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Anatomy

Assessment of the Impact of a New Multimedia Tool for the Study of Osteology and Radiology in Medical Students

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Abstract: The use of multimedia tools for learning anatomy has been widely accepted in recent years. They have developed as a result of technological progress and the need to adapt the new organization of the theoretical and practical teaching of Anatomy. The anatomy software has been widely used, but few data has been obtained in relation to improving knowledge of the student's anatomy. In the present work we develop an interactive software for the study of osteology and radiological anatomy with connections to the surface anatomy, the muscular system, arthrology and pathology. In addition, we incorporate an autoevaluation system for the student. We use this new multimedia tool in teaching of the anatomy for medical student. After a specific training to the use of the software, we demonstrated a significant improve in the knowledge of different groups of students in relation to the recovery of anatomical structures, interpretation of the radiological images and correlation of anatomy to pathological findings. Therefore, the development of our new computer application improves knowledge of anatomy and suggests that software in this field should be stimulated as a complementary element of the study of this discipline.

Keywords: Human anatomy, anatomy software, multimedia tools, radiology.

INTRODUCTION

Currently, a significant reduction of the time dedicated to anatomy teaching in the curricula of the different degrees has been detected, especially in what refers to practical teaching [1].

A change in the classical form to learn human anatomy is necessary [2], looking for new ways to present the anatomy to the student in a way that allows them a continuous study and an autonomous work regardless to the availability of the teacher. In this context, new technologies have revolutionized university teaching including the classical teaching in anatomy [3]. Technological innovation in the field of anatomy has allowed the development of video material with animated images and especially software as a multimedia tool [4-7]. They can be used by the students in a individually form or in groups and offer them not only the knowledge of the anatomical structure but also their clinical importance and the practical utility connecting the morphological knowledge with clinical cases and the imaging tests that are used in the usual clinical practice in a hospital. Previous works indicate that the development of software for the study of human anatomy have a good acceptance by the students and facilitates the practical understanding of anatomy, especially in relation to the three-dimensional structures and their representation as bi-dimensional structures (radiology) [8-11]. However, in many cases, the student's appreciation is that this technology is not able to replace the development of practices in anatomy rooms using real models. Different studies suggest that the use of computer tools in anatomy does not improve theoretical knowledge and that practical learning is lower than with the traditional method [12, 13].

The aim of this work is to develop a software related to the osteology and radiology study in Medicine. This software uses real three-dimensional images that can be manipulated from the computer, allows the marking of different parts of the bones, allows the location of muscle insertions and incorporate radiological images and interactive schemes with explanatory text and images of clinical application. In addition, we evaluated the improvement in the knowledge of this subject by the students of Medicine through the use of this software

MATERIALS AND METHODS

Materials

Bone pieces from the Department of Human Anatomy and Embryology of the Granada University were selected to generate 3D and 2D images and to develop an integrated anatomo-clinical multimedia material including radiology images. The radiological material, magnetic resonance, bone reconstruction (3D), arthroscopies and pathology images were obtained from the University Hospital of Granada and the Department of Health Sciences of the University of Almeria (Prof. JM Egea). All the radiological material was processed in the Scientific Instrumentation Center of the University of Granada.

Generation of three-dimensional images and labeling

The three-dimensional images were obtained by a 3D laser scanner (KMinolt 3D Laser Scanner; Anthropology department, Granada University). Data processing was carried out by the Rapidform program including its labeling. This processing included the correspondence between the bone element represented by B-rep and the bone element in the radiography, pathology images and explanatory schemes of muscular insertions and visualization of the muscle localization. Finally, the application for the labeling of the pieces was designed from a file in wrl format and using the OpenGL graphic library and the additional glut library.

Generation of an interactive CD and evaluation

Once the multimedia tool was developed, a CD was generated with the application. Medical student (monitors) in an number of 80 were trained in their use for software specially in the upper limb osteology and radiology. The CD was free use by the students. After a month of self-learning, the academic knowledge of the students were evaluated in and compared with a group of students who studied using traditional methods.

