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A single centre case series of microvascular decompression surgery for classical trigeminal neuralgia: functional outcomes and report of a unique conflict

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Abstract

Background: Microvascular decompression surgery for trigeminal neuralgia is now considered the benchmark surgical procedure for intractable trigeminal neuralgia of any variety. The objective of this study is to share our experience in managing classical trigeminal neuralgia with microvascular decompression surgery looking into both immediate and late functional outcomes at 3 and 6 months post op. We also report a unique case of trigeminal neuralgia due to a tributary of the petrosal vein passing through the substance of the trigeminal nerve itself at its root entry zone.

Results: This study included 20 patients; it showed that microvascular decompression surgery of the trigeminal nerve is an effective method for treatment of classic trigeminal neuralgia (p value < 0.001). The trigeminal root was compressed by the superior cerebellar artery in 75% of patients. A vein contributed to the compression in 45% of patients and was the only compressing vessel in 15%.

Conclusion: Microvascular decompression surgery is the treatment of choice in patients with medically refractory trigeminal neuralgia, unless their general condition prohibits it. It's also worth noting that the normal anatomy of the veins in this region is quite variable and the venous structures causing a neurovascular contact are more or less inconsistent. To the best of our knowledge and despite the wide range and progress in microvascular decompression surgery for trigeminal neuralgia, this is the first reported case in the literature for a neurovascular conflict caused by a vein passing through the trigeminal nerve itself.

Keywords: Trigeminal neuralgia, Microvascular, Decompression, Petrosal vein

Introduction

Trigeminal neuralgia (TN), also known as Fothergill's disease or "tic douloureux", is a neuropathic disorder characterized by paroxysms of severe, lancinating, electric shock-like bouts of pain restricted to the distribution of the trigeminal nerve in the face. It has been described as one of the most painful conditions known to humankind [1].

The trigeminal nerve is a paired cranial nerve that has three major branches: the ophthalmic nerve (V1), the maxillary nerve (V2), and the mandibular nerve (V3). One or more of the three branches may be affected. Trigeminal neuralgia most commonly involves the middle branch (V2) and the lower branch (V3) of the trigeminal nerve, or rarely, the ophthalmic branch. In the majority of cases, TN symptoms begin appearing more frequently over the age of 50, although there have been

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cases with patients being as young as three years of age. It is common in females more than males [2].

Most cases are classic or primary TN, which lack objective evidence of motor or sensory deficit and usually due to a vascular loop. It is the most common form of TN, while a minority of cases is symptomatic or secondary TN, which is related to underlying structural pathology such as tumors, vascular malformations, or it can be the result of multiple sclerosis [3, 4].

Management of trigeminal neuralgia includes medical treatment, minimally invasive procedures or surgical microvascular decompression (MVD). MVD is now considered the benchmark surgical procedure for intractable TN of any variety [5].

Decompression is relatively straightforward when the surgeon is always mindful of two concepts: (1) "there must be a vessel, and it is my task to find it"; and (2) the dorsal root entry or exit zone can be variable in length, particularly in the case of the trigeminal nerve, and may extend to a more distal portion of the nerve. Trigeminal nerve microvascular decompression requires sharp dissection of all arachnoid around the trigeminal nerve and superior cerebellar artery. The most common vessel found is a rostroventral superior cerebellar artery loop, which compresses the trigeminal nerve either at the brainstem or distally [6].

Here, we share our experience in managing classical trigeminal neuralgia with microvascular decompression surgery looking into immediate and late post op functional outcomes. We describe the different demographic and anatomical variation encountered and we also report a unique case of trigeminal neuralgia due to a tributary of the petrosal vein passing through the substance of the trigeminal nerve itself.

Methods

This is a prospective, cohort study conducted at Alexandria Main University Hospital in the period from 2018 to 2020. This study included 20 patients who underwent microvascular decompression (MVD) of the trigeminal nerve for treatment of classic trigeminal neuralgia.

The following data were collected from each patient's filling records: (age, sex, occupation, residency, medical and family history).

