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DOI: 10.2478/rjr-2020-0012

Romanian Journal of Rhinology, Volume 10, No. 38, April - June 2020

SHORT SCIENTIFIC COMMUNICATION

The role of 3D reconstruction in surgical training for the ENT young surgeon

Francesco Maria Passali, Barbara Flora, Emanuela Fuccillo, Stefano Di Girolamo

Department of Otolaryngology, "Tor Vergata" University of Rome, Rome, Italy

ABSTRACT

BACKGROUND. Nose and paranasal sinus surgery requires an accurate anatomical knowledge and a fine systematic learning. Surgical practice on cadaveric specimens is very important for the ENT resident to allow for a step-by-step learning, but it is not easy in all countries to have access to this compound.

MATERIAL AND METHODS. We propose 3D-printed anatomical bone model exercitations as an alternative method for anatomical study, morphological research and surgical learning

RESULTS. We have achieved very satisfactory morphological results both for the colours and shapes.

CONCLUSION. The use of 3D modelling simulation allows the young surgeon to improve their technical skills and to the expert surgeon to plan the preoperative strategy in complex situations.

KEYWORDS: 3D model, surgical simulation, training, anatomic model.

INTRODUCTION

Nose and paranasal sinus surgery and, in particular, fiberoptic endoscopic surgery require an accurate anatomical knowledge and a fine systematic learning. Surgical practice on cadaveric specimens is very important during ENT residency to allow for a step-by-step learning, but students do not have the same opportunity to access to this compound in all countries.

Young surgeons often use cadaveric specimens to study the morphology of human nasal cavity and improve their surgical technique[1]. From ancient Greece to the modern era, the use of cadaveric dissections for learning anatomy was widely diffused. Since the 14th century we have documented the change in attitude of religious authorities towards the body dissection and the diffusion of donation programs in medical schools[2]. Otherwise, in some countries, the access to anatomic compounds is still limited and expensive because of cultural reasons that discourage people from donating their body for scientific research.

For example, China's universities and medical schools face an ongoing shortage of cadavers for education and research[3]. We can find the same situation, or similar, even in Italy. Without a large enough number of cadaveric specimens, surgeons can learn surgical skills only by video and studying images that cannot allow to evaluate the feasibility of a new technique on a human body.

The use of 3D printing has been adopted for almost a decade in the medical field, with a limited application especially in dentistry and orthopedics. However, as the printers and dedicated software are becoming more widely available and cheaper, there is an increase in their use in medical practice for rendering solutions. With the recent development of 3D-printed anatomical bone models and the possibility to simulate specific clinical cases, some specialist has tried to use 3D models as an alternative method for anatomical study, morphological research and surgical learning. However, the real accuracy of the morphology of a 3D-printed model

Corresponding author: Barbara Flora, "Tor Vergata" University of Medicine, Department Head and Neck Surgery- Institute of Otolaryngology, "Tor Vergata" Hospital, Viale Oxford 81, 00133, Rome, Italy

e-mail: barbara.flora@hotmail.it

Received for publication: January 20, 2020 / **Accepted:** February 10, 2020

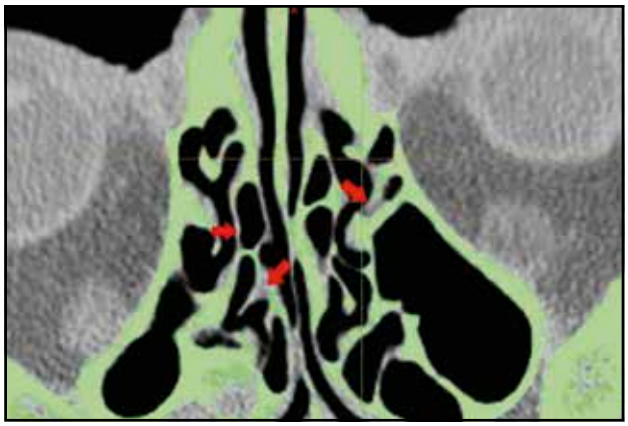

Figure 1. CT scan reconstruction.

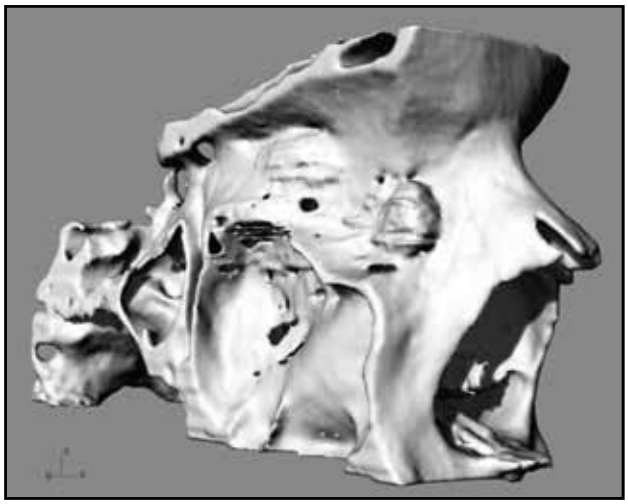

Figure 2. 3D modelling for bioprinting.

