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Endoscopic endonasal approach to mesencephalic cavernous malformations: a case report

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Abstract

Background: Symptomatic cavernous malformations involving the brainstem are difficult to access by conventional approaches, which often require dramatic brain retraction to gain
adequate operative corridor. Here we present a successful endoscopic endonasal transclival approach for resection of a hemorrhagic, symptomatic mesencephalic cavernous malformation.

**Case Description:** A 20-year-old woman presented with acute onset of headache, nausea and vomiting. Computed tomography scan revealed a ventral midbrain hemorrhage. On day 3 of admission, the patient developed left-sided hemiparesis, restriction of medial and lateral left-eye movements, and loss of left pupillary light reflex. Subsequent magnetic resonance imaging demonstrated an increase of the midbrain lesion to 1.2 cm × 1.7 cm. Diffusion tensor imaging showed compression and lateral displacement of the right corticospinal tract near the thalamus and cerebral peduncle. Given the patient’s clinical presentation and the findings on imaging, we suspected a mesencephalic cavernous malformation.

**Conclusions:** The patient underwent an endoscopic endonasal transclival resection of a ventral midline mesencephalon cavernous malformation. A dark red lesion was directly visualized under the endoscope. After a small corticectomy, the pial and perforator vessels were dissected, and dark-brown blood was drained from the cavernoma cavity. Using a biopsy forceps and with careful attention to the cavernoma borders, the lesion was removed and hemostasis was achieved. Pathologic examination confirmed cavernous malformation. One week after the operation, MRI demonstrated total resection of the lesion. A 3-month follow-up revealed improved neurologic symptoms with minimal surgical morbidity.

**KEY WORDS:** Brainstem, Cavernous malformation, Endoscopic, Endonasal
Introduction

Cerebral cavernous malformations (CMs) are relatively benign vascular malformations with an estimated prevalence of 0.4-0.6%. Brainstem CMs account for 18-35% of all cerebral CMs\(^1\). As CMs are angiographically occult, MRI remains the preferred imaging modality for CM diagnosis\(^2\). The most feared complication is hemorrhage. Reported annual hemorrhage rates range from 1.6 to 3.1% per patient-year, while re-hemorrhage rates vary from 4.5 – 22.9\(^3\)\(^3\). Surgical intervention is considered in all patients who have experienced \(\geq 2\) symptomatic hemorrhages with a CM present at the pial surface\(^4\). However, it is quite challenging to resect CMs located at the ventral aspect of the mesencephalon. Here we present a rare case of applying endoscopic endonasal transclival approach for resection of a hemorrhagic, symptomatic cavernous malformation located in mesencephalon.

Case report

A 20-year-old female presented to the emergency room with acute onset of headache, nausea and vomiting. Computed tomography (CT) of the head demonstrated a hemorrhage in the ventral midbrain. She was admitted to the intensive care unit for further observation. On day 3 of admission, the patient developed gradual left-sided hemiparesis with diminished proximal strength of the left lower extremity (2/5) and left upper extremity (0/5). She was also found to have absent lateral and medial left eye movements, as well as left pupillary dilation to 4 mm and loss of left pupillary light reflex. Subsequent magnetic resonance imaging (MRI) demonstrated an increase in the midbrain lesion to 1.2 cm × 1.7 cm (Figure 1). Given the patient’s clinical presentation and findings on imaging, we suspected a mesencephalic cavernous malformation. Subsequent diffusion tensor imaging showed compression and lateral displacement of the right corticospinal tract near the thalamus and cerebral peduncle (Figure 1D).
**Intervention**

Given the patient’s rapid development of neurologic symptoms with evidence of hemorrhage on CT and MRI, the decision was made to offer surgical resection. MRI and DTI localized the lesion to the right ventromedial mesencephalon, a location that is particularly difficult to access by conventional surgical approaches. Thus, we chose to reach the lesion using an endoscopic endonasal transclival approach (see Video 1, Supplementary Digital Content).

