectiveness and incorporation of modern technologies in its learning[3]. Studies show a temporal evolution of the methods applied in the discipline of anatomy, which adapts to the models available in each epoch, ranging from the use of cadaveric dissection to 3D graphic representations and application of anatomical knowledge in various educational experiences[3].

The increasing complexity of medical knowledge and easy access to information through technological means complement the traditional teaching of medicine and provide greater information management, especially in the clinical environment, instead of just establishing memorization of the applied contents[13]. Changes in anatomical education can be observed in the analysis of the studies included in this review, in which nine[9-15,22,27], from a total of 21 articles, address the use of technology to the detriment of the isolated use of cadavers.

The most traditional method found in the studies was isolated cadaveric dissection, described in 4 studies[16-19] analyzed. In one of the studies[16], the effects of an alternative dissection scheme on practical performance in the anatomy laboratory were evaluated, which recognized the difficulty of students in dissection of different areas of the human body and the complexity of learning each region[16].

Two studies[17,19] compared the academic success and satisfaction of undergraduate medical students who perform an optional dissection course with data from a similar cohort not exposed to cadaveric dissection. Students perceived these optional dissection courses as important in the consolidation of their knowledge and in their general medical education[17,19]. The opportunity for self-learning directed by the dissection of cadavers from

clinically relevant regions is important in a systems-based curriculum[19]. The data affirm the importance of dissection as an instrument for consolidating learning in anatomy.

Students' understanding of human anatomy is often evaluated with laboratory practices: students who dissected would perform better than students who did not have the same opportunity; with this performance may be different for groups that perform dissection due to differences between dissected regions, complexity of the region and volume of information[16].

Cadaver-based laboratory opportunities are long awaited and often heralded as a rite of passage for those seeking careers in health sciences. A 2021 study conducted at the University of Guelph, Canada, compared the performance of groups in traditional dissection (performed by the students themselves) and a modified gradual dissection project (they used the dissections performed by the other group for teaching)[20]. The results suggested that students in both cohorts had positive course experiences. However, dissection students outnumbered prosection students in skill-based laboratory oral assessments. Dissection was considered positively associated with learning and performance of oral laboratory evaluation[20].

Medical schools have been implementing new learning methods in place of the traditional model. Although anatomical teaching, through cadaveric dissection, improves active and deep learning, imitating surgical skills, so that the student can better understand the relationship between patients' symptoms and the underlying pathology[5], this method has disadvantages in relation to its cost, obtaining and conserving cadavers, the time necessary for its practice and challenges, such as the religious belief of students[18].

Another study[25] addressed a teaching method that was introduced into a medical curriculum and evaluated by students, in which series of body painting exercises were performed in integrated clinical skills teaching sessions, which included clinically important aspects of the respiratory system, musculoskeletal system, and regional topics, including head and neck. The activity was positively evaluated, as a complementary activity, in anatomical teaching by its kinesthesis nature, active participation and visual images of anatomy, proving to be effective in the consolidation of learning associated with other methods[25].

An extension project implemented by a university, which teaches human anatomy promoting integration of relations between human body and environment, was evaluated[26]. The development of interdisciplinary action research activities with the use of intuitive teaching-learning methods (constructed images; mental construction), active (field exits) and constructivists (integration of art and education), generated different possibilities of articulating educational and recreational activities, integrating related knowledge, in a concrete way to stimulate dialogue between sciences and to opportunities the application of different methodologies in the teaching of human anatomy[26]. The results obtained were positive since they allied the knowledge of a basic science, anatomy, usually taught through exhibition classes, to environmental knowledge, in a model of differentiated teaching-learning process[26].

Another teaching strategy found in the research was repeated tests that, although not well evaluated by the students, demonstrated to have contributed to their performance in the final anatomy tests. These data show that this method can be used as a theoretical learning tool in a way complementary to other practical methods[21].

