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Long-term follow-up of microvascular decompression for management of trigeminal neuralgia

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Abstract

Background: Trigeminal neuralgia (TN) is mostly caused by neurovascular compression of the trigeminal nerve and the root entry zone at the brain stem. Microvascular decompression (MVD) has been established as a standard treatment for trigeminal neuralgia in patients not adequately controlled by medications.

Objectives: Reporting the long-term outcome of MVD in our group of patients with follow-up period equal to or more than five years.

Patients and methods: Twenty-one patients operated by MVD for TN were followed up for at least five years, they were evaluated describing the patient criteria and operative findings, complications, and the long-term clinical outcome.

Results: Sixteen of the twenty-one patients had complete pain relief maintained for up to five years and three of them up to eight years. Two patients had significant improvement but with mild occasional pain not requiring medications only one of them had his occasional pain maintained till five years, three patients experienced persistent pain which was still there after five years one of them showed mild improvement in his pain after one year of follow-up. Complications were mild and/or transient most frequent were headache nausea and dizziness.

Conclusion: In the long-term follow-up, microvascular decompression still maintains its clinical benefit with most patients still pain free after at least five years and up to eight years. It is safe procedures and should be considered in every patient with failed medical treatment.

Background

Trigeminal neuralgia is a disorder characterized by recurrent unilateral brief electric shock-like pain, abrupt in onset and termination, limited to the distribution of one or more divisions of the trigeminal nerve, and triggered by innocuous stimuli including chewing, speaking, swallowing, or brushing teeth [1].

The classic episodes of shooting pain are interrupted by pain-free intervals with remissions occasionally lasting for years [2]. The resulting pain has a negative impact on patients' daily functioning, profoundly impairing quality of life [3, 4].

Trigeminal neuralgia is a relatively rare condition; however, it is the most common cranial neuralgia, and population-based studies report a prevalence ranging from 0.03 to 0.3% with annual incidence of 4.7/100,000 [5].

TN was classified in different ways, Burchiel and colleagues differentiated idiopathic trigeminal neuralgia from other causes of trigeminal neuropathies or facial pain such as nerve injury, multiple sclerosis, or Herpes zoster, he further subdivided idiopathic TN into TN1 with sharp, shooting, electrical shock-like episodic pain, and TN2 with aching, throbbing, burning, > 50% constant pain. Neurovascular compression of trigeminal nerve at

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the root entry zone was reported as being the most common cause of idiopathic trigeminal neuralgia [6].

There are various treatment modalities for trigeminal neuralgia, medications with carbamazepine being the gold standard drug therapy, [7] radiosurgery, minimally invasive interventions (as glycerol injections, radiofrequency lesion, and balloon compression) and microsurgical treatment in the form of microvascular decompression of the trigeminal neuralgia and the root entry zone at the brain stem, a procedure developed initially by Janettta in the late sixties [8, 9].

MVD is an effective treatment of TN with sustained favorable outcome, viable studies are reporting significant improvement/relief of pain after MVD between 87 and 98% which declines to 80% after 2 years [10–13].

In our study twenty-one patients with TN who underwent MVD were followed up for a minimum of 5 years, we aim at evaluating the long-term results for idiopathic TN patients, in addition to evaluating safety and prognostic factors.

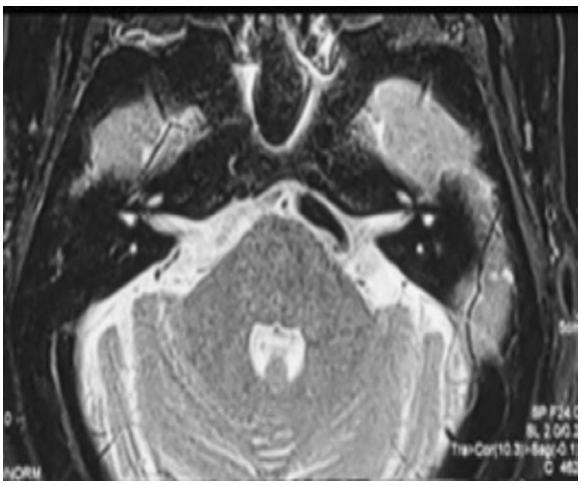

Fig. 1 Axial T2 weighted image MRI brain of one of the patients showing left sided neurovascular compromise (found to be SCA)

Patients and methods

Patients

In the period from 2009 to 2017 twenty-one patients with typical or idiopathic TN were operated for MVD by the main author. In a retrospective cohort study, this group was followed with respect to the clinical outcome after surgery in terms of pain improvement or relief and postoperative morbidity and complications. All patients in this study had preoperative drug therapy with no adequate benefit for more than three years and some had undergone other interventions. Preoperative MRI brain was done for all patients including 3D T1- and T2-weighted high-resolution sequences, for clear visualization of the trigeminal nerve and all vascular structures and for other causes of TN to be ruled out. Patients with MS and other secondary trigeminal neuropathies were excluded in this study (Fig. 1).

