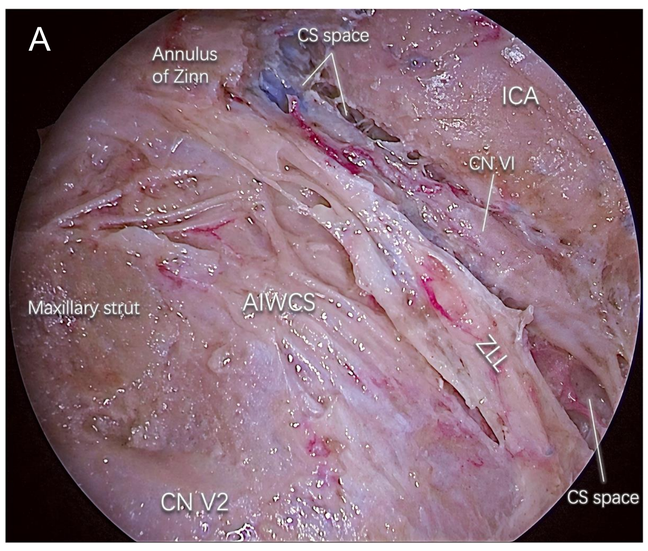
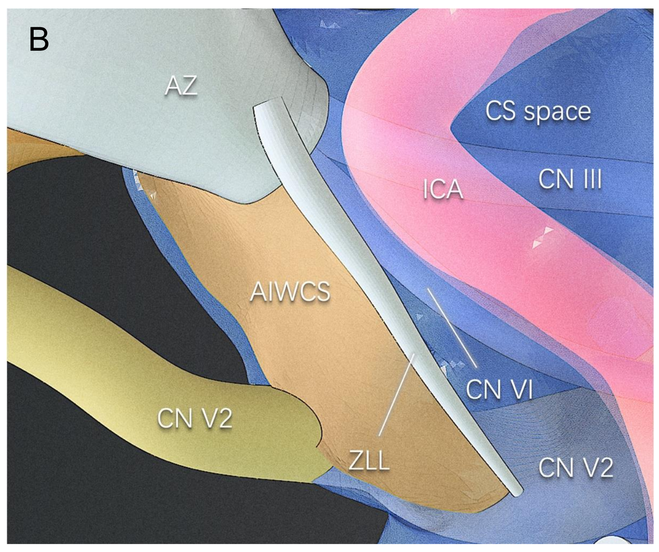
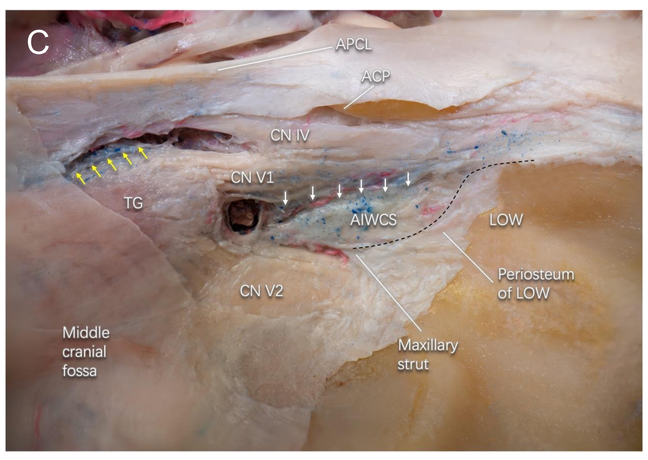
Digital 3D "Sculpting" Multilayer Microsurgical Anatomy of the Cavernous Sinus: A Novel Approach to Visualize and Understand Skull Base Anatomy

Hao Tang, M.D. Chiara Angelini, M.D. Marco Obersnel, M.D. Roberto Rodriguez Rubio, M.D.
Skull Base and Cerebrovascular Laboratory, Department of Neurological Surgery, UCSF

How to achieve an active, constructive understanding of complex skull base anatomy?







