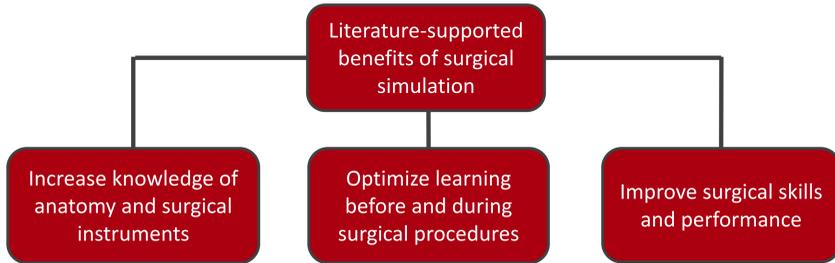# Implementing a Virtual Reality Anatomical Model for Anterior Skull Base Surgical Education

Tony Satroplus, MD[1]; Steven Goicoechea, MD[1]; Jer Weann Ang, MS[2]; Wesley A Fisher[2]; Eli Piilonen[2]; Jordan Zhang[2]; Elizabeth Svoboda, PhD[2]; Dheeraj Varandani, MS[2]; Daniel Surdell, MD[3]; Noha A Algahimi, BS[4]; Christie Barnes, MD[1]

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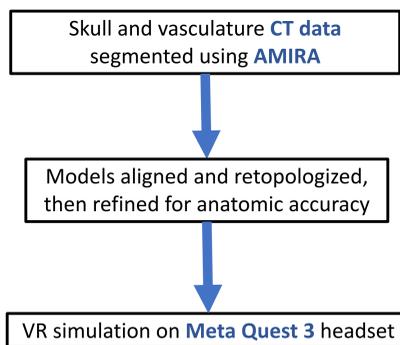
## Introduction

- VR simulations for anterior skull base anatomy are currently limited
- Surgical simulation has a growing role in medical and procedural training

Literature-supported benefits of surgical simulation

- Increase knowledge of anatomy and surgical instruments
- Optimize learning before and during surgical procedures
- Improve surgical skills and performance

## Methods and Materials

### Simulation Design

Skull and vasculature **CT data** segmented using **AMIRA**

↓

Models aligned and retopologized, then refined for anatomic accuracy

↓

VR simulation on **Meta Quest 3** headset

### Survey Design

Study participants: **Otolaryngology and Neurosurgery residents, medical students**

→ **5-Point Likert scale surveys** for pre- and post-simulation utilization

Pre- and post-simulation **knowledge-based assessment** of 11 anatomical structures

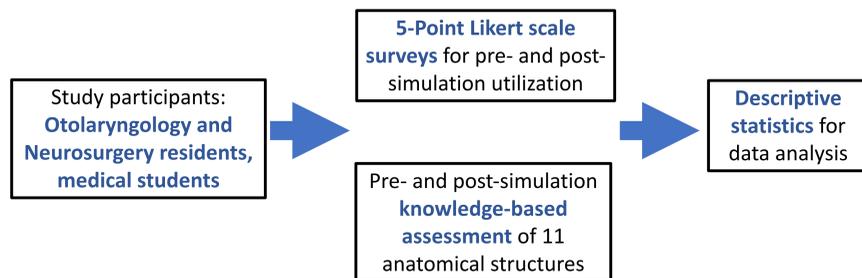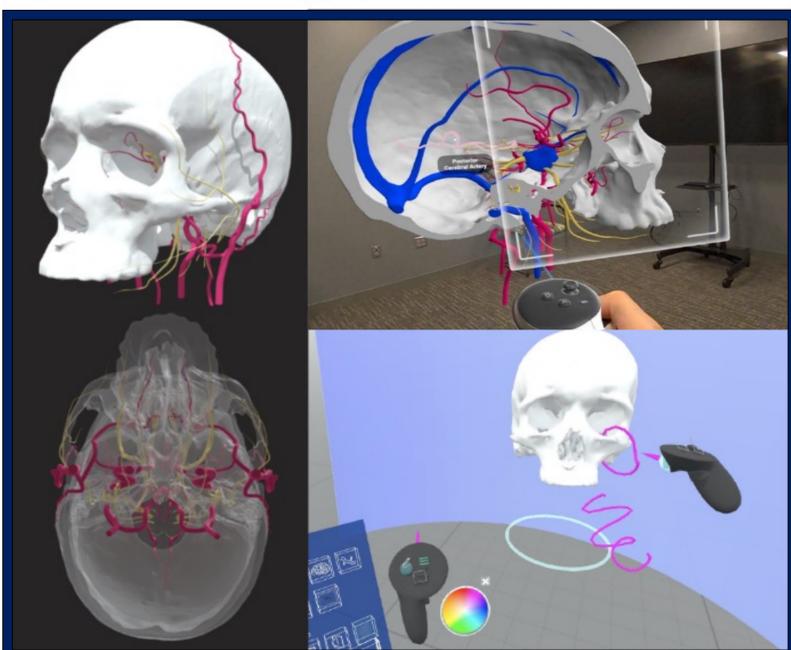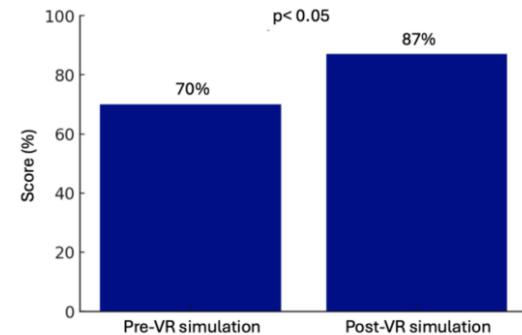→ **Descriptive statistics** for data analysis

