Reproducibility of the 3D-Models for Baby and Mother phantom using the platform 3D-Slicer

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Abstract: The evolution of segmentation over the years has offered unlimited potential, with extensive applications in the field of Anatomy. Female pelvis anatomy is reaping great benefits, especially in terms of surgical planning and guidance.

Personalize mannequin design are the basic element in virtual garment simulation and visualization and mannequin construction from scanned point cloud and regenerates their shapes by inputting variant dimension., we will describe the segmentation of an existing mannequin and regenerating a new one through 3D Slicer platform, this work is the result of cooperative work between CIGT (Image Guided Therapy Center in the Faculty of Medicine in Nouakchott University-Mauritania) and the IUIBS (Institute for Biomedical and Healthcare Research- University of Las Palmas de Gran Canarias- Spain), involving the segmentation and generation of 3D models for both baby and mother using the 3D Slicer platform.

Key Words: 3D Slicer, 3D-Models, Mannequins, reproducibility, Segmentation.

1. Introduction

The 3D Slicer is a free, open-source software for visualization, processing, segmentation, registration, and analysis of medical, biomedical, and other 3D images and meshes; planning and navigating image-guided procedures [1]. The evolution of segmentation over the years has offered unlimited potential, with extensive applications in the field of Anatomy. Female pelvis anatomy is reaping great benefits, especially in terms of surgical planning and guidance.

In this article, our focus is on the segmentation of two mannequins representing a baby and a mother at our CIGT (Center IGT in the Nouakchott Faculty of Medicine-Mauritania), Image-Guided Therapy (IGT) refers to medical procedures that are performed with the assistance of real-time imaging guidance.

Many institutions have overcome problems surrounding dissection with plastic models [2,3]. Plastic specimens are modeled to perfection and possess a longer shelf-life than cadavers, but they will eventually pose problems. radiological images or anatomical models cannot substitute the benefits of conventional dissection [4].

The work will be based on the 3D Slicer program for the treatment and management of CT scans of the mannequins. The main objective is to perform segmentation and generate 3D models of the baby's head, baby's body, and the mother.

This work is the first step to evaluate how to integrate the 3D models into training simulations for students in the CIGT (Computer-Integrated Guided Therapy) through IGT.

Positioning data from the tracking device, such as a camera, are transferred to 3DSlicer using the PLUS toolkit [5] and the Open IGT Link communication protocol (Refer to the following image (image 1)).

Image: 1

2. Materials / Methodology

We obtain the Baby and Mother mannequins from the Simulation Center of the Medical School of Nouakchott-Mauritania (figure:1a-b) This center is dedicated to training medical students in clinical activities and surgical procedures. Students practice on these mannequins before undertaking real procedures in hospitals. The CT scans are conducted at the National Centre of Cardiology (CNC) in Nouakchott, Mauritania, and the results are provided in two folders (and on a DVD).
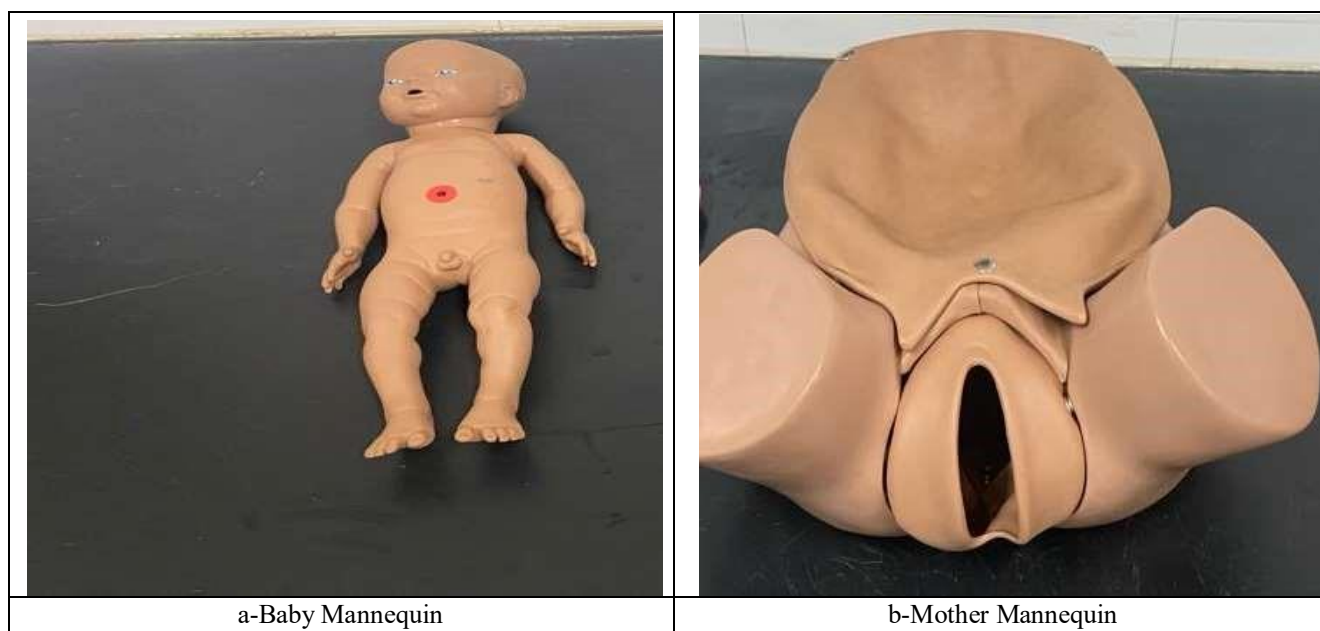

