International Journal of Engineering Research and Development
***e**-ISSN : 2278-067X, **p**-ISSN : 2278-800X, www.ijerd.com*
Volume 5, Issue 11 (November, 2016), PP.70-72

3D Viewer Software Build Based on Scanned Synthetic Female Pelvic Floor Model

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Abstract: Anatomy is considered an essential subject for Medicine students. Furthermore, the practice class using a comprehensive and manageable anatomic tool is fundamental for a satisfactory teaching and learning process.The goal of this study was to build a tutorial type softwareof the female pelvic floor anatomy utilizing data from the three-dimensional laser scanning of a physical resinated syntheticmodel. The synthetic model was constructed emphasizing the intricated system of layers of the female pelvic floor. These anatomical structures are very difficult to be understood when studied in the cadaver and bi-dimensional figures and even in other three-dimensional samples. It was hypothesized that this schematic model was a useful and meaningful tool for visualization and manipulation of the anatomical elements once it being in the virtual environment. The tutorial was constructed based on the manipulative perspective that allowed a tridimensional viewing of all anatomical elements expressed in this model.

Keywords:software, pelvic floor model, three-dimensional laser scanning, anatomy

I. INTRODUCTION

Anatomy is considered an essential subject for Medicine students. Furthermore, the practice class using a comprehensive and manageable anatomic tool is fundamental for a good teaching and learning process. The knowledge of anatomical structures of the female pelvic floor is crucial to the satisfactory understanding and comprehension in several areas of Medicine.

The bone pelvis, the pelvic floor muscles and the related anorectal structures are one of the most complex regions of the Human Anatomy. The study of the pelvic floor is difficult for several reasons. First, this region is often inaccessible because of the very near pelvic bones, located around it. This relatively small space also contains many organ systems, and selected structures are observable only by special dissections that sacrifice other structures [1]. In addition, during surgery or cadaver dissection, the syntopy differs from the normal state once there is a change in muscles tone.

Inevitably, the study of the female pelvic floor anatomy comes up against the difficulty of learning. This is due to the complexity of the structures involved and the overlapping of the anatomical elements in the pelvic cavity, especially in the cadaveric material.As the two-dimensional figures do not express the depth of anatomical structures, the virtual constructions based on magnetic ressonance and computadorized tomography have limitations,since extremely importantelements asthe fascia, tendinous arch and pericervical ring structures are very thin and difficult to detect and be expressed.

Based on the difficulty in understanding the anatomy of these intrincated structures, a physical model was built in resin, based on the literature and on the previous research of a synthetic model [2,3], emphasising those anatomical elements of vital importance, especially for the surgeon.

The three-dimensional scanning presented in this paper consists in the development of virtual models from already physically existing objects. According to Ferreira[4], scanning and reconstruction of complex shapes of objects have evolved rapidly in recent years, and the three-dimensions laser scanning method brings greater automation in data acquisition. The processing occurs after the areas or objects aredefined, and then, the cloud of points acquisition is performed. The point cloud is the set of mathematical coordinates X, Y and Z representing the scanned surface, assuming million points.. Computer systems CAE (Computer-Aided Engineering) and CAM (Computer-Aided Manufactoring) filter these points joining them in threes, forming three-dimensional mesh of the surface of the object. From that point, the images obtained can be managed in software which allows three-dimensional viewing. Segmentation of images is needed to determine areas of interest in the image and in many cases accurate demarcation of objects yields valuable information [5]. Manipulations include assembling and disassembling the model, rotations on several axes, fittings of parts individually and by clusters.

II. MATERIALS AND METHODS

A synthetic schematic anatomical model, made of resin and designed to be subjected to three-dimensional laser scanning has been called MARAPsynthetic model. This model was made using as a base another synthetic model previously studied by the author and presented significant didactic application, reducing the learning curve[3]. It was constructed in rigid resin with better anatomical approach in relation to its basic model, however, also in schematic form for educational purposes.

Fig 1. Three-dimensional laser scanner Smartscan Breuckmann.