The evolution of technological means, used for the creation of 3D anatomical models, is allowing greater similarity between the objects of the devices and the real part, increasing their use in different disciplines of the health sciences. The teaching methods found in this review related to 3D images showed satisfactory results[13-15]. Of the nine studies[9-15,22,27] that refer to technological evolution, two[9,14] addressed the creation of systems that represent 3D anatomy, which may be related to diseases such as aortic aneurysm and trauma. The resource used represents high applicability of the area of examinations to the study of anatomy, integrating computed tomography and tomographic angiography. The results of these teaching models were promising, with students exposed to 3D images generating significantly better post-learning test results compared to students exposed to 2D images[9,14]. These data confirm the importance that the insertion of modern technologies represents in the teaching-learning process of the discipline, allowing the visualization of structures, sometimes with greater definition than in traditional models.

Another method using 3D resources was presented in one of the studies[13] of this review with different scanning devices. The creation of models using 3D printers and their incorporation into teaching allowed students to have greater access to anatomical parts, in a more economical way, obtaining physical objects from a digital object. After printing, different bone parts were demonstrated with morphological details[13]. This method proved to be effective by improving the quality of anatomical components used in teaching practices. It became possible to replicate an anatomical model, capable of studying, copying, modifying and distributing more identical copies, allowing greater diffusion and access to this technology[13].

One of the methods that can be used is imaging that can bring benefits to the teaching of human anatomy. The pedagogical use of radiology, seen in two articles[28,29], is an instrument of significant importance, because it compares anatomical knowledge with imaging techniques, reiterating interdisciplinarity and reinforcing the need for comparison between areas of knowledge. One of these studies[28] evaluated radiology in the teaching of human anatomy and the incorporation of a radiologist as a professor of sessions, especially in the medical course. There is a trend in which physicians (30%) and anatomists (43%) seem quite comfortable teaching medical students on radiological images without the help of a radiologist. Although this attitude could be understood in the past, when radiology consisted of simple radiographic images, this is no longer the case today. Computed tomography is the main recognized test in the clinical diagnosis process and, in addition to magnetic resonance imaging, sophisticated examinations that produce exquisitely detailed and complex images that take a radiologist to five or more years of study to be competent in reading[28].

Regarding the correlation with clinical practice exams, one study[22] addressed the integration of ultrasound use associated with the teaching of musculoskeletal anatomy to improve students' performance in semiology. The use was seen as beneficial by the students, who participated in the experiment and obtained a significantly better performance in the knee and shoulder examination. With the advent of cross-sectional imaging in the 1970s, it became possible to visualize anatomy in a much more detailed way[30]. It was observed that the instructions guided by reference points are accepted as the standard for the teaching of surface anatomy and the use of ultrasound facilitated the identification of these structures[30].

Ultrasound allows the visualization of all regions of the human body and, therefore, can easily be adapted to the needs of students in learning teaching in anatomy. A 2019 study from the University of Glasgow addresses the benefit of 2D, 3D, 4D and Doppler diagnostic and educational ultrasound in diverse ways with transducers that can produce images of excellent quality and with high fidelity to human anatomy. It discusses the use of linear transducers as a good starting point in educational environments due to their ability to produce rectangular images of scanned areas, allowing students to easily compare 2D images with 2D anatomical diagrams, causing the development of a better understanding of anatomy. In addition, these devices allow the evaluation of physiological changes, such as artery dilation[23]. Modern medicine has placed the arterial and vascular system at the center of minimally invasive techniques. Therefore, regardless of their specialty, most physicians should have a clear and precise knowledge of vascular anatomy and basic access techniques[23,24]. Active learning to perform peripheral vascular ultrasound exams may increase students' understanding of vascular anatomy and cardiovascular pathophysiology. Although it is debatable whether such skills should be considered essential, the imaging exam is easy to understand and reproduce, making it useful to guide practical skills[24]. It is still questionable when to implement the study of anatomy with ultrasound, the fact is that standardized curricula for ultrasound training in medical schools in the United States do not yet exist, but is increasing the interest in developing such protocols, because it evidences the importance of the study complemented with such techniques[24].

It is concluded that, for the purpose of visualizing anatomical structures and developing a better understanding of the underlying physiology, ultrasound is effective in terms of improving knowledge and increasing confidence among students, but it is still important to consider that ultrasonography is an adjunct to be used alongside traditional approaches to the teaching of topographic anatomy and not as the only means for learning anatomy[23,24].