| a-Baby Mannequin | b-Mother Mannequin |

Figure 1: a-Baby Mannequin, b-Mother Mannequin

It is recommended: The resolution for the CT scan should be as high as possible to ensure an accurate reconstruction/segmentation of the 3D models from the mannequins. This means acquiring the CT with a small thickness (1 mm would be enough) if possible.

we need to scan the mannequin of the mother and the baby. While it's possible to perform a single acquisition, it's important to place them separately on the bed to facilitate segmentation.

The CT scan generates DICOM files, Digital Imaging and Communications in Medicine (DICOM), the DICOM is a global Information-Technology standard that is used in virtually all hospitals worldwide. Its current structure, which was developed since 1993, is designed to ensure the interoperability of systems used to: Produce, Store, Display, Process, Send, Retrieve, Query or Print medical images and derived structured documents as well as to manage related workflow.[6]

DICOM:

This module allows importing and exporting and network transfer of DICOM data. Slicer provides support for the most used subset of DICOM functionality, with the features driven by the needs of clinical research: reading and writing data sets from/to disk in DICOM format and network transfer - querying, retrieving, and sending and receiving data sets - using DIMSE and DICOM web networking protocols (image: 2) [7].
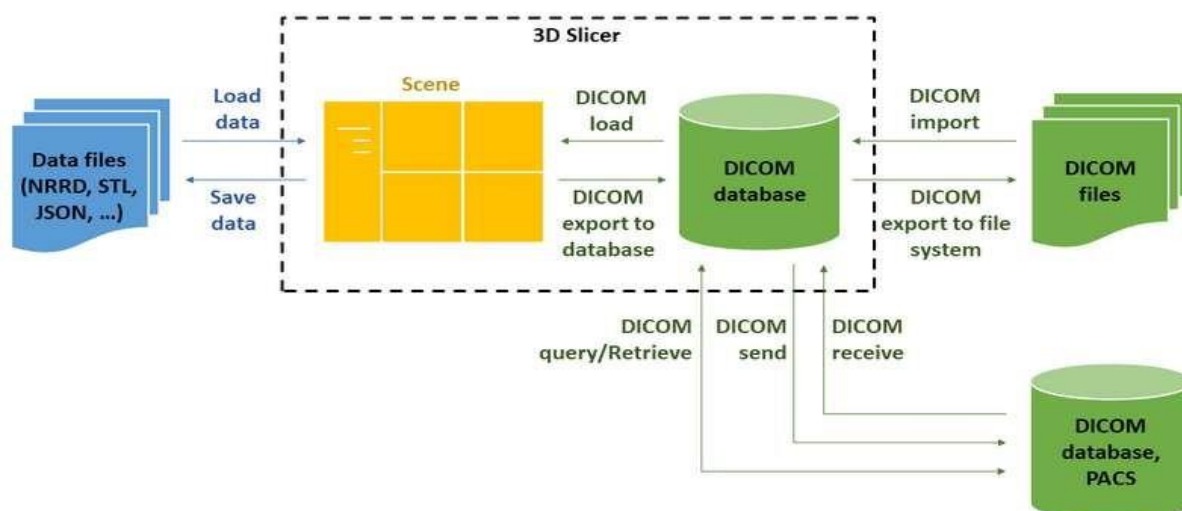

Image :2

data can be loaded from DICOM files into the scene in two steps(fig.2):

