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Case Report

Anterior transpetrosal resection of the lower ventral pontine cavernous malformation: A technical case report with operative video

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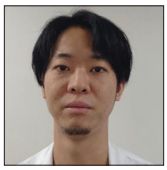

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Received : 03 February 2021
Accepted : 29 April 2021
Published : 07 June 2021

DOI
10.25259/SNI_102_2021

Video available on:
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ABSTRACT

Background: Surgical treatment of pontine cavernous malformations (CMs) is challenging due to the anatomical difficulties and potential risks involved. We successfully applied an anterior transpetrosal approach (ATPA) to remove a lower ventral pontine CM, and herein we discuss the outline of our procedure accompanied by a surgical video.

Case Description: A 50-year-old woman presenting with progressively worsening diplopia was urgently admitted to our hospital. Preoperative images showed a lower ventral pontine CM compressing the corticospinal tract posteriorly. Considering the location of the CM, we determined that an ATPA was the appropriate approach to achieve a more anterolateral trajectory. We performed extradural anteromedial petrosectomy and penetrated the brainstem from the point just below the anterior inferior cerebellar artery and above the root exit zone of the abducens nerve, which might be located in the somewhat lowest border of actual maneuverability in the ATPA. Maneuverability through this corridor was sufficient without hindering and darkening the high magnification microscopic view, as demonstrated in our surgical video.

Conclusion: This report demonstrates surgical treatment of a lower ventral pontine CM using the ATPA. The surgical video we present provides information that is useful for understanding this technique's maneuverability and working window.

Keywords: Anterior transpetrosal approach, Cavernous malformation, Peritrigeminal zone

INTRODUCTION

Although surgical treatment of brainstem cavernous malformations (CMs) is challenging due to its anatomical difficulties and potential risks, it is a crucial course of action when bleeding recurs or when symptoms are progressively deteriorating.[10] Various approaches depending on the location of the hemangioma have been proposed thus far,[3,5,7,11-17,21,25-27] and recent studies have reported the usefulness of the anterior transpetrosal approach (ATPA) for CMs located in the ventral pons; however, the data are limited and further research is needed.[19,24,29] The reported craniotomy range and excavation range of the petrous bone also vary, and it is difficult to visualize the actual surgical field and maneuverability involved using illustrations or the digital capture of video images from the previous reports.

Herein, we share our experience with the application of an ATPA to surgically remove a lower ventral pontine CM from the peritrigeminal zone (PTZ) in a case patient along with a surgical video.

CLINICAL PRESENTATION

Preoperative course

A 50-year-old woman presenting with sudden-onset diplopia associated with headache and vomiting was urgently admitted to our hospital. On admission, neurological examinations revealed esotropia in the right eye (5° angle at the front) and abducens nerve disorder (approximately Grade 4 on a five-grade evaluation of right gaze). These symptoms had been worsening progressively for several days before the admission. Magnetic resonance imaging revealed a heterogenous hyperintense mass (maximum diameter of 16 mm) with a hypointense rim located at the lower half of the ventral pons [Figure 1a]. Cerebral angiography did not reveal any vascular anomaly.

We diagnosed the patient with pontine CM. We initially selected conservative treatment, but the patient's symptoms were not mitigated and she eventually opted for surgical treatment. Therefore, we decided to remove the CM. Because of the ventral location of the patient's CM, as preoperative tractography showed posterior displacement of the corticospinal tract (CST) [Figure 1b], we selected the ATPA to realize a more anterolateral trajectory.

Surgical procedure

The patient underwent surgical removal with motor-evoked potential, auditory brainstem response, and facial nerve monitoring throughout the operation. A lumbar drain was preoperatively inserted to minimize brain retraction during surgery.

