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NEW GENERATION OF THREE-DIMENSIONAL TOOLS TO LEARN ANATOMY

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Abstract:	We present a new generation tool based of interactive 3D models. This models are based on the radiological two-dimensional images by computed tomography imaging. Our article focuses on the anatomical region of the skull base. These new three-dimensional models offer a wide field of application in the learning, as they offer multiple visualization tools (rotation, scrolling, zoom…). In this way, understanding of the anatomical region is facilitated. A feature to be dismissed is that a professional workstation is not required to work with three-dimensional models, since a personal computer can be viewed and interacted with the models. Educational and clinical applications are also discussed.

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Abstract

We present a new generation tool based of interactive 3D models. This models are based on the radiological two-dimensional images by computed tomography imaging.

Our article focuses on the anatomical region of the skull base.

These new three-dimensional models offer a wide field of application in the learning, as they offer multiple visualization tools (rotation, scrolling, zoom…). In this way, understanding of the anatomical region is facilitated.

A feature to be dismissed is that a professional workstation is not required to work with three-dimensional models, since a personal computer can be viewed and interacted with the models.

Educational and clinical applications are also discussed.

Keywords

Anatomical 3D models; skull base; TC images; free software

Introduction

Significant technological advances have been made in recent years, introducing innovative teaching and learning techniques into health sciences, in particular to medicine [1,2].

An example is radiological imaging postprocessing. With the latest technological advances in image reconstruction we can generate three-dimensional models (3D) from conventional 2D computed tomography (CT) o magnetic resonance (MR) images [3–5].

With new 3D imaging techniques, spatial perception and anatomical understanding are enhanced, since it allows interaction with the models.

This technology has enabled the development of crucial tools for teaching and learning of different disciplines, particularly in biomedical field [4,6].

In anatomy, it is particularly important represent different anatomical structures in images, because they bring more information for appropriate understanding of the structures.

Material and methods

A literature search was performed in PubMED database of the National Library of Medicine.

The process of creating 3D models consists of several phases and depends on various software packages.

Previously the authors needed a tool chain of at least three or even four different software applications but today the number of tools can (and should) be reduced to a one or maximum of two applications.

All these steps are necessary to create the final document, but once completed, the user only need one sofware to open the file and interact with the model.

Images of CT (Philips, 16 detectors) skull base (Fig 1) are obtained from databse of studies conducted at the Hospital Virgen de la Concha (Zamora, Spain).

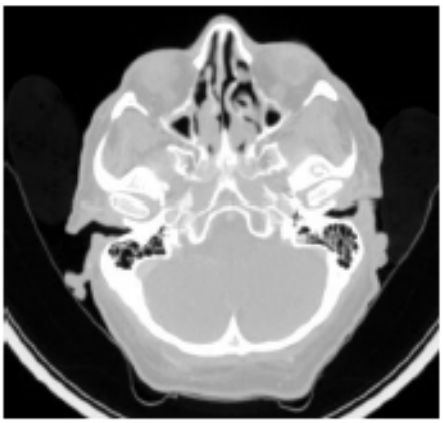

Fig 1. Axial CT section of skull base.

Interesting images s are selected and stored in DICOM format. The creation of the anatomical model consist on a few steps:

Images obtained from radiological studies in DICOM format are incorporated into the 3D Slicer© software; 5.4.0-1 version, obtained free of charge from the net.

Once images are loaded, they are analyzed, reformatted and processed (segmented) to obtain representative three-dimensionalmodels of the area of interest, in this paper, the base of the skull (fig 2 and 3).

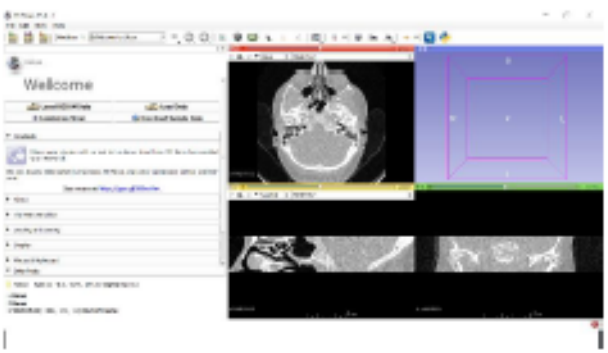

Fig 2. Screenshot 3D Slicer program.

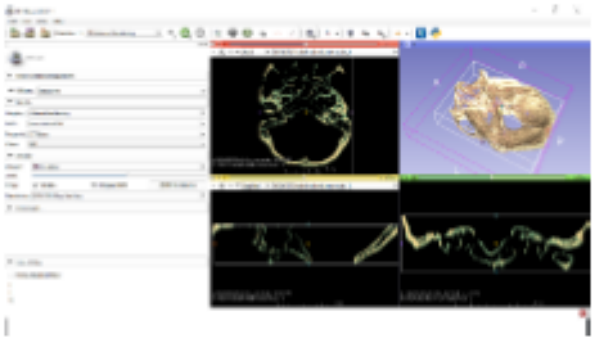

Fig 3. Screenshot 3D Slicer program. Segmentation images.

Finally, the three-dimensional models and the key images of anatomical region of interest are created, they are saved selecting the storage format that most interest.

Results

We get 3D models and several three-dimensional images from CT images in DICOM format.