1. Import: add files into the application's DICOM database, by switching to DICOM module and drag-and-dropping files to the application window (fig.3)
2. Load: get data objects into the scene, by double-clicking on items in the DICOM browser. The DICOM browser is accessible from the toolbar using the DICOM button [8].
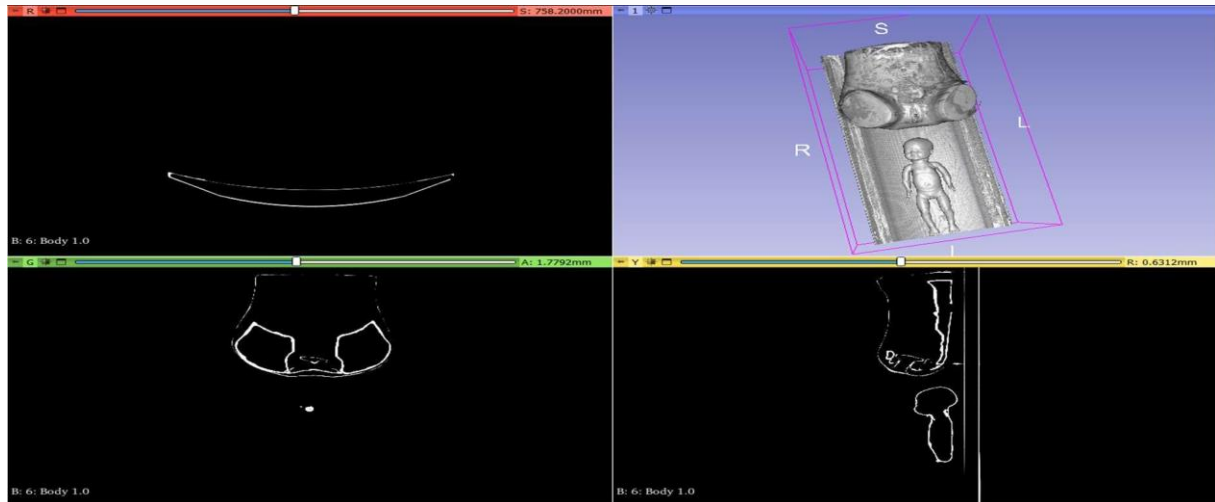

Figure:2 The CT Scan (DICOM) imported(loaded) in a scene of 3D-Slicer
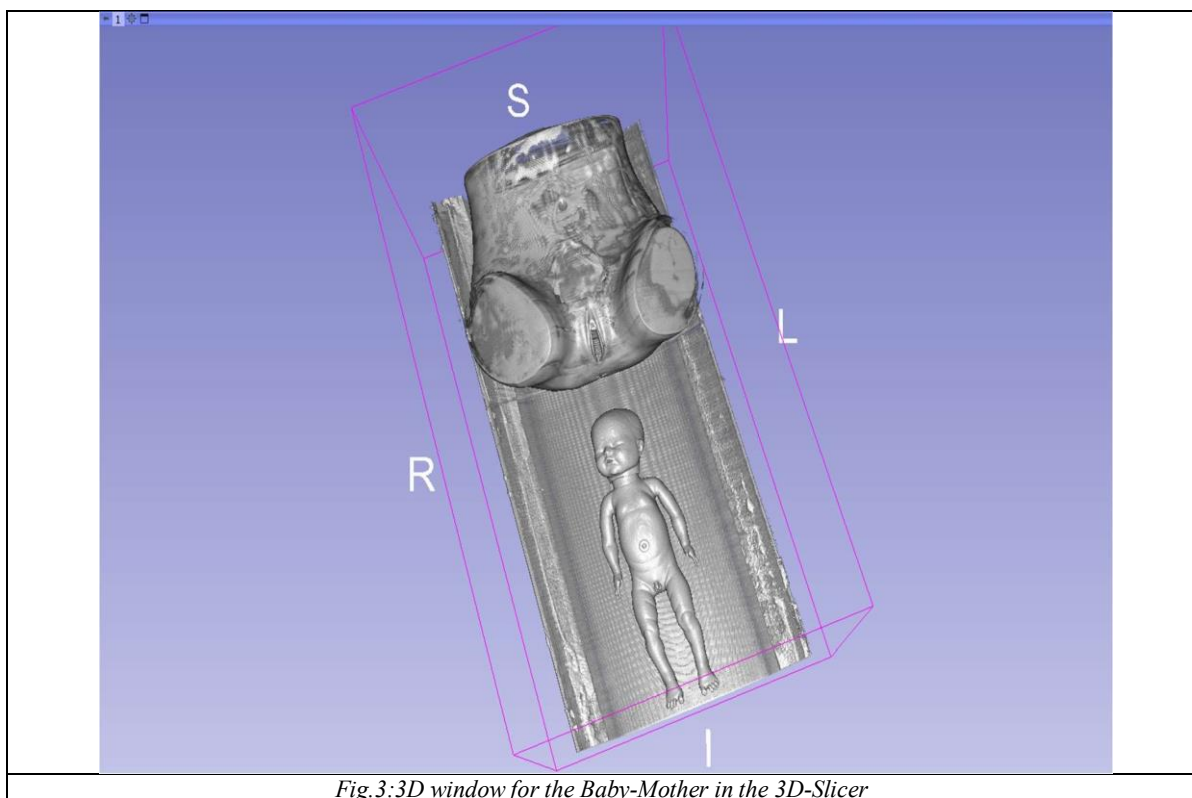

Fig.3:3D window for the Baby-Mother in the 3D-Slicer

The next step is to generate 3D models of the mannequins using the Segment Editor module in 3D Slicer.

