International Journal of Medical Arts

Volume 4, Issue 7, July 2022

https://ijma.journals.ekb.eg/

Print ISSN: 2636-4174

Online ISSN: 2682-3780

Available online at Journal Website
https://ijma.journals.ekb.eg/
Main Subject [Neurosurgery]

Original Article

Endoscopic Microvascular Decompression for Trigeminal Neuralgia

Ebrahim Samy Atiah [1]*, Mustafa Abd El-Samie Rabea [1], Ahmed Adel Ayad [2]

[1] Department of Neurosurgery, Damietta Faculty of Medicine, Al-Azhar University, Damietta, Egypt.
[2] Department of Neurosurgery, Faculty of Medicine, Al-Azhar University, Cairo, Egypt.

ABSTRACT

Article information

Received: 22-06-2022

Accepted: 03-09-2022

DOI: 10.21608/IJMA.2022.146440.1474

Corresponding author

Email: ebrahimsamy865@gmail.com

Citation: Atiah ES, Rabea MA, Ayad AA. Evaluation of Endoscopic Microvascular Decompression for Trigeminal Neuralgia. IJMA 2022 July; 4 [7]: 2485-2493. doi: 10.21608/IJMA.2022.146440.1474.

Background: A severe, intermittent pain in the trigeminal nerve distribution area on one side of the face is known as trigeminal neuralgia. The primary pathophysiological cause of trigeminal neuralgia is neurovascular compression, which results in demyelination of the trigeminal nerve root in the cerebellopontine angle area. Endoscopes offer 360-degree views and bright lighting, making it much easier to spot and treat vascular conflicts than with conventional techniques.

The Aim of the work: To evaluate the effectiveness of endoscopic microvascular decompression in patients with primary trigeminal neuralgia regarding pain control, recurrence rate and procedure-related complications.

Patients and methods: The current study was applied on 12 patients with 1ry trigeminal neuralgia whom afforded to endoscopic micro-vascular decompression with mean age 59.1±9.54 years. All were submitted to clinical assessment through full history, clinical neurological examination, laboratory and imaging studies. The outcome was assessed by different scales, like visual analogue scale [VAS], pain intensity score of Barrow Neurological Institute [BNI], general and facial function scores. The follow up visits were scheduled directly after surgery, and at 3 and 6 months postoperatively.

Results: The commonest affected vessel in the present study was superior cerebellar artery [SCA] [41.75%] then anterior inferior cerebellar artery [AICA] [16.7%]. Majority of patients use carbamazepine [66.7%], followed by gabapentin [58.3%]; 33% of the patients were on monotherapy and 66.7% were on combined therapy. There was significant progressive improvement of pain, general and facial function directly after surgery and till the end of follow up duration. The most common reported complication was transient unsteadiness [16.7%], with recurrence rate of 8.3% after 6 months.

Conclusion: Endoscopic microvascular decompression for trigeminal neuralgia can have a promising result as regard relieving of pain with subsequent improvement of general and facial function scores with low frequency of complications and recurrence.

Keywords: Trigeminal; Neuralgia; Endoscope; Microvascular; Decompression

INTRODUCTION

Recurrent pain attacks in the region where the trigeminal nerve branches are spread are referred to as trigeminal neuralgia [TGN]. One of the most common types of facial pain is this one. The majority of the time, the pain is unilateral, acute in start, momentary in duration, and stimulus-dependent. Maximum teeth [V2] and mandibular [V3] branches are where the pain is most frequently felt, and the ophthalmic [V1], V2, V3, or all three divisions are where it is felt least frequently. It is extremely uncommon to only involve V1. There are two categories of TGN: [1] classical or primary TGN, and [2] secondary TGN. Vascular loop is responsible for "classical TGN". Secondary TGN results from multiple sclerosis, post-herpetic neuralgia, post-traumatic neuralgia, and space-occupying lesions like meningioma, arterio-venous malformation, and CPA tumor [1, 2].