All the patients had been treated with anticonvulsants, i.e., carbamazepine (up to 1200 mg per day) and/or colanzepam (up to 6 mg per day) for a period of at least 6 months and most patients had never had complete pain relief with drugs (85%), the others (15%) could not tolerate the drugs.

All the patients were clinically examined before an MRI Brain with T2 constructive interference in steady state (CISS)/Fast Imaging Employing Steady-state Acquisition (FIESTA) sequences was done to identify the compressing vascular loop and to exclude brain tumors, vascular malformations and multiple sclerosis.

Inclusion criteria:

- Patients with classic trigeminal neuralgia (Unilateral, episodic, Paroxysmal, electrical shock-like pain, along the distribution of one and/or more of the divisions of trigeminal nerve) who experienced failure or intolerability of medical treatment.

Exclusion criteria:

- Patients with atypical trigeminal neuralgia (Constant, dull, diffuse, burning pain beyond the duration of typical paroxysms.
- Patients with history of post- herpetic neuralgia or multiple sclerosis.
- Patients with bleeding disorders.
- Patients with trigeminal neuralgia due to brain tumors.
- Patients who are surgically unfit.

All cases underwent surgery in the form of microvascular decompression (MVD) of the trigeminal nerve. If a contact between the trigeminal nerve and a blood vessel is found at the site where the nerve enters the brainstem, this neuro-vascular conflict is then separated by the insertion of a piece of synthetic material, e.g., a small Teflon sponge.

If visualization with the microscope is poor, the endoscope is introduced to identify any aberrant vessel and to perform or improve the decompression of the trigeminal nerve at the root entry zone. Postoperatively, the patients were kept overnight in a well-staffed nursing unit.

Postoperative assessment of the patients with the visual analog pain scale (VAS) was reported for pain relief. Postoperative follow up examination was completed at 3 and 6 months post op.

Results

This prospective study included 20 patients who underwent microvascular decompression of trigeminal nerve for treatment of TN. This study was done in Alexandria main university hospital over a period of 18 months. The male to female ratio was about 1 to 1.5 (8 males and 12 females) and their ages ranged from 50 to 68 years with mean age of 58 years. Characteristics of 20 patients with TN who underwent microvascular decompression are given in Table 1.

The results of this study are organized in the following points.

Table 1 Characteristics of 20 patients with TN who underwent microvascular decompression

Socio demographic data	No.	%
Age		
50–	6	30
55–	6	30
60–	6	30
65–70	2	30
Min.–Max	50–68	
Mean ± SD	57.8 ± 5.1	
Gender		
Male	8	40
Female	12	60
The side affected		
Right	14	70
Left	6	30
Pain distribution		
V1 only	0	0
V2 only	3	15
V3 only	5	25
V1 and V2	2	10
V2 and V3	7	35
V1 and V2 and V3	3	15

1. Initial pain relief

All the patients had immediate pain relief. Follow up of the patients was done after 3 and 6 months. The evaluations included pain relief (by VAS), facial sensitivity deficit, hypoesthesia, neurological deficit and clinical complications. The patients were classified into three groups according to their results (Table 2).

- Group 1: excellent results (VAS ≤ 6): Complete pain relief, analgesia with no neurological complication.
- Group 2: good results (VAS 7–8): partial pain relief, analgesia, with transient neurological complication.
- Group 3: poor results (VAS 9): no pain relief.

Table 2 Immediate postoperative results after microvascular decompression

Results of VAS postoperative	VAS score	No.	%
Excellent	≤ 6	14	70
Good	7–8	5	25
Poor	9	1	5
Total		20	100

2. Compressing vessels responsible for the trigeminal neuralgia

The operative findings are summarized in Table 3. The trigeminal root was compressed by the superior cerebellar artery in 75% of patients. A vein contributed to the compression in 45% of patients and was the only compressing vessel in 15%.

3. Postoperative pain relief and follow up

Scores using visual analog pain scale (VAS) were reported by the patients before, after the operation and on 3–6 months follow up.

Immediate post operatively, almost all patients had improvement of VAS. After 3, 6 months most of patients had more improvement in VAS results except for one patient who showed subtle improvement (Fig. 1 and Table 4). The overall results of 20 cases according to type (pain characteristics) and pain distribution are summarized in Table 5.