Segment editor:

This module is for specifying segments (structures of interest) in 2D/3D/4D images. Some of the tools mimic a painting interface like photoshop or gimp but work on 3D arrays of voxels rather than on 2D pixels. The module offers editing of overlapping segments, display in both 2D and 3D views, fine-grained visualization options, editing in 3D views, create segmentation by interpolating or extrapolating segmentation on a few slices, editing on slices in any orientation. [9]

The module now allows you to work with different sets of segmentations, depending on the volume you are interacting with, as you can see in the first two drop-down menus of the interface.

The segmentations are generated individually, by means of the button bar that appears.[10]
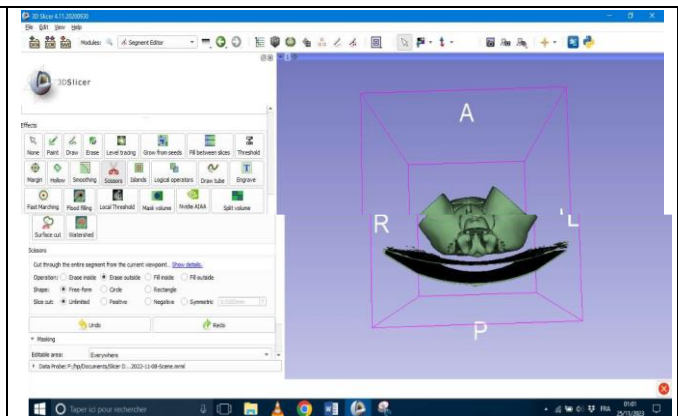
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The resume of steps is below:

