# Far Lateral Transpontomedullary Sulcus Approach for Supraolivary Pontine Cavernous Malformations
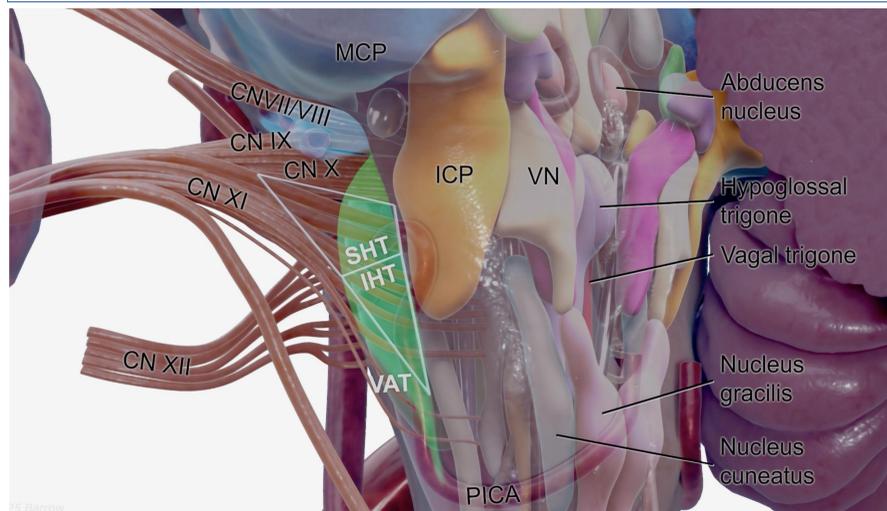## Microsurgical Anatomy of the Vagoaccessory Suprahypoglossal Triangle

**Kivanc Yangi, MD**[1]; Sahin Hanalioglu, MD, PhD[2]; Egemen Gok[1]; Hilal A. Aktas, MD, PhD[3]; Carlos E. Calderon Valero, MS[1]; Osman Tunc, BS[1]; Jack T. Olson, BS[1]; Jarett E. Prince, BS[1]; Kashif Qureshi, MS[1]; Michael T. Lawton, MD[1]; Mark C. Preul, MD[1]

1: The Loyal and Edith Davis Neurosurgical Research Laboratory, Dept. of Neurosurgery, Barrow Neurological Institute, St. Joseph's Hospital and Medical Center, Phoenix, Arizona, United States
2: Dept. of Neurosurgery, Hacettepe Medical Faculty, Ankara, Turkiye 3: Dept. of Anatomy, Hacettepe University Medical Faculty, Ankara, Turkiye

## Introduction

Anatomical triangles formed by neurovascular structures function as important microsurgical landmarks, guiding access to deep-seated targets. Among these, the vagoaccessory suprahypoglossal triangle (SHT), bounded by the vagus nerve (CN X), the lateral medullary surface, the spinal accessory nerve (CN XI), and the hypoglossal nerve (CN XII), has not yet been systematically characterized. Its potential role as a safe, expandable microsurgical corridor to the ventromedial posterior fossa, particularly the paramedian deep pontine region and the pontomedullary sulcus (PMS), is of particular interest. The PMS represents a potential entry zone for supraolivary pontine cavernous malformations (CMs), underscoring the need for detailed anatomical definition of this region.

This study provides a descriptive and quantitative evaluation of the vagoaccessory SHT, analyzing its anatomical boundaries, expandability, and extent of surgical exposure to clarify its applicability in microsurgical approaches.



**Figure 1:** Artist's illustration of the vagoaccessory (VAT), suprahypoglossal (SHT), and infrahypoglossal (IHT) triangles and their surrounding anatomical structures as visualized through the far lateral surgical corridor.
*MCP:* Middle cerebellar peduncle, *ICP:* Inferior cerebellar peduncle, *VN:* Vestibular Nuclei

## Methods

Five formalin-fixed, latex-injected cadaveric heads (10 sides) were dissected using the far lateral craniotomy and transpontomedullary sulcus approach. Neuronavigation-based measurements were obtained to assess triangle dimensions under standard and expanded exposures, and statistical analyses were conducted with R software (v4.4.3). Three additional specimens were dissected to illustrate relevant brainstem anatomy. Ultrahigh-resolution 7-Tesla MRI with 3D-modeling was also used to visualize the regionally associated white matter tracts.
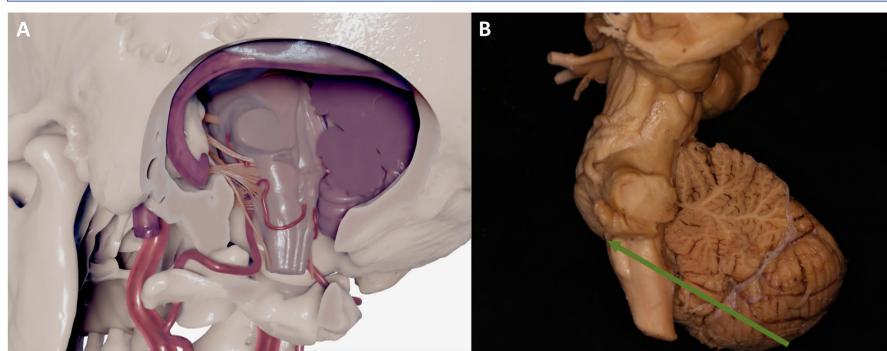


