

Evaluation of resident satisfaction with a temporal bone surgery simulation course using a synthetic model

Z. Sarda ^{1,*}, O.Oulghoul ¹, M. Moufannane ¹, M. Chehbouni ¹, Y. Lakhdar ¹, O. Benhoummad ², Y. Rochdi ¹ and A. Raji ¹

¹ Department of ENT and HNS Surgery, Mohammed VI University Hospital, Marrakech, Morocco.

² Department of ENT and HNS Surgery, Faculty of Medicine and Pharmacy of Agadir, Ibn Zohr University, Agadir, Morocco.

World Journal of Advanced Research and Reviews, 2026, 30(02), 2430-2436

Publication history: Received on 18 April 2026; revised on 24 May 2026; accepted on 26 May 2026

Article DOI: <https://doi.org/10.30574/wjarr.2026.30.2.1510>

Abstract

Purpose: Temporal bone dissection is essential in otologic training. However, the scarcity of cadaveric bones has led to alternative training methods, such as synthetic bone models. This study aimed to evaluate the satisfaction of ENT residents with a hands-on course using synthetic temporal bones.

Methods: A hands-on dissection course was conducted in an experimental surgical training laboratory at a university medical faculty. A total of 48 ENT residents from different university hospitals participated voluntarily and were divided into 24 pairs. Each team performed standardized dissections on synthetic temporal bones, guided by senior ENT surgeons. A structured satisfaction questionnaire was completed after the session, assessing anatomical realism, technical difficulty, and equipment quality.

Results: Among participants, 75% were male and 25% female. Most (87.5%) had prior experience in otologic dissection. High similarity was reported for the dura mater (81%), sigmoid sinus (63%), and lateral semicircular canal (73%), but lower similarity for the facial nerve (40%). Incidents included facial nerve damage (64.5%) and sigmoid sinus injury (58.3%). Equipment satisfaction was high (63%) except for the aspiration system (33%). Overall satisfaction with the course reached 100%.

Conclusion: Synthetic temporal bone dissection is a highly appreciated training method by ENT residents. It enhances anatomical understanding and surgical confidence. Further controlled studies are needed to confirm the transferability of acquired skills to the operating room.

Keywords: Temporal Bone; Surgical Simulation; Synthetic Model; Otologic Training; Resident Satisfaction

1. Introduction

Temporal bone dissection is a fundamental component in the training of otorhinolaryngology (ENT) residents, as it provides the anatomical and surgical foundation for all otologic procedures. It enables trainees to develop a precise understanding of ear anatomy and practice surgical skills in a controlled environment.

Historically, dissection on cadaveric temporal bones has been considered the gold standard for teaching otologic surgery [1]. However, over recent decades, the availability of human temporal bones has declined due to stricter legislation and fewer body donations for educational purposes [2]. As a result, alternative training methods have

* Corresponding author: Z. Sarda

emerged, including synthetic temporal bones and 3D virtual simulation technologies [3]. These models have rapidly proven to be effective pedagogical tools and are increasingly integrated into surgical training curricula.

This study aimed to evaluate the satisfaction of ENT residents with a simulation-based otologic surgery course using synthetic temporal bones, and to assess its perceived educational value.

2. Methods

A simulation-based dissection course using synthetic temporal bones was held at the experimental surgery laboratory of the Faculty of Medicine and Pharmacy. A total of 48 otolaryngology residents from various university hospitals voluntarily participated. They were divided into 24 pairs, each assigned to a dissection station equipped with a mounted synthetic temporal bone, an optical microscope, a surgical drill, and a suction system (figure1).



Figure 1 Installation of residents at their workstations

At the beginning of the session, residents attended a video-based lecture on surgical anatomy and step-by-step dissection techniques. The procedures covered included mastoidectomy, atticotomy, anterior and posterior tympanotomy, cochleostomy, and cochlear implantation. Throughout the session, six senior ENT surgeons facilitated and supervised the residents' dissections (figure 2).



Figure 2 Teaching of proper techniques by the professors

At the end of the course, each participant completed a structured satisfaction questionnaire. (See Supplementary Material 1). This questionnaire assessed several aspects: anatomical realism of the synthetic model, perceived difficulty in identifying key anatomical landmarks, evaluation of the surgical instruments and microscope, and overall course satisfaction. Responses were rated using a 5-point Likert scale, from 1 (very dissatisfied) to 5 (very satisfied).

3. Results

Of the 48 participants, 75% were male and 25% were female (Figure 3). Regarding academic level, 16 participants were in their third year of residency, 11 in their fourth year, 6 in their fifth year, and 2 were certified ENT specialists.

