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Case Report

Trigeminal neuralgia caused by compression of the trigeminal nerve between the vertebral artery and Meckel's cave meningioma extending to the posterior fossa successfully treated with the endoscopic-assisted anterior petrosal approach

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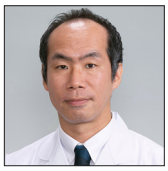

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Received: 06 December 2024
Accepted: 11 March 2025
Published: 04 April 2025

DOI
10.25259/SNI_1053_2024

Quick Response Code:

Video available on:
https://doi.org/10.25259/SNI_1053_2024

ABSTRACT

Background: Microvascular decompression (MVD) using a microscope is commonly performed for trigeminal neuralgia (TN). The advantages of endoscopic surgery for MVD are not clear. We report a case of TN caused by a Meckel's cave meningioma extending to the posterior fossa, which was successfully treated through surgical resection using a combination of a microscope and endoscope.

Case Description: A 63-year-old patient complained of left facial pain. Magnetic resonance imaging showed a 30 × 30 × 25 mm mass lesion in the left petroclival region that had extended into Meckel's cave. Three-dimensional computed tomography angiography demonstrated that the trigeminal nerve passed between the tumor and the tortuous vertebral artery (VA). We selected the anterior transpetrosal approach. The trigeminal nerve was displaced due to compression by the tumor, so the entire course of the trigeminal nerve was difficult to visualize even after tumor removal. Consequently, we switched from the microscope to an endoscope and observed the root entry zone (REZ) of the trigeminal nerve. We confirmed that the VA compressed the REZ of the trigeminal nerve and inserted small Teflon pieces to relieve the compression. TN disappeared, and he was discharged home with no complications.

Conclusion: Surgical resection of tumors near the trigeminal nerve causing TN must carefully examine the trigeminal nerve from the REZ to Meckel's cave to identify any coexistent vascular compression, which may be difficult using only a microscope due to significant displacement of the trigeminal nerve. In such cases, the use of an endoscope is effective to inspect the entire trigeminal nerve directly.

Keywords: Anterior petrosal approach, Endoscope, Meningioma, Trigeminal neuralgia

INTRODUCTION

Trigeminal neuralgia (TN) can result from various causes, but compression and excessive stimulation of the trigeminal nerve by arteries or tumors are widely recognized as common.[6,12,13,15,19] Tumor compression is the cause of TN in 1–13% of all cases and is mostly

the result of trigeminal and vestibular schwannomas and meningiomas located in the cerebellopontine angle.[14] Pain in some cases of tumor-induced TN does not originate from direct compression by the tumor but from displacement of the blood vessels or the trigeminal nerve, leading to vascular compression and pain.[17] In such cases, the release of vascular compression, in addition to tumor removal, must be confirmed.[11,12] However, direct microscopic observation of the whole course of the trigeminal nerve can be difficult due to the significant nerve displacement by the tumor compression. We believe that endoscopic microvascular decompression (MVD)[10,15] has pronounced benefits, especially in cases of dislocation of the trigeminal nerve. We report a case of Meckel's cave meningioma extending to the posterior fossa and tortuous vertebral artery (VA), causing TN to be treated with a combination of microscopic tumor removal and endoscopic vascular decompression.

CASE DESCRIPTION

A 63-year-old patient with a history of hypertension visited a local doctor. The main clinical symptom was paroxysmal sharp pain on the left side of the face in the V2 and V3 distribution continuing for 2 years, which was induced by brushing the teeth, washing the face, and eating. Each attack lasted for about 30 s. This pain was not controlled with carbamazepine 800 mg daily. Neurological examination revealed no cranial nerve deficit other than facial pain. Magnetic resonance (MR) imaging demonstrated a 30 × 30 × 25 mm mass in the left Meckel's cave extending to the posterior fossa, appearing as isointense on T1-weighted and T2-weighted imaging and uniformly enhanced with gadolinium contrast medium [Figures 1a-c]. Considering the dural attachment of the tumor, we inferred that the left trigeminal nerve was displaced caudomedially. Three-dimensional computed tomography angiography showed strong vascular tortuosity of the VA caused by arteriosclerosis, and the bent and tortuous VA contacted the medial tumor [Figure 1d]. Based on these findings, the left trigeminal nerve was considered to be deviated between the tumor and the tortuous VA. Medical control of the pain was unsatisfactory, so surgical resection was planned.