**Figure 4.** Utilization of the 3D anatomical model with VR headset.



## Results

**Figure 1.** Pre- and post-VR simulation knowledge assessment of 11 standardized anatomical structures.



$p < 0.05$; Pre-VR simulation: 70%; Post-VR simulation: 87%

> ### The VR model significantly improved surgical resident and medical student understanding of skull base anatomy.

**Figure 2.** Comparison of participants' confidence in knowledge and application of anterior skull base anatomy pre- and post-VR simulation.
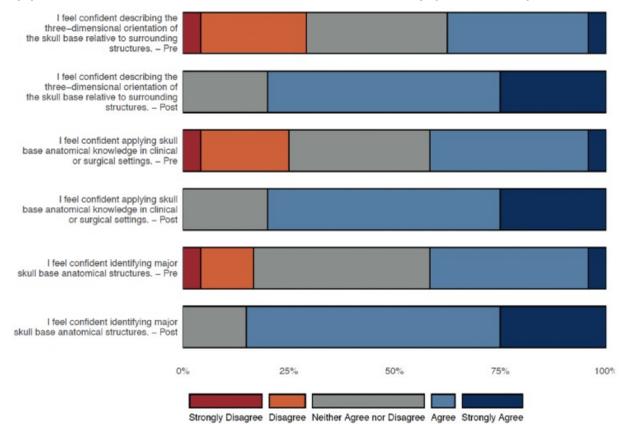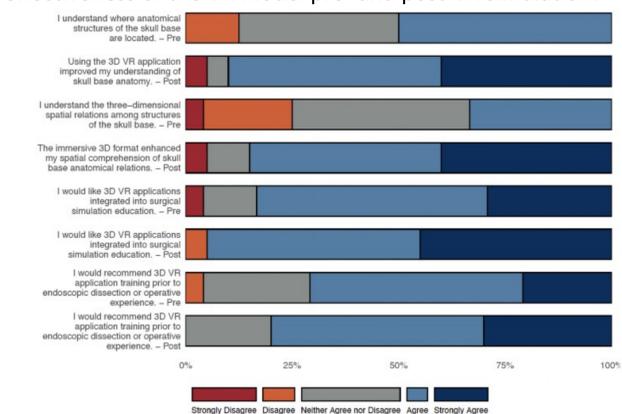


I feel confident describing the three-dimensional orientation of the skull base relative to surrounding structures. – Pre
I feel confident describing the three-dimensional orientation of the skull base relative to surrounding structures. – Post
I feel confident applying skull base anatomical knowledge in clinical or surgical settings. – Pre
I feel confident applying skull base anatomical knowledge in clinical or surgical settings. – Post
I feel confident identifying major skull base anatomical structures. – Pre
I feel confident identifying major skull base anatomical structures. – Post

Strongly Disagree — Disagree — Neither Agree nor Disagree — Agree — Strongly Agree

**Figure 3.** Comparison of participants' perception of the educational effectiveness of the VR model pre- and post-VR simulation.



I understand where anatomical structures of the skull base are located. – Pre
Using the 3D VR application improved my understanding of skull base anatomy. – Post
I understand the three-dimensional spatial relations among structures of the skull base. – Pre
The immersive 3D format enhanced my spatial comprehension of skull base anatomical relations. – Post
I would like 3D VR applications integrated into surgical simulation education. – Pre
I would like 3D VR applications integrated into surgical simulation education. – Post
I would recommend 3D VR application training prior to endoscopic dissection or operative experience. – Pre
I would recommend 3D VR application training prior to endoscopic dissection or operative experience. – Post

Strongly Disagree — Disagree — Neither Agree nor Disagree — Agree — Strongly Agree

## Conclusions and Future Directions

**VR simulation improved residents' already established knowledge of anterior skull base anatomy.**

**Fidelity:** Refine the simulation to better represent real-world anatomy and characterize fidelity based patient imaging.

**Usability:** Decrease the learning curve for VR navigation and refine instrument ergonomics.

**Recorded simulations:** Record training videos to highlight key anatomical landmarks and surgical steps.

### Abstract



### Online VR model



### References



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