

# Resection of pontine cavernous malformation by the full neuroendoscopic telovelar approach

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## Case report

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# Abstract

**Introduction:** Lesions located in the fourth ventricle and/or pontine tegmentum were treated by telovelar approach under a microscope. However, it is difficult to access upper fourth ventricle from caudal to rostral without removal posterior arch of the atlas due to the vertical working angle of microscope. Neuroendoscope has a good degree of freedom in surgery and can reach this area easily. We tried to remove pontine cavernous malformation by full neuroendoscopic telovelar approach and the results was excellent.

**Clinical Presentation:** Two women presented with dizziness and numbness and were diagnosed as pontine cavernous malformation. The cavernous malformations were removed by a full neuroendoscopic telovelar approach without removal of the posterior arch of the atlas.

**Conclusion:** Neuroendoscope can remedy the flaws of microscopy and can provide greater application for the telovelar approach in pons and fourth ventricle.

## 1. Introduction

Lesions located deep in the fourth ventricle and/or pontine tegmentum are challenging to neurosurgeons due to the limited working space and the complexity of the surrounding structures which including the medulla, lower cranial nerve nuclei, cerebellar peduncles and posterior inferior cerebellar artery(PICA). Traditional approaches to this area involve splitting the inferior vermis to gain better direct access, which is also known as the transvermian approach. However, this procedure can lead to postoperative disturbances of equilibrium and cerebellar mutism<sup>[1]</sup>. Operating through cerebellomedullary fissure by telovelar approach has also been used to reach this area without injury inferior vermis which has been demonstrated to be a reliable approach<sup>[2-4]</sup>. During the last 3 decades, all telovelar approach have been performed under microscope, and it was gradually found difficult to access the upper fourth ventricle and pontine tegmentum<sup>[1, 5]</sup>.

To date, no case of upper fourth ventricle and pontine tegmentum lesions resected by full neuroendoscopic telovelar approach was reported. We used neuroendoscope to remove pontine cavernous malformation via telovelar approach, and the patients recovered excellent.

## 2. Clinical Presentation

Case 1: A 62-yr-old woman presented with dizziness and vomiting for 12 days and was transferred to our hospital. Neurological examination showed difficulty walking, but other exams were normal for cranial nerves, motor/sensory function, coordination, and reflexes. CT imaging showed a small hematoma in the right fourth ventricle, middle cerebellar peduncle and pontine tegmentum. Magnetic resonance imaging performed with T1-weighted, T2-weighted and SWAN sequences suggested a cavernous malformation. The preoperative diagnosis was a cavernous malformation in the right middle cerebellar peduncle and pontine tegmentum. After discussion with her family, suboccipital craniotomy was planned.

Case 2: A 54-yr-old woman presented with numbness in right side for one year. One year ago, she felt numbness in he right limb and CT scan shown a small hemorrhage in the brain stem. After conservative treatment, she was improved and discharged from hospital. But two weeks ago, she felt numbness in right side and came to hospital again, and CT scan shown a rebleeding in her brain stem. Then she was admission to our department and MRI suggested a cavernous malformation in her left pontine tegmentum. After consent of the patient and her family, suboccipital craniotomy with telovelar approach by the neuroendoscopy was prepared.

### **Surgical Technique**

Surgical procedures were performed with the patient in the lateral prone position, the head fixed in a head-holder with slight flexion. A midline suboccipital craniotomy was performed to expose the craniovertebral junction, and the posterior arch of the atlas was preserved. Under neuroendoscopic view, a Y-shaped dural opening was made, and the inferior edge of the tonsils, uvula, PICA and obex was exposed (Figure 1,2). The tonsil and uvula were elevated and retracted by a thin transparent endoport, and then the tela choroidea, inferior medullary velum and floor of the fourth ventricle were visualized and protected. Looking forward to the upper ventricle, the hematoma was identified and removed under the neuroendoscope. With further access to the cerebellar peduncle and pontine tegmentum area, the residual hematoma in the cerebellar peduncle was cleared away, and a small cavernous malformation in the pontine tegmentum was identified and removed (Figure 1,2).

### **Postoperative Course**

The symptoms of dizziness and vomiting disappeared immediately after the surgery in the first patient and the numbness was decreased in the second patient. Both of patients' hospital course and recovery were uneventful. They recovered well and showed no new signs of brainstem or cerebellar dysfunction, and were discharged home 2 weeks postoperatively.