1. Load/Import CT image
2. Segment Baby and mother to be 3D-Models(fig.8(1-8)).
3. Save Baby, Baby Head, Baby Body, Mom Perineum, Mom Lumbar and Mom Belly segment to STL file for 3D-Models.
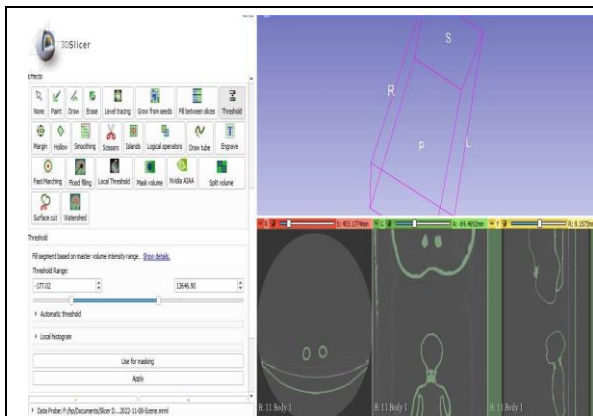
1.Using the Threshold module, we define the range to make the mother and baby segmented	2.3D View
3.out the table under Baby-Mother with scissors module, erase outside operation	4. Baby-Mother Alone and add 2 different segments. In which we add the entire mask segment with the logical operators
