Microvascular Decompression by Interposition Method for Treatment of Trigeminal Neuralgia Due to Vertebrobasilar Dolichoectasia: A Retrospective Single-Center Study

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Abstract

Trigeminal neuralgia (TN) due to vertebrobasilar dolichoectasia (VBD) is a rare disease that can be challenging to treat. The objectives of this study are to investigate the characteristics of patients with TN due to VBD and to analyze the efficacy of microvascular decompression (MVD) by the interposition method for treatment of the condition. From 2010 till 2020, the data of 30 patients with TN due to VBD who were treated with MVD by the interposition method were analyzed retrospectively. The characteristics of the patients were compared with those of patients with non-VBD TN ($n = 815$). Kaplan–Meier survival analysis was performed to determine pain-free survival. The 30 patients (21 males, 9 females; mean age, 63.03 years) accounted for 3.55% of all patients with TN during the study period. In 30 patients, the offending vessel was the basilar artery (BA) in 1 patient, the vertebral artery (VA) in 6 patients, the VA plus the superior cerebellar artery (SCA) in 6 patients, the VA plus the anterior inferior cerebellar artery (AICA) in 12 patients, and the VA+SCA+AICA in 5 patients. Compared to non-VBD TN patients, those with TN due to VBD were significantly more likely to be male, to have TN of the left side, and to have hypertension (all $P < 0.001$). Mean age at surgery ($P = 0.057$) and symptom duration ($P = 0.308$) were comparable between the two groups. All 30 patients had immediate relief of facial pain after MVD and could stop medication. There were no postoperative complications. Over mean follow-up of 76.67 months, 3 patients had recurrence. The mean duration of pain-free survival was 70.77 months. In conclusions, TN due to VBD appears to be more likely in males, in those with hypertension, and to involve the left side. The interposition method performed by experienced and skilled neurosurgeons is a safe and effective treatment for TN due to VBD. Further studies are needed to analyze the associated long-term results and the pain recurrence rate among this special population.

Introduction

Vertebrobasilar dolichoectasia (VBD), first described by Smoker, is a rare cerebrovascular disease characterized by ectatic, elongated, and tortuous vertebrobasilar arteries (VBA)[24]. In angiographic and autopsy studies, the prevalence of VBD is less than 0.05%[5, 8]. A study from Japan found asymptomatic VBD in 1.3% of patients undergoing magnetic resonance imaging (MRI) or magnetic resonance angiography (MRA) examinations for various reasons[13]. The ectatic elongated arteries may sometimes compress the root of the trigeminal nerve or facial nerve and cause trigeminal neuralgia (TN) and/or hemifacial spasm. Impingement on the trigeminal nerve root is less likely because of the anatomy of the region. TN due to VBD accounts for only about 2%-7.7% of all cases of TN[7, 15, 19, 20, 25, 26, 29, 30]. Surgical treatment can be challenging as the tortuous VBAs are difficult to separate from the nerve root in the narrow space of the cisterns. Microvascular decompression (MVD) is the treatment of choice because it is nondestructive and addresses the vascular etiology. There are two methods to deal with the offending VBA during MVD: the interposition method and the transposition method. The former, which is the traditional method, involves insertion of an implant between the offending vessel and the nerve, while the latter method involves repositioning of the VBA using clips, biomedical glues, or other measures. Both methods have advantages and disadvantages. Several authors have found the interposition method to

be simple and effective[1, 7, 25, 27, 29, 31], but others believe that transposition method—although more risky—is more efficacious and also avoids the complications associated with the interposition method (e.g., adhesion and granuloma formation)[10, 12, 14, 16, 20, 28].

At our hospital, over the last 10 years, we have used the interposition method to treat 30 patients with TN due to VBD. The aim of this study is to describe the characteristics of the patient, our surgical technique, and the long-term outcomes of treatment.

