CURRENT STATE OF VISUALIZATION OF MORPHOLOGICAL ELEMENTS OF THE ORBITAL CAVITY, WITH STATE-OF-THE-ART TECHNOLOGY, FOR TEACHING PURPOSES

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Abstract

Throughout medical training we can find different areas. One of them is Human Anatomy, a course shared by many degrees in health sciences. The study of this topic has evolved over the years. Given the advance of knowledge and technology nowadays, the study is supported by different means such as radiological images, videos, podcasts, open access, scientific articles. Even with so, it is not always easy to understand all the elements of the anatomical structures and the relationships between them. Although current techniques have improved, they also have their limitations. That is why the advance in the development of new techniques helps and improves the quality of the studying. In this context, the aim of our study is to complete the education in the field of human anatomy by developing new tools for anatomical study. This tool is based on the creation of three-dimensional (3D) anatomical reconstructions through the post-process of radiological images. We will focus on the anatomical region of the orbit and visual pathway given the confluence of several structures (4 walls formed by 7 bones, 4 cranial nerves, among many others) and their interest in different medical specialties such as ophthalmology, otorhinolaryngology, neurosurgery, maxillofacial surgery.

Keywords: 3D reconstruction, technology, education.

1 INTRODUCTION

The field of health sciences is very broad: the area of medicine, nursing, biology, etc. ... All these specialties have several elements in common including the study of the human body. This includes its physiology, histology, embryology and anatomy.¹

The study of human anatomy is a challenge for students: it is difficult to understand the relationships between all structures, specially those of small size such as the orbit.

Traditional study of anatomy includes anatomical dissection, atlases, books, etc. Subsequently, with the rapid technological development in all areas of life, including education, new tools have been developed: radiological images, videos, podcasts, scientific articles.²

Nowadays students are constantly in touch with technology, it is part of their day to day and therefore this affects the study as well. More and more people are using the internet to search for anatomical images or programs that simplify study in this field.²

Usually morphological comprehension is complicated since the student finds it difficult to transfer the two-dimensional image to a three-dimensional one.¹

That is why we continue to develop innovative study techniques, and this is what our case focuses on: the creation of three-dimensional anatomical models thanks to the post-process of radiological (two-dimensional) images. This allows to manipulate and rotate the images which facilitates the study and understanding of the anatomy.²

This develops a new scenario that has entered the classrooms in the last decade and that supposes the present and the future. It is a new learning method that affects both teachers and students, constituting a challenge for both.³

It is necessary to maintain the interest of the students, adapt teaching to the new times and create methods that suppose an incentive for students. The goal is not to replace these methods, but to expand the teaching methods so that they all coexist at the same time.³,⁴
As mentioned previously, there are certain areas in the human body more complex due to the size or importance of the structures that it houses.\(^5\), \(^6\) This is the reason why our paper will be focused on the study of the orbit and visual pathway.

This area is of special interest not only from a student point of view but also professional; it involves several medical specialties (ophthalmology, otorhinolaryngology, neurosurgery, neurology or maxillofacial surgery).\(^5\), \(^6\)

### 2 GOALS

- Create three-dimensional anatomical models that facilitate the study of the structures of the orbit and visual pathway for both students and medical practitioners.
- Demonstrate the importance of integrating new technologies and the advantages they offer in the didactic field, including medical training as well as updating teaching methods in the field of Human Anatomy.
- Assess the possibility of other novel techniques or other protocols, such as 3D printing, based on three-dimensional anatomical models using radiological images.

### 3 METHODOLOGY

For the elaboration of three-dimensional anatomical models, images obtained by different diagnostic imaging devices are used: computerized tomography (CT), magnetic resonance (MR) or even ultrasound (US). CT was performed on the Helical TC General Electrics and the Helical TC Philips.

CT emits multiple simultaneous X-rays from different angles. The tissues in a tomographic plane are assigned a density value proportional to their coefficient of absorption of xrays. The beams are detected after they have passed through the body creating a cross-sectional image, which will be weaker if they have passed through dense tissue. Either two- or three-dimensional images are digitally constructed from these density measurements.\(^7\)

MRI was performed on 1.5 teslas RM General Electrics and 1.5 teslas RM Phillips.

MR imaging provides characterisation specially of soft tissues. MRI has a powerful magnetic field that forces the protons in the body to align with that field.\(^7\), \(^8\) When a radiofrequency current is pressed through a patient, the protons are stimulated, and they spin out of balance, fighting against force of the magnetic field. When the field of radiofrequency, the MRI sensors are capable of detect the energy released while the protons are realign with the magnetic field.\(^8\)

Orbital CT and MRI scans are usually obtained in 2mm sections and for greater detail fine cuts at 1mm intervals may be requested. Orbital images can be obtained in the axial plane, parallel to the course of the optic nerve; in the coronal plane, showing the eye, optic nerve, and extraocular muscles in cross section; or in the sagittal plane, parallel to the nasal septum.\(^7\), \(^8\)

The images used come from the radiodiagnosis service of the Complejo Asistencial Universitario de Salamanca and the Affidea center.