1. Preparation of MARAP for the Three-dimensional Laser Scanning

The prerequisites for laser reading optimization of anatomical elements were met providing:

- sufficient opacity to mitigate the refraction of laser radiation;
- rigidity to prevent deformation during handling for digital reading;
- absence of hollowsavoiding to limit the laser scan;
- absence of areas of porosity to attenuate the reading roughness;
- light coloring to block the absorbency of the laser radiation.

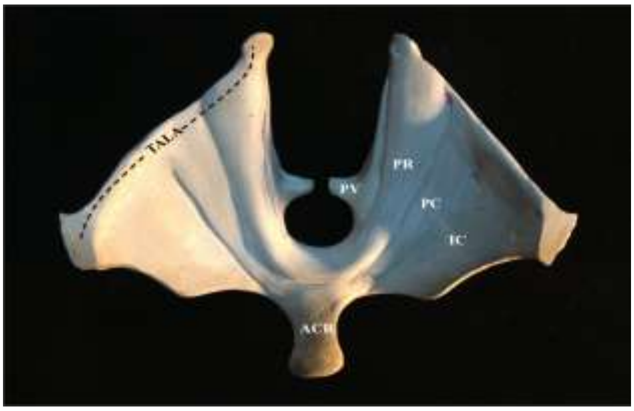

Fig 2. Schematic resinated model of the Levator ani muscle formed by beams: pubovaginalis (PV), puborectalis (PR), pubococcygeus (PC) and iliococcygeus (IC). The main anchorage points of these muscles are the tendinous arch of the levator ani (TALA) and the anus coccygeal raphe (ACR). (Segment of the MARAP synthetic model).

2. Capture of the Compatible Files with the CAE Systems * / CAM **

The twenty-five anatomical parts of the MARAP model were submitted to the SMARTSCAN 3D scanner – BREUCKMANN, in the IMAGO laboratory - Department of Informatics, Federal University of Parana. The files generated by the laser scanner were compatible with the computer systems CAE (*Computer-Aided Engineering) and CAM (**Computer-Aided Manufactoring). These systems have enabled the manipulation of three-dimensional images and files with .PLY .STL extensions, allowing corrections and improvements of the anatomical structures in the virtual environment.

3. Segmentation of the Images

Image segmentation is the method that enables the sharing of digital images in multiple regions or objects in order to simplify or change the representation of these images to facilitate analysis. This process was carried out in the CAE / CAM systems, tracking objects like lines, curves and edges on the images acquired from the laser scanning. The MeshLab, 3DsMax and SOLID WORKS softwareswere used for fine tuning procedures of point clouds and positioning of anatomical elements.

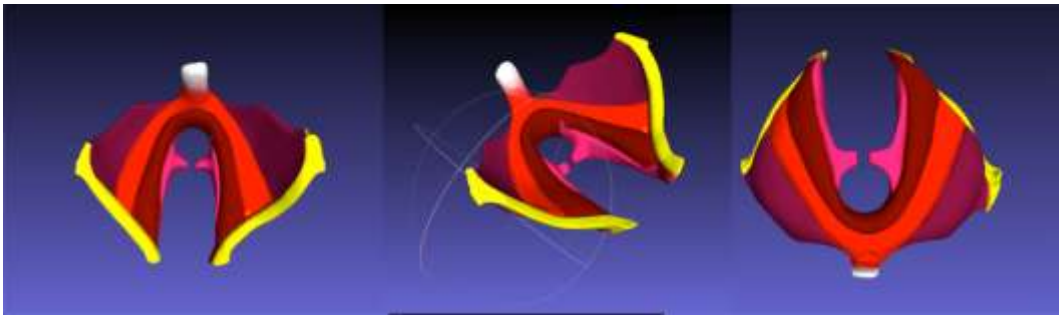

Fig. 3 A schematic model of the Levator ani muscle virtually colored emphasizingthe beams: pubovaginalis (pink), puborectalis (dark red), pubococcygeus (red), iliococcygeus (wine); as well as the tendinous arch of the Levator ani muscle (yellow) and the anus coccygeal raphe (white), in three different views. (Segment of the MARAP virtual model).