Materials And Methods

Between 2010 and 2020, out of 845 patients presenting with TN at our center, 30 (3.55%) patients were diagnosed to have TN due to VBD and were treated by the interposition technique. Among of them, 2 patients coexisted ipsilateral hemifacial spasm and the rate of associated hemifacial spasm was 6.67%. The demographic and clinical data of these patients were collected from the hospital records and retrospectively analyzed. All patients underwent high-resolution MRI and computed tomography (CT) scans and MRA preoperatively. To clearly define the structure of the vessels, three-dimensional time-of-flight and fast imaging employing steady-state acquisition sequences were adopted. In all patients, the imaging features satisfied the VBD diagnostic criteria. There was a clear relationship between the VBA and the trigeminal nerve in all 30 patients (Figure 1A-D).

Mvd Procedure

With the patient in the lateral decubitus position, retrosigmoid suboccipital craniotomy was performed. The arachnoid membrane around the trigeminal nerve was opened to reveal the tortuous vertebral arteries situated ventral to the caudal cranial nerves (Figure 2A, C). The degree of vasculonervous conflict (VNC) varied: it was classified as grade I if the vessel was in contact with the nerve root but there was no visible indentation; as grade II (the most frequent) if there was displacement and/or distortion of the root; and as grade III if there was marked indentation of the nerve root[22]. To decompress the trigeminal nerve, shredded Teflon sponge was introduced piece-by-piece between the VBA complex and the trigeminal nerve and the medulla oblongata to obtain progressive mobilization (Figure 2B, D).

Clinical Evaluation

Therapeutic efficacy was assessed using the Barrow Neurological Institute (BNI) pain intensity score: BNI score I indicates no pain, without need for any medication; BNI score II indicates occasional pain, but no need for medication; BNI score III indicates some pain that is adequately controlled with medication; BNI score IV indicates some pain, not adequately controlled with medications; and BNI score V indicates severe pain, not relieved by medication[21].

Immediate postoperative outcome was classified as “complete pain relief” (BNI score I), “adequate pain relief” (BNI score I and II), or “treatment failure” (BNI score IV and V). Long-term follow-up was by telephonic or in-person interviews. Recurrence was defined as a return to preoperative pain status after achieving adequate pain relief (BNI score I-III).

The study was approved by the institutional review board of our hospital, with waiver of the need for consent.

Statistical analysis

Data analysis was with SPSS 20 (IBM Corp., Armonk, NY, USA). Age at surgery, duration of symptoms, sex distribution, side affected, and prevalence of hypertension were compared between patients with TN due to VBD and patients with non-VBD TN. The *t* test was used to compare continuous data between groups and the chi-square test to compare categorical data. *P* < 0.05 was considered statistically significant. Pain free survival was defined as the time to recurrence of facial pain after surgery. Kaplan–Meier curves were constructed based on pain free survival.

Results

Of the 845 patients with TN treated at our hospital from 2010 to 2020, 30 had TN due to VBD and 815 had non-VBD TN; Table 1 lists the characteristics of patients in the two groups. Compared to patients with non-VBD TN, patients with TN due to VBD were significantly more likely to be males (70% vs. 37.7%, *P* < 0.001), with a trend toward older patients (*P* = 0.057); to have TN of the left side (73.3% vs. 36.9%, *P* < 0.001); and to have hypertension (73% vs. 25.9%, *P* < 0.001).

Table 1
Comparison of characteristics between patients with non-VBD TN and with TN due to VBD

	Non-VBD TN, n = 815	TN due to VBD, n = 30	P
Age at surgery (years)	59.23 ± 10.83	63.03 ± 7.55	0.057
Symptom duration (months)	69.72±25.29	56.13±29.57	0.308
Males (M)	307 (37.7%)	21 (70%)	<0.001
Side (L)	301 (36.9%)	22 (73.3%)	<0.001
Hypertension [†]	211 (25.9%)	22 (73%)	<0.001
Data are means ± SD or n (%)			
TN: Trigeminal neuralgia; VBD: vertebrobasilar dolichoectasia			
[†] Systolic blood pressure ≥140 mmHg and/or diastolic blood pressure of ≥90 mmHg			