The surgery was performed through the anterior petrosal approach. After temporal craniotomy, the foramen spinosum was identified, and the middle meningeal artery was coagulated and cut. The greater superficial petrosal nerve was identified and preserved. The third division of the trigeminal nerve was identified, and the dura propria was peeled off. The temporal fossa floor was sufficiently elevated in both anterior and posterior directions. Kawase's triangle was identified, and anterior petrosectomy was performed using 4-mm and 2-mm diamond burrs for drilling. The temporal dura was incised, and the temporal lobe was elevated to

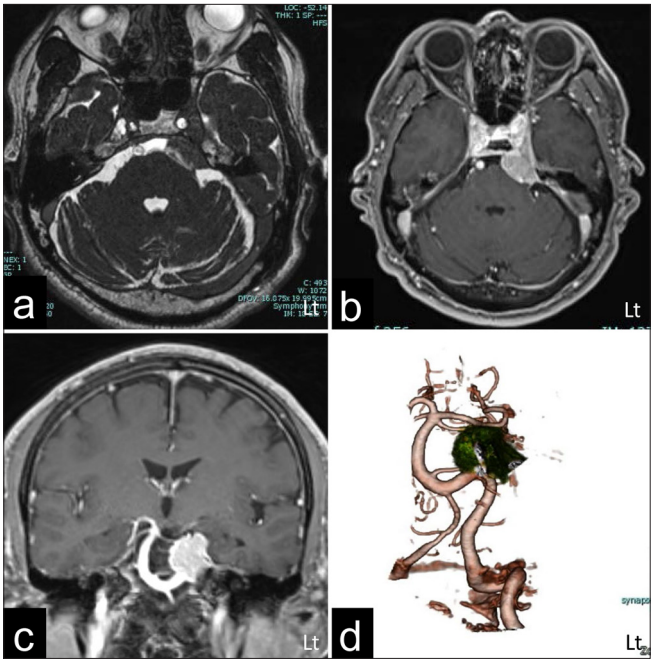

Figure 1: Preoperative magnetic resonance (MR) imaging. (a) Axial MR images using constructive interference in a steady state demonstrated the root entry zone of the left trigeminal nerve was slightly shifted posteriorly. (b and c) Axial and coronal T1-weighted MR images with gadolinium demonstrating a tumor adjacent to the left Meckel's cave extending to a petroclival lesion. (d) Three-dimensional computed tomography angiogram demonstrating the tortuous left vertebral artery had contacted the medial tumor.

identify the trochlear nerve on the inner side of the tentorial dura. The superior petrosal sinus was cut anterior to the superior petrosal vein. The tentorial dura and posterior fossa dura were then incised. The tumor was found to adhere to the tentorium and the superior petrosal vein. Next, Meckel's cave was opened [Figure 2a], and the tumor within Meckel's cave was removed. The trigeminal nerve was then identified as caudomedially deviated and in contact with the pyramidal bone due to long-term compression by the tumor [Figure 2b]. The abducens nerve was confirmed in the deeper region. The tortuous VA behind the trigeminal nerve had also compressed the trigeminal nerve [Figure 2c].

The root entry zone (REZ) of the trigeminal nerve could not be adequately visualized with the microscope due to deviation of the nerve. Furthermore, retraction of the tentorium was not feasible to preserve venous perfusion of the posterior cranial fossa through the petrosal vein draining into the superior petrosal sinus. This limitation also narrowed the surgical field, so complicating visualization of the entire length of the nerve [Figures 2c and d]. Therefore, we used a 4-mm rigid endoscope mounted on the EndoArm, a floor-standing pneumatic endoscope holder system, to observe the REZ, which was found to be compressed caudally by the VA, and identified as the origin of the facial pain [Figure 3a].

However, gentle repositioning of the left VA allowed us to create a space between the nerve and the VA [Figure 3b]. We determined that MVD of the trigeminal nerve was necessary, so small pieces of Teflon were inserted in this space to achieve decompression [Figure 3c] [Video 1]. MR imaging on the day after surgery showed that the tumor had been nearly totally removed [Figures 4a and b].

His TN disappeared immediately after surgery, and the patient was discharged home with no neurological deficit. The pathological diagnosis was transitional meningioma, according to the World Health Organization Classification of Tumors of the Central Nervous System grade 1. No recurrence of the tumor or pain was found at the 1-year follow-up visit.