Subsequently, for the processing of these images, different programs are used: OsiriX Lite, 3D slicer, vitrea software, amira ...; in our study to produce anatomical reconstructions vitrea software was used as a tool. Vitrea software is a multi-modality advanced visualization system providing comprehensive applications in a variety of information technology environments. This software can manipulate any image to reconstruct any section in any direction (axial, coronal, or sagittal). It can help you standardize and consolidate your radiology footprint.
You can use the manipulated images for 3D printing. 3D printing uses three-dimensional data for producing 3D physical models. The principle of prototyping is to use the 3D anatomical models for reconstruction the physical 3D models by the addition of material layers. This is produced using different programs such as the ITK-SNAP 3D printing software, which performs a segmentation of the images and subsequently create a file recognizable by 3D printers. Subsequently, the materials to be used in printing as poli-lactic acid are chosen. [9], [10]
We value the opinion of students of health sciences degrees where the subject of Human Anatomy is taught through a satisfaction survey to evaluate their opinion. Thus, our objective is to analyze whether the practical study of anatomy with these recently incorporated technological resources is a motivating element in learning as well as their opinion on the effectiveness of these methods. The evaluation of our technological developments of teaching innovation will be considered from a double perspective: a formative and a summative evaluation. The criteria that we apply for the summative evaluation or results is both the quality of the technological environment from a technical, pedagogical and functional dimension (level of effectiveness for the achievement of the objectives set, the relevance of the learning, relation to the cost of tools) as the quality of the learning achieved.

From a formative evaluation approach, that is, with the aim of improving those aspects of the technological background of immersive environments that are detected weaker, we apply some criteria and indicators to be able to contrast and take the appropriate decisions.

The indicators and their objective measure would be satisfaction surveys on the quality of the environment, detecting strengths, weaknesses and suggestions for improvement, by the teachers involved in the innovative experience and by the students.

4 RESULTS

The three-dimensional anatomical models have become a crucial tool for learning and understanding complex anatomical structures such as the orbit.

With this new technology, all the anatomical details of all the structures are better defined, improving the morphological understanding, which usually with the traditional study means is a challenge for students.

Emphasizing on the small dimensions: entrance height 35mm, entrance width 40-45mm, medial wall length 40-45mm and 40 mm depth, 3D reconstruction facilitates its morphological comprehension. Its limits are defined by its 4 walls:

- The roof of the orbit is formed by the orbital plate of the frontal bone and the lesser wing of the sphenoid bone. It is located adjacent to the frontal sinus and has some important landmarks such as the supraorbital notch or the lacrimal gland fossa, which can be perfectly distinguished with these methods.

- The medial wall is composed of the frontal process of the maxillary bone, the ethmoid bone, the lacrimal bone and the lesser wing of the sphenoid bone. It is also located adjacent to two sinuses: ethmoid and sphenoid. And some of the most important landmarks that are perfectly defined are the frontoethmoidal suture and the entry of the anterior and posterior ethmoidal arteries.

- The lateral wall is composed of the zigomatic and sphenoid bone. The superior orbit fissure (an important area from an anatomic point of view) can be viewed with the three-dimensional reconstructions and all the structures that passed through it.

- Finally, the floor of the orbit is composed of the palatine, maxillary and zigomatic bone. Here we can perfectly see some important and tiny structures such us the infraorbital groove and the infraorbital canal.
3D reconstructions allow the integration of new technologies in didactic areas, including in the study of health and in particular of human anatomy. Nowadays it is necessary the participation of these new techniques and constant updating by teachers and students.

Thanks to advances in the handling of radiological images, we can go one step further with 3D printing of anatomical models. With these the anatomy of structures such as the visual path is simplified in a visual and actual way.

Possible applications of these materials are not only for University students, but it also has its role in medical practice: medical research, implant and tissue designing and planning surgery. In the last one, as we mentioned before, given the region in which our study has focused (the orbit) it has its interest in many specialties: ophthalmology, otorhinolaryngology, neurology, neurosurgery and maxillofacial surgery.
5 CONCLUSIONS

Our work aims to demonstrate the advantages of these new systems. Among them we can find: helping in medical training, facilitating new study tools in this area, accessibility, morphological comprehension, improvement of spatial perception, establishing a better anatomy-radiological and clinical correlation, carrying out a wider differential diagnosis, possible application for the planning of technically complex surgeries, practicing surgical procedures on anatomical models before the patients themselves.

- As we have shown the creation of three-dimensional anatomical models have different advantages: simplification of anatomical structures, possibility of manipulation, orientation towards self-learning.
- The creation of these models is especially useful in the didactic field, keeping the teaching of human anatomy updated, something that current society demands. It allows to take advantage of the current modalities and that so much uses the young people: mobiles, tablets, applications…
- The three-dimensional anatomical reconstructions also have an important role in medical practice allowing a better anatomo-radiological correlation, which allows a wider differential diagnosis.
- Nowadays these models are used for the practice of surgery prior to their realization in patients, having been described in different regions of the human body but yet with little literature in the area of the orbit and visual pathway.

REFERENCES