ACTA SCIENTIFIC NEUROLOGY (ISSN: 2582-1121)

Volume 7 Issue 8 August 2024

Research Article

Surgical Management of Trigeminal Neuralgia Caused by the Vertebrobasilar Artery

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DOI: 10.31080/ASNE.2024.07.0759

Received: May 24, 2024

Published: July 05, 2024

Abstract

Introduction: Trigeminal neuralgia with the vertebrobasilar artery as the responsible vessel is relatively rare. Trigeminal neuralgia involving the vertebrobasilar artery is a difficult surgical procedure with a high complication rate. In this report, we describe our recent surgical experience of successfully managing trigeminal neuralgia involving the vertebrobasilar artery.

Materials and Methods: Eight cases (four men and four women) have been reported in the past 5 years. The mean patient age was 61 years. The preoperative Barrow Neurological Institute grade was Ⅳ in three cases and V in five cases. The mean illness duration was 2.5 years. The surgery was performed using the conventional retrosigmoid approach with continuous monitoring of the auditory brainstem response.

Results: The interposition was used in all cases. Surgical outcomes were excellent, with six cases of Barrow Neurological Institute grade I and two cases of grade II. No surgical complications occurred. The average follow-up duration was 2.5 years; no cases of recurrence were observed.

Conclusion: Surgery for trigeminal neuralgia with the vertebrobasilar artery as the responsible vessel is challenging but can help achieve highly favorable results and should be aggressively considered. Trigeminal neuralgia with the vertebrobasilar artery as the responsible vessel can be successfully treated using the interposition method.

Keywords: Trigeminal Neuralgia; Microvascular Decompression; Vertebrobasilar Artery; Interposition; Retrosigmoid Approach

Abbreviations

3D-MRC/MRA: Three-Dimensional Magnetic Resonance Cisternography/Angiography; ABR: Auditory Brainstem Response; AICA: Anterior Inferior Cerebellar Artery; BNI: Barrow Neurological Institute; MVD: Microvascular Decompression; SCA: Superior Cerebellar Artery; TN: Trigeminal Neuralgia; VBA: Vertebrobasilar Artery

Introduction

Trigeminal neuralgia (TN) causes paroxysmal stinging pain on one side of the face; it is triggered by basic tasks such as eating and washing one's face, hindering activities of daily living. TN is mainly caused by nerve compression by blood vessels [1,2]. Surgical procedures for TN include microvascular decompression (MVD) to move the blood vessels compressing the trigeminal nerve, which is a fundamental and the gold standard treatment performed worldwide [1,2]. The most common compression vessels are the superior cerebellar artery (SCA), followed by the anterior inferior cerebellar artery (AICA), vein, and vertebrobasilar artery (VBA). TN with VBA as the responsible vessel is relatively rare, accounting for 2-6% of all TN cases [3,4]. TN associated with VBA is more challenging because VBA is highly difficult to move, and surgical complications are a concern [3,4].

In this article, we report on the successful results of MVD for TN associated with VBA and the surgical precautions to be adopted.

Materials and Methods

MVD for TN was performed in 196 patients from April 1, 2018, to March 31, 2023. Of them, eight (4.1%) were included in this study (four men and women each). Their age range was 40-78 years (average, 61 years). Four cases each of the affected right and left sides were present. The duration of illness was 1-5 years (average, 2.5 years). The main affected territory of the trigeminal nerve was the second branch in three cases and the third branch in five cases. All patients presented with typical TN symptoms, with paroxysmal stinging pain triggered by basic tasks. The pain level was evaluated using the Barrow Neurological Institute (BNI) pain intensity scale [5] pre- and postoperatively. Three-dimensional magnetic resonance cisternography/angiography (3D-MRC/MRA) fusion was preoperatively performed to evaluate the anatomical architecture around the trigeminal nerve and responsible vessels [6,7]. Here, we briefly describe the surgical technique [8]. MVD was performed with the patient in the lateral recumbent position with intraoperative auditory brainstem response (ABR) monitoring and the conventional retrosigmoid approach. A linear skin incision was made in the retroauricular region, and a small craniotomy was performed. The horizontal fissure was opened to access the trigeminal nerve, and trigeminal nerve compression by the responsible vessel was identified. The arachnoid membrane around the blood vessel was incised to ensure mobility and decompression procedures were performed on the trigeminal nerve. Medical histories included hypertension in 7 patients (85%), hyperlipidemia in 4 (50%), diabetes in 3 (38%), myocardial infarction in 1 (13%), and cerebral infarction in 1 (13%). The postoperative follow-up duration was 1-4.5 years (average, 2.5 years). All procedures used in this research were approved by the Ethical Committee of International University of Health and Welfare