Due to its successful surgical outcomes and ability to avoid long-term recurrence, microvascular decompression [MVD] has come to be recognized as the preferred surgical method for the treatment of trigeminal neuralgia [TN]. For some patients, pharmaceutical therapy is enough to effectively control the symptoms of TN, which include intense, sporadic facial pain brought on by inflammation and injury to the trigeminal or fifth cranial nerve [3-5].

TG is a clinical syndrome interfering with patients' daily activity; although pain could be remediable with medical therapy, 20-23% of patients fail to hold permanent relief. MVD is the treatment of choice in these particular cases [6-8].

Acute TN symptoms can be improved with ablative techniques, however microvascular decompression has shown to be superior in terms of short- and long-term recurrence [9-11].

In neurosurgery, the endoscope has established itself as a common instrument, but the shift from microvascular decompression to totally endoscopic MVD has been slower and more recent. Enhancements and applications may have a positive impact on outcomes as EMVD usage increases. In contrast to conventional MVD, fully EMVD may be carried out using 4 mm 0º and 30º endoscopes. A pneumatic holding mechanism is utilized to attach the endoscope [12, 13], and this allows for the detection of perforators and neurovascular compression. With the help of Teflon string and fibrin adhesive, the damaged vessel is securely transposed while the perforator is preserved [14, 15].

THE AIM OF THE WORK

The aim of the work was to evaluate the effectiveness of endoscopic microvascular decompression in patients with primary trigeminal neuralgia regarding: pain control, recurrence rate and procedure-related complications.

PATIENTS AND METHODS

This research is a prospective observational study, held in a tertiary care single-center analysis [The department of Neurosurgery-Functional Unit-Faculty of medicine Al-Azhar University, Damietta, Egypt] for 12 patients with primary trigeminal neuralgia. Endoscopic microvascular decompression was done for all patients. The follow up visits were immediate post-operative, and 3 and 6 months after intervention.

Ethical aspects: The study protocol was reviewed and accepted by the committee of ethics [Faculty of Medicine, Al-Azhar University, Cairo, Egypt]. Each participant signed an informed consent and the study had been completed according to the codes of research conduct and reporting [Helsinki declaration].

Inclusion criteria: Patients with primary trigeminal neuralgia, who had no response to the medical treatment for at least 6 months.

Exclusion criteria: Patients with trigeminal neuralgia symptoms secondary to tumors or multiple sclerosis.

Methods: All patients were submitted to clinical assessment by complete history about the condition, general and neurological examination and assessment of pain by visual analogue scale [VAS], and pain intensity score of Barrow Neurological Institute [BNI] for facial pain [Table 1] [16]. A specific radiological assessment was completed by the fast imaging employing steady state acquisition [FIESTA] MRI of the brain was the pre-operative neuroimaging modality. In addition, brain non-contrast computed tomography [CT], and MRI with contrast were used to exclude secondary causes. Finally, magnetic resonance angiography [MRA] of the brain was used to detect the responsible vessels. The routine preoperative laboratory workup included complete blood count [CBC], liver and renal function tests, and coagulation profile. Electrocardiography, echocardiography and plain chest X-ray were used to assess the general condition of the patient.

Table [1]: Barrow Neurological Institute [BNI] pain intensity score [17]

Grade of pain intensity	Score of pain	Description
I	0	No pain, no treatment
II	1	Occasional pain, no treatment required
III	2	Some pain, adequately controlled with treatment
IV	3	Some pain, not adequately controlled with treatment
V	4	Severe pain/no pain relief

VAS Score: The visual analogue scale [VAS] is a straightforward evaluation tool that is frequently used to measure pain. It consists of a 10-cm line with 0 on one end, signifying no pain, and 10 on the other end, signifying the worst pain ever felt. A patient is asked to indicate the perceived intensity of their pain using the VAS.

BNI score: Barrow Neurological Institute [BNI] pain intensity score is a tool used to measure the degree of facial pain. It is graded from I to V and has 2 elements. 1st part measure pain intensity [no pain, occasional pain, some pain, sever pain]. 2nd part is level of medications used [17].