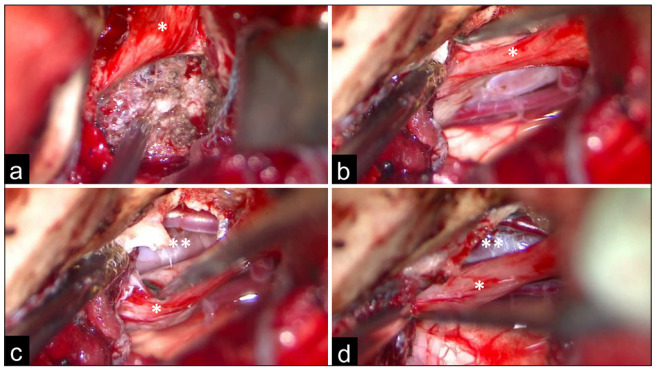

Figure 2: Intraoperative photographs. (a) After the tumor in Meckel's cave was removed, the trigeminal nerve was confirmed (asterisk). (b) After complete removal of the tumor in the cisternal portion, the trigeminal nerve could be observed, but the root entry zone (REZ) could not be identified (asterisk). (c) The tortuous left vertebral artery (VA) (double asterisk) behind the trigeminal nerve was compressing the trigeminal nerve (asterisk). (d) Although we could confirm the trigeminal nerve (asterisk) compressed caudally by the left VA (double asterisk), the REZ was not fully visible using the microscope.

DISCUSSION

Three mechanisms of tumor involvement may cause TN: first, the nerve encased by the tumor; second, the nerve compressed and stretched by the tumor; and finally, the nerve compressed by both the tumor and adjacent blood vessels.[14] Most of these cases are caused by trigeminal and vestibular schwannomas and meningiomas located in the cerebellopontine angle. Several large case series have shown that the trigeminal nerve was compressed by both the tumor and a blood vessel in many patients with tumors and TN. However, the trigeminal nerve was compressed only by a blood vessel and not by the tumor in some cases.[1,12,18] Determination of the specific cause of pain among these three mechanisms can be challenging before surgical treatment of tumor-induced TN. Therefore, both tumor removal and identification of any compression of the blood vessels along the entire length of the nerve are essential.[20]

Many cases of TN associated with tumors of the ipsilateral cerebellopontine angle or petroclival lesions have been treated by tumor removal through the retromastoid approach and MVD if necessary. However, in other cases, the procedure was performed using the anterior petrosal approach.[1,12,18] The surgical approaches for petroclival lesions include the retrosigmoid approach, pretemporal approach, transpetrosal approach, and endoscopic endonasal approach.[5] The pretemporal approach is very appropriate for tumors primarily localized in the cavernous sinus or middle cranial fossa. However, the tumor in our case extended from Meckel's cave to the posterior fossa, so the retrosigmoid approach or the transpetrosal approach was considered more appropriate. The retrosigmoid approach is familiar to many neurosurgeons and offers a wide working area, so it is often the most suitable approach to a posterior fossa tumor. Modifications, such as tentorial opening or suprameatal drilling, can also achieve access to Meckel's

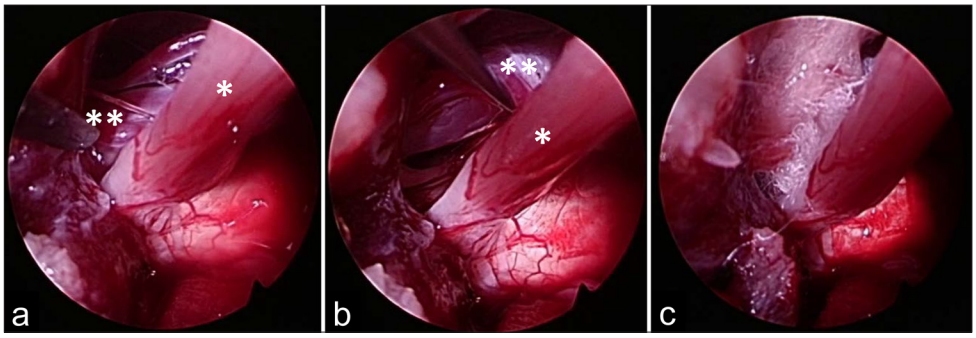

Figure 3: (a) Endoscopic view demonstrating the left vertebral artery (VA) as the offending vessel (double asterisk) inferomedial to the root entry zone (asterisk). The medial side of the trigeminal nerve was compressed and elevated upward. (b) By gently repositioning the left VA, we could create a space between the nerve (asterisk) and the VA (double asterisk). (c) After repositioning the left VA, Teflon pieces were inserted to achieve decompression.