The patient was placed in a supine position in the operating room. Facial features were registered to the frameless stereotactic guidance system (Vector-Vision, BrainLAB, Munich, Germany). A 2-surgeon, 4-handed binarial approach was used to perform the surgery. After nasal irrigation, the endoscope was inserted through the right nostril, and the inferior 1/3 part of the right middle turbinate was resected to provide greater visibility. The opening to the sphenoid sinus was identified, and the right nasoseptal flap was elevated and prepared around the sphenopalatine artery for future closure. The nasal bone at the root of the nasoseptum and the left middle-turbinate were displaced to the left. Then the anterior wall of the sphenoid sinus was opened widely and the mucosa was removed under endoscope. After entering the sphenoid sinus, the stereotactic guidance system was again applied to identify the midline connecting the sellar floor and upper clivus bone. Both bipolar electrocautery and fluid gelatin were applied to achieve hemostasis. A high-speed (7000 rpm) electric endonasal drill equipped with both cutting and diamond bits was used to remove the bone along the midline. This was limited laterally by the petrous portion of the internal carotid arteries. The superior limit reached the sellar floor, and the inferior limit reached the the lower end of the upper clivus.

The dura was opened along the midline. After hemostasis with bipolar electrocautery, the arachnoid membrane was exposed and carefully opened. A dark red lesion was directly visualized on the right midbrain (Figure 2). The lesion was located inferiorly to the bilateral
mammillary bodies, superiorly to the right posterior cerebral artery and its branches, and medially to the bilateral oculomotor nerves. A small corticectomy was performed starting by dissecting the edge of the tumor. Dark-brown blood was then drained from the cavernoma cavity. After separating the boundaries between the cavernoma and normal tissue, the lesion was resected using an endoscopic biopsy forceps. The cavernoma tissue was found to be dark brown with malformed vessels inside. Once the cavernoma was fully resected, hemostasis was achieved.

Autologous fascia lata harvested from patient’s right anterior lateral thigh was placed intradurally to reconstruct the defect. Synthetic dura mater (Neuro-Patch, Aesculap AG & CO.) was applied and covered with the nasoseptal flaps prepared at the beginning of the surgery. Gelfoam and micro-balloon were placed over the closure, and nasal packing was placed. There was no attempted clival bone reconstruction. Lumbar drainage was applied immediately after the operation, and the drainage was removed 6 days after the operation.

Immediately after the surgery, the patient remained afebrile and showed improved oculomotor symptoms. One week postoperatively, MRI demonstrated total resection of the lesion (Figure 3). At the 3-month follow-up, the patient’s limitations in left eye movements had largely improved. Her left pupillary reflex and diameter had returned to normal. Her left arm and leg strength had improved to 4/5 strength.

There was no severe bleeding or nerve palsy intraoperatively. During the postoperative period, the patient showed no nasofacial complications (no delayed bleeding), no continual frontal headache (postoperative sphenoid sinusitis), no fever, no CSF leakage, no CNS infection. The patient’s consciousness improved and there was no sign for intracranial comatose. We did not observe any endocrine complications, including posterior pituitary insufficiency (permanent postop diabetes insipidus) or anterior pituitary insufficiency during postoperative period and 3-month follow-up.
Discussion

The presentation of repeated bleeding, increased cavernoma size and new lesions supports the diagnosis of mesencephalic cavernous malformation. Mesencephalic CMs are challenging, but can be successfully treated by gross total resection. Given the location of delicate nearby neural tissues, progressive hemorrhages tend to present with dramatic neurologic symptoms followed by periods of improvement. Repeated hemorrhage can be life-threatening. For lesions located in the brainstem—and especially the midbrain—the ideal surgical approach should provide good visualization of the entire surgical field, minimal brain retraction, and good working angles to facilitate neural tissue resection. For the lesions in ventral midbrain, there are several potential approaches to be selected, such as the fronto-temporal trans-sylvian route via orbito-zygomatic craniotomy, controlateral supraorbital approach without fronto-orbitotemporozygomatic approach and the traditional pterional/trans-sylvian approach. These techniques follow the “2-point” rule, which connects the center of the lesion to the point where the lesion comes closest to the brain surface. With proper microsurgical and skull base technique, these approaches are ideal trajectories to approach lesion in the midbrain. However, considering the lesion’s location in this case, applying these approaches implies the possibility of extensive exposure and damages to vital structures, and even excessive brain retraction. Furthermore, most of these approaches did not provide a direct working pathway to reach ventromedial mesencephalic lesions. Weighing the pros and cons between open surgery and endoscopic surgery, we believe the endoscopic endonasal transclival approach, which offers several advantages such as better operative trajectory and less brain retraction, is the best option for this case.