Consent for surgery: All participants who agree to share in this study signed an informed consent form after being fully informed about the technique and its circumstances prior to the operation of full EVD. It includes discussing the operative procedure with its intended benefits of pain relief and possible improving function. Also discussing possible postoperative complications

Surgical technique

The surgery was completed under general anesthesia. Intravenous prophylactic antibiotics were given 30 minutes before surgery. The surgery done while the patient was in the lateral [park-bench] position with the affected side facing upwards. In order to make mastoid at the highest position and maintain blood flow to the neck, the head should be lowered by 15°, and rotated 10° to the healthy side. The hair of the head on intended area was shaved. Fixation of the head onto the operating bed to be achieved with Mayfield head frame. Monitoring of auditory evoked potentials and any abnormal muscle response. To make a 2cm burr hole opening in the skull, a 3 cm length skin incision behind the auricle should be done. Suboccipital retro sigmoid craniectomy was done. Dural opening is behind the junction of the sigmoid and the transverse sinus. The endoscope is used in all next steps without using the microscope at any stage alone or with assistance. Maintaining a strict triangle during the introduction and placement of the endoscope and hand instruments and fixation to the operative field by a mechanical holding system attached to the operative table. Endoscope was placed at the vertex of a virtual equilateral triangle in surgical field of view; the vertex represented the "12 o'clock" position. The aspirator and micro-instrument passed underneath the endoscope at the "5 o'clock" and "7 o'clock" positions. The subarachnoid space was open to release the CSF very slow. To avoid brainstem retraction to see any hidden structure adjust the angle of endoscope. The trigeminal nerve was identified and the arachnoid membrane surrounding the nerve was dissected for complete release. The operative area was washed by saline and aspiration of such saline. Gelatin sponge was attached to bleeding points. The vascular conflict was identified and Teflon strips was placed in between artery and the nerve root. Removal of endoscope then watertight dural closure.

The postoperative assessment included clinical and radiological assessment. The clinical neurological included the conscious level, cranial nerves examination, and symptoms of increased intracranial pressure. The postoperative radiological assessment was achieved through computed tomography [CT] of the brain without contrast. The follow up was scheduled direct postoperative time, 3 and 6 months after intervention. Checking and recording of any postoperative unwanted situation such as [e.g., pain relief, [CSF] leakage, intracranial infection, cerebral hemorrhage, and neurological deficits].