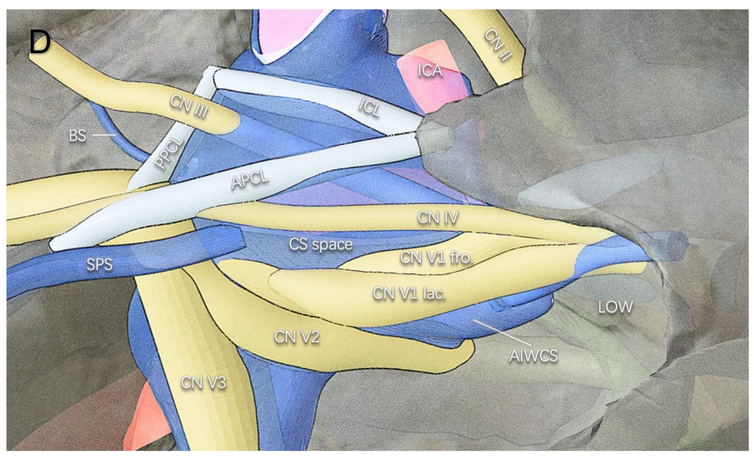


Figure 2

(A) Neuroendoscopic transnasal view of the right cavernous sinus and its anterior region. The anterior wall of the cavernous sinus and its anterior extension have been removed.
(B) Three-dimensional reconstruction of key structures in the region shown in Figure **(A)**. Refer to the QR code at the bottom for the 3D visualization and video.
(C) Right-sided axial view of the skull base specimen. Displays the venous and neural pathways in the right cavernous sinus region.
(D) Three-dimensional reconstruction of key structures (nerves, vessels, ligaments, etc.) in the region shown in Figure **(C)**. Refer to the QR code at the bottom for the 3D visualization and video.

Successful 360° configuration of the cavernous sinus with selective transparency and rotation

Introduction

three-dimensional (3D) reconstruction is essential for neuroanatomical education, enabling the transition from two-dimensional (2D) to 3D visualization.
Traditional cadaveric dissection is a "passive" process in terms of creating deep personal 3D spatial reconstructions.
Core Question: Can an "active procreational" strategy — building anatomy from the deepest layer upward — foster a better understanding of spatial relationships?

Methods and Materials

Specimens: Five embalmed, latex-injected cadaveric specimens explored via endoscopic endonasal approach.
References: 2D and 3D anatomical landmarks from dissections served as sculptural references.
Modeling: Stepwise construction (bone, membranes, vessels, nerves) using **Nomad Sculpt 2.7** on iPad (Hexanomad, Les Lilas, France) . (Figure 1)
Rendering: Final models rendered in **Blender 4.5** (Blender Foundation, Amsterdam, Netherlands) and uploaded to **Sketchfab** (Sketchfab Inc., New York, USA) for web-based interaction.

Results

Successful construction of a volumetric model of the cavernous sinus and middle cranial fossa (Figure 2).
Enabled free rotation, scaling, and selective isolation of anatomical components.
Models are deployable for both local (Blender) and online (Sketchfab) interaction (Sketchfab 1&2).

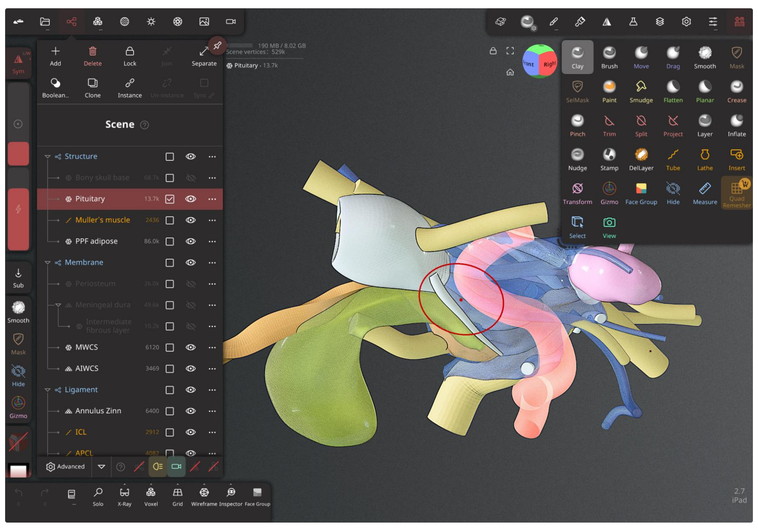


Figure 1. *Nomad Sculpt* Sculpting Scene

Sketchfab 1 **Sketchfab 2** **YouTube Video**

Discussion

To enhance anatomical and educational understanding and to visually communicate the multilayer spatial relationships of the fine elements described in studies, we created 3D models of the cavernous sinus region using the Nomad Sculpt application based on documented endoscopic and microsurgical dissections we performed. The relative spatial relationships between the cavernous sinus and surrounding structures are clearly labeled (Sketchfab 1&2, Youtube Video), which may serve as useful teaching references.

Conclusions

This surgeon-led "sculpting" approach provides enhanced structural clarity and intuitive visualization compared to specimen-based reconstructions.

The framework reinforces anatomical understanding by shifting from physical exploration to digital creation.

Contact

Hao Tang, M.D., Roberto Rodriguez Rubio, M.D.
Skull Base and Cerebrovascular Laboratory, Department of Neurological Surgery, UCSF
513 Parnassus Ave HSE 817, San Francisco, CA, 94143
Tanghaopisces@gmail.com; Luis.rodriguezrubio@ucsf.edu
415-514-3374

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