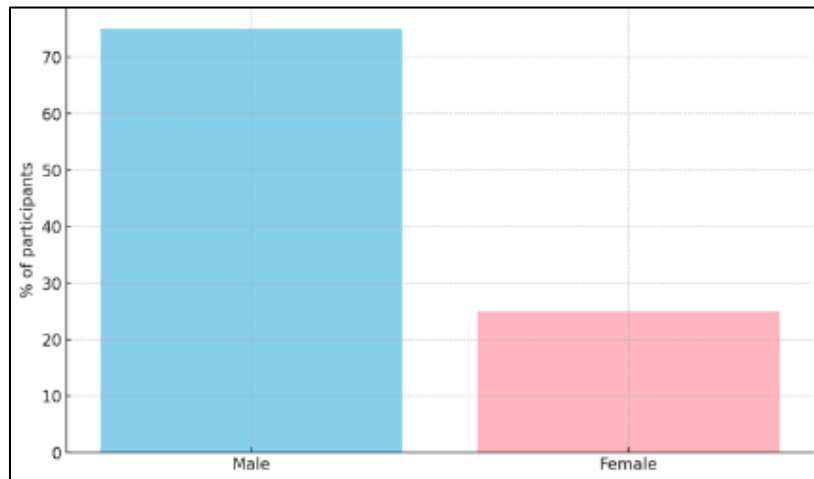


Figure 3 Gender distribution of participants (x: gender, y: % of participants)

In terms of prior experience, 87.5% of residents reported being adequately prepared for the course: 20.8% had previously performed temporal bone dissection in the operating room on human bone, 4.16% on cadaveric specimens, and 27% had already practiced on synthetic models. All participants had at least observed a dissection in the operating room.

When evaluating the anatomical realism of the synthetic bone, 81% of participants found the dura mater very similar to that observed in live patients, 63% for the sigmoid sinus, 60% for the external auditory canal, 73% for the lateral semicircular canal, 52% for the ossicles, and only 40% for the facial nerve (figure 4).

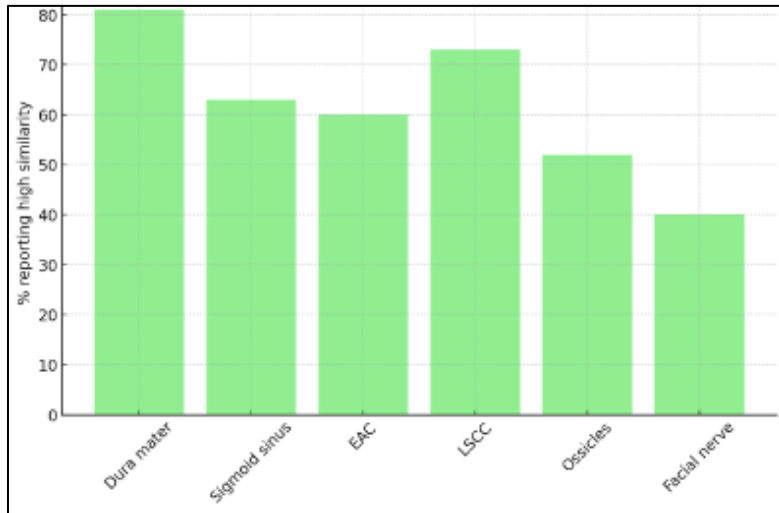


Figure 4 Anatomical similarity perceived in synthetic bone (x: anatomical structures, y: % of similarity)

As for the difficulty of identifying key anatomical structures, 23% found dura mater identification difficult, 33% for the lateral semicircular canal, 37.5% for the ossicles, and 50% for the facial nerve (figure 5).

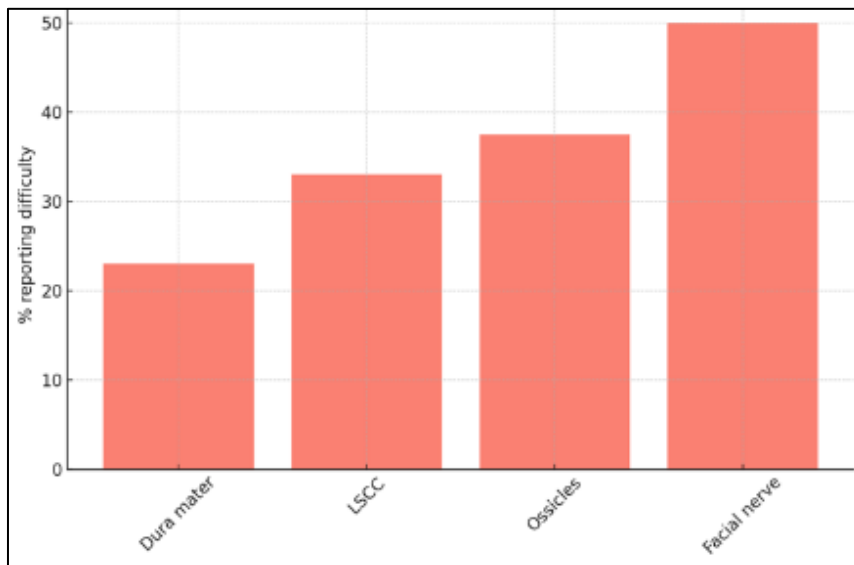


Figure 5 Difficulty in identifying anatomical structures (x: anatomical structures, y: % of difficulty)