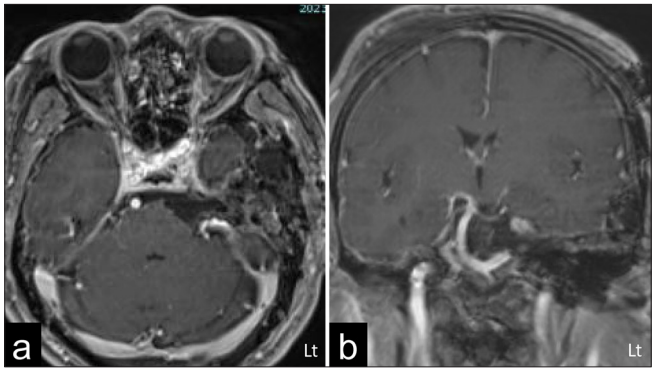

Figure 4: Postoperative axial (a) and coronal (b) T1-weighted magnetic resonance images with gadolinium demonstrating near total removal of the tumor.

Video 1: A short intraoperative video showing the usefulness of endoscopic assistance.

cave and the middle fossa. However, the major disadvantage of this approach is that the facial and auditory nerves cross the surgical field, so they carry the risk of hearing loss and facial paralysis. The transpetrosal approach includes anterior petrosectomy, posterior petrosectomy, or combined petrosectomy. This approach offers advantages such as reduced working distance and early tumor devascularization but also carries risks such as cerebrospinal fluid leakage and venous infarction caused by temporal lobe retraction. A comparison of the retrosigmoid approach and the anterior petrosal approach using cadaveric specimens found that the working area around the brainstem and clivus was significantly wider with the retrosigmoid approach, with similar degrees of surgical freedom at the trigeminal REZ, the origin of the anterior inferior cerebellar artery, and Dorello's canal for both approaches.[3] However, the anterior petrosal approach provided more freedom at the trigeminal porus. This limitation in the retrosigmoid approach could be improved by adding suprameatal extension. In our case, the retrosigmoid approach was expected to have advantages for observing the trigeminal REZ and VAs. However, the operating neurosurgeon did not have experience with suprameatal drilling, so the anterior petrosal approach was chosen rather than the retrosigmoid approach. This approach offers the advantage of removing tumors extending into Meckel's cave. Examination of the entire length of the nerve is critical to alleviate TN.[20] However, the trigeminal nerve was significantly displaced caudally in the present case, so the full length was difficult to visualize in the surgical field. This displacement also complicated the dissection between the trigeminal nerve and the VA. The limitations of this approach were effectively addressed through the use of an endoscope, which also ensured safety during the procedure.

Endoscopic MVD for TN[10,15] and endoscopic resection of petroclival meningioma are now available.[9] The concept of "endoscope-assisted microsurgery" was introduced in 1998 by Hopf and Perneczky.[7] The main benefits, particularly in skull base surgery, are a better operative field of vision, reduced brain retraction, and improved exposure through enhanced illumination and wider viewing angles.[2,16] Endoscope-assisted microsurgery is especially useful for deep-seated lesions that cannot be fully visualized with only the microscope, as demonstrated in our case. Recently, endoscopic surgical techniques have been reported to utilize an external endoscope instead of a microscope.[4,8]

CONCLUSION

The present case of TN was caused by a combination of Meckel's cave meningioma extending to the posterior fossa and tortuous VA. The tumor had significantly displaced the trigeminal nerve and blood vessels, so the entire course of the trigeminal nerve was difficult to visualize with only the microscope. This case report illustrates the advantages and key techniques for the temporary use of an endoscope in conjunction with microscopic surgery.

Ethical approval: All procedures performed in this study involving human participants were conducted in accordance with ethical standards of the Institutional and/or National Research Committee and the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.
Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent.
Financial support and sponsorship: Nil.
Conflicts of interest: There are no conflicts of interest.
Use of artificial intelligence (AI)-assisted technology for manuscript preparation: The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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How to cite this article: Moteki M, Aihara M, Oya S. Trigeminal neuralgia caused by compression of the trigeminal nerve between the vertebral artery and Meckel's cave meningioma extending to the posterior fossa successfully treated with the endoscopic-assisted anterior petrosal approach. Surg Neurol Int. 2025;16:123. doi: 10.25259/SNI_1053_2024