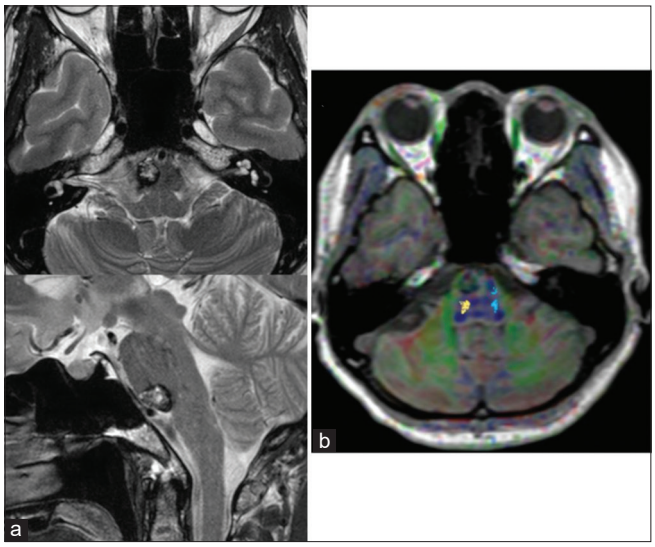

Figure 1: (a) Preoperative T2-weighted image (b) preoperative tractography.

With the patient in a 10° semi-Fowler position, the head was rotated until parallel with the floor and fixed in a Mayfield skull clamp. A question mark scalp incision started at the midpoint of the zygomatic arch (anterior to the tragus), extended by one fingerbreadth posteriorly, and then turned anteriorly to the superior frontal area [Figure 2a]. The muscle-skin flap was reflected anteriorly. The latter half of the zygomatic arch was exposed, and the supramastoid crest (along the middle base of the temporal fossa), on the extension of the zygomatic arch, was confirmed. Right temporal craniotomy was performed and the middle base was flattened using a 5-mm diamond drill [Figure 2b]. The dura mater was rapidly detached from the calvarium up to the foramen spinosum and the groove of the greater superficial petrosal nerve (GSPN) was exposed, with the middle meningeal artery subsequently cauterized and cut. The dura mater was elevated interdurally, leaving the GSPN on the middle base, up to the point where the GSPN submerges inside the foramen ovale, and the tip of the petrosal bone and the latter half of the trigeminal impression were exposed [Figure 2c]. Extradural anteromedial petrosectomy was carried out in the range up to the GSPN on the lateral border, internal carotid artery (ICA) on the deep anterior border, geniculate ganglion, basal turn of the cochlea, as well as the arcuate eminence (anterior semicircular canal) on the posterior border and mandibular division of the trigeminal nerve on the medial border. Opening the anterior superior wall of the internal auditory canal (IAC) and removing the tip of the petrous bone up to the height of the inferior petrosal sinus (IPS) further broadened the extent of the petrosectomy inferior-posteriorly to expose the posterior fossa dura as wide as possible [Figure 2d]. The dura mater of the middle fossa floor and posterior fossa was incised perpendicular to the superior petrosal sinus (SPS). The SPS was cauterized and divided at the point anterior to the petrous vein, and the cerebellar tentorium was cut toward the free edge of the tentorium. The root entry zone (REZ) of the trigeminal nerve, swollen pons, basilar artery (BA), anterior inferior cerebellar artery (AICA), and abducens nerve arising from the bulbopontine groove were confirmed [Figure 2e]. The brainstem was incised at the point of the PTZ with yellow discoloration between the AICA loop and abducens nerve, and the CM was drawn toward the center and completely removed [Figure 2f]. Dural closure was performed using the femoral fascia, and the bone defect was packed with abdominal fat plus fibrin glue You can see the actual surgical video on electronic supplementary material [Video 1].