4. Postoperative morbidity and mortality

There were no perioperative mortalities. Cerebrospinal fluid leak developed after surgery in 1 patient who was managed conservatively by additional stitches and repeated dressing. One patient in the series had a superficial wound infection that was successfully treated with a course of oral antibiotics. Facial numbness occurred after microvascular decompression in 2 patients and it was well tolerated, it usually disappears after one month. There were no cases of postoperative anesthesia dolorosa (facial anesthesia with severe paresthesia). Meningitis did not occur in this study.

Case presentation

Our patient, a 52-year-old female, had a 2-year history of a typical left TN. She suffered from paroxysms of electric shock-like pain that involved the second and

Table 3 Distribution of the studied sample according to the offending vessels:

The offending vessel	No.	%
AICA	1	5
SCA	9	45
Vein	3	15
SCA and AICA	1	5
SCA and vein	6	30
Total	20	100

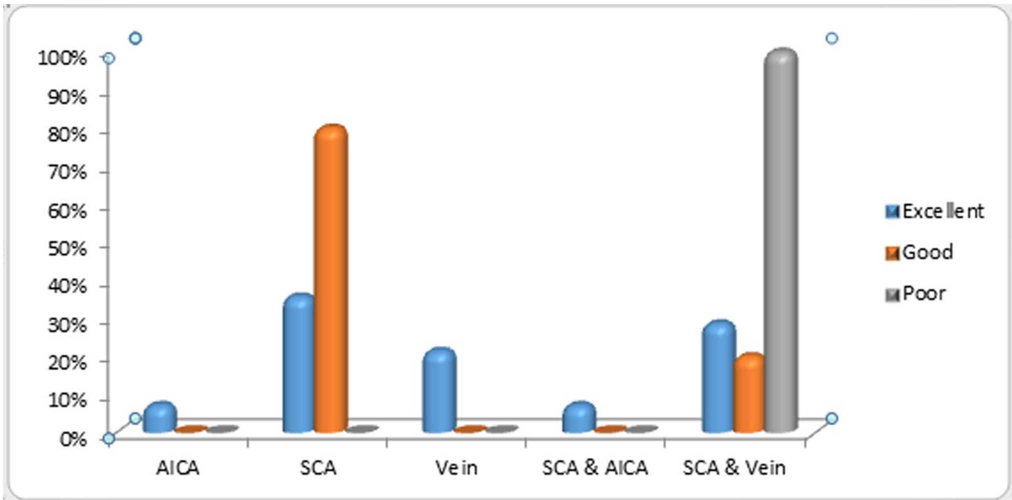

Fig. 1 Overall results of 20 cases of MTN according to causes of TN

Table 4 Relation between the VAS results of the studied sample

VAS	Preoperative	Postoperative			χ^2	*p* value
		Immediate	After 3 months	After 6 months		
Min–Max	9–10	5–9	3–9	0–8	59.455	0
Mean ± SD	9.7 ± 0.47	6.1 ± 1.12	4.35 ± 1.5	1.85 ± 1.79		
Median	10	6	4	1.5		
Mean Rank	4	2.95	2.05	1		

χ^2 = Friedman test

Table 5 distribution of the immediate postoperative VAS results according to pain distribution

Pain distribution	Immediate postoperative VAS results					
	Excellent		Good		Poor	
	No.	%	No.	%	No.	%
V1	0	0	0	0	0	0
V2	2	14.3	1	20	0	0
V3	3	21.4	1	20	1	100
V1 and V2	1	7.2	1	20	0	0
V2 and V3	5	35.7	2	40	0	0
V1 and V2 and V3	3	21.4	0	0	0	0
Total	14	100	5	100	1	100

third trigeminal branches without autonomic symptoms or other neurological deficits. Carbamazepine was ineffective in achieving pain relief at a daily dose of 600 mg without side effects.

Cranial magnetic resonance imaging (MRI) with constructive interference in steady state (CISS) demonstrated offending vascular loop near the left trigeminal nerve complex (Fig. 2).