All procedures in human participants were performed in accordance with the ethical standards of the institutional and/or national research committee and the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. Written informed consent for publication was obtained from the patient's family members.

## **3. Discussion**

Surgical access to lesions in the fourth ventricle may be achieved utilizing transvermian or transtelovelar trajectories. Traditional transvermian approaches require splitting of the inferior vermis to gain better direct access from the posterior direction to the fourth ventricle. This approach inflicts the midline cerebellar structures and has been implicated in postoperative "cerebellar mutism syndromes"<sup>[3]</sup>.

Matsushima et al. first described the microsurgical anatomy of the cerebellomedullary fissure and found that it was actually a virtual space existing between the cerebellum and the medulla oblongata that was a

natural corridor to the fourth ventricle<sup>[6]</sup>. By elevating the cerebellar tonsils and opening the cerebellomedullary fissure, the tela choroidea and the inferior medullary velum could offer wide access to the fourth ventricle cavity without the need for splitting the vermis<sup>[7]</sup>. This technique was applied by other surgeons and has been developed and described as the “telovelar approach”<sup>[1, 7, 8]</sup>.

Since then, numerous reports of resection of various fourth ventricle tumors, arteriovenous malformations and aneurysms via this approach have been extensively described<sup>[1, 3, 8, 9]</sup>, and it appears that this approach has the potential to become the standard treatment for most lesions of the fourth ventricle with satisfactory results<sup>[1]</sup>. However, in terms of the vertical working angle of the microscope, it was easy to look from the roof to the floor of the fourth ventricle but was very difficult to assess from caudal to rostral via the telovelar approach. Therefore, this approach was limited in achieving access to the rostral third of the fourth ventricle and middle cerebellar peduncle. Under microscope, a possible maneuver to achieve more favorable working angle to the upper ventricle is to cut the posterior arch of the atlas. Deshmukh et al. found that additional removal of the C1 arch offered a larger working area that contributed to reaching the rostral half of the fourth ventricle<sup>[10]</sup>. Neuroendoscope can overcome the limitations of microscope by taking advantage of the freedom achieved during surgery, as the neuroendoscope can be operated easily from caudal to rostral in the fourth ventricle. Several authors have reported using angled endoscopy assistance for facilitating additional inspection around the anatomic corners and of tumor resection in the fourth ventricle<sup>[11]</sup>, but none full neuroendoscopic telovelar approach was attempted. Our successful cases demonstrated that access to the upper fourth ventricle via the full neuroendoscopic telovelar approach without removal of the posterior arch of the atlas was feasibility.

## 4. Conclusions

The telovelar approach has gained popularity as a safe and effective strategy for lesions in fourth ventricular and pons. However, it is difficult to access the upper fourth ventricle under microscope without removal of the posterior arch of the atlas. Neuroendoscopy can remedy this flaw of microscopy and can provide greater application in the fourth ventricle and pons.

## Declarations

**Ethics approval and consent to participate** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Consent for publication** Informed consent was obtained from all individual participants included in the study.

**Competing interests**—The authors claim that none of the material in the paper has been published or is under consideration for publication elsewhere, and no potential conflicts of interest were disclosed.

