The Surgical Outcomes and Nuances of the Telovelar Approach for Pontine and Medullary Cavernous Malformations: A Multi-Institutional Case Series

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Background

Brainstem cavernous malformations (CMs) are characterized by dilated sinusoidal channels related to capillary telangiectasia and developmental venous anomalies. Brainstem CM hemorrhages present with focal neurological symptoms, according to their invasive lesions. Surgical removal should be considered for symptomatic and recurrent bleeding of brainstem CMs. Despite the risk of surgery with highly eloquent tissue, surgical removal should be performed to protect patients from stepwise decline due to recurrent hemorrhage. Pontine and medullary CMs are approached via retrosigmoid, far lateral, and suboccipital craniotomies, with or without the telovelar approach.

Methods and Materials

Between January 2019 and December 2022, patients with brainstem CMs treated using the telovelar approach were enrolled from three institutions. Despite the variations in technical details, three neurosurgeons followed the same key steps.

Telovelar approach step by step and technical nuances

A standard midline suboccipital craniotomy was performed with unroofing of the foramen magnum in the prone position. Exposure of the transverse sinus was not necessary. If the lesion extended upward into the cerebral aqueduct and lateral recess, C1 laminectomy may be beneficial for visualization through an extended inferior-to-superior operative trajectory. The dura mater was incised in a curvilinear or Y-shaped manner and retracted superiorly. After the arachnoid membrane was incised at the midline, the inferior cerebellar surface, cerebellar tonsils, and the pyramid of the vermis were exposed (Fig. 1). The medullotonsillar space of the cerebellomedullary fissure and the uvulotonsillar space were sharply dissected to release the tonsils from the uvula and medulla oblongata, bilaterally. The medial surface of the two tonsils was then retracted supralaterally, and the uvula was retracted superomedially
to expose the floor of the fissure, that is, the inferior medullary velum and tela choroidea. The tela choroidea, which forms the caudal part of the lower half of the roof of the fourth ventricle, was coagulated and incised superolaterally from the foramen of Magendie, and the inferior medullary velum was further divided to access the fourth ventricular floor and lateral recesses. Subsequently, the uvula was free to retract to expose the fourth ventricle, and dynamic retraction was used to expand and secure the uvulotonsillar space. After floor exposure, surgical landmarks, including the obex, median sulcus, striae medullaris, vagal triangle, hypoglossal triangle, median eminence, and facial colliculus, were carefully identified (Fig. 2). In this case series, the infrafacial collicular safety zone was used as the entry point. Usually, the brainstem decompresses rapidly after hematoma evacuation, and the CM can beexposed and removed using conventional microsurgical techniques. Minimal coagulation around the normal brainstem tissue is required. To visualize the rostral portion of the lesion, the microscope was rotated to an orthogonal or inverted angle (Fig. 3). After the removal of the CM, routine watertight dural closure was performed.

Table 1. Summary of patient demographics and clinical outcomes

Variable	Case No.		
	1	2	3
Age (yr)	49	68	51
Sex	Male	Male	Female
Location	Pons	Pons	Medulla
Size (cm)	2.9	2.0	2.1
Hemorrhagic event	3	2	1
Previous intervention	Radiosurgery	None	None
Neurologic symptoms	Dizziness, paresthesia, diplopia, hemiparesis	Dizziness, paresthesia	Dizziness
Cranial nerve paresis	6, 7, 8, and lower cranial nerves	None	12
Extent of resection	Total	Total	Total
New deficit after surgery	None	None	None
Follow-up period (mo)	12	52	16
Initial mRS	5	4	3
mRS at follow-up	4	1	2

Results

Three patients with brainstem CM underwent successful resection using the telovelar approach without noticeable complications. The surgeries were performed by three different neurosurgeons in the respective institutions.One neurosurgeon performed each operation on one patient. Patient demographics and surgical outcomes are summarized in Table 1.

