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Preoperative Simulation Of Hepatic Nodules Using Three-Dimensional Modeling

Zinai Kamilia[1], Saidi Mohammed[1]
[1](Department of general anatomy and Morpho Functional Explorations, établissement hospitalier universitaire, E.H.U, 1er Novembre, Oran, Algeria

Abstract:
Background: *The aim of this study was the preoperative simulation of hepatic nodules by three-dimensional modeling, in a 63-year-old patient with a hepatic tumor, using Osirix software.*
Four hundred and twenty abdomino-pelvic CT sections were required. These slices were serialized and thin, with a thickness of less than 1 mm.
The scanned images were modeled in several stages. First, volumetric modeling was performed, then model segmentation was generated, and finally nodules were highlighted in frontal, sagittal and coronal dimensions.
The information obtained from the reconstructed three-dimensional images complemented that provided by the axial sections. Three-dimensional reconstruction of our patient's hepatic nodules revealed contact with the inferior vena cava. This aspect was not visible on CT scans.
Materials and Methods: *The medical imaging software used for modeling was Osirix. This three-dimensional reconstruction software can be used on MACHINTOCH. Four hundred and twenty abdomino-pelvic CT slices of one patient were processed. The woman was sixty-two years old.*
Study Location: This study was carried out at the department of general anatomy and Morpho Functional Explorations, EHU, university hospital in Oran, Algeria.
Inclusion criteria : The cuts were serialized and thin, less than 1mm thick
Results: *The information obtained from the 3D reconstructed images complemented that provided by the axial section.*
- Bone-windowed surface modeling enables visualization of the thoraco-abdomino-pelvic skeleton. It revealed a frontal deviation of the dorso-lumbar spine.
- The images obtained by volume modelling enabled us to accurately, determine the number of hepatic nodules, their size, their limits, and their relationship with neighboring structures, in particular with the inferior vena cava
Conclusion: *Three-dimensional reconstruction of our patient's hepatic nodules revealed contact with the inferior vena cava. This aspect was not visible on CT scans. This 3D modelling could have complemented the information provided by the axial slices.*
Key Word: *Three-Dimensional; Modeling; Simulation; Preoperative; Osirix software.*

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I. Introduction

Medical imaging has become a high-tech sector with the emergence of 3D. As an emerging technology relevant to materials science, 3D printing technology simplifies the materials production process, shortens the preparation cycle and offers a wider space for disease treatment. This technology can be found in a variety of applications, including drug delivery, tumor modeling and organ printing.[1, 2, 3, 4, 5].

Among the areas of interest in three-dimensional reconstruction are its application in anatomy using virtual reality functions.[6,7,8,9,10].

One tool used in 3D is Osirix software. It is a tool for diagnostic imaging, teaching and research, with many possible applications in the field of maxillofacial surgery and stomatology. [11,12,13,14].

One of the best uses of 3D is in tumor modeling. Their surgical treatment is still largely based on precise knowledge of preoperative imaging, in order to define the appropriate margins for tumor resection. Three-dimensional tumor modeling provides a better understanding of the relationships between tumors and neighboring organs. [15, 16, 17].

The aim of this study was the preoperative simulation of hepatic nodules by three-dimensional modeling, in a 63-year-old patient with a hepatic tumor, using Osirix software.

Four hundred and twenty abdomino-pelvic CT sections were required. These slices were serialized and thin, with a thickness of less than 1 mm.

The scanned images were modeled in several stages. First, volumetric modeling was performed, then model segmentation was generated, and finally nodules were highlighted in frontal, sagittal and coronal dimensions.

The information obtained from the reconstructed three-dimensional images complemented that provided by the axial sections.

II. Material And Methods

The medical imaging software used for modeling was Osirix. [11,12,13,14] . Osirix is a tool for diagnostic imagery, teaching and research tasks, which presents many possible applications in maxillofacial and oral surgery. It is a free and open-source software developed on Mac OS X (Apple®) by Dr Antoine Rosset and Dr Osman Ratib, in the department of radiology and medical computing of Geneva (Switzerland).

This three-dimensional reconstruction software can be used on MACHINTOCH. Four hundred and twenty abdomino-pelvic CT slices of one patient were processed. The woman was sixty-two years old.

Study Location: This study was carried out at the department of general anatomy and Morpho Functional Explorations, EHU, university hospital in Oran, Algeria.