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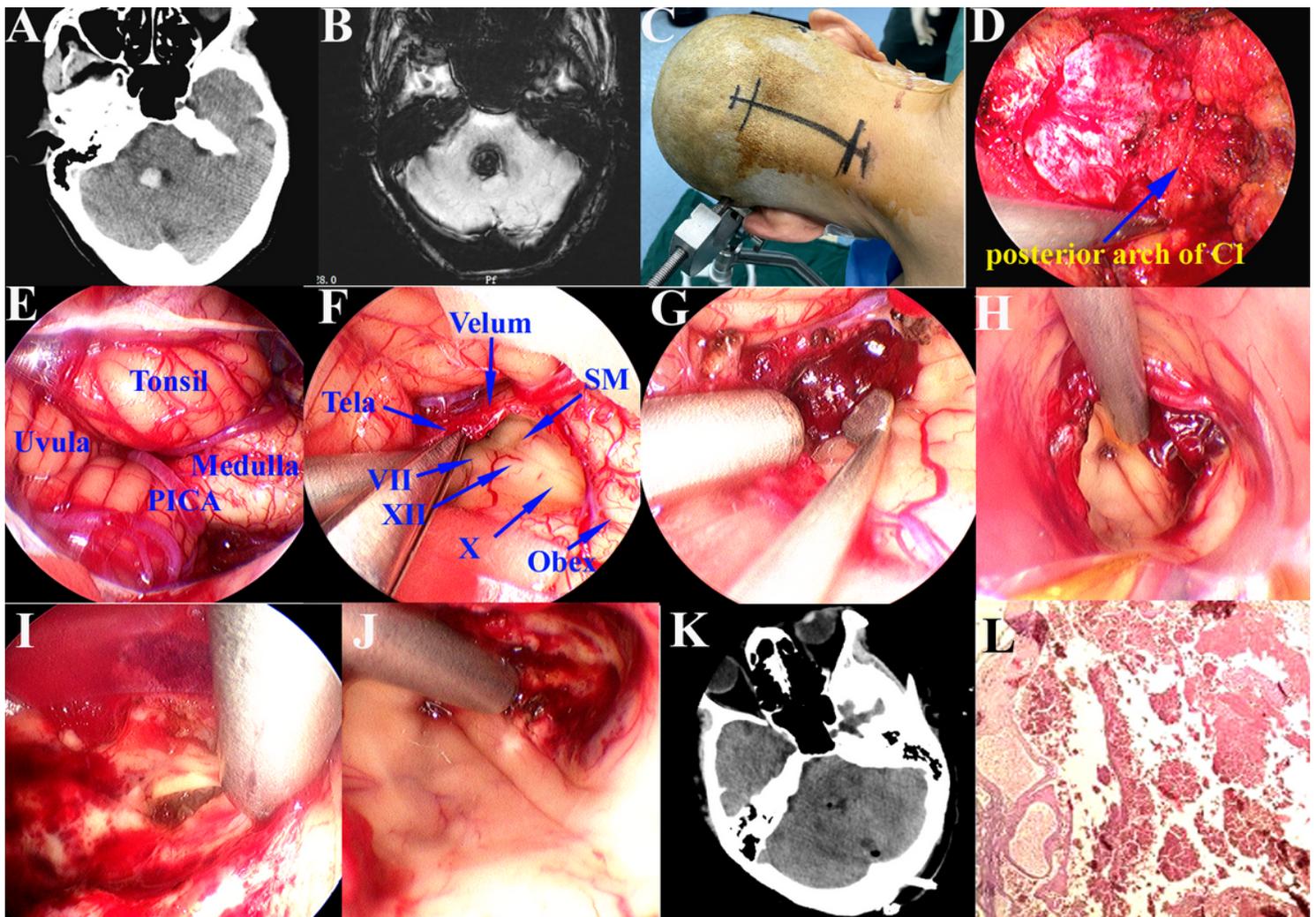
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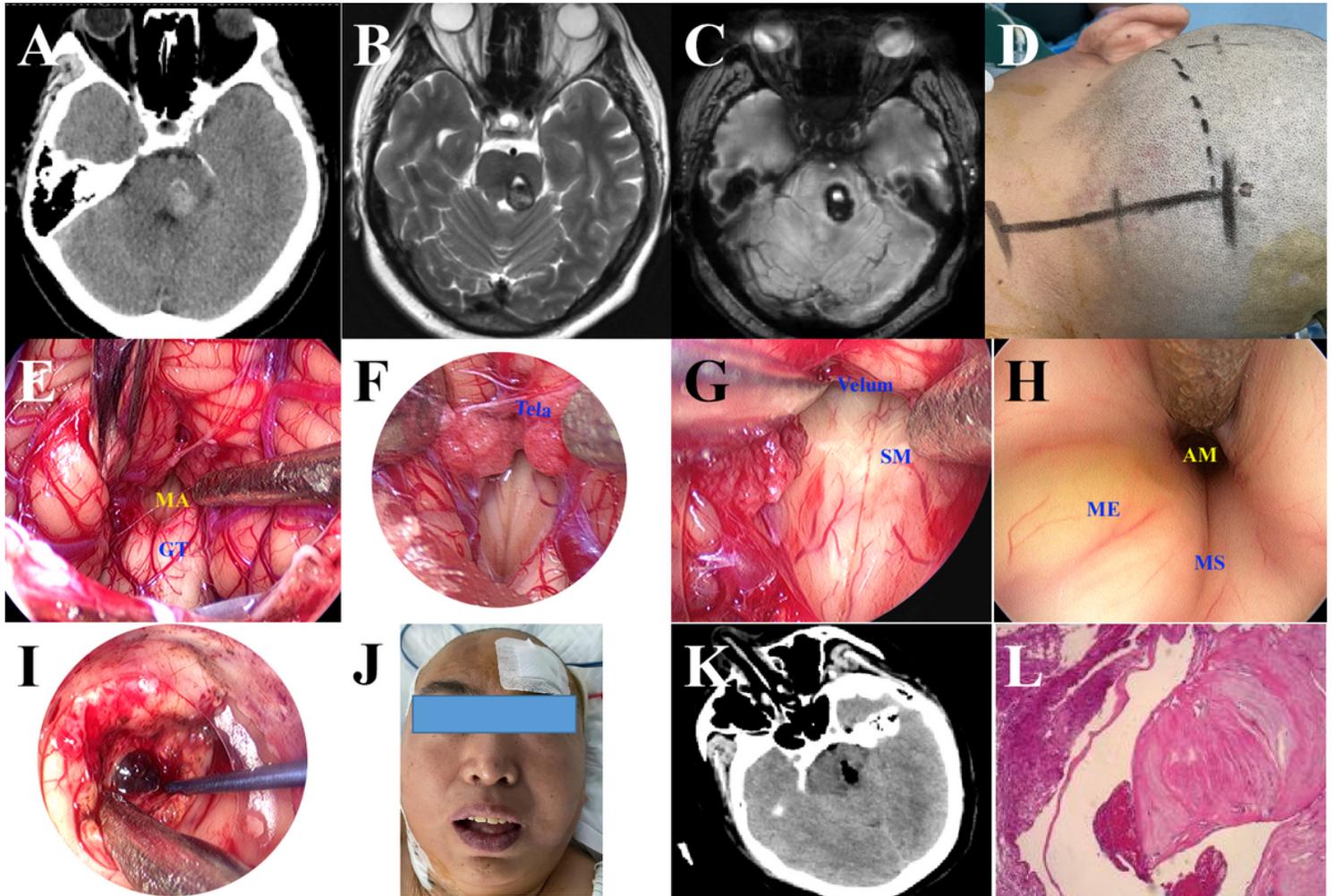
## Figures



