Immersive 3D Anatomic Models: Transforming Surgical Education for Medical Students

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Background

- Computer-generated imagery and three-dimensional (3D) modeling offer innovative, interactive ways to enhance the learning experience beyond the traditional study of anatomic illustrations and cadavers
- Photogrammetry, a technique that creates detailed 3D anatomic models from images or videos, offers a cost-effective solution for producing high-quality visualizations
- **Aim:** To describe the integration of photogrammetry into a surgical dissection elective course for fourth-year medical students and evaluate its potential to improve anatomic understanding, surgical skills, and educational outcomes in otolaryngology

Methods

- Four adult cadaveric head specimens with arterial dye injections were prepared for photogrammetry
- Students performed endoscopic endonasal dissections including septoplasty, inferior turbinectomy, middle meatal antrostomy, anterior and posterior ethmoidectomy, sphenoidotomy, nasoseptal flap harvesting, pituitary gland exposure, pterygopalatine and infratemporal fossae exposures, and optic nerve canal decompression
- Video recordings of the dissections were captured using the AIDA recording system (Karl Storz Endoscopy, Germany), and uploaded to a photogrammetry software 3D scanner app (Laan Labs, USA), which generated detailed 3D meshes with textures

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Results

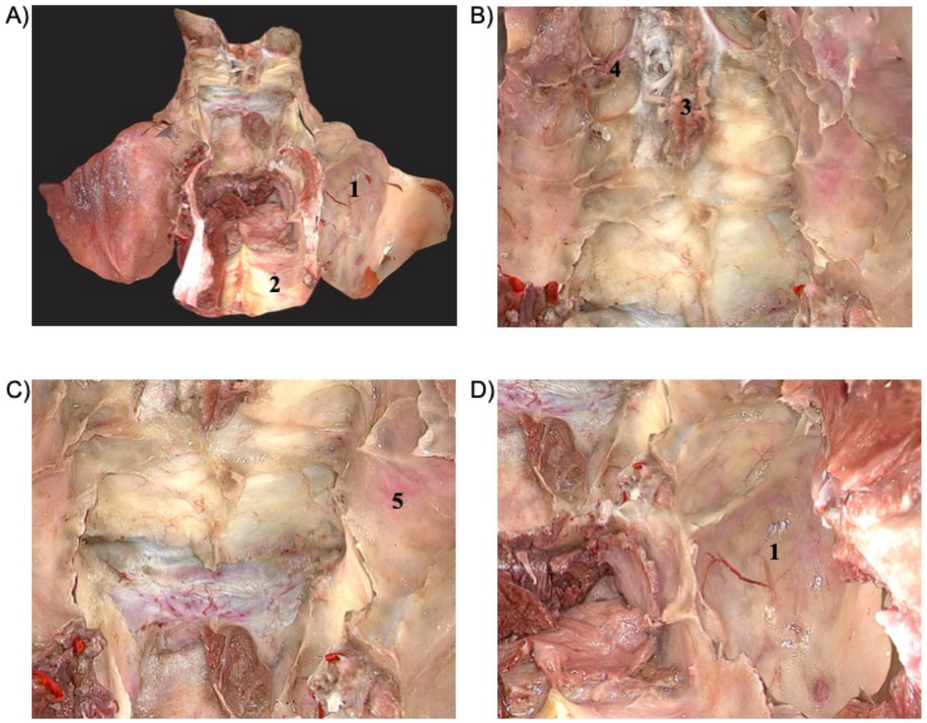

Figure 1. 3D model of sinus dissection showing posterior wall of the maxillary sinus (1), palatine process of the maxilla (2), cribriform plate (3), anterior ethmoidal artery (4), and lamina papyracea (5).

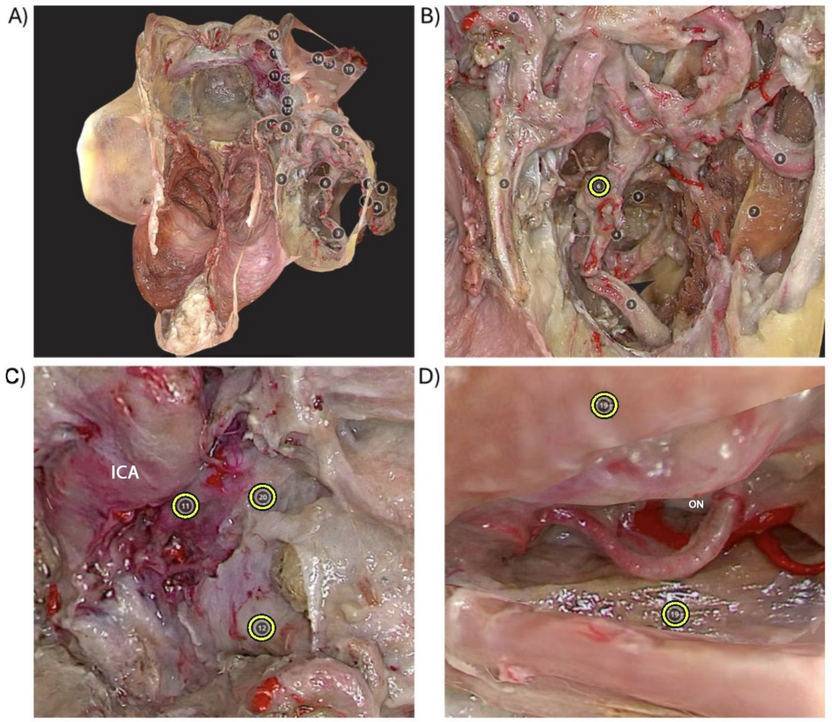

Figure 2. 3D model: (A) wide view; (B) infratemporal fossa with internal maxillary artery (6); (C) internal carotid artery (ICA), abducens (11), and trigeminal nerves (12,20); (D) orbit close-up with optic nerve (ON) and recti muscles (19).

Conclusions

- Student-led development of interactive 3D anatomic models are potentially valuable educational tools for visualizing and understanding complex anatomy and surgical procedures
- Photogrammetry enabled the creation of accurate, 3D models from cadaveric dissections and showed lasting value compared to traditional anatomy teaching
- As a low-cost, accessible tool, photogrammetry represents a promising adjunct for advancing surgical training and learner engagement in otolaryngology

Future Directions

- Future studies should incorporate validated assessment tools, controlled study designs, and larger sample sizes to rigorously evaluate the impact of photogrammetric models on medical education
- Multi-year validation and integration into residency training to further establish the efficacy of this tool for both knowledge and skill acquisition and formative assessment
- Integration with learning management systems and collaborative digital platforms to enhance the accessibility and usability of these models across institutions

Interactive 3D Models

Please scan the following QR codes to view the full interactive, 3D models created by the students through this elective course:

Student 1 Sinus Dissection | **Student 2 Sinus Dissection** | **Student 3 Sinus Dissection** | **Student 4 Sinus Dissection** | **Infratemporal Fossa**

References

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3. Piazza A, Leonel LCPC, Torregrossa F, et al. Photogrammetry Foundations and Guidelines for Acquisition of High-Definition 3-Dimensional Models Using Photographic Cameras and Smartphones: An Optimized Tool to Improve Neuroanatomy Research and Education. Operative Neurosurgery. Published online June 23, 2025. doi:10.1227/ons.0000000000001675