Postoperative course

The lesion was completely removed postoperatively [Figure 3a] and the symptoms mitigated rapidly. The patient

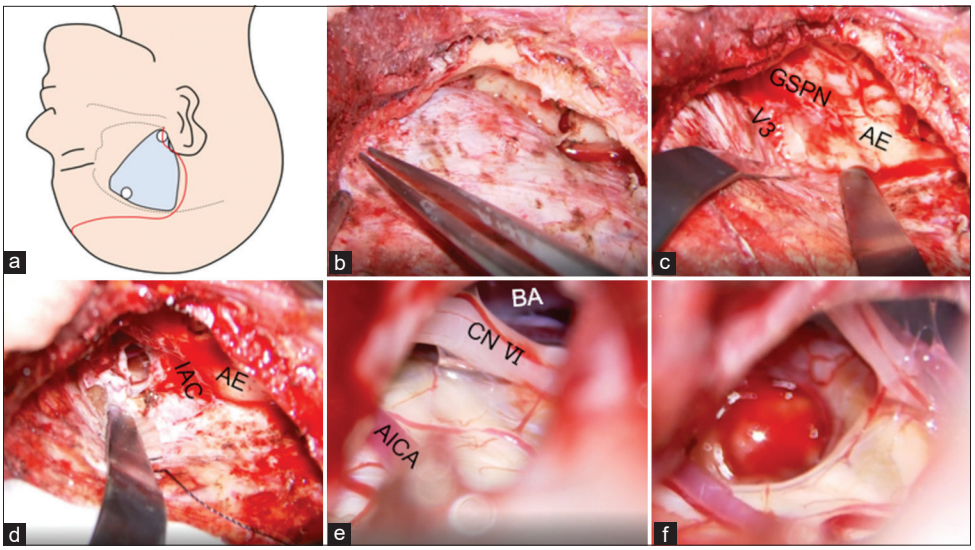

Figure 2: (a) Schema demonstrating the scalp incision and craniotomy range. (b) The middle base was flattened. (c) The dura mater was elevated up to the point where the GSPN submerges inside the V3. (d) Extradural anterior–medial petrosectomy was carried out in the range up to the GSPN on the lateral border, ICA on the deep anterior border, geniculate ganglion, basal turn of the cochlea and AE on the posterior border, and V3 on the medial border. The extent further expanded inferior-posteriorly by opening the anterior superior wall of the IAC and removing the tip of the petrous bone up to the height of the IPS. (e) The REZs of the trigeminal nerve, swollen pons, BA, AICA, and CN VI were confirmed. (f) The brainstem was incised at the point of the Peritrigeminal zone with yellow discoloration between the AICA loop and CN VI, and the hemangioma was completely removed. GSPN: Greater superficial petrosal nerve, V3: Mandibular division of the trigeminal nerve, AE: Arcuate eminence, IAC: Internal auditory canal, BA: Basilar artery, AICA: Anterior inferior cerebellar artery, CN VI: Abducens.

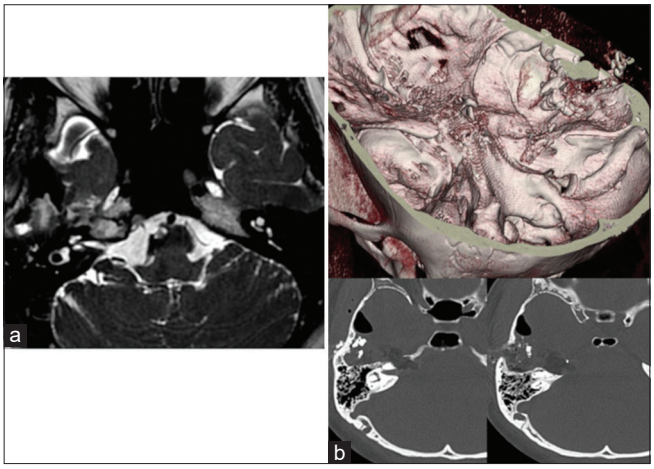

Figure 3: (a) Postoperative T2-weighted image showing that the hemangioma was completely removed (b) postoperative bone window computed tomography showing the extent of petrosectomy.

was discharged with a Modified Rankin Scale score of 1, and the abducens palsy disappeared 2 months later.