Fig. 4A schematic model of the vagina enveloped by the anterior and posterior fascias, showing also the different views (a, b and c) of these anatomical elements rotated virtually. The fascias were attenuated for better visualization of the internal structures.(Segment of the MARAP virtual model).

III. DEVELOPMENT OF AN ANATOMY TUTORIAL TYPE SOFTWARE

After the segmentation of the images we developed a special three-dimensional viewer, which allows the full exploration of the anatomical elements. Some access buttons were available for individual visualization of the pieces or in conjunction with others (cluster mode). The option of visualizing regions and structures with different colors was inserted, as well as color attenuation and transparency adjustments to provide a better understanding of the anatomical relationships.

The three-dimensional images of the anatomical elements were categorized and organized in sequence:

Bone Pelvis:

a) overview for rotation on three axes;
b) focus on the points and anchore regions of ligaments, tendons and tendinous arches.

***MainLigaments*:**

a) sacrospinal; b) sacrotuberous; c) cardinal; d) uterosacral; e) pubourethral.

Muscles:

a) bulboespongiosus; b) external sphincter of the anus; c) ischiocavernosus; d) superficial transverse perineal; e)deep transverse perineal; f) bundles of the levatorani (pubovaginal, pubo-rectal, pubococcygeus,iliococcygeal); g) coccyx; h) piriformis.

Fasciae:
a)rectovaginal (posterior); b) vesicovaginal (anterior).

***Organs*:**
a) anus and anal canal; b) bladder; c) uterus and attachments.

Other anatomic elements:
a) raphe anococcigea; b) anorectal ligament; c) perineal body; d) pericervical ring; e) obturator membrane; f) neurovascular plexus; g) pudendal nerve; h) urethra; i) vagina; j) anus and anal canal.

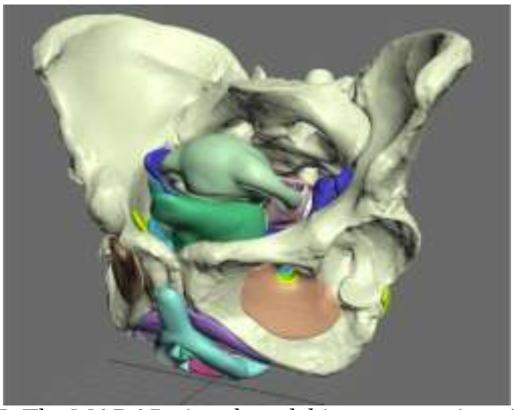

Fig 5. The MARAP virtual model in a perspective view.

IV. RESULTS AND DISCUSSION

Except for the head and the neck, the pelvic floor is considered the most complex anatomical region of the human body, and its comprehension is such quite difficultas important. In this paper we have presented and analyzed a method for creating a tutorial type software based on a physical female pelvic floor, previously studied and fabricated for this purpose.

The use of anatomical models in medical curricula has been reported as effective in teaching and learning anatomy, although the form of the model and its presentation may impact efficacy in learning [6-9]. The anatomical model does not have to be physical. Digital 3D anatomical models have been reported to be effective in enhancing learning and retention in medical and dental students [10-14].

The fact that the base model MARAP was made schematically in resin, made it possible to transfer important anatomical characteristics to the virtual environment. Since the cloud of dots generated in the digital laser scanning could be translated into high quality three-dimensional image, we obtained the presentation of an expressive mesh, textured in a schematic way.

Emphasis was placed on the expression of certain anatomical structures, which are often difficult to understand, mainly because they are constituted of a thin, fragile and little translucent tissue. Such elementsas the fascias, pericervical ring and tendinous archesgenerally dissolve in formalin that is one of the preserving solutions for corpse pieces, and thus are poorly distinguished during dissection. In addition, they are extremely difficult to detect and visualize in vivo during surgical procedures. Although these structures were thickened for better visualization in the base model, they were also presented as attenuated staining in the virtual model, compensating for the increased thickness. The software also allows a multicolored viewing of the model, presenting it in a consistent and comprehensible way, which is difficult to do in other formats.