Surgical decompression was proposed because medication was poorly tolerated. A left retrosigmoid approach was performed with cerebellopontine angle and trigeminal nerve exposure. Arachnoid dissection revealed the

Fig. 2 Preoperative axial MRI with constructive interference in steady state showing the offending vascular loop (long arrow) near the left trigeminal nerve complex (short arrow)

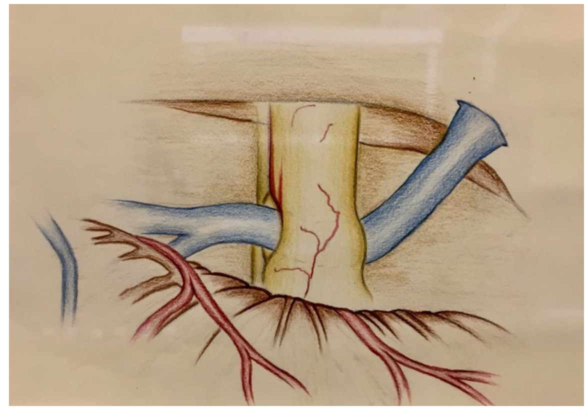

Fig. 4 Illustration of the neurovascular conflict caused by the vein passing through the trigeminal nerve itself at its root entry zone. "© 2020 [Asmaa Edres]. Used with permission"

offending vessel as a Tributary of the petrosal vein passing through the trigeminal nerve itself. Microvascular decompression was performed by coagulating the offending vein and dividing it proximal to the root entry zone of the trigeminal nerve followed by placing pieces

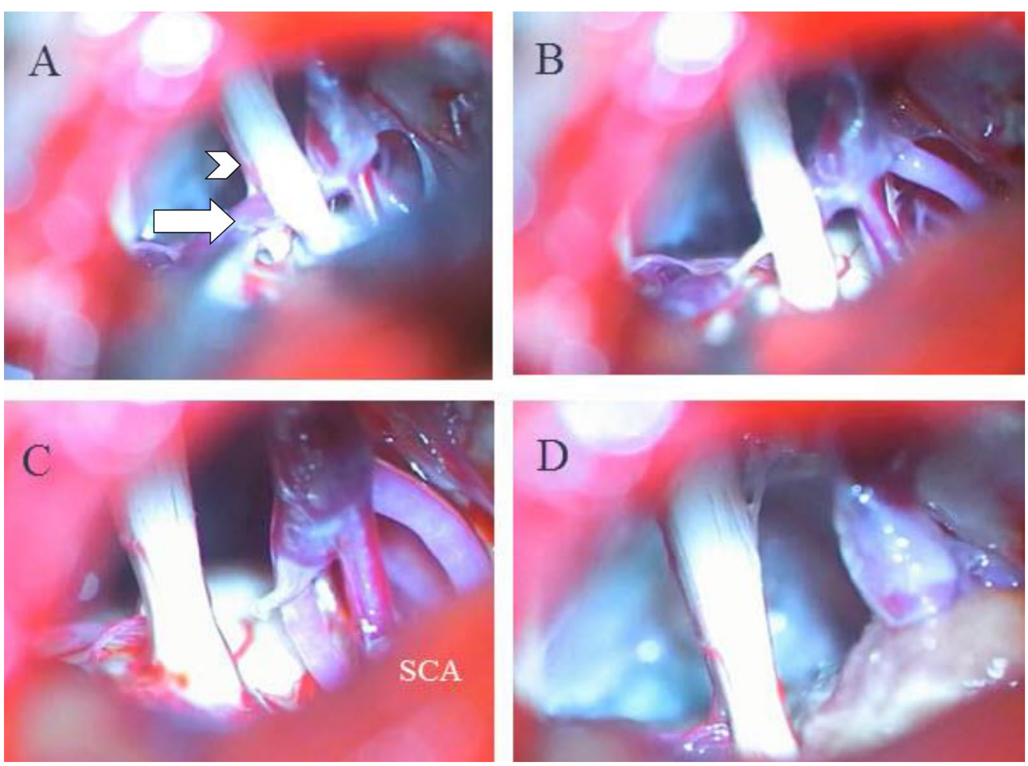

Fig. 3 Surgical approach of our case. **A** Intraoperative microscopical view of the neurovascular conflict via a retrosigmoid approach demonstrating a tributary of petrosal vein (long arrow) passing through the substance of trigeminal nerve itself (short arrow). **B** Coagulation of the offending vein prior to **C** dividing it proximal to the root entry zone of the trigeminal nerve with vivid view of the SCA (black arrow) beneath. **D** Transposing the stump by placing pieces of Gelfoam between the nerve and the vessel stump. SCA: superior cerebellar artery