**Figure 2.** Artist's illustration (A) demonstrating the boundaries of the far-lateral craniotomy and the key neurovascular structures visualized through the surgical window. (B) Cadaveric dissection illustrating the trajectory of the far-lateral transpontomedullary sulcus approach (green arrow).
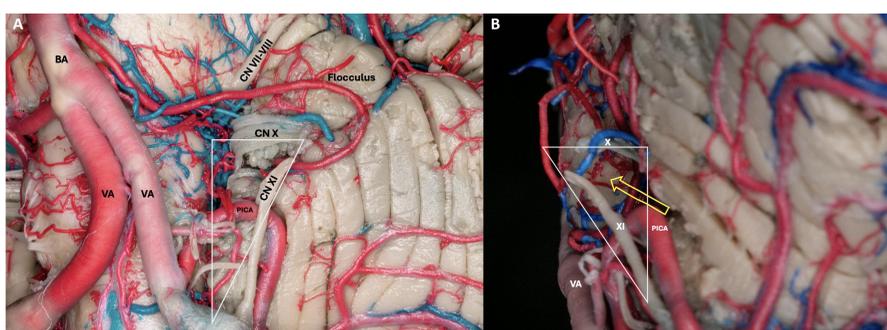


**Figure 3.** Cadaveric dissections demonstrating the anatomical boundaries of the VAT (A). (B) Cadaveric view in the far-lateral position showing the trajectory of the far-lateral transpontomedullary sulcus approach.

## Results

SHT is bounded superiorly by the lowest rootlet of CNX, inferiorly by CNXII, laterally by CNXI, and medially by the lateral edge of the medulla, with mean edge lengths of 31.9(18.4) mm, 9.3(6.6)mm, 29.5(13.3)mm, and 19.5(10.7) mm, respectively. Evaluation of the SHT vertex angles showed that the inferolateral and inferomedial vertices were wider, measuring 124.3(43.5)° and 104.7(42.5)°, whereas the superolateral and superomedial vertices were narrower, at 45.3(27.6)° and 85.5(45.8)°, respectively. The distance between the craniotomy centroid and the SHT centroid was calculated at 46.2(13.5)mm. Standard brainstem exposure through the SHT measured 160.9(84.3)mm², increasing to 295.4(176.7)mm² after mobilization of the retractable edges (p=0.058). The craniocaudal angle of attack was measured at 33.8(26.7)°, while the mediolateral angle of attack measured 61.2(34.0)°. SHT provides access to the V4 segment of the vertebral artery, the p1–p2 segments of the posterior inferior cerebellar artery, the inferior olivary nucleus, and the pontine underbelly. In addition, utilization of the SHT allows exposure of the PMS, posterolateral sulcus, olivary zone, and lateral medullary zone as safe entry zones. During this approach, the supraolivary trajectory leads toward the central pons, in proximity to the medial and lateral lemnisci, the spinothalamic tract, the superior olivary nucleus, the trapezoid body, and the rubrospinal tract.
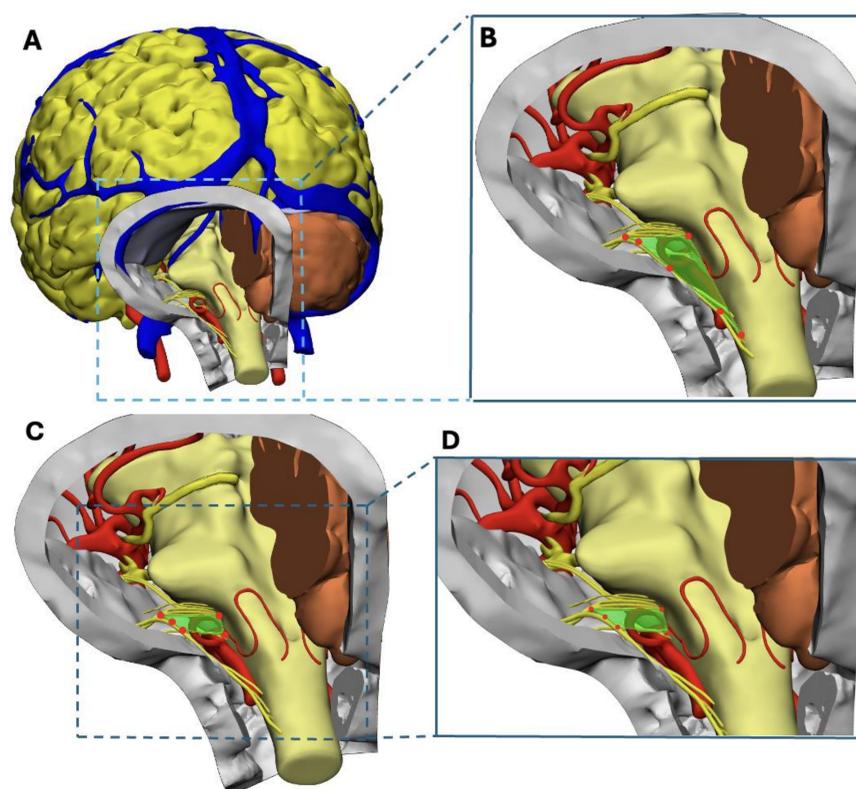