The baseline demographic and clinical preoperative data were collected (including sex, age, duration of disease, affected side, distribution of pain) and history of previous ablative procedures (radiofrequency rhizotomy).

The intraoperative data of the patients were also recorded, including the type of the offending vessel, the postoperative assessment was done at one month, one year, two years, five years for all patients and, for available patients, longer follow-up was done for up to 8 years.

Surgical methods

All operations were performed by one neurosurgeon (the main author). After general anesthesia, the patients were placed in the park bench semi prone position with the affected side facing upward immobilized in Mayfield clamp and the head. The suboccipital retrosigmoid approach was used for all operations. The diameter of the bone window was approximately 4 cm. After opening the dura mater, part of the cerebrospinal fluid was suctioned out, and the arachnoid surrounding the trigeminal nerve was carefully dissected. The position of the patient's head and the angle of the microscope were adjusted, and the full length of the trigeminal nerve root was carefully explored to identify the compressing vessels. The compressing vessel was identified, mobilized, and displaced away from the nerve and the root entry zone, and pieces of shredded Teflon implant were used to keep the vessel away from the nerve and the root entry zone. The operation was ended after the full length of the trigeminal nerve including the REZ was explored and confirmed to be clear of any offending vessels; all offending vessels were double-checked and reconfirmed to be removed from the nerve. At the end, the dura was closed with watertight-interrupted sutures to prevent cerebrospinal fluid leakage.

Evaluation of outcome

The postoperative outcome in terms of pain improvement/relief was assessed by Barrow neurological institute pain intensity scale (BNI) the outcome was divided into the following two categories: favorable (BNI score I-II) and unfavorable (BNI score III-V) Table 1.

Statistical analysis

SPSS statistical software 25.0 (IBM Corp., Armonk, NY, USA) was used for data analysis. Numerical variables are expressed as the mean ± SD. Qualitative variables are described as the absolute value of cases in the distinctive

Table 1 Barrow neurological institute pain scale

Score	Pain
I	No trigeminal pain, no medications
II	Occasional facial pain, not requiring medications
III	Some pain, adequately controlled with medications
IV	Some pain, not adequately controlled with medications
V	Severe pain or no pain relief

Reproduced from Rogers CL, Shetter AG, Fiedler JA, Smith KA, Han PP, Speiser BL. Gamma knife radiosurgery for trigeminal neuralgia: the initial experience of The Barrow Neurological Institute. Int J Radiat Oncol Biol Phys. 2000;47(4):1013–1019. © 2000 Elsevier Science Inc. Published by Elsevier Inc. All rights reserved.14

Fig. 2 Intraoperative view of the same patient showing adequate mobilization of the SCA away from TN and placing the Teflon implant

group. Significant differences between groups were indicated when $p < 0.05$.

Results

Clinical features

In the period from 2009 to 2017, MVD was performed in 21 patients with idiopathic trigeminal neuralgia who were followed up for a minimum of five years with three patients also available for follow-up after 8 years with mean follow-up period 5.4 ± 1.1.

Of the twenty-one patients twelve were females (57%) and nine were males (43%), the average age at surgery was 52 with maximum being 64 and minimum 38 years old. The duration of pain had a mean of 6.24 ± 2 with eleven patients (52%) the left side was affected and in 10 patients (48%) suffered from the right side (Fig. 2).

In our group of patients, we did not have any patients with affection of V1 division weather isolated or in combination with V2 or V3; however, we had seven patients

Table 2 Summary of the patients' characteristics

	Number of cases	Percentage %
Total	21	100
Sex		
Male	9	43%
Female	12	57%
Age		
< 40	1	5%
40–60	17	81%
> 60	3	14%
Side		
Right	10	48%
Left	11	52%
Location		
V2	7	33%
V3	2	10%
V2 + V3	12	57%

Three of our patients had previous intervention in the form of radiofrequency ablation all of them with combined V2 and V3 affection, one had no improvement after RF and two had temporary improvement with recurrence of symptoms in less than a year

Fig. 3 intraoperative view in a patient with only venous compression found at the root entry zone

(33%) with isolated V2 two patients with isolated V3 and twelve patients (57%) with combined V2 and V3 Table 2.