5. Mother segment we remove the baby with scissors	6.Baby segment we remove the Mom with scissors
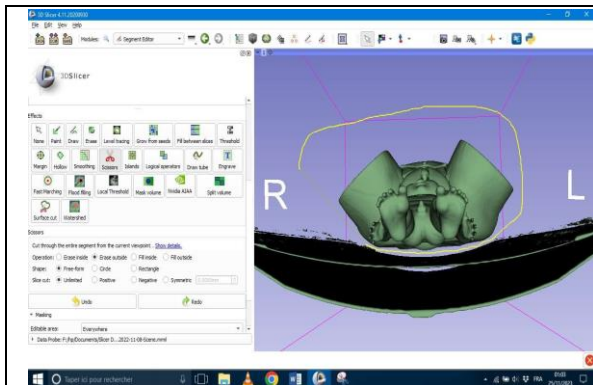
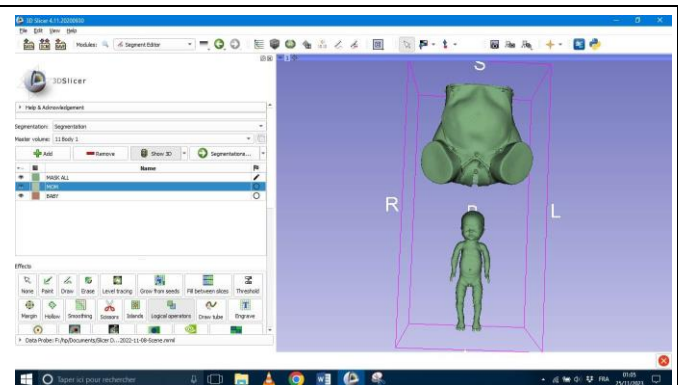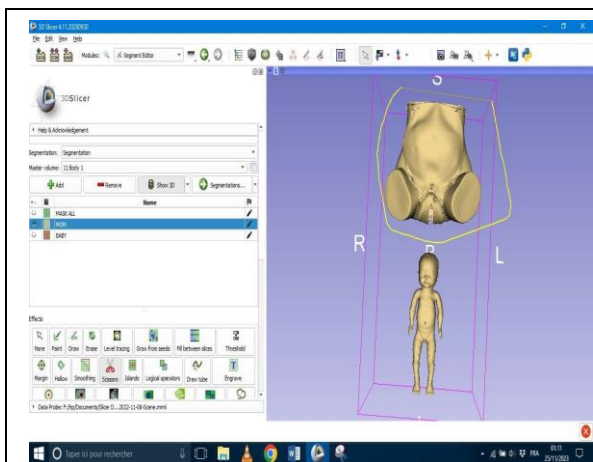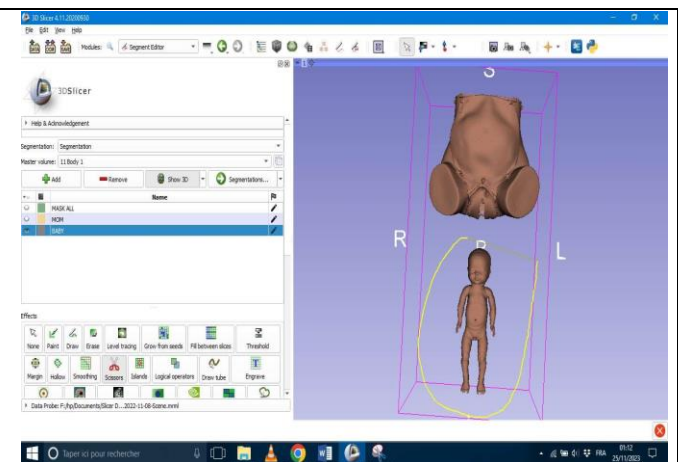|	
7.Mother organs	8.Mother Perineum, we paint different organs in 3D view and then we use scissors to make it more accurate
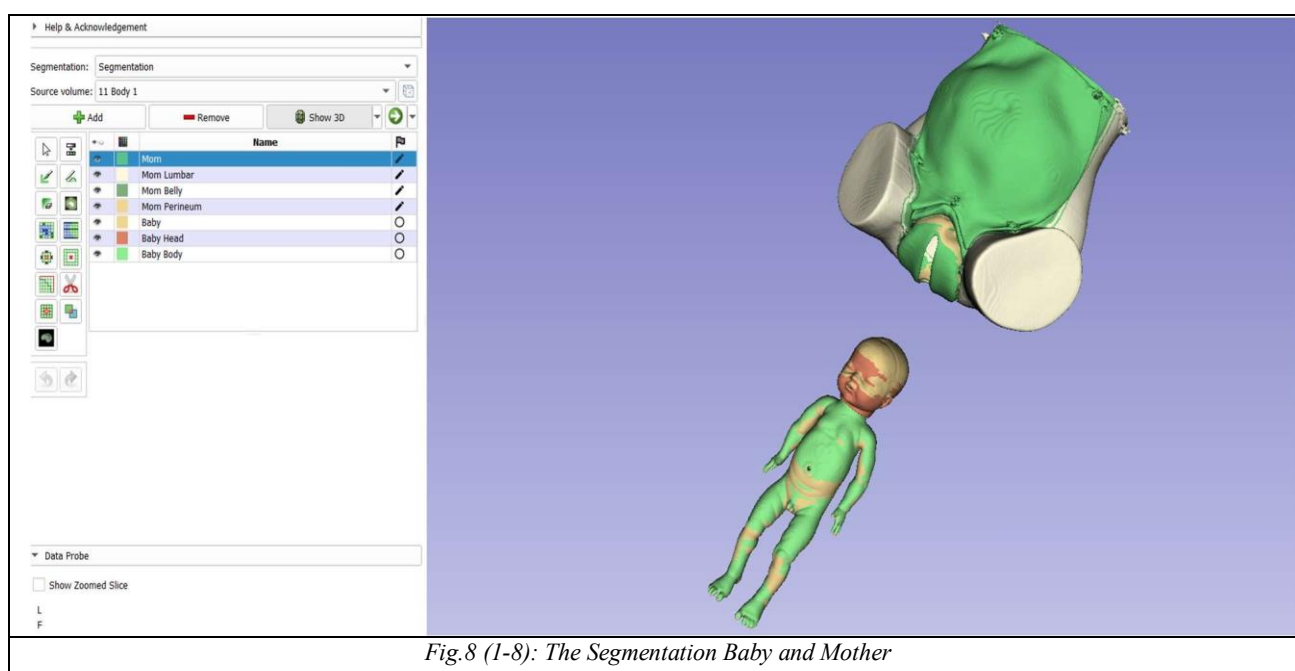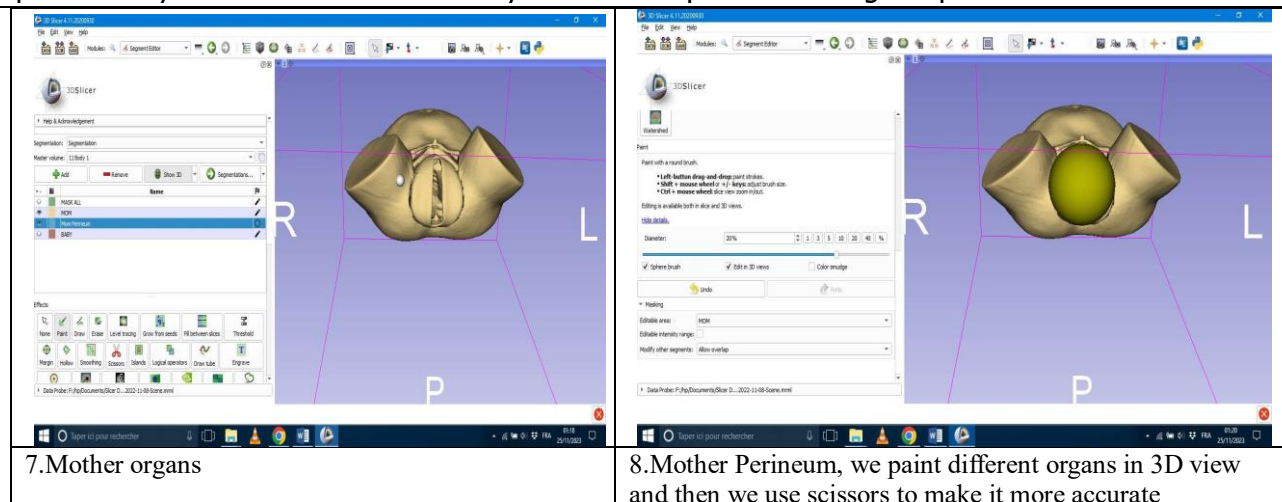
Fig.8 (1-8): The Segmentation Baby and Mother