**Figure 4:** 3D-rendered illustrations depicting the vagoaccessory (A-B) and suprahypoglossal (C-D) triangles through far lateral craniotomy (green shaded areas)
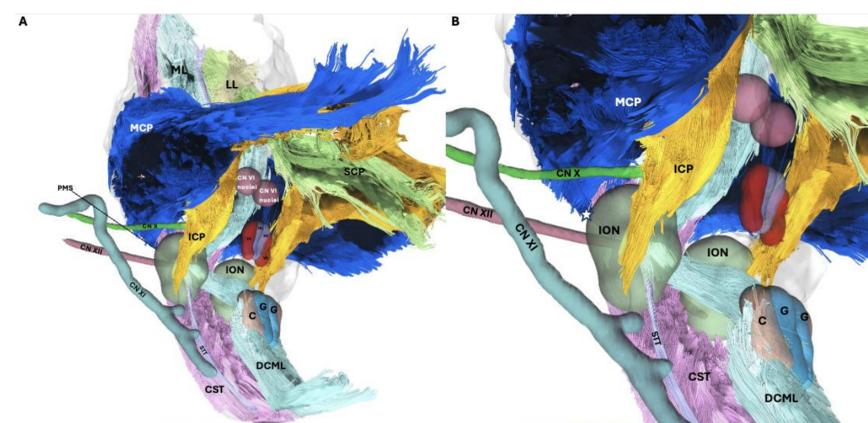


**Figure 5:** Fiber tractographies of the brainstem with segmentations of critical structures related to VAT, SHT, and IHT (A-B). The white star on B indicates the location of PMS.
*CST:* Corticospinal Tract, *ICP:* Inferior Cerebellar Peduncle, *MCP:* Middle Cerebellar Peduncle, *SCP:* Superior Cerebellar Peduncle, *STT:* Spinothalamic Tract
*DCML:* Dorsal Column Medial Lemniscus, *ML:* Medial Lemniscus, *LL:* Lateral Lemniscus, *PMS:* Pontomedullary Sulcus, *ION:* Inferior Olivary Nucleus, *G:* Nucleus Gracilis, *C:* Nucleus Cuneatus

## Conclusions

SHT provides a consistent, expandable microsurgical route to the PMS and the central pontine region. Quantitative evaluation of the vagoaccessory SHT supports its value in surgical planning for paramedian pontine lesions, particularly supraolivary CMs. Integration of microsurgical dissection with advanced MR tractography and 3D modeling provides a detailed understanding of these anatomical corridors, thereby potentially refining surgical strategies and enhancing both precision and patient outcomes.

## Contact

Kivanc Yangi, M.D.
Dept. of Neurosurgery, Barrow Neurological Institute
St. Joseph's Hospital and Medical Center
2910 N 3rd Ave, 85013, Phoenix, Arizona, USA
kivancyangi@gmail.com
602-767-9802

## References

1. Benner D, Hendricks BK, Benet A, et al. A system of anatomical triangles defining dissection routes to brainstem cavernous malformations: definitions and application to a cohort of 183 patients. *J Neurosurg*. 2022;138(3):768-784. Published 2022 Aug 26. doi:10.3171/2022.6.JNS212907
2. Catapano JS, Rumalla K, Srinivasan VM, Lawrence PM, Larson Keil K, Lawton MT. A taxonomy for brainstem cavernous malformations: subtypes of pontine lesions. Part 2: inferior peduncular, rhomboid, and supraolivary. *J Neurosurg*. 2022;137(5):1477-1490. Published 2022 Mar 25. doi:10.3171/2022.1.JNS212691