Inclusion criteria : The cuts were serialized and thin, less than 1mm thick.

Scanned images were modeled in the following stages:

1) Visualization of scanned images, after processing in DICOM (Digital Imaging and Communications in Medicine) format, compatible with all brands of imaging equipment.
2) Insert the CD-ROM into the CD drive.
3) Import of scan sections into the Osirix database.
4) Selection of 420 serial cuts with a thickness of less than 1mm.
5) Surface modeling, by clicking on "3D surface rendering" in the toolbox.
6) The volumetric model was created by clicking on "3D volume rendering".
7) The model segmentation was generated.
8) Highlighting of the tumor in three planes: frontal, sagittal and coronal.

III. Result

- The information obtained from the 3D reconstructed images complemented that provided by the axial section.
- Bone-windowed surface modeling enables visualization of the thoraco-abdomino-pelvic skeleton. It revealed a frontal deviation of the dorso-lumbar spine (figure 1).

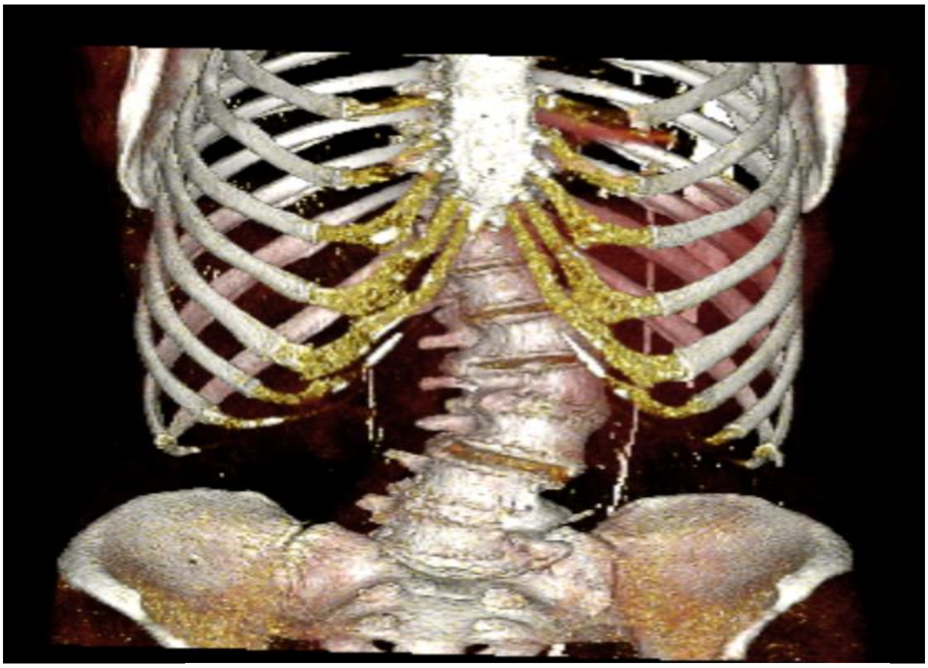

Figure no 1: Bone Fenestration - Frontal Deviation of the Dorso-lumbar Spine.

The images obtained by volume modelling enabled us to accurately determine the number of hepatic nodules, their size and boundaries, and their relationship with neighbouring structures, in particular the inferior vena cava (Figures 2A, 2B, 2C and 2D).

The Figures 2 show 3D reconstruction in volume mode. They show the visulization of liver nodules after using the "scissors" function to make the sections.