Intraoperative findings and offending vessel

During MVD surgery the offending vessel was mostly the SCA, found in 15 patients (71%), four patients (24%) had the AICA as the offending vessel and in two patients we did not have evident arterial compression, but significant venous compression (Fig. 3) was found at the root entry zone Table 3.

Table 3 Type of the offending vessel

Vessel	number	Percentage %
SCA	15	71
AICA	4	19
Venous	2	10

Table 4 Postoperative complications of patients after MVD

Postoperative complication	Number	Percentage (%)
Headache, dizziness, and nausea	8	38
Confusion	1	4.8
Facial hypoesthesia	3	14.3
Hearing loss	1	4.8
Facial palsy	1	4.8
CSF leak	1	4.8

Surgical outcome

One month after surgery 18 of the 21 patients had favorable outcomes, sixteen of them had no pain without medications (BNI I), and two patients had only occasional pain not requiring any medications (BNI II), three patients had unfavorable outcomes in the form of persistent pain not relieved by analgesics (BNI IV), two of them had no signs of arterial compression intraoperatively with venous compression only found at the root entry zone, and the third one had severe arterial compression by the SCA.

At the long-term follow-up, all patients with favorable outcomes were still maintaining their improvement at the five-year follow-up assessment. The three patients followed up for eight years were still pain free without medications at their final follow-up. One of the three patients with unfavorable early outcome in the early follow-up reported some improvement in his pain which started to be occasional and controlled by medications (BNI III); however, the two patients with venous compression remained complaining of pain not adequately controlled by medications (BNI IV).

Complications

The postoperative complications are shown in Table 4. Headache, dizziness, and nausea were observed in eight patients which improved within less than a week, confusion occurred in one patient which resolved in two days. Facial hypoesthesia found in three patients, two were persistent at five years while one of them improved within six months. Mild hearing loss occurred in one patient and facial nerve palsy in one patient, both were temporary and were completely resolved at the one-year follow-up, one patient had postoperative CSF leak managed by follow-up and frequent dressing and spontaneously resolved in two weeks.

Discussion

TN has been referred to in the medical literature for centuries, description of unilateral facial pain causing spasms was found in ancient writings [15], it is considered the most common cranial neuralgia with annual incidence 4.7/100,000 [16]. A diagnosis of TN is usually based on the patient's history describing the pain as agonizing paroxysmal lancinating pain in the distribution of one or more divisions of the trigeminal nerve [1].

The age of onset of TN is usually between 40 and 60 years and seldom in patients younger than 40 years of age [16]. In our patents the mean age was 52 ± 7 with only one patient younger than 40 years old. TN occurs more often in females (female to male ratio 1.8:1) and more often on the right facial side 16 (60% right, 39% left, 1% bilateral). Twelve of our patients were females (57%) but unlike the literature, most of our patients (52%) had the left side which is probably due to the relatively small sample size. Neither age nor sex of our patients showed statistically significant correlation with the postoperative pain relief. In TN most affected nerve branches are usually a combination of the maxillary nerve (V2) and the mandibular nerve (V3) (31%), this is followed by an isolated involvement of V3 (19.3%) and V2 (18.7%). [16], in our group of patients twelve (57%) had affection of the both maxillary and the mandibular branches while seven patients (33%) had isolated maxillary affection and two patients only had isolated mandibular branch affection we did not have any ophthalmic V1 branch affection in our patients whether isolated or in association with the other divisions while presentation in the first branch is rare (only 2%) and we found no correlation between the affected trigeminal branch and the clinical outcome in terms of pain improvement or relief Table 5.

It has been shown that in about 96% of cases of typical TN, vascular compression is found [8, 17]. In the large series published by Barker and Collogues in 1996, the authors reported the operative finding in 1185 patients with trigeminal neuralgia they described that in 75% of his cases SCA was the offending vessel this was followed by AICA in 10% of cases, PICA in 1% and vertebral artery 2% they found that venous compression was a part of nerve compromise in 68% of cases being the only offending factor in 13% of cases [18], this resembles the findings in our patients where the most common offending vessel was the SCA found in 15 Patients (71%), followed by AICA in four patients (19%) venous compression was the offending factor in two patients.