Anatomical models are important educational tools in institutions or settings that are unable to support the space, costs, or regulatory requirements required for cadaveric dissection or specimen storage. For these reasons, anatomy education will always benefit from a finely constructed three-dimensional model [15].The proposal, therefore, is to provide a better understanding of these anatomical structures, so important for health professionals, especially for those dedicated to the dysfunctions and diseases of the female pelvic floor.We believe that it will possiblybe a useful tool for those longing to implement some alternative for the study of this complex anatomical segment of the human body.

We intend to continue the research on this subject, submitting this software to a practical application, comparing it with other didactic tools, in order to estimate its didactic potential.Novel studies and approaches for anatomical structures recognition in the female pelvic floor should be developed and also encouraged.

REFERENCES

[1]. W.C. Smith,"The levator ani muscle: its structure in man, and its comparative relationships",Anat Rec., vol. 26, pp. 175–203, 1923.

[2]. H.S.P. Portugal,"Synthetic pelvic model as an effective didactic tool compared to cadaveric pélvis", Rev Bras Ed Méd.,vol. 35, pp. 502-506,oct./dec, 2011.

[3]. P. Palma, C. Riccetto, R. Fraga, et al."Tridimensional anatomy and virtual surgery for transobturator procedures",*Actas Urol Esp*vol.31,, pp. 361-365, 2007.

[4]. J. Ferreira, "Integration of reverse engineering and rapid tooling in foundry technology", J Mat Proc Tech; vol.142, pp.374-382, 2003.

[5]. V.Sruthi, K.Soundararajan, V.Usha Sree,"Accurate Multimodality Registration of medical images", International Journal of Engineering and Development, vol 1, pp.33-36, 2012.

[6]. W. Pawlina, R.L. Drake,"Anatomical models: don't banish them from the anatomy laboratory yet" Anat Sci Educ., vol.6, pp. 209–210.22, 2013.

[7]. Z. Khot,K. Quinlan, G.R. Norman, B. Wainman,"The relative effectiveness of computer-based and traditional resources for education in anatomy", Anat Sci Educ., vol. 6, pp. 211–5, 2013.

[8]. D. Preece, S.B. Williams, R. Lam, R. Weller, "Let's get physical": advantages of a physical model over 3D computer models and textbooks in learning imaging anatomy", Anat Sci Educ., vol. 6, pp. 216–24, 2013.

[9]. S.A. Lombardi, R.E. Hicks, K.V. Thompson, G. Marbach-Ad. "Are all hands-on activities equally effective? Effect of using plastic models, organ dissections, and virtual dissections on student learning and perceptions", Adv Physiol Educ., vol. 38, pp. 80–6, 2014.

[10]. J. Fredieu,J.Watson,C.HughartT. Nikiforova,"Human development:development of the face andpalate", MedEdPORTAL, 8334, 2011.

[11]. A. Hu, T. Wilson, H. Ladak, P. Haase, P. Doyle, K. Fung, "Evaluation of a three-dimensional educational computer model of the larynx: voicing a new direction" J Otolaryngol Head Neck Surg., vol. 39, pp. 315–22, 2010.

[12]. K.R. Marsh, B.F. Giffin, D.J. Lowrie Jr, Medical student retention of embryonic development: impact of the dimensions added by multimedia tutorials. Anat Sci Educ., vol. 1, pp. 252–7, 2008,

[13]. S. Tan, A. Hu, T. Wilson, H. Ladak, P. Haase, K. Fung, "Role of a computer-generated three-dimensional laryngeal model in anatomy teaching for advanced learners.", J Laryngol Otol., vol. 126, pp. 395–401, 2012.

[14]. C. Yue, J. Kim, R. Ogawa, E. Stark, S. Kim, "Applying the cognitive theory of multimedia learning: an analysis of medical animations". Med Educ., vol. 47, pp. 375–87, 2013.

[15]. J.R. Fredieu, J. Kerbo, M. Herron et al. "Anatomical Models: a Digital Revolution", Med.Sci.Educ, vol. 25, pp. 183-194, 2015.