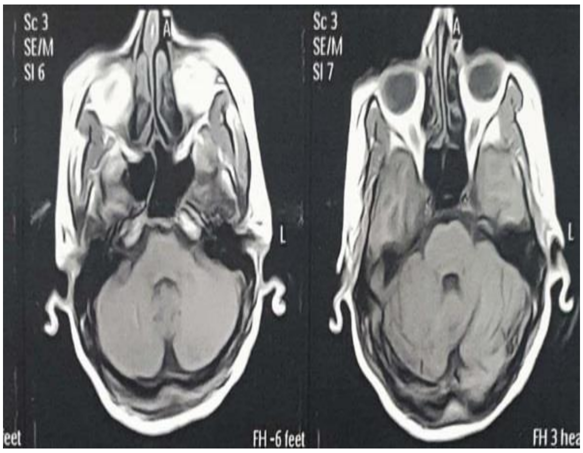

Figure [1]: Preoperative MRI brain with contrast

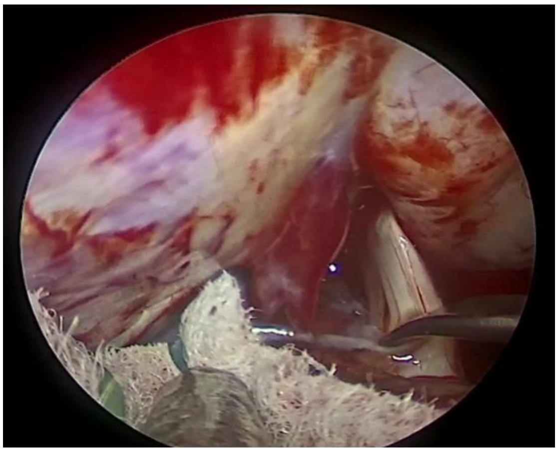

Figure [2]: Intraoperative view of EMVD

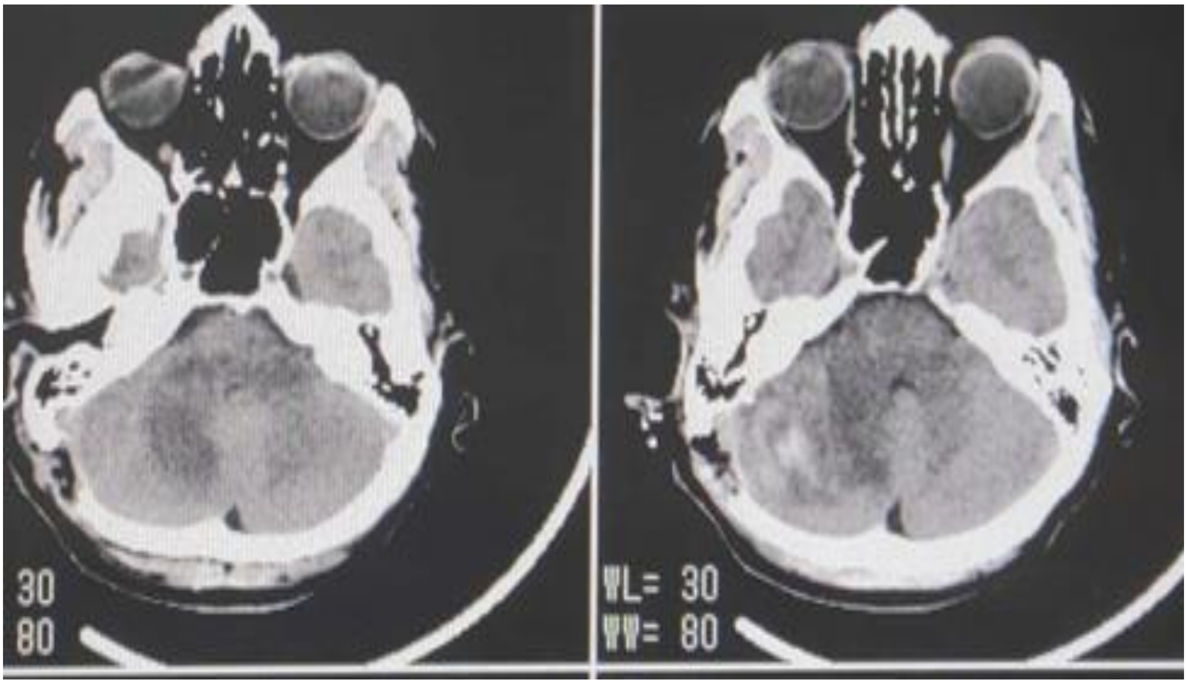

Figure [3]: Postoperative CT brain without contrast

Statistical analysis

SPSS statistical programme version 12 was used for data entry and analysis [SPSS, Inc., Chicago, IL, USA]. A mean and standard deviation were used to present the quantitative data. To assess the effect of surgery on the mean of outcome scores, a paired t-test was performed. The qualitative data were shown as percentages and numbers. The connection between the variables in the qualitative data was determined using the chi-square. Significant results are indicated by P values of <0.05.

RESULTS

In the current work, 12 patients were included. Their age ranged between 46 and 76 years, the majority were females [58.3%]. The mean age at the onset of symptoms was 57.42±8.67 years. The pain distribution was V2 in 5 cases [3 right and 2 left], V3 in 2 cases [one on the right and one on the left], V1 and V2 was reported on one case on the right side, V2 and V3 was reported in 3 patients [2 on the right and one on the left]. The V1, V2 and V3 was reported by one patient [left side] [Table 2].

According to vessel distribution, the most common was superior cerebellar artery [SCA] among five cases [41.7%] then anterior inferior cerebellar artery in 16.7%. The least affected vessel was basilar artery [8.3%] [Table 3].

The majority of patients use carbamazepine 8[66.7%] followed by gabapentin 7[58.3%] 4 [33.3%] of the patients were on monotherapy and eight [66.7%] were on combined therapy [Table 4].