Regarding complications encountered during dissection, the most common were injury to the external auditory canal (68.75%), the facial nerve (64.5%), the sigmoid sinus (58.3%), the dura mater (46.6%), and accidental opening of the lateral semicircular canal (18.75%) (figure 6).

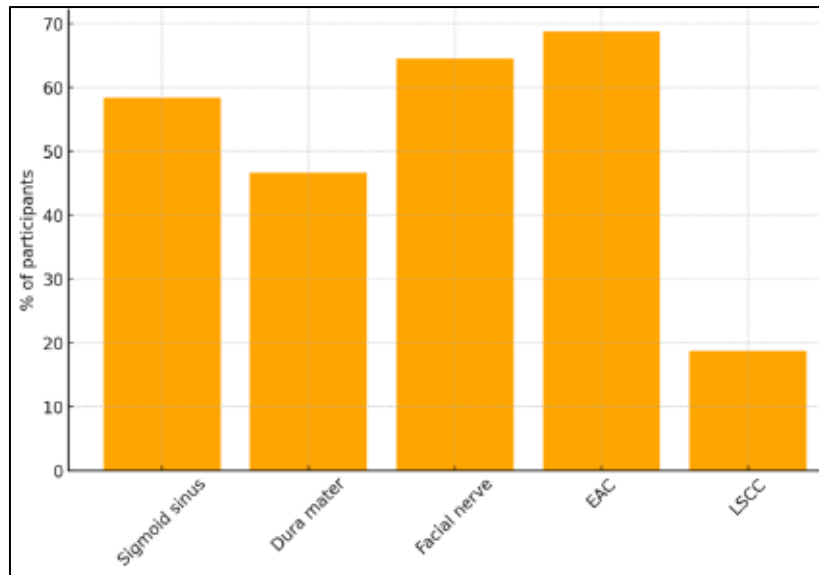


Figure 6 Incidents encountered during dissection (x: anatomical structures, y: % of participants)

With respect to equipment evaluation, 63% of participants were satisfied with the surgical drill and optical microscope, while 33% were dissatisfied with the suction system.

Overall satisfaction with the training was unanimously high (100%), both in terms of the learning of surgical techniques and improved understanding of ear anatomy. All participants agreed that such simulation-based training should be integrated into the ENT residency curriculum.

4. Discussion

Otologic surgery has significantly evolved over the past decades with the advent of microscopic techniques. Mastery of these procedures demands precise anatomical knowledge and fine surgical skills [4]. Given the complexity of the field, simulation has emerged as a cornerstone in otologic surgical education.

Available simulators can be grouped into three main types: organic (cadaveric or animal-based), synthetic, and virtual reality (VR)-based simulators [5]. Each offers unique benefits for skill acquisition. Although cadaveric bones remain a highly realistic tool [6], they pose limitations including cost, ethical concerns, infection risk, and limited availability [7,8]. These factors have led to the exploration of alternative models.

Synthetic bones produced via 3D printing represent a promising option. Since their first description in 1998 by Begall et al. [9], models such as Pettigrew®, Temp'Os®, and Biomodex® have gained popularity. These models provide anatomical consistency and can even simulate pathology or bleeding [10,11]. Bakhos et al. [12] and Chenebaux et al. [13] demonstrated high user satisfaction and anatomical fidelity. In our study, the overall satisfaction rate of 100% echoes these findings.

However, limitations remain. Some models offer poor representation of the ossicular chain or facial nerve [14], and differences in tactile feedback may hinder realism [15]. Our findings also reported difficulties identifying the facial nerve (50%) and frequent iatrogenic injuries, highlighting areas for improvement.

Interestingly, some authors report that training on synthetic bones improves performance on cadaveric dissections [16], validating their pedagogical relevance. Further, pediatric and pathological variants exist, increasing training flexibility [17,18].

Finally, simulation in other surgical fields (e.g., neurosurgery, orthopedics) has also confirmed its value, especially when linked with 3D printing technologies and case-specific imaging [19,20]. These advances support the broader application of synthetic models in surgical education.