Results and Discussion

Preoperative 3D-MRC/MRA fusion showed the responsible vessel to be vertebral artery (VA) + PICA in 3 cases (37.5%), BA + AICA in 3 (37.5%), and VA in 2 (25.0%). All patients showed severe trigeminal nerve deformities. Intraoperative findings were confirmed to be identical to preoperative 3D-MRC findings. All patients were treated using the interposition method because there was insufficient space to move the VBA or a risk of abducens nerve palsy or perforating branch injury associated with adequate movement. In the interposition, a Teflon felt was placed between the brainstem and the responsible vessel to avoid direct contact with the trigeminal nerve. Intraoperative bleeding was minimal, and the average operative time was 1.5 h. No significant postoperative complications were observed. TN resolved immediately after surgery in all patients. The preoperative BNI grade was IV in three cases and V in five cases. The surgical results were excellent: six (75%) had BNI grade I and two (25%) had BNI grade II. The average postoperative hospital stay was 8 days. No recurrence was observed.

Illustrative case

- **Present illness:** The patient was a 40-year-old man who experienced paroxysmal stinging pain caused by compression of the right third branch of the trigeminal nerve; the pain was triggered upon washing his face for 1 year. He was referred to our department because of the declining effectiveness of his medications. His medical history included hypertension and diabetes mellitus. The patient's pain level was BNI grade 5 [5]. Preoperative 3D-MRC/MRA fusion (Figure 1) showed that the right trigeminal nerve was severely compressed directly by PICA, and a large VA was also compressed posteriorly, resulting in a severe deformity. VA also compressed the facial-vestibulocochlear nerve complex. Based on these findings, the patient decided to undergo surgery.
- **Surgical findings:** Surgery was performed with the patient in the left lower lateral recumbent position with continuous ABR monitoring and a conventional right retrosigmoid approach.

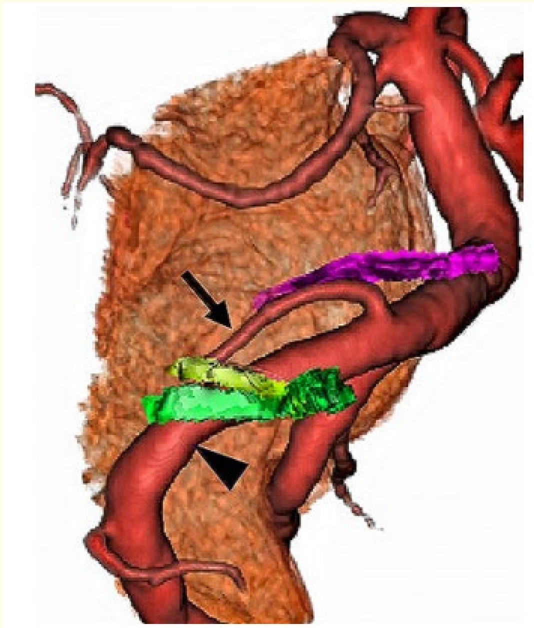

Figure 1: Preoperative three-dimensional magnetic resonance cisternography/angiography (3D-MRC/MRA) fusion

Preoperative 3D-MRC/MRA fusion imaging showing the right trigeminal nerve (purple) being severely compressed directly by PICA (arrowhead), and a large vertebral artery (arrow) being compressed posteriorly, resulting in a severe deformity. The vertebral artery is also compressing the facial (yellow–green)–vestibulocochlear (green) nerve complex.

The trigeminal nerve was directly compressed by PICA and VA compressed it posteriorly, causing severe deformity (Figure 2A). First, PICA and VA surroundings were dissected to obtain vessel mobility. There was no substantial space to move VA, and it moved as far posteriorly as possible. Next, PICA was moved by adhering it to VA, and Teflon felt was inserted and fixed between the brainstem and PICA to decompress the trigeminal nerve. Trigeminal nerve deformity improved (Figure 2B). (Figure 2)

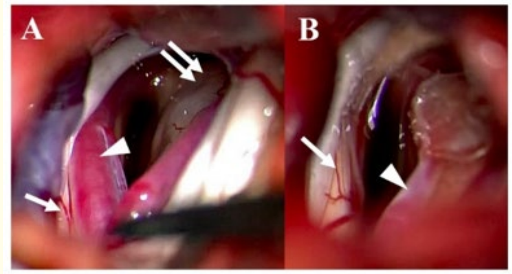

Figure 2: Surgical view.

A: Pre-decompression of the trigeminal nerve.

The trigeminal nerve (arrow) is being directly compressed by PICA (arrowhead) and VA (double arrows) is being compressed posteriorly, causing severe deformity.

B: Post-decompression of the trigeminal nerve.

After moving PICA (arrowhead), adequate decompression of the trigeminal nerve (arrow) and improvement in the deformity observed.

- **Postoperative course:** TN disappeared immediately after surgery with no complications, and the patient was discharged 8 days later with good progress. Postoperative 3D-MRC/MRA fusion (Figure 3) showed adequate decompression of the trigeminal nerve and improvement in the deformity. Three years postoperatively, no recurrence has been observed.