These images have multiple viewing options, being able to be displayed superimposed on the original 2D anatomical images or as three-dimensional models.

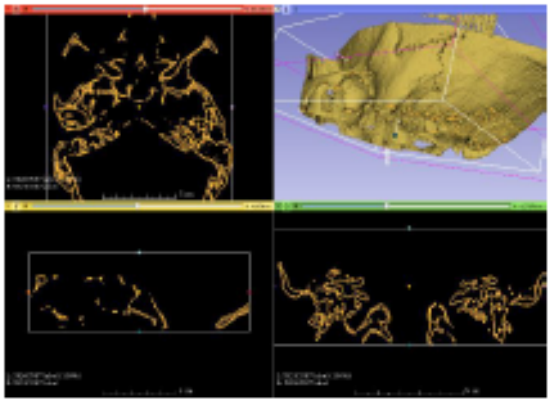

Fig 4. 3D model and postprocesed images.

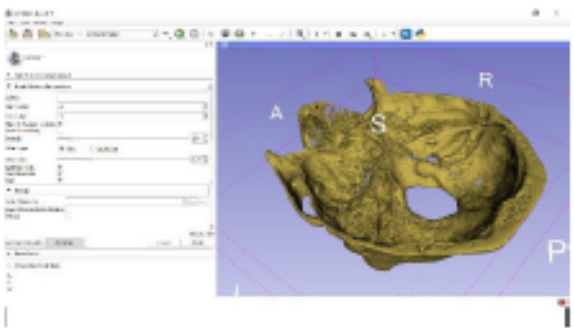

Fig 5. Screenshot 3D Slicer program.

Tridimensional models and images generated by this way can be imported into different formats (U3D, VTK, OBJ ...) to visualize and manage them using the tools that are present in the different free available software on the web.

These images can be processed on any personal computer. This represents an important advance because it allows any user to process and to format radiologic CT images without the necessity of a professional workstation.

Using these models interaction is allowed, offering several visualization and management tools that facilitate the work and comprehension of anatomical region of the study area (fig 6).

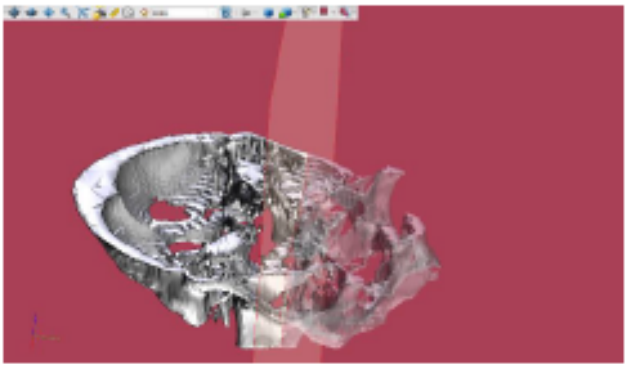

Fig 6. PDF Program interface with model created.

These models created can be opened from several software packages (free or paid), allowing their transformation and interaction with the software tools available (fig 7). For example, measurements can be made and can be used as patterns for other projects.

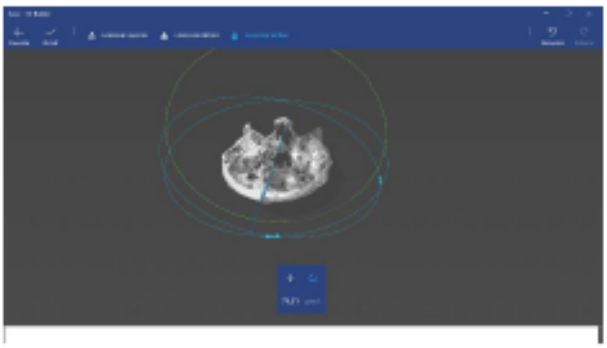

Fig 7. 3D builder Program interface with model created.

Discussion

These 3D models provide a better understanding of complex anatomical regions. The use of these techniques can be extended to different fields, whether in clinical, educational and investigation field.

For the educational field, mental representation of the shape and organization of various anatomical structures is a crucial step in the process of learning, particulary in anatomy. Three-dimensional models can represent more anatomical details than traditional models.

Therefore, we consider, along with other authors, that these tools are useful for anatomical education because they accelerate and facilitate the process of understanding, improving teaching [2,7–11].

The resources of three-dimensional imaging can be integrated efficiently with traditional methods of drawings and descriptive schemes in order to improve the teaching of anatomy [12,13].

Another important advantage involving these models is the ability to share and transmit this information with other users quickly, without complex software packages or payment ones. This allows each user to access content from his/her personal computer.

Regarding the clinical or investigation field, 3D models is also important as a tool for training clinical or surgeons, because they need several trials to learn the essential procedures and gain experience [14,15].

In addition, it is also important that with the same model you can work from several programs. This allows to use the different tools for interaction with the models.

Conclusions

This 3D models provide more information than conventional ones. Therefore, we consider that these tools are useful for anatomical teaching.

3D images could accelerate the learning process, and facilitating the capacities of understanding.

This models can be managed from any personal computer without expensive professional workstations.

Ethical statement: This article does not contain any studies with human participants or animals performed by any of the authors.

Conflict of interest: The author declare that they have no conflict of interest.

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