5. Conclusion

Dissection of the middle ear using synthetic temporal bone models represents an essential component of both initial and continuous training in otologic surgery. This educational approach helps residents acquire surgical skills in a safe environment and improves operative confidence, potentially reducing intraoperative errors. It also accelerates the learning curve through repetitive, standardized practice.

Based on our study, synthetic bone dissection appears to significantly enhance technical competence in mastoidectomy under microscopic guidance. Nonetheless, further controlled, randomized studies with larger sample sizes are needed to assess the long-term impact and skill transferability to real-life surgical settings.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

The study did not require formal ethical approval according to the regulations of our institution as it involved the anonymous and voluntary participation of medical residents in an educational workshop.

Statement of informed consent

Participation was based on informed consent, and no identifiable or sensitive personal data were collected.

Funding

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

References

- [1] Naik SM, Naik MS, Bains NK. Cadaveric temporal bone dissection: is it obsolete today? *Int Arch Otorhinolaryngol.* 2014;18:63–67.
- [2] George AP, De R. Review of temporal bone dissection teaching: how it was, is and will be. *J Laryngol Otol.* 2010;124(2):119–125.
- [3] Javia L, Deutsch ES. A systematic review of simulators in otolaryngology. *Otolaryngol Head Neck Surg.* 2012;147(6):999–1011.
- [4] Feigl G, Kos I, Anderhuber F, Guyot JP, Fasel J. Development of surgical skill with singular neurectomy using human cadaveric temporal bones. *Ann Anat.* 2008;190:316–323.
- [5] Granry JC, Moll MC. Rapport de mission: état de l'art en matière de pratiques de simulation dans le domaine de la santé. Haute Autorité de Santé. 2012.
- [6] Bhutta MF. A review of simulation platforms in surgery of the temporal bone. *Clin Otolaryngol.* 2016;41(5):539–545.
- [7] Wiet GJ, Stredney D, Kerwin T. Virtual temporal bone dissection system: OSU virtual temporal bone system: development and testing. *Laryngoscope.* 2012;122(Suppl 1):S1–S12.
- [8] O'Leary SJ, Hutchins MA, Stevenson DR. Validation of a networked virtual reality simulation of temporal bone surgery. *Laryngoscope.* 2008;118:1040–1046.
- [9] Begall K, Vorwerk U. Artificial petrous bone produced by stereolithography for microsurgical dissecting exercises. *ORL J Otorhinolaryngol Relat Spec.* 1998;60(5):241–245.
- [10] Awad Z, Ahmed S, Taghi AS, et al. Feasibility of a synthetic temporal bone for training in mastoidectomy: face, content, and concurrent validity. *Otol Neurotol.* 2014;35(10):1813–1818.
- [11] Suzuki M, Hagiwara A, Ogawa Y, et al. Rapid-prototyped temporal bone and inner ear models replicated by adjusting computed tomography thresholds. *J Laryngol Otol.* 2007;121:1025–1028.

- [12] Bakhos D, Velut S, Robier A, et al. Three-dimensional modeling of the temporal bone for surgical training. *Otol Neurotol*. 2010;31(2):328–334.
- [13] Chenebaux M, Lescanne E, Robier A, et al. Evaluation of a temporal bone prototype by experts in otology. *J Laryngol Otol*. 2014;128(7):586–590.
- [14] Mills R, Lee P. Surgical skills training in middle-ear surgery. *J Laryngol Otol*. 2003;117:159–163.
- [15] Rose AS, Webster CE, Harrysson OL, et al. Multi-material 3D models for temporal bone surgical simulation. *Ann Otol Rhinol Laryngol*. 2015;124:528–536.
- [16] Aussedat C, Venail F, Nguyen Y, et al. Usefulness of temporal bone prototype for drilling training: A prospective study. *Clin Otolaryngol*. 2017;42(6):1200–1205.
- [17] Probst R, Stump R, Mokosch M, Roosli C. Evaluation of an infant temporal-bone model as training tool. *Otol Neurotol*. 2018;39:e448–e452.
- [18] Longfield EA, Brickman TM, Jeyakumar A. 3D printed pediatric temporal bone: a novel training model. *Otol Neurotol*. 2015;36:793–795.
- [19] Paiva WS, Amorim R, Bezerra DA, et al. Application of the stereolithography technique in complex spine surgery. *Arq Neuropsiquiatr*. 2007;65:443–445.
- [20] Lambrecht JT, Berndt D, Christensen AM, Zehnder M. Haptic model fabrication for undergraduate and postgraduate teaching. *Int J Oral Maxillofac Surg*. 2010;39:1226–1229.