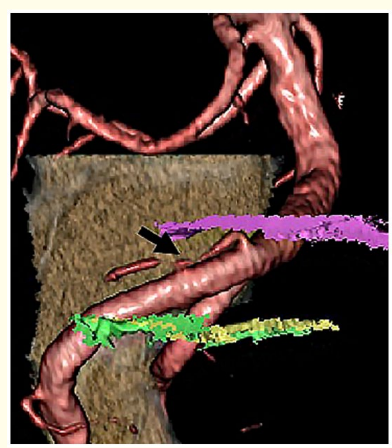

Figure 3: Postoperative three-dimensional magnetic resonance cisternography/angiography (3D-MRC/MRA) fusion.

Postoperative 3D-MRC/MRA fusion imaging showing PICA (arrow) has moved and is not in direct contact with the trigeminal nerve, confirming excellent decompression of the trigeminal nerve and improvement in the deformity.

TN involving VBA is different from conventional TN; the latter is more common in men, and the left side is more likely to be affected [4]. In our cases, no sex- or affected side-specific differences were found. Compared with conventional TN, TN caused by VBA may be related to arteriosclerosis, as many patients have a medical history of conditions that induce arteriosclerosis, such as hypertension and diabetes mellitus [3,4]. In our series, 85% of the patients had a medical history of hypertension, 50% had hyperlipidemia, and 38% had diabetes. In a review of the vessels responsible for TN with VBA, Linskey., *et al.* [4] indicated that VA was involved in 58% of cases, BA in 39%, and the vertebrobasilar junction in 3%, with VA alone involved in 17% of cases and indirectly involved together with multiple vessels, such as PICA, AICA, and veins, in 83% of cases. Similarly, in our cases, 62% of the cases involved VA, 38% involved BA, and 25% involved VA alone, whereas others had multiple responsible vessels, including AICA and PICA. MVD for TN involving VBA improves symptoms in 73-90% of cases, but the improvement rate tends to be slightly lower than that with MVD in common cases involving SCA and AICA [9-11]. The postoperative recurrence rate for TN involving VBA is approximately 10%, which is not much higher than that in usual cases [11]. However, surgical complications include facial dysesthesia (30-41%), hearing impairment (4-23%), and diplopia (22-24%) [3,9-11]. MVD for TN involving VBA is challenging and requires careful surgical manipulation.

VBAs have long diameters and thick hard walls, which make them difficult to move adequately [3,9-11]. There may be insufficient space to move a VBA with a long diameter [3,9-11]. In a comparison between transposition and interposition in MVD for TN involving VBA, Chai., *et al.* [12] reported that transposition had superior long-term postoperative results and was associated with no differences in the incidence of complications. However, there was no significant difference in the effect on TN when comparing the group that remained in slight contact with the transposition group [13]. Yu., *et al.* [14] described the usefulness of interposition because it is safe and relatively simple for achieving satisfactory surgical results. In this series, we were able to move the responsible vessel adequately while keeping it safe because of lack of space to move it sufficiently or the presence of a short perforating branch. Therefore, the arachnoid membrane around the responsible vessel was sufficiently dissected to obtain mobility, and a Teflon felt was inserted and fixed between the brainstem and responsible vessel as an interposition. Care was taken to avoid direct contact between the Teflon felt and trigeminal nerve to prevent adhesions. Fortunately, all patients had very good results, and no complications were observed; however, further careful follow-up is necessary. In cases of TN, in which VBA is the responsible vessel, interposition can be used to achieve good results based on safety considerations; therefore, there is no need to consider transposition.

We performed preoperative 3D multi-fusion imaging to evaluate TN and investigate the anatomic relationship between the nerve and constriction vessels [6,7]. 3D Multi-fusion imaging can superimpose 3D-MRC and 3D-MRA images to depict pressure conditions of responsible vessels. In cases of TN caused by compression of VBA, the responsible vessel may also be in contact with the facial and vestibuloacoustic nerves, making it possible to obtain a three-dimensional image of not only the region but also the entire region, which is useful in the simulation of surgery. However, in cases of TN involving VBA, simultaneous compression of the abducens and trochlear nerves can be expected, and the anatomical relationship between these nerves and blood vessels needs to be evaluated using 3D multi-fusion imaging preoperatively.

Conclusion

MVD for TN with VBA as the responsible vessel is challenging but can help achieve highly favorable results and should be aggressively considered. It is necessary to approach surgery with a wide view of the entire area, not the local area around the trigeminal nerve alone. TN with VBA as the responsible vessel can be successfully treated using the interposition method.

Acknowledgements

We would like to thank Editage (www.editage.jp) for English language editing.

Conflict of Interest

The authors declare that they have no conflict of interest.

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