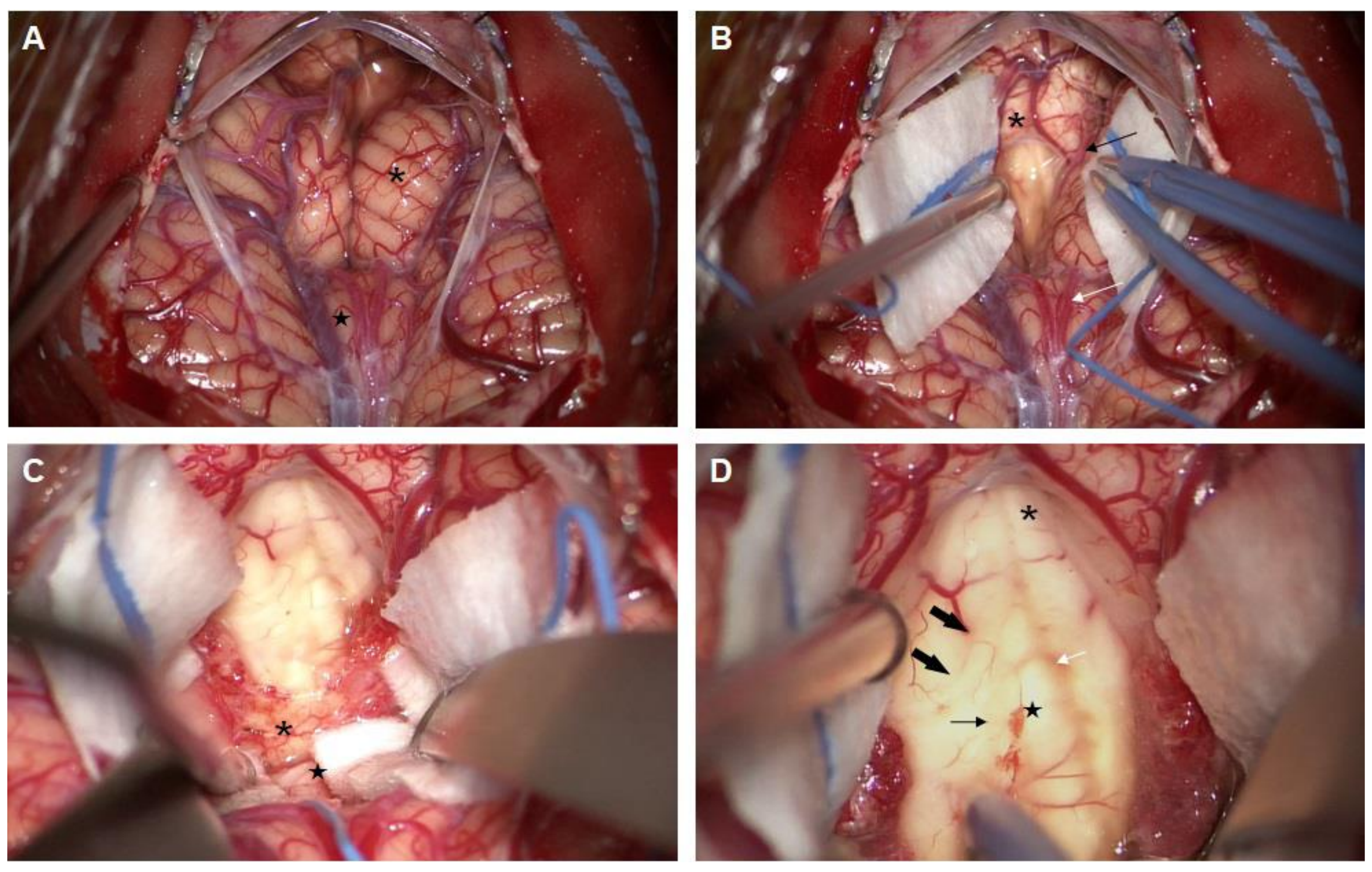

Figure 1. Stepwise illustration of the exposure of the fourth ventricle floor. (A) After the arachnoid membrane is incised at midline, the cerebellar tonsils (asterisk) and the pyramid of vermis (star) are exposed. (B) The cerebellar tonsils are retracted, and the fourth ventricle floor and the obex and area postrema (asterisk) are exposed. The tonsilomedullary segment of the posterior inferior cerebellar artery (PICA, black arrow) can be traced along the posterolateral medulla and inferior cerebellar peduncle, which ascends between the tonsils and medulla to reach the interval between the tonsils and uvula. The PICA and its cortical branches (white arrow) should be preserved. (C) After arachnoid dissection between the tonsils and uvula (star) with the retraction of the tonsils, the tela choroidea (asterisk) and choroid plexus are exposed. (D) The tela choroidea and part of the inferior velum are incised to widely expose the fourth ventricle. The median sulcus (white arrow) is deviated towards the contralateral side of the pontine hematoma. The landmarks include the hypoglossal triangle (asterisk), stria medullaris (black thick arrows), facial colliculus (star), and sulcus limitans (black arrow).