Comparison between students

To determine the influence of the teaching material generated, a study of the grades obtained by the two groups of students (with and without the he use of the multimedia tool) (n=60) in osteology and radiology was carried out. In addition, a Group that used the application without previous training was included (n=60). In addition, a comparison was carried out with the student of previous course in which this new system had not been used (n=60).

Statistical analysis

Data analysis was performed with the GraphPad Prism program, using the chi-squared test and the Fisher's test for the comparison of percentages, and the Student's t test for the comparison of means. Values of p <0.05 were considered statistically significant. The open answers were established by categories and fragments of phrases were chosen according to a criterion as the text's representative.

RESULTS AND DISCUSION

Application development

The application developed allowed to autonomously visualize the bones in a three-dimensional way by turning them to observe their morphology (Fig-1). These pieces were labeled so the student could identify their different parts.

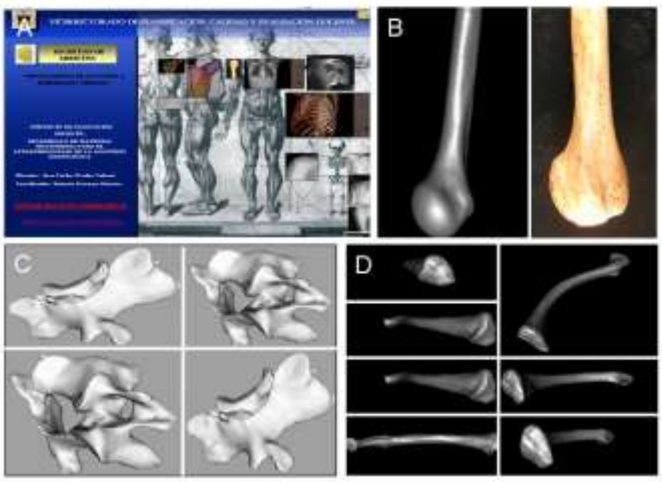

Fig-1: Development of teaching software for anatomy study (upper limb osteology). A. CD application developed for the self-learning of the student; B. Representative image of the capture process, 3D scanner and processing of a bone in the software construction process; C. Representative image of the three-dimensional reconstruction of a bone piece (cervical vertebra) and the possibility of mobilization by the student to analyze its characteristics. D. Representative image of the three-dimensional reconstruction of a bone piece (clavicle) and the possibility of mobilization by the student to analyze its characteristic.

The student's learning process included training in radiological anatomy through links of the bone radiographs. The training in this task was supported by the generation of diagrams with explanatory text (Figure-2).

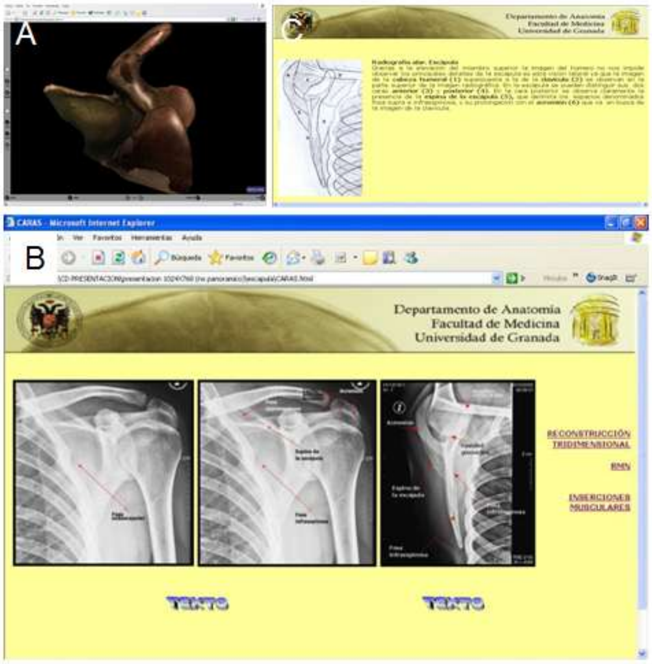

Fig-2: Learning accessories in the teaching software for the anatomy study (upper limb osteology). A. Representative image of the three-dimensional reconstruction of a bone piece (scapula) and the possibility of connection with complementary information (B and C); B. Radiological information on the bone piece under study (scapula), information extension in the form of text; C. Outline and explanatory text on the radiology.