Table 5 The univariate analysis of factors potentially associated with pain control outcomes in MVD

	Favorable (BNI I,II)	Unfavorable (BNI III-V)	*P* value
Age			0.614
< 50	7	1	
> 50	11	2	
Sex			0.935
Male	8	1	
Female	10	2	
Duration of illness			0.042
< 10y	20	0	
> 10y	0	1	
Distribution of pain			0.489
V2	6	1	
V2 + V3	11	1	
V3	1	1	
Offending vessel			0.014
AICA	4	0	
SCA	14	1	
Venous	0	2	

MVD has been reported to be an effective treatment of trigeminal neuralgia aiming at mobilization and displacement of the offending vessel and preserves its new position using pieces of shredded Teflon (polytetrafluoroethylene), some groups use different techniques like dural sling or different implant material like Ivaron (polyvinyl alcohol sponge), fibrin glue muscle [19, 20], and Fibrillar (oxidized cellulose). Significant improvement was reported among different groups with pain freedom ranging from 58 to 80%. A metanalysis by Holste and colleagues is carried out on 3897 patients, years estimated the mean pain freedom to happen in 76% of patients with mean follow-up 1.7 years [20], and this benefit was found to be sustained in the available long-term follow-up studies with sometimes minor changes either increase or decline in the clinical benefit [21].

We had total resolution of pain in 16 of our 21 patients 76% similar to that reported in the literature [20], and in two patients only mild occasional pain was found postoperatively not requiring any medications which makes the favorable outcome accomplished in 86%, three patients with unfavorable outcome, in two of them no offending artery could be detected and only venous compression was found in the root entry zone, this unfavorable outcome lasted up to the 5-year follow-up. This correlation between the type of offending vessel being venous compression and poor clinical outcome was statistically significant and had also been reported by different groups [20–22] (Table 5).

The third patient having unfavorable outcome had severe SCA compression with discoloration and deformation of the nerve and the root entry zone, this might be due to the permanent structural changes in the nerve fibers, the patient had mild improvement in the 5-year follow-up, this patient also had the longest preoperative symptom duration of almost 12 years, longer duration of symptoms which had been previously correlated with less favorable outcome [18, 20].

The two patients followed up for eight years did not have any clinical change than their 5-year follow-up visit.

We had a single case of recurrence, the pain initially had favorable outcome then after five years he started to experience severe attacks of pain to which he received radiofrequency ablation with only mild improvement, this might be due to recurrence of compression or Teflon granuloma recurrence was reported by other groups to happen from 0 to 26% [23].

Complications of MVD are mostly transient. Cerebellar hematoma, brain stem infarction hydrocephalus, all have been reported but only rarely, the most common complications include CSF leak and chemical meningitis, other cranial nerve affection, namely trigeminal and vestibulocochlear, have also been reported which are mostly transient 18.

We did not have any major permanent complications, the most frequent complication in our group of patients was headache, nausea, and dizziness which occurred in six patients, this might be due to CSF egress during surgery or transient chemical meningitis from the implant material, this resolved in all patients in less than a week, other cranial nerve affection occurred in two patients one of them suffered from facial palsy and the other patient had mild sensorineural hearing loss, this was transient in both cases and could be attributed to the manipulation near the nerves during mobilization of the offending vessel. One patient had postoperative CSF leak with spontaneous resolution in two weeks, in our patients we did not find correlation between incidence of complications and either patients age, duration of symptoms or offending vessel.

Conclusions

MVD is effective treatment for TN with sustained long-term benefit of up to eight years, complications are mild and/or transient and should be considered as a standard of care for patients with medically intractable TN who are adequately fit for anesthesia and craniotomy, research should continue on the pathophysiology of the disease and factors associated with favorable and unfavorable outcome for better patient selection, operative techniques, and hence clinical outcome.

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Author contributions
ZF performed the surgery, analyzed, and interpreted the patient data regarding the preoperative clinical and radiological findings and early postoperative follow-up. HA assisted in patient selection and late postoperative follow-up, data analysis and was a major contributor in writing the manuscript. All authors read and approved the final manuscript.

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Availability of data and material
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
Our study protocol was reviewed and approved by the ethical board of the department of neurosurgery Ain Shams University. Written informed consent was obtained from all involved patients enrolled in our study.

Consent for publication
Not applicable

Competing interests
The authors declare that they have no competing interests.

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