In the current work, the function outcome at the end of follow up was favorable, as there was statistically progressive significant decrease of pain, general functions score and facial function scores after surgery an at the follow up visits [Table 5].

The frequent postoperative complications were transient unsteadiness/dizziness [16.7%]. Then, hearing loss, vertigo, headaches, vision problems, CSF leak, and facial palsy [each in 8.3%] [Table 6].

Table [2]: Demographic and pain distribution data of the studied patients

			The studied patients [N=12]
Age [years]		Mean±SD [range]	59.1 ±9.54 [46 - 76]
Sex		Male Female	5 [41.7%] 7 [58.3%]
Age at onset of symptoms Mean ± SD			57.42 ± 8.67
Pain distribution	V2	Right Left	3 [25%] 2 [16.7%]
	V3	Right Left	1 [8.3%] 1 [8.3%]
	V1 and V2	Right	1 [8.3%]
	V2 and V3	Right Left	2 [16.7%] 1 [8.3%]
	V1, V2 and V3	Left	1 [8.3%]

Table [3]: Vessels distribution among the studied subjects

	The studied patients [N=12]	
	No.	**%**
Superior cerebellar artery [SCA]	5	41.7%
Anterior inferior cerebellar artery [AICA]	2	16.7%
Vein only	1	8.3%
SCA and AICA	2	16.7%
SCA and vein	1	8.3%
Basilar artery	1	8.3%

Table [4]: Drug treatment distribution among the studied subjects

	Monotherapy [N=4]		Double therapy [N=2]		Triple therapy [N=3]		Quadruple therapy [N=3]	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Phenytoin	1	25%	1	50%	1	33.3%	2	66.7%
Carbamazepine	1	25%	1	50%	3	100%	3	100%
Oxcarbazepine	1	25%	1	50%	2	66.7%	1	33.3%
Gabapentin	1	25%	1	50%	2	66.7%	3	100%
Baclofen	0	--	0		1	33.3%	3	100%

Table [5]: Functional outcome of the studied patient

Variables		Baseline	Immediate PO	At 3 months	At 6 months	P value
Pain	Score at its Worst	9.88 ± 1.31	6.27 ± 1.02	1.63 ± 0.528	0.0	<0.001*
	Score at its Least pain	1.25 ± 0.445	1.03 ± 0.369	0.881 ± 0.101	0.0	<0.001*
General function store	Activity	8.66 ±2.51	5.68 ± 1.93	1.87 ± 0.954	0.0	<0.001*
	Mood	8.35 ±2.16	6.37 ± 2.08	1.92 ± 0.642	0.0	<0.001*
	Walking	3.26 ±1.13	2.11 ± 0.917	0.942 ± 0.346	0.0	<0.001*
	Work	8.19 ±1.27	5.44 ± 1.62	1.75 ± 0.747	0.0	<0.001*
	Relationships	7.56 ±1.92	4.51 ± 1.14	1.97 ± 0.854	0.0	<0.001*
	Sleep	7.64 ±2.13	4.78 ± 1.27	1.35 ± 0.612	0.0	<0.001*
	Enjoyment of life	9.32 ±2.68	7.14 ± 1.15	1.71 ± 0.851	0.0	<0.001*
	Mean score	6.42 ±1.87	4.05 ± 1.19	2.48± 0.972	1.1 ± 0.057	<0.001*
Facial function score	Eating	9.67 ± 2.58	5.32 ± 1.38	1.63 ± 0.651		<0.001*
	Touching	8.71 ± 1.67	3.54 ± 1.04	1.01 ± 0.652		<0.001*
	Brushing	9.28 ± 2.27	5.23 ± 1.68	1.72 ± 0.843		<0.001*
	Smiling	8.43 ± 2.31	4.54 ± 1.53	1.64 ± 0.751		<0.001*
	Talking	8.87 ± 1.41	4.72 ± 1.37	1.83 ± 0.882		<0.001*
	Opening mouth	8.38 ± 1.57	4.92 ± 1.38	1.33 ± 0.762		<0.001*
	Hard foods	10.14 ± 2.85	5.42 ± 1.64	1.58 ± 0.921		<0.001*
	Mean total score	7.61 ± 1.19	5.58 ± 1.02	2.16 ± 0.935	1.3 ± 0.074	<0.001*