Other studies on methods refer to the combination of computers with traditional alternatives, such as dissection[12,15]. These studies were conducted in the USA and New Zealand in 2004 and 2018, respectively, and aimed at developing software to perform browser-based dissection and link the compressed digital images of anatomical structures[12,15]. Thus, students were able to access these images during the laboratory dissection time and as a review learning resource. Both are interactive and easily accessible, important and fundamental criteria for online learning tools. This method is a natural evolution of technology and creative, joining the teaching strategy adapted to anatomy laboratories of the 21st century[12,15].

For students to develop clinical judgment skills, a clinic-oriented problem-solving approach is often required, and technology can provide flexibility of schedules for students and encourage self-assessment through exercises that provide immediate feedback. In two studies[10,11], the use of video classes and clinical cases addressing the theme of human anatomy was observed. Those students who were already engaged in classrooms improved their performance in student evaluations by using complementary resources[10,11]. These studies show the benefits of combining traditional teaching of human anatomy with complementary. Anatomical educators began to recognize the pedagogical potential of virtual anatomy, as emerging and viable adjuncts, and cases of substitution, to traditional teaching materials and recommend that these digital representations be

integrated into future medical curricula to facilitate the understanding of information[22].

Innovative concepts are important for the student's greater interest and performance for the study of anatomy. A study[27] evaluated a pre-clinical workshop developed by a team of anatomists and surgeons, who introduced surgical exposures in on-screen presentations of videos, from the anatomical regions, aligning the practical and theoretical parts. It was observed greater interest of the students in relation to an isolated method, with better results, when compared only to dissection[27].

The development of innovative projects in the field of educational technology, especially the design of computerized educational materials, imposes constant challenges regarding the structures, forms and languages of representation of scientific knowledge[15]. This is because, in addition to functioning as a tool for the realization of the most sophisticated illustrations, the computer has been demonstrating enormous potential for the dissemination of information, together with the new teaching proposals. For the adequacy of new teaching models, it is necessary to add computers in laboratories for the reorganization and enrichment of anatomy with laboratory experience[15]. The incorporation of computerized learning methods guides and facilitates the understanding of the contents and has been support to the teaching process, besides resulting in additional motivation to the study of anatomy[31]. Computers, 3D teaching, and workshops are important because they facilitate certain aspects of instruction, such as process development animation. Therefore, it is important to evaluate these new methods as something enriching, to add the performance of the study, since, in anatomy, observation and direct study of three-dimensional structures are considered fundamental conditions for learning. The importance of the correlation between new teaching methodologies, reading and dissection is emphasized as useful ways to develop the ability to solve clinical problems, since, according to one study[31], when in association, there is a broad understanding of the subject and a better relationship between teacher and student31. Moreover, it is important to highlight the issues of costs that may arise with the introduction of new methods, related to the adaptations that must be made in laboratories and the professionalization of the educator, which can generate conflicts also due to the resistance to the adoption of new technologies[31].

This study has limitations associated with the analyzed studies that do not have elevated levels of evidence and do not emphasize the main limitations faced regarding the application of the methods, not allowing to recognize whether there is a superior methodology for the application of the contents. However, it is observed that all studies contribute to stimulate independence and responsibility, besides instigating more didactic, practical and malleable teaching, for example, through 3D, dissection and body painting. The way the modern methodology reaches the student is what differs it from traditional anatomy, because it allows students to participate more actively in the applied teaching method.

CONCLUSION

The teaching of human anatomy in health sciences has undergone changes over time due to the growing need for the incorporation of more modern and technological methods, with a view to making learning more effective, but without abolishing more traditional methods. From methods such as cadaveric dissection to the integration of human anatomy with the environment, body painting, the application of problem-based learning, the use of different technological resources,

3D graphic representations and the application of anatomical knowledge in assisted surgical procedures were identified. The studies suggest that the new alternatives allow interaction and autonomy of students, which allows them to better understand the contents addressed and evidence the benefits of combining these methods in the traditional teaching of human anatomy to facilitate the understanding of information.

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