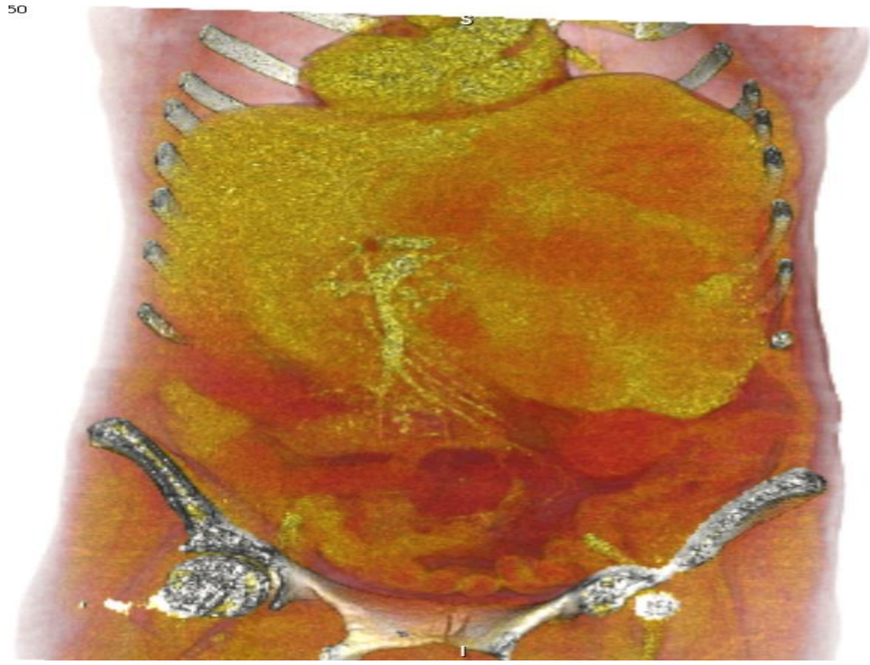

Figure no 2A: Frontal Sections of Liver Nodules

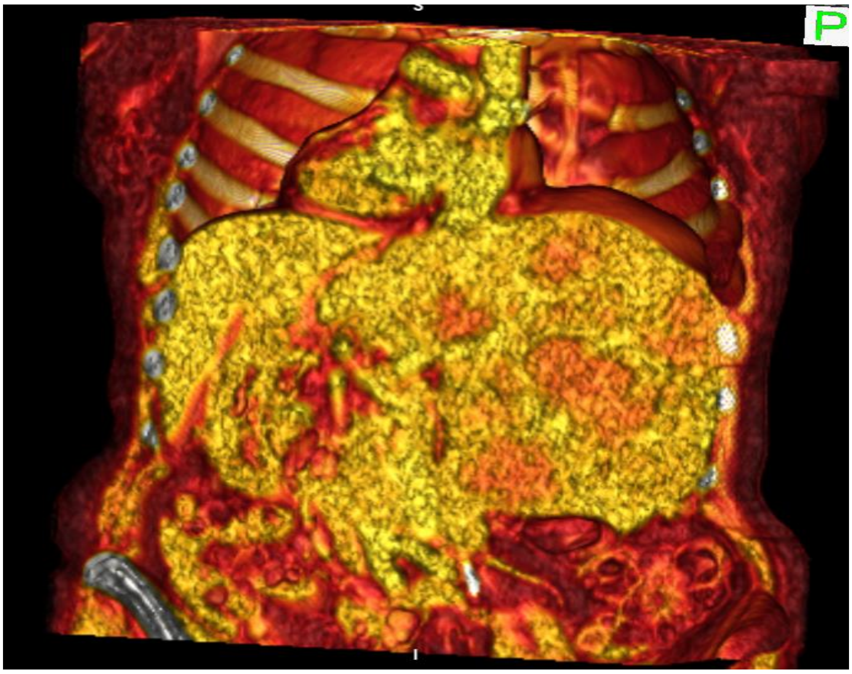

Figure no 2B: Frontal Sections of Liver Nodules

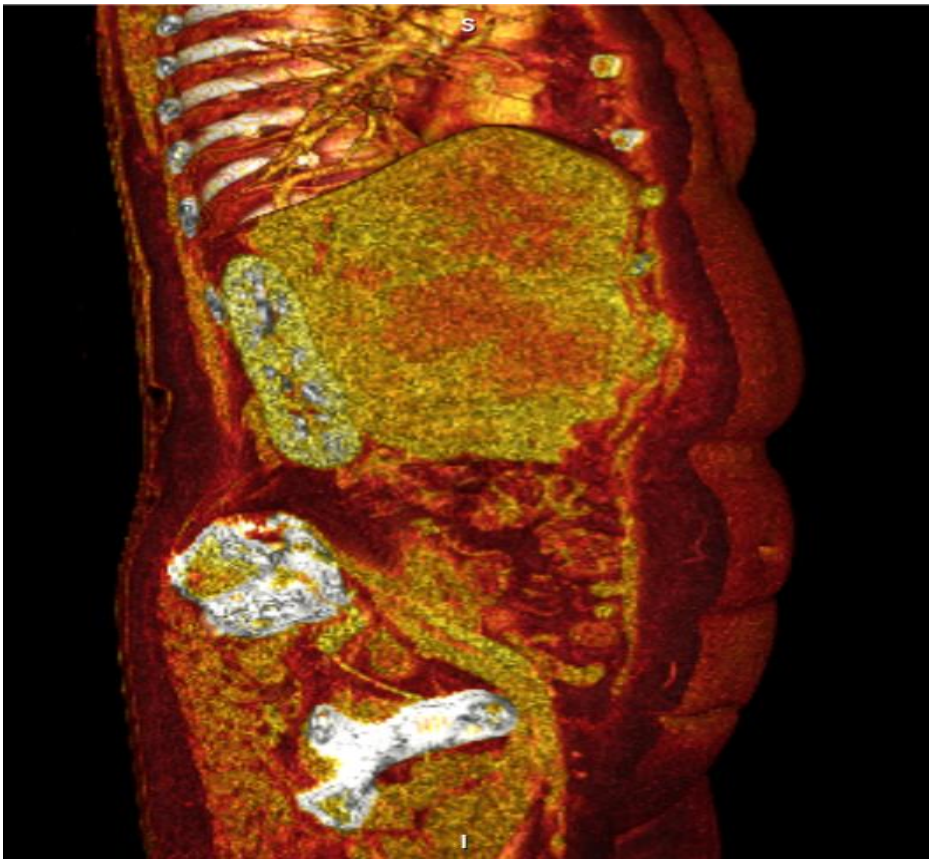

Figure no 2C: Sagittal Sections of Liver Nodules

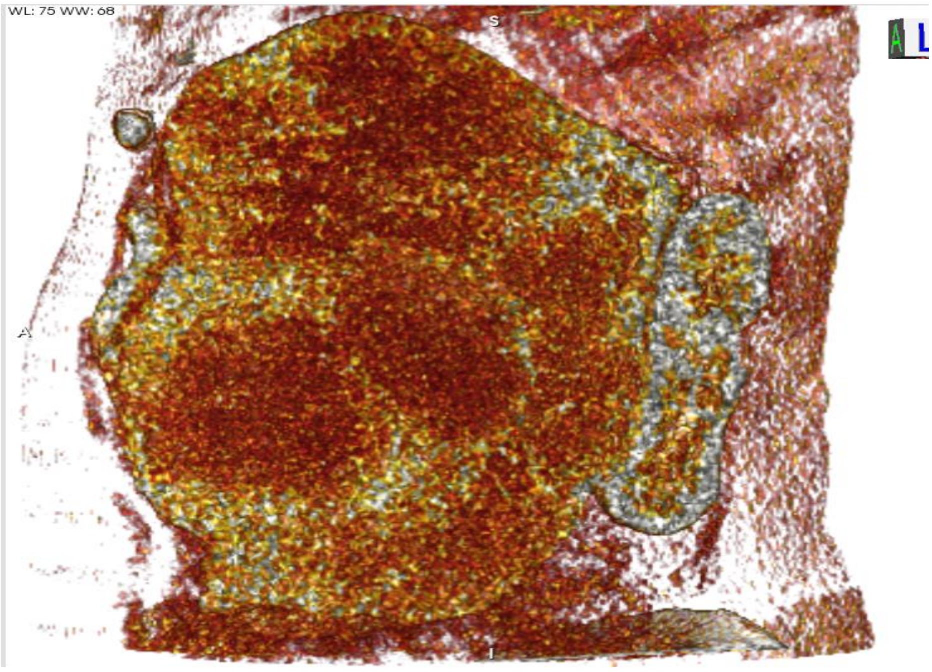

Figure no 2D: Sagittal Sections of Liver Nodules

The images obtained by volume modelling enabled us to accurately, determine the number of hepatic nodules, their size, their limits, and their relationship with neighboring structures, in particular with the inferior vena cava (Figures 2).

IV. Conclusions

Three-dimensional reconstruction of our patient's hepatic nodules revealed contact with the inferior vena cava. This aspect was not visible on CT scans. This 3D modelling could have complemented the information provided by the axial slices.

In surgery, it could have provided a precise idea of the situation, a good anatomical and topographical study of the region to be operated on, and better planning of the surgical procedure. This would avoid intraoperative surprises by identifying anatomical variations in advance. It also reduces the risk of complications.

Surgical procedures can be simulated using 3D reconstruction, which can provide information on the degree of difficulty, feasibility and, in some cases, even better synchronization of surgical teams in complex operations.

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