3. Results

Our goal is to obtain 3D-Modles for Baby and Mother by converting all segments:

To convert the segments into 3D models, simply navigate to the Segmentations module and then, under the section Export/import models as label maps, select the operation Export and then as Output type select Model. Finally, click Export.

To save them, click the button SAVE in the top left corner of Slicer, select all the models we have created, and click in file format to select one from all the available options (we should have stl, obj, vtk, ply and a couple more). we can save them as stl for instance.

Finally, we generate the 3D-models files for the Baby and the mother(fig.9(1-7)).

| Fig.9(1): Baby-3D Model | Fig.9(2): Baby Body-3D Model | Fig.9(3): Baby Head-3D Model |

| Fig.9(4): Mom-3D Model | Fig.9(5): Mom Perineum-3D Model | Fig.9(6): Mom Lumbar-3D Model | Fig.9(7): Mom Belly-3D Model |
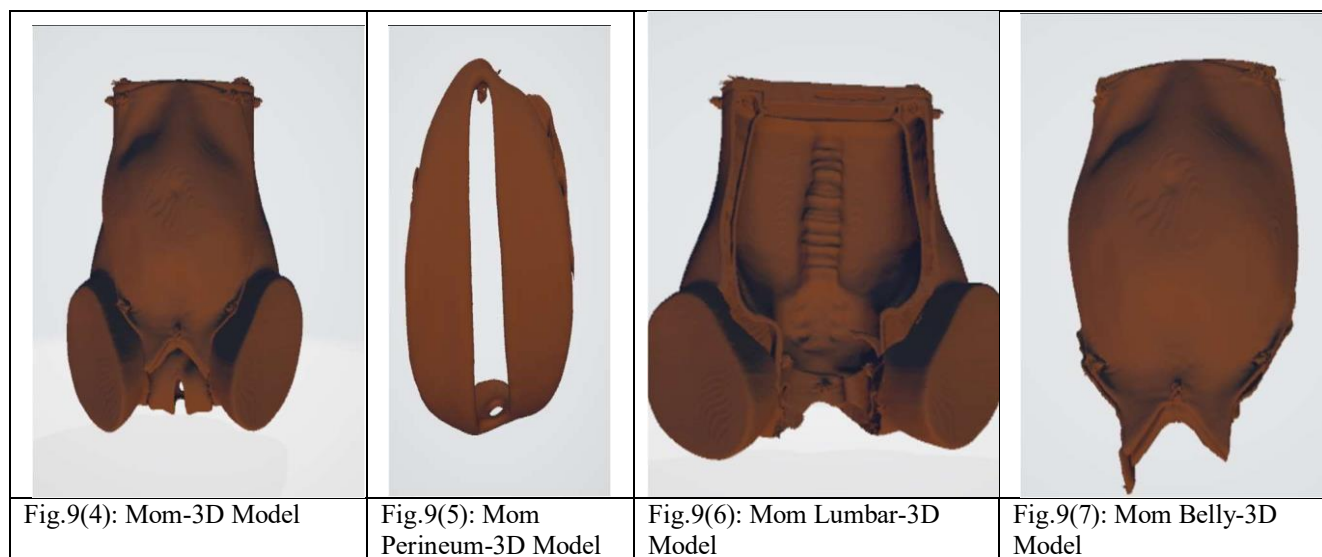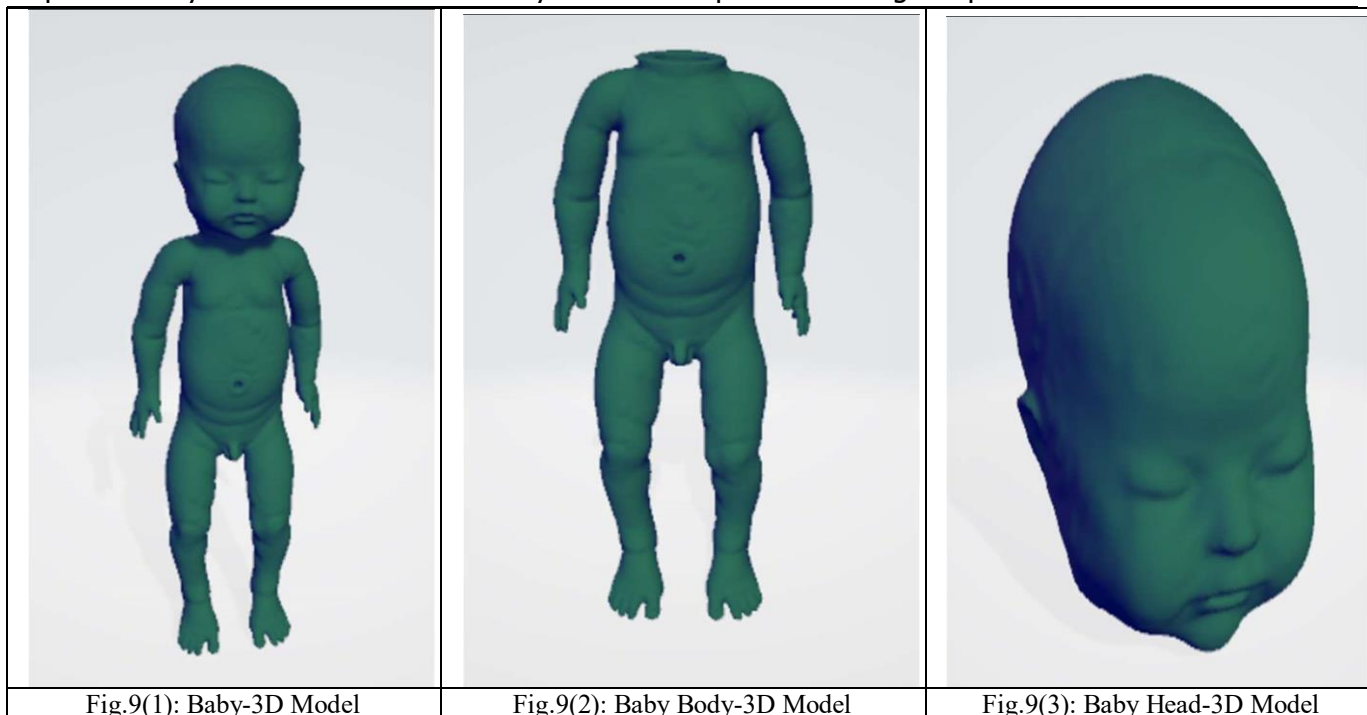
4. Discussion

The selection of two compatible but mechanically diverse elements (baby and Mothor) was key to the success of dual material printing described in this paper. The models captured the essential features of gross anatomy however, the resolution and accuracy of the two materials sets a limit on the scale of anatomical structures than are printable. Popular currently available manufactured anatomical models, most of which are primarily composed of hard plastics, are expensive and relatively limited in functionality. For example, commercially available models The 3D slicer is a software which we have selected for dual segmentation proved to be ideal. this pilote study demonstrated early feasibility and utility in the use of 3D slicer segmentation in anatomical education. This aligns with previous literature highlighting the utility of teaching 3D segmentation and printing in anatomical education[11-16] , as well as studies showing that 3D virtual and physical models can enhance understanding of female pelvis anatomical structures [11,17-19].