DISCUSSION

Selecting an access route that preserves essential neural tissue is crucial in the surgical treatment of brainstem CMs, and it is often determined based on the two-point method proposed by Brown [6] In our case patient, the lesion was ventrally located at the lower half of the pons and the CST was displaced posteriorly; therefore, we accessed the legion from the PTZ through an ATPA.

Although pontine CMs are common, constituting 57–77.8% of brainstem CMs, their anatomical features (large amount of cranial nerve nuclei in addition to sensory and motor pathways) make surgical treatment extremely difficult.[2,9,22]

Lateral access through lateral suboccipital craniotomy can obtain substantial working space along with the longitudinal axis of the brainstem, but the working angle of the horizontal axis is extremely narrow and obstructed by cranial nerves, especially the seventh-to-eighth cranial nerve complex, resulting in higher postoperative risk of auditory impairment and facial palsy.[20,21] A recent report proposed the far lateral transpontomedullary sulcus approach to the lower pontine lesion, and this approach may have been useful for our case.[1]

Among anterior approaches, the transclival route offers the most linear path to the anterior surface of the brainstem, and some successful cases using transnasal endoscopy have been reported.[8,18] However, this approach is not suitable for more anterolateral located pontine CMs due to its narrow working window toward the lateral side and the relatively high postoperative risk of cerebrospinal fluid leakage.[23]

Other methods, such as the transsylvian transtentorial approach[14] and subtemporal approach,[4] have also been reported, but these are inconvenient for securing visibility to the lower pons.

These data suggest that the ATPA is the ideal approach if the lesion is located more ventral and spreads to the relatively caudal side of pons.

Reports on the observable range of the ATPA vary as well. One report indicated that the range is limited to the upper pons around the trigeminal nerve cranial to the AICA even if the upper edge of the zygoma was drilled off prior to applying the ATPA.[19,28] In contrast, other reports showed that it is possible to expose the anterolateral pons caudal to the axial plane in parallel with the SPS and cranial to the facial nerve at the bulbopontine groove when the petrous apex is removed up to the interior of the Gasserian ganglion along the GSPN and trigeminal notch, without exposing the IAC, geniculate ganglion, and ICA.[9,24]

Although safe entry zones of the pons have been widely reported on,[3,5,7,11-13,15-17,26,27] in most cases of ventral pontine CMs, the lesion is often located close to the anterolateral surface of the pons and the CST and lateral lemniscus are displaced posterior-medially. Therefore, the PTZ between the trigeminal nerve and the facial-vestibulocochlear nerve complex is a classic safe entry zone.[9]

In our case, we penetrated the lesion at the point of the PTZ just below the AICA and above the REZ of the abducens nerve, which might be located at the somewhat lowest border of actual maneuverability in an ATPA. By exposing the posterior fossa dura as wide as possible, exposing the anterior dura of the IAC, and exposing the petrous bone to as low as the IPS [Figure 3b], we could appropriately observe the anterolateral pons widely in the range of the REZ of the trigeminal nerve on the cranial side, bulbopontine groove on the caudal side, middle cerebellar peduncle on the posterior side, and the BA trunk on the anterior side; moreover, we could manipulate the necessary instruments, such as dissecting forceps and bipolar forceps, safely without hindering and darkening the high magnification microscopic view, as demonstrated in our surgical video. These outcomes indicate that the ATPA is a highly versatile approach for pontine CMs as the extent of the petrosectomy can be expanded to the cranial side by tentorial incision and medial transposition of the trigeminal nerve.

CONCLUSION

Our surgical [Video 1] presents useful information about the ATPA's sufficient maneuverability and working window for comprehensive observation and removal of the lower ventral pontine CM.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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How to cite this article: Tsunoda S, Inoue T, Segawa M, Akabane A. Anterior transpetrosal resection of the lower ventral pontine cavernous malformation: A technical case report with operative video. Surg Neurol Int 2021;12:261.