**Figure 1**

Resection a middle cerebellar peduncle and pontine tegmentum cavernous malformation by full neuroendoscopic telovelar approach. A: CT imaging shown a small hematoma in the right fourth ventricle, middle cerebellar peduncle and pontine tegmentum. B: MRI SWAN sequence suggested a cavernous malformation; C: Patient in the lateral prone position with the head fixed in a head-holder and

slightly flexed; D: A midline suboccipital craniotomy was performed, and the posterior arch of C1 was preserved; E: Under neuroendoscopic view, the inferior edge of the tonsils, uvula, PICA and obex was exposed. F: The tela choroidea, inferior medullary velum and floor of the fourth ventricle were visualized and protected. G: The hematoma in the fourth ventricle was exposed and removed. H: The hematoma in the middle cerebellar peduncle was exposed and removed. I: A small cavernous malformation in the pontine tegmentum was identified and removed. J: The cavity was checked after the operation. K: Postoperative CT scan shown the hematoma was removed completely. L: Histopathological examination revealed a cavernous malformation.



**Figure 2**

Resection a pontine tegmentum cavernous malformation by full neuroendoscopic telovelar approach. A: CT imaging shown a small hematoma in the left pontine tegmentum. B: T2-MRI shown irregular and heterogeneous signals in pontine tegmentum; C: MRI SWAN sequence suggested a cavernous malformation; D: Head fixed in a head-holder and slightly flexed; E: The median aperture of the fourth ventricle was exposed. F: The tela choroidea, inferior medullary velum were visualized and protected. G: The floor of the fourth ventricle was exposed. H: The upper fourth ventricle floor was exposed, and the median eminence yellowing. I: A small cavernous malformation in the pontine tegmentum was identified and removed. J: The patient recovered well after the operation. K: Postoperative CT scan shown the

hematoma was removed completely. L: Histopathological examination revealed a cavernous malformation. Abbreviations: SM: stria medullaris; VII: facial colliculus; XII: hypoglossal triangle; X: vagal triangle; GT: Gracile tubercle; MA: Median aperture; MS: Median sulcus; ME: Median eminence; AM: Aqueduct of midbrain