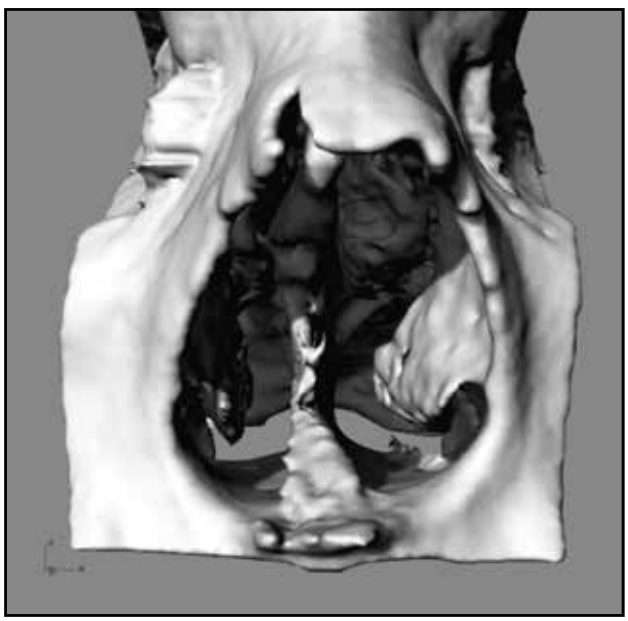

Figure 3. 3D modelling for bioprinting.

Figure 4. 3D model of the left middle turbinate and COM.

Figure 5. 3D model of the right middle turbinate and COM.

has not been completely determined.

The 3D anatomic model allows to perform a surgical simulation reproducing the visual, auditory, and all salient aspects of a real procedure. Zhao et al.[4] demonstrated in 2011 that virtual reality simulators could be used to improve performance on cadaver dissection of the temporal bone in comparison with traditional teaching methods alone.

3D models for surgical training simulation allow the trainees to practice surgical procedures in a safe environment and exercise until they have mastered them[5]. A recent study found that students who used three-dimensional models had a better and shorter learning curve when compared with students who used digital models or textbook[6].

For these reasons, we decided to create a 3D silicone model reproducing the anatomy of the nose

and paranasal sinuses of a healthy human adult and keeping the colours and the anatomical features of the different structures.

MATERIAL AND METHODS

We have therefore asked expert surgeons to create a course for medical students and ENT resident doctors, performing an anatomical dissection and a simulation of the surgical techniques, highlighting the many anatomical structures and focal points of the different surgical times using CT scan, 3D reconstruction and 3D silicon model (Figures 1,2,3).

We have achieved very satisfactory morphological results both for the colours and shapes. We have used these 3D models to perform dissection exercises. This represented an excellent method of learning surgery, especially for young ENT doctors who have not had technical skills yet (Figures 4,5).

The 3D models allow to perform anatomical dissection and to simulate surgical techniques, highlighting the many anatomical structures and focal points of the different surgical steps. The most important limitation of this technology that we found was the difficulty in rendering the multiple tissue textures. In particular, we assessed that the consistency of bone structures is different from the real ones and that could represent a limit for the practice, especially in learning surgery. Otherwise, this limitation can be solved using various colours to indicate different layers.

CONCLUSIONS

In the light of this experience, the chance to reproduce the exact anatomic layout could represent a valid support in addition to the technical learning, also for the assessment of complex clinical cases in which the normal structural morphology is subverted due to congenital malformations or pathological processes. Thus, it provides a useful tool for young surgeons to improve their technique and a valid support for expert surgeons in pre-operative surgical planning.

Contribution of authors: All contributors meet the criteria for authorship.

Conflict of interest: The authors have no conflict of interest.

Financial disclosure: The authors declared that this study has received no financial support.

Acknowledgements: None

REFERENCES

1. Delgado-Vargas B, Romero-Salazar AL, Reyes Burneo PM, Vasquez Hincapie C, de Los Santos
2. Granado G, Del Castillo Lopez R, et al. Evaluation of resident's training for endoscopic sinus surgery using a sheep's head. Eur Arch Otorhinolaryngol. 2016;273(8):2085-9. DOI: 10.1007/s00405-015-3877-1.
3. Ghosh SK. Human cadaveric dissection: a historical account from ancient Greece to the modern era. Anat Cell Biol. 2015;48(3):153-69. DOI: 10.5115/acb.2015.48.3.153.
4. Zhang L, Wang Y, Xiao M, Han Q, Ding J. An ethical solution to the challenges in teaching anatomy with dissection in the Chinese culture. Anat Sci Educ. 2008;1(2):56-9. DOI: 10.1002/ase.15.
5. Zhao YC, Kennedy G, Yukawa K, Pyman B, O'Leary S. Improving temporal bone dissection using self-directed virtual reality simulation: results of a randomized blinded control trial. Otolaryngol Head Neck Surg. 2011;144(3):357-64. DOI: 10.1177/0194599810391624.
6. Waran V, Narayanan V, Karuppiah R, Pancharatnam D, Chandran H, Raman R, et al. Injecting realism in surgical training-initial simulation experience with custom 3D models. J Surg Educ. 2014;71(2):193-97. DOI: 10.1016/j.jsurg.2013.08.010. Epub 2013 Nov 22.
7. Preece D, Williams SB, Lam R, Weller R. "Let's get physical": advantages of a physical model over 3D computer models and textbooks in learning imaging anatomy. Anat Sci Educ. 2013;6(4):216-24. DOI: 10.1002/ase.1345. Epub 2013 Jan 24.