of Gelfoam and Teflon between the nerve and the vessel stump (Figs. 3, 4).

Post operatively trigeminal neuralgia resolved completely, and there were no adverse effects of surgery. She was discharged on day 3 post op.

Three weeks after surgery, the patient was seen in consultation and still had no pain, despite the halving of its drug treatment. There was no hearing loss, dizziness, other neurological sign, or cerebrospinal fluid (CSF) leak.

Discussion

TN is the most frequent disorder to affect the fifth cranial nerve. It usually begins as a relapsing disease with pain-free intervals that may last months or years. These intervals, however, typically grow shorter and eventually disappear. As the disease progresses, patients can have difficulty talking, eating, and maintaining facial hygiene out of fear of triggering the pain. Current treatment usually begins with carbamazepine, which frequently provides relief from symptoms. Unfortunately, the relief provided by carbamazepine or other drugs may decrease over time, and side effects such as hyponatremia or difficulty with balance may necessitate discontinuation of the medication. About half of all patients eventually require an operation for pain relief [7].

The characteristics of the patients in this series, such as sex, affected side, and affected division, were consistent with those of the previous reports [8, 9]. In this study, patients were predominantly female (male to female ratio was 2–3), pain was mainly right sided (right to left ratio was 2.3:1) and the mandibular area was most affected. The mean age of symptom onset was 57 years in the patients with all types of TN.

MVD is the mainstay of treatment for refractory TN. Furthermore, after MVD, the trigeminal nerve is preserved, and denervation of the face, with facial dysesthesia and anesthesia dolorosa, is avoided. Large published studies have shown that the pain is completely relieved in 70–91% of patients and is reduced in another 6–7.6% after MVD [10, 11] and the annual recurrence rate at long-term follow-up is estimated to be 1–3.5%.

The current study showed that MVD is effective in classical trigeminal neuralgia (p value < 0.001). The comparison of the outcomes with those in large published series showed similar success and recurrence rates. Barker et al. [10] presented their long-term outcome results after MVD of 1185 patients. Eighty percent of their patients were completely pain free after MVD, and 7.6% obtained partial relief. At the 10-year follow-up evaluation, 70% of them still had pain relief and no extra medications were needed, whereas 4% had partial relief. In the series of Tyler-Kabara et al. [12], 98.2% had immediate pain relief and excellent long-term pain relief was achieved in 73.7% patients.

Careful inspection of the trigeminal nerve in a circumferential fashion allowed us to detect the various patterns of neuro-vascular conflicts. Barker et al. in his series of 1185 operated patients, found the superior cerebellar artery (SCA) as the main vessel in contact with the nerve (75.5%), the anterior-inferior cerebellar artery (AICA) was involved in 9.6%, the vertebral artery in 1.6%, the basilar and the posterior-inferior cerebellar artery (PICA) in 0.7% and the labyrinthine artery in 0.2%. A vein contributed to the compression in 68% of patients and was the only compressing vessel in 12%. However, the veins involved in this compression were not listed completely by name [10].

Various patterns of neuro-vascular conflicts are seen through posterior approach of right cerebello-pontine angle, superior cerebellar artery located supero-medial or superolateral to the trigeminal nerve or anterior inferior cerebellar artery inferiorly compressing the trigeminal root entry Zone at the pons [13].

Venous structures causing a neurovascular contact were more inconsistent. The normal anatomy of the veins in this region is quite variable and it includes, among other things, the superior petrous vein that arises after the junction of a transverse pontine vein, the vein of the medial cerebellar peduncle and the cerebellar-pontine scissure vein among others. The superior petrous vein goes up and laterally to find the superior petrous sinus [14].