Recent advances in endoscopy have made it possible to perform surgical resection of the anterior skull base and brainstem. As the operative field is strictly limited due to the deep location of the lesion, applying endoscopic technique could offer superior visibility to facilitate hemostasis and complete resection. In addition, brain stem incision is minimized to
avoid damaging the surrounding issue. Previously there are reports of cavernous brainstem malformations being treated successfully with endoscopic approach, most of lesions were occurred in the pons. Nikhil et al. reported 4 cases of brainstem CMs resections employing endoscopy to minimize trauma and improve visualization, including CMs in midline ventral pons, posterolateral midbrain, midline ventral medulla and lateral pons. Sanborn et al. also reported a case resection of brainstem cavernoma by pure endoscopic endonasal approach. In addition, this approach was also used for resection of upper clivus chordoma. These reports demonstrate the unparalleled visualization and illumination of endoscopic approaches, without significant limitation on operative mobility.

To the best of our knowledge, this is the first time for resecting ventral midline mesencephalic cavernous malformation with the application of endoscopic endonasal transclival approach. In this case, the operative trajectory was below the pituitary gland. As a result, we were able to design a surgical corridor without pituitary interference by using extradural pituitary transposition to increase the access to the lesions behind the clivus. This approach provides an increasing degree of access to the upper clivus as well as reduced risk of pituitary dysfunction. After partial removal of the sellar face and floor, the elasticity of the dura will allow for limited elevation of the sellar contents, which helps to access the lesion behind the upper clivus. Based on our experience, sometimes the transposition requires visualization with an angled (45-degree) endoscope. After partial removal of upper clivus and dural opening, the surgeons were able to maintain good visibility of the surgical field, allowing for identification of the mammillary body, posterior cerebral artery, superior cerebellar artery and oculomotor nerve (Figure 2). In addition, this allowed critical structures such as mesencephalic perforators and venous structures to be carefully identified in order to avoid damage. The cavernoma was removed after gentle suction and dissection. The patient’s immediate postoperative response showed improved eye movements and body strength. Due to the location of the lesion and the potential complications of the surgery, several methods had been applied to prevent the common complications after surgery. We did not observe any
surgical related postoperative complications and endocrine complications. However, surgeon experience and skill in endoscopic techniques are high priority for performing the approach and key factor for better recovery without more complications.

Conclusion

Here we report a successful endoscopic endonasal transclival resection of mesencephalic cavernous malformations. This approach provides the most direct pathway to reach cavernous malformations of the ventral mesencephalon. This unique endoscopic approach requires delicate and experienced endoscopic skull base skills. This rare case may provide valuable information to surgeons choosing to tackle similar difficult lesions.

Disclosure

SPECTRA™ is a viewing technique introduced by KARL STORZ GmbH & Co. KG. The authors have no personal financial or institutional interest in any of the drugs, materials, or devices described in this article.

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**Figure Legend.**

**Figure 1.** Axial T1-weighted (A), T2-weighted (B) and sagittal (C) magnetic resonance image demonstrating a cavernous malformation of the ventromedial mesencephalon. Diffusion tensor imaging (DTI) showed compression of the right corticospinal tract.

**Figure 2.** Intraoperative view of a 0° endoscope showing anatomical structures of interpeduncular fossa with ventral mesencephalic CM. Normal view (A) and SPECTRA™ view (B). CM: cavernous malformation, MB: mammillary body, CP: cerebral peduncle, PCA: posterior cerebral artery, SCA: superior cerebellar artery, CN.III: oculomotor nerve, P: perforator vessel.

**Figure 3.** 7-day postoperative axial T1-weighted (A), T2-weighted (B) and sagittal (C) magnetic resonance of the brain revealing the resection cavity in the right ventral mesencephalon without residual cavernous malformation.
Supplemental Video.

Video that demonstrates a successful endoscopic endonasal transclival resection of mesencephalic cavernous malformations. 5 minutes 14 seconds, 314 MB.
Due to the limitation of the EES submission system, this video could not be uploaded (video size is too big for the system). Please check the following Dropbox link below and watch this supplementary video.

Thank you!

https://www.dropbox.com/s/eqjff90as09wmm4/CMs%20.mov?dl=0
**Abbreviation list:**

CM: Cerebral cavernous malformations.

CT: Computed tomography.

MRI: Magnetic resonance imaging.

DTI: Diffusion tensor imaging.
Highlights:

- Here we present a successful endoscopic endonasal transclival approach for resection of a hemorrhagic, symptomatic mesencephalic cavernous malformation.

- Symptoms include acute onset of headache, nausea and vomiting. Endoscopic endonasal transclival was applied to resect the lesion.

- A 3-month follow-up revealed improved neurologic symptoms with minimal surgical morbidity.

- This rare case may provide valuable information to surgeons choosing to tackle similar difficult lesions.