Surgical Findings

Table 2 lists the surgical findings (offending vessels and degree of VNC), pain distribution, and BNI scores in patients with TN due to VBD. While only one branch of the trigeminal nerve was affected in 7 patients, two branches were affected in 20 patients, and all three branches were affected in 3 patients. The offending vessel was the basilar artery (BA) in 1 patient, the vertebral artery (VA) in 6 patients, the VA plus the superior cerebellar artery (SCA) in 6 patients, the VA plus the anterior inferior cerebellar artery (AICA) in 12 patients, and the VA+SCA+AICA in 5 patients. Degree I VNC was seen in 1 patient, degree II VNC in 17 patients, and degree III VNC in 12 patients.

Table 2

Operative findings and outcomes in the 30 patients with trigeminal neuralgia due to vertebrobasilar dolichoectasia

Findings	n (%)
Offending vessel	
VA	6 (20%)
BA	1 (3.3%)
VA+SCA	6 (20%)
VA+AICA	12(4%)
VA+SCA+AICA	5 (16.7%)
Degree of VNC	1 (3.3%)
0	
1	17 (56.7%)
2	12 (40%)
Pain distribution	0 (0%)
V1	6 (20%)
V2	1 (3.3%)
V3	5 (16.7%)
V1+2	15 (50%)
V2+3	3 (10%)
V1+2+3	30(100%)
BNi score immediately after surgery	0 (0%)
0	27 (90%)
1-2	3 (10%)
BNi score at last follow-up	
I	
IV	
VA: Vertebral artery; BA: basilar artery; SCA: superior cerebellar artery; AICA: anterior inferior cerebellar artery; VNC: vasculonervous conflict; BNi: Barrow Neurological Institute	

Surgical Outcomes

Following MVD, all 30 patients had complete relief of facial pain and could stop medication. No obvious postoperative complications (facial numbness, facial palsy, hearing loss, or diplopia) occurred in any patient. There were no deaths. Patients were followed up for periods ranging from 16 months to 130 months (mean, 76.67 months). Pain recurred in three patients (at 7, 12, and 52 months post operation); two of these patients underwent percutaneous radiofrequency thermocoagulation for pain relief, while one patient underwent repeat MVD by the interposition procedure.

Pain-free Survival

Of the 30 patients included in the Kaplan–Meier survival analysis, 3 patients had pain recurrence (at 7, 12, and 52 months post-operation, respectively). The mean duration of pain-free survival was 70.77 months (Figure 3).

Discussion

Cause of VBD

The pathogenesis of VBD is not clear, and many factors are probably involved. The vertebral arteries arise from the subclavian artery. While the right subclavian artery arises from the brachiocephalic trunk, the left subclavian artery springs directly from the aortic arch. Therefore, blood flow and stress are higher in the left vertebral artery than the right one. Some scholars believe that atherosclerosis is the main cause of VBD[2, 3]; however, the relationship remains to be confirmed. Histopathologically, tears in the internal elastic lamina, smooth muscle atrophy, and reticular fiber deficiency have been demonstrated in the dolichoectatic arteries, suggesting that VBD may be caused by congenital dysplasia in some patients[9, 11, 18].

Safety Of Interposition Method

MVD is the treatment of choice for TN caused by VBD. The interposition method and the transposition method both aim to separate the offending vessel from the nerve. We preferred to use the interposition technique in our patients for two reasons. First, interposition of Teflon patches between the root entry zone and the offending vessels is relatively easily performed. Once the tense trigeminal nerve is loosened, further attempts to mobilize the VBA complex are not necessary. Meanwhile, transposition of the large and tortuous VBA is often not easy due to the large size and poor elasticity of the arteries, and the difficulty of surgical manipulation within the narrow available space. There is also the risk of chemical vasculitis and adhesion of neurovascular structures with use of glues, or of avulsion of perforators to the brainstem due to aggressive movement of the VBA complex. If multiple vessels are involved, the manipulation becomes even more difficult and risky.