Matsushima et al. found three kinds of veins to be the offending vein. The transverse pontine vein was the vein most frequently found in 67.2% of the cases. Both the ponto-trigeminal vein and the vein of the cerebellar-pontine fissure were found in 28.6% [15].

Depending on the anatomic situation, three different methods for decompression of the veins are used, including cutting, interposing, and transposing by the sling technique. The offending vein is coagulated and cut when the vein is one of several superior petrosal veins. However, the vein is not cut in cases in which it was a large main drainer, such as the single superior petrosal vein, because of fear of complications arising when sacrificing the superior petrosal vein. In our case, we used the cutting method followed by interposing pieces of Teflon between the nerve and the vessel stump.

The use of the endoscope after microscopic decompression was completed yielded no further benefit. It was performed in 4 patients to evaluate the quality of the initial decompression and/or defining any missed trigeminal nerve conflicts. Using a similar technique on a larger number of cases, Jarrahy et al. [16] found that 14 out of 51 (28%) compressive vessels were only visible on endoscopy and that MVDs were inadequate in 21 patients (25%) after endoscopic review. However, comparison of patient outcomes with those of larger series [10, 17] suggested that despite a subjectively better perspective and an objectively improved detection of pathology, overall surgical results are unchanged by the addition of endoscopy.

Low rates of severe postoperative facial numbness and dysesthesia in our study are additional advantages of microvascular decompression which are more likely with both radiofrequency thermal rhizotomy and glycerol rhizotomy [18]. The morbidity rates in the largest published series included: intracranial hemorrhage or stroke after MVD develops in 0.1–2%, hearing loss is noted in 3–8%, sensory loss occurs in 5–31%, and the mortality rate is 0–1% (42–53). In the series of Levi and Jannetta [17] that included 1336 consecutive MVD procedures, there were 2 deaths (0.15%), 5 vascular complications (0.37%), and 42 permanent cranial nerve deficits (3.1%). In another large series reported by Tyler-Kabara et al. [12], vascular complications were recorded in 0.2%, edema in 0.4%, hydrocephalus in 0.1%, facial nerve palsy in 1.7%, and hearing loss in 1.4%; other cranial nerves were affected in 4.6%, CSF leak occurred in 1.6%, and the mortality rate was 0.2%. There were no perioperative mortalities regarding our study.

Conclusion

In summary, we found microvascular decompression to be safe and effective in relieving typical trigeminal neuralgia. The high rate of long-term success makes MVD is the treatment of choice in patients with medically refractory TN, unless their general condition prohibits it. It's worth noting that the normal anatomy of the veins in this region is quite variable and the venous structures causing a neurovascular contact are more or less inconsistent. To the best of our knowledge and despite the wide range and progress in microvascular decompression surgery for trigeminal neuralgia, this is the first recorded case in the literature for a neurovascular conflict caused by a vein passing through the trigeminal nerve itself.

Abbreviations

TN: Trigeminal neuralgia; MVD: Microvascular decompression; MRI: Magnetic Resonance Imaging; CISS: Constructive interference in steady state; FIESTA: Fast Imaging Employing Steady-state Acquisition; VAS: Visual analog pain scale; CSF: Cerebrospinal fluid; SCA: Superior cerebellar artery; AICA: Anterior-inferior cerebellar artery; PICA: Posterior-inferior cerebellar artery.

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Author contributions

AA has participated in performing surgical procedures, helped in writing and reviewing manuscript and data collection. TR has participated in performing surgical procedures; WK participated in performing surgical procedure and helped in writing and reviewing manuscript and data collection. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study protocol was formally reviewed and approved by the ethics committee for human research at Faculty of Medicine, Alexanria University.

Consent for publication

In behalf of my co-author, I hereby confirm that the patient had capacity and consented to the operation of retrosegmid craniotomy for trigeminal nerve microvascular decompression in reference to the manuscript submitted and that the patient consented for the publication of his/her information in the present manuscript.

Competing interests

The authors declare there are no competing interests.

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