Radiological images allowed toconnect with a three-dimensional reconstruction video to a best understanding of the spatial structure and with magnetic resonance images (Figure-3A and B). To allow an integrative training, the application offered the possibility of obtaining information about the musculature and arthrology related to the bone and its disposition and a graphic representation about a real subject (surface anatomy) (Figure-3C). It was also possible to obtain information from arthroscopy videos (data not shown). Finally, all anatomical learning was contrasted with pathological images such as those shown in Figure-4D that allows the student to have a reference of the alterations of these structures. The application also allowed a final autoevaluation (data not shown).

Learning of student (monitors)

Using our application as a self-learning system and after a period of training (1 month) we have evaluated a group of 60 students (group 1) in relation to the recognition of bone structures, description of their anatomical characteristics, radiology, muscular system apparatus and articular structures. This group was compared with another (n=60) in which the students prepared the subject (osteology and radiology) through the classical form (seminars and practices) (group 3). In addition, a group (group 2) that used the application without previous training was included. The evaluation was made following a classical system including recognition of anatomical structures, relationships and radiology images. The results (Fig-4), expressed in the average grade of each group (scale of 10), clearly show that the Group 1 obtained a better result indicating that our teaching tool greatly improved academic performance.

Fig-3: Learning accessories in the teaching software for the anatomy study (upper limb osteology) A. Representative image of the three-dimensional reconstruction of the thoracic area with connection to other imaging techniques (B); B. MRN; C. Integral training: representative image of the muscular system (surface anatomy) related to the joint studied (scapulohumeral joint); D. Integral training: information of a pathology related to the analyzed bone structure with explanatory text on the radiology.

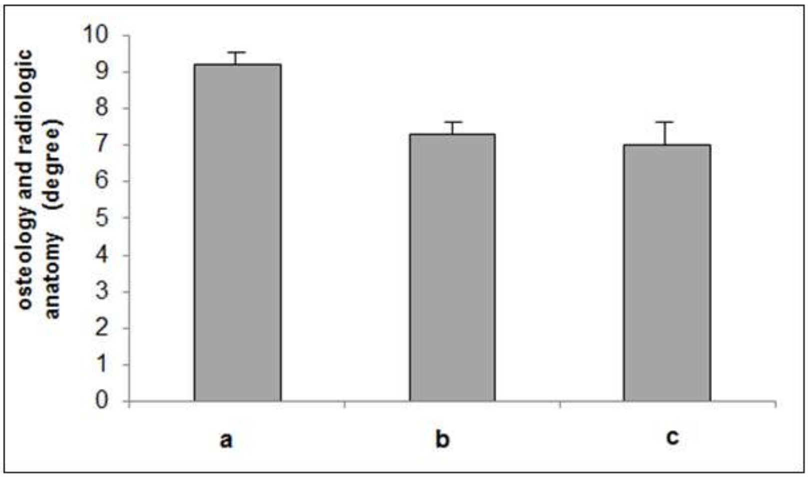

Fig-4: Average grades obtained by the student groups evaluated. The graph shows how the group of students with training through the software (a) achieved a higher average grade than the Groups that used the application without trainning (b) or the group that use only classical system (seminars) (c).

Acquisition of knowledge in relation to previous course

The comparison of the evaluation of osteology and radiology knowledge between students trained by the computer application and the previous course in which application was not used (Fig. 5), clearly demonstrated an increase in the degrees.