Clinical Outcomes

Excellent immediate outcomes were achieved with the interposition method in all 30 of our patients. Only 3 patients had recurrence (over mean follow-up of 76.67 months) and the recurrence rate is 10%. The current literature reports immediately pain relief in 90% patients and a successful outcome at 15 years of 75%[23]. However, the specific efficacy of MVD in case of VBD is rarely evaluated. A random-effects meta-analysis between 1990 and 2020, which including 167 patients with TN caused by VBD, demonstrated that the rate of pain relief immediately after surgery is approximately 97%. At last follow-up (55 months), this rate decreased to 92.9% confirming MVD as effective treatment for TN due to VBD[6]. This result is similar to our recurrence rate in consideration of an average TN recurrence rate of 3.5% per year [4]. We can identify three reasons for the excellent results with MVD in our patients. First, the offending vertebrobasilar vessel complex was usually obvious intraoperatively and easily identified by the operator; second, the VNC was mostly grade II or III, the effect of MVD is superior to TN caused by undefined vessels; and third, the narrow space made it difficult for other vessels to translocate to the root entrance/exit zone after the VBA complex was moved.

Age at surgery and mean preoperative symptom duration were not significantly different between patients with TN due to VBD and patients with non-VBD TN at our hospital. However, in the study by Linskey[15], patients with TN due to VBD were older than patients with non-VBD TN.

Repeat Mvd

To the best of our knowledge, repeat MVD after failure of the first treatment for TN due to VBD has not been reported previously; one patient in our series needed a repeat procedure for pain relief. According to a previous study, Teflon granuloma is the main reason for pain recurrence.[17] Surgical removal of the granuloma combined with repeat of the MVD is the preferred treatment. In our patient, the previously planted Teflon had not become stiff and knotted, also without Teflon granuloma, and there was impingement by a new VNC (the SCA). We excised part of previously inserted Teflon sponge, and introduced shredded Teflon sponge piece-by-piece between the SCA and the trigeminal nerve and brain stem. The patient became pain-free and off medication again, although there was short period of facial numbness after the repeat surgery.

Study Limitations

Our study has some limitations. First, the sample size is small because of the relative rarity of the pathology; thus, statistical analysis may be somewhat underpowered. Second, this was a non-randomized, retrospective single-center study, so substantial bias is likely. Finally, postoperative follow-up in some patients was relatively short. Despite these limitations, this study provides insight into the postoperative pain-free survival and repeat MVD in patients with TN due to VBD.

Conclusions

Patients with TN due to VBD appear more likely to be males, with a trend toward older patients, with hypertension, and to involve the left side. Surgical management of those patients is challenging. In the hands of experienced neurosurgeons, microvascular decompression by the interposition method can provide excellent outcomes in patients with trigeminal neuralgia due to vertebrobasilar dolichoectasia. Major complications, such as cerebellar hemorrhage or swelling, permanent facial numbness, hearing impairment were not encountered.

Declarations

Data availability May be considered upon request.

Compliance with ethical standards

Conflicts of interest The authors declare that they have no conflict of interest.

Ethical approval Research protocol was approved by the Institutional Review Board of PLA 960th hospital.

Informed consent Informed consent was provided before intervention by each patient and his/her nearest family member.

Code availability Not applicable.

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Figures

Figure 1

Figure 2

(a) Severe compression of the left trigeminal nerve against the tentorium by the ectatic, tortuous VA and AICA has resulted dislocation and distortion of the nerve. (b) A Teflon sponge was interposed between the VA and the trigeminal nerve. (c) The left vertebrobasilar dolichoectasia with atherosclerotic plaque is seen compressing the trigeminal nerve against the tentorium. (d) Pieces of shredded Teflon were introduced between the VBA and the trigeminal nerve to relieve the pressure on the trigeminal nerve. (VA: vertebral

artery; PV: petrosal vein; AICA: anterior inferior cerebellar artery; UA: unnamed artery/arteriole; VBA: vertebrobasilar arteries)

Figure 3

Kaplan–Meier survival analysis. Recurrence of pain occurred in three patients (at 7, 12, and 52 months post-operation).