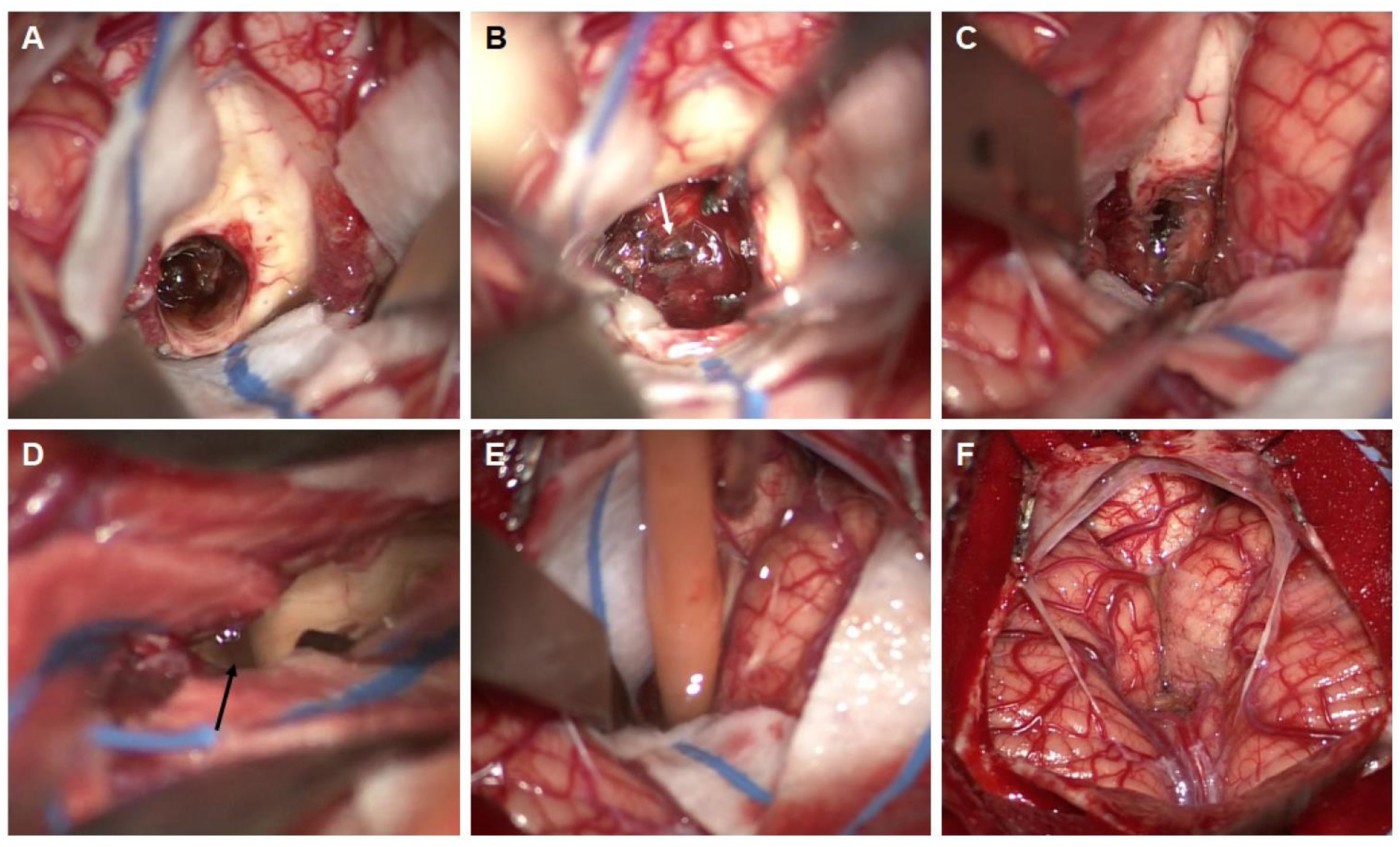

Figure 2. Operative findings and surgical nuances. (A) An initial incision is made and widened in the infrafacial collicular zone, which is inferior to the facial colliculus, lateral to the median eminence and sulcus limitans, and superior to the stria medullaris. (B) After the removal of hematoma, a typical appearance of cavernous malformation (CM) is noted (white arrow). (C) CM is completely removed using a unilateral telovelar approach. (D) The cerebral aqueduct (black arrow) can be identified by adjusting the microscope viewing angle. (E) Continuous warm saline irrigation using a Nelaton catheter situated in the operative field is advantageous to clear hematoma and surgical debris. (F) The tonsils and vermis are intact without any retraction injuries.

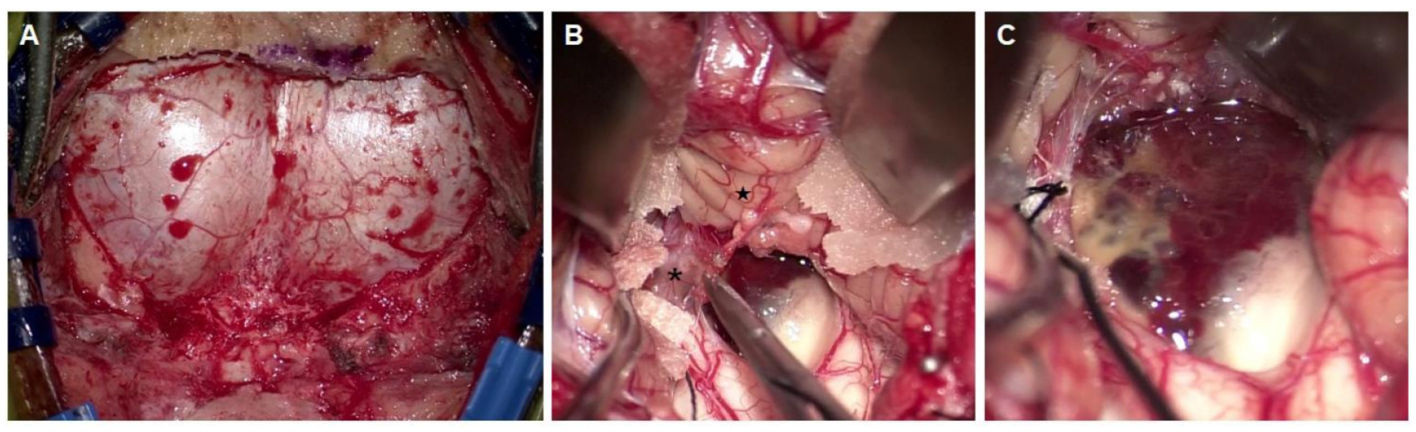

Figure 3. Medullary cavernous malformation (CM) resected via the telovelar approach. (A) A conventional suboccipital craniotomy without C1 laminectomy is performed. Note that the surgeon looks at the surgical field through a microscope from the back of the patient in the prone position. (B) The uvula (start) and tela choroidea (asterisk) are widely exposed because of the retraction of the tonsils on oth sides. The tela choroidea is coagulated and divided superolaterally between the tonsils and uvula. (C) A typical CM with an old hematoma protruding towards the fourth ventricular floor is well visualized.

Conclusions

In conclusion, the telovelar approach is safe and effective for the treatment of posterior pons and medullary CMs. Further studies are warranted to validate this surgical approach for pons and medullary CMs.

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