While our study did not involve 3D printing the segmented models due to limitations to 3D printers in our center, it represents a natural next step in typical 3D model workflows and warrants consideration for inclusion in future workshops. 3D printers and plastinated mannequin is a cost-effective and widely researched approach for producing accurate models for anatomical education [20]. Existing literature has demonstrated the role of physical 3D-printed models in stimulating students' interest in and improving their understanding of human anatomy [11,21,22] as well as in fields such as obstetrics and mother's pelvis and fetus measurments. Together, the paired segmentation and printing process offers a unique and engaging method of refining one's anatomical knowledge [23]. A study by Fasel et al. that integrated 3D segmentation and printing into undergraduate anatomy teaching found that involving students in the reconstruction process resulted not only in the creation of accurate anatomical models usable for teaching but also higher student satisfaction and engagement. However, the study did

not discern nor quantify the specific impact of the 3D segmentation process versus 3D printing on learning [24]. however, the impact of each individual element has not been formally assessed; a further study investigating this would be beneficial.

A notable strength of our study is using 3D segmentation as a process for students to practice CT scan interpretation and anatomical knowledge. suggesting that 3D segmentation may be a valuable tool for training in cross- sectional imaging interpretation. This has clear benefits in radiology specialty training, where trainees require 3D image interpretation skills and a strong understanding of complex anatomical structures. However, the implications extend more broadly to all doctors: considering the rapidly increasing prevalence of diagnostic medical imaging in the twenty-first century, nowadays all junior doctors are required to comprehend basic imaging modalities [25]. A study by Ayesa et al. also highlighted the lack of more formal medical imaging education at all levels of medical training, from medical students to non- radiologist specialists, as well as the critical role of medical image interpretation even as a non-radiologist clinician. As such, there is a demand for the delivery of more medical imaging education at all levels, ranging from medical students to non-radiologist specialists [11,26]. 3D segmentation may be an engaging and complementary teaching tool that is able to effectively train doctors and students in radiological interpretation. Future studies should aim to objectively measure learning outcomes.

Logistically, tracking progress of segmentation and troubleshooting across virtual platforms was challenging. Computing power was a significant issue as workshops were run on personal computers. 3D rendering software in general are computationally demanding, and when 3D Slicer is used alongside the communications software, it can result in a significantly slower experience. While cost-effectiveness remains to be validated, this pilot study highlights an exciting opportunity to integrate a new method of anatomical teaching into the curriculum.

The limitations of the study in determining the effectiveness of the teaching delivered include the self-selection bias of segmentation signing up and completing the measurements, which may have been those that had an inherent interest in 3D Printer. Pre- and post-segmentation results were analyzed in an unpaired manner, which limited our ability to assess individual changes. The pre- and post- segmentation mannequin were compared through subjective self-reported as it was challenging to objectively measure learning outcomes. Another limitation is that we did not record the specific training levels of the medical students and doctors involved, which may have been important to establish pre-existing anatomical knowledge. to overcome these limitations, future studies should look at larger cohorts, ensure completion of paired pre- and post-segmentation studies, and use objective learning measures and questionnaires in addition to self-reported subjective feed- back. The effectiveness of 3D segmentation and printing works.

5.Conclusion

After this segmentation operation and after providing the 3D models for the baby and mother's organs separately, the students can to exercise more with the virtual 3D-models and not linked to the Simulation Centre,

Dual segmentation can produce inexpensive functional anatomical models which offer a diverse range of user inter-action. This technology can radically change how anatomists choose to teach via models. The combination of hard/stiff and soft/elastic materials permits a much greater diversity in manufacture of customized models which can illustrate Anatomy, biomechanics or principles of function.and finally, we plan:

1- To place the Aruco markers (Optical MarkerTracker is virtual device that provides position tracking of markers using any webcam or camcorder. You can print your own markers on any regular printer and attach to a flat surface on an object [11,27,28].

2- To start the printing of the 3D-Models by the 3D-Printer in the CIGT, the mannequins not available in the local market, this printing operation will serve the students to find more chance to practice with themes.

Conflict of interest:

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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