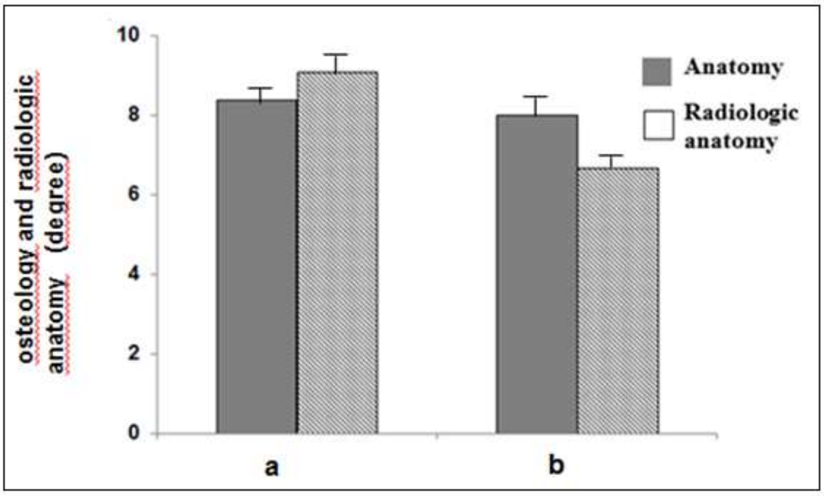

Fig-5: Average grades obtained by the student groups evaluated. The graph shows how the group of students with training through the software (a) achieved a higher average score in both anatomy and radiology than the group evaluated in previous course (b).

Technological advances make it easier to develop software that implements teaching, especially practice, in many subjects including human anatomy. These tools try to make up for the loss of hours that this subject is suffering in all the degrees in which are included as a discipline. There are many Universities that develop teaching applications through teaching innovation projects. Moreover, system as a ADAM (Animated Dissection of Anatomy for Medicine,) 3.0 Interactive Anatomy 1997 presents schemes of the regions and systems of the human body or Netter compact disc also shows interactive schemes of the anatomical systems. These applications are interactive and gather a large amount of information but require prior learning to acquire skills but they have the advantage of self-training and can be used by the student at any time. However, using these resources as the only source of learning can also lead to bad teaching practice. In general, the anatomy software is well evaluated by the students. They allow an autonomous preparation of the subject especially of the practical part but it does not replace the theoretical classes [14]. In fact, the classes that integrate complex anatomical concepts and that join them to the practical, clinical or experimental application are still essential for the students. Although the teaching software with interactive schemes includes a widely range of information [15], there are very few system that have been evaluated in an objective way according to the acquired knowledge by students in a classical evaluation process. Our work shows the development of an new application in relation to the osteology and radiology learning and its application to a group of students after their adequate training that allows self-learning. Our results show a significant increase in the knowledge acquired that is reflected in a better qualification. Other studies have shown that the use of computer programs improves the performance of practical activities, in terms of better comprehension and / or better marks obtained by the student in practical evaluations [8, 16, 17]. Unlike the images without animation that are classically used in Anatomy, our software with animation captures the student's attention, they lead it in an orderly way through the subject and allow us to introduce the student in other areas such as pathology. Other studies have shown that the incorporation of the radiological image in the anatomical programs helps the students to understand the three-dimensional relationships between the different anatomical structures [18-20]. However, our results also showed that the trainig period is essential to obtain an adequate performance. In fact, there is a significant benefit to use radiological imaging software in the first year of medicine. In fact, in subsequent clinical courses, these students have a more effective response time in the patient's analysis and image test [21].

CONCLUSION

In conclusion, the development of teaching software is an excellent to support the practical activities of the anatomy courses that allows, without replacing the classical teaching, the best recognition of the anatomical elements and facilitates its relationship with aspects of clinical practice. The universities should take the aim to improve teaching quality through this methodology especially at a time in which the curricula limit the time of theoretical anatomy.

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