Table [6]: Postoperative complications and mortality among the studied patients

		The studied patients [N=12]	
		No.	%
Complications	Hearing loss	1	8.3%
	Transient unsteadiness/dizziness	2	16.7%
	Vertigo	1	8.3%
	Headaches	1	8.3%
	Vision problems	1	8.3%
	CSF leak	1	8.3%
	Facial palsy	1	8.3%

DISCUSSION

The current work aimed to evaluate the effectiveness of endoscopic microvascular decompression in patients with primary trigeminal neuralgia regarding pain control, recurrence rate and procedure-related complications. Twelve patients were included, females represented 58.3% of them. The V2 distribution was the commonest and superior cerebellar artery as the commonest vessel. transient unsteadiness [16.7%] was the common reported postoperative complication. The functional outcome was favorable as the pain score was progressively and significantly reduced from its basal preoperative values to be nearly absent at the end of follow up duration. All domains of general function and facial function scores were significantly improved immediately postoperative and progressive improvement was witnessed until the end of follow up duration.

Farid and Elkheshin [18] reported a female sex predominance [76.0%] among 25 patients with TN, and SCA was the commonest compressed vessel [88%]. **Yadav *et al.*** [19] found 28/51 patients [54.9%] were V2 and 20/51 were V3 [39.2%]. These results are confirmed in the current work, regardless of the high percentages of females in **Farid and Elkheshin** [17] which could be explained by different inclusion criteria and increased their sample. Similarly, **Dubey *et al*.** [20] included 230 patients with TN for full endoscopic micro-vascular decompression and found that SCA was the utmost frequent vascular dispute followed by AICA [96/230].

In the current study; the most common postoperative complication was transient unsteadiness [16.7%]. Another study by **Teo *et al*.** [21] which was conducted on 114 patients with TN who underwent endoscopic micro-vascular decompression and reported that 9 patients had trigeminal sensory dysfunction, and

2 patients had hearing affection postoperatively. **Thirumala *et al.*** [22] reported on 93 TN patients with different types of neuralgias and revealed the percentage of hearing loss accounted 30.84%. **Kher *et al.*** [23] conducted a study on 178 patients with TN who underwent endoscopic microvascular decompression and found that only 11/178 of patients their pain relief was less than 75% and required pain medications, there was no death, temporary complications included trigeminal dysesthesia [3.9%], CSF leak, facial paresis, decreased hearing and vertigo in 5, 7, 3, 6 patients respectively**. El-Garem *et al.*** [24] A study was done on 42 TN cases to evaluate the use of endoscopy in TN cases. It found that 10% of the patients had CSF leaks, but only 1% of them required revision surgery. Facial palsy struck 3% of individuals. **Abdeen *et al.*** [25] study which was conducted on 12 cases of TN. Another study by **Artz *et al.*** [26] was conducted on 20 TN patients who underwent endoscopic vascular decompression which found a reduced incidence of complications and a better prognosis than other studies. Careful repair and avoiding the use of brain retractors can prevent these issues.

The current study revealed statistically significant decreased mean pain score as its worst and least from baseline to follow up. Another study by **Akkaya *et al.*** [27] included 63 TN patients, 69.8% were pain free following pure microscopic microvascular decompression. Also, **Sindou *et al.*** [28] explained how SCA may have branches that are masked by the medial trigeminal root and lateral pons, making it difficult to see under a microscope. An almost two-fold greater Field of view was offered by a 30º endoscope than by a microscope, according to **Tang *et al.*** [29]. Another study by **Setty *et al.*** [30] assessed the outcomes of a group of TN patients who underwent EMVD treatment and found that 98% of them either total pain reduction or well-controlled pain following surgery. Another study by **Dubey *et al.*** [20] at the end of a 3-month and 5-year follow-up period, respectively, 93.5% and 82.6% of patients had completely relieved their pain.

In contrast, several studies found no appreciable difference between the cure rates for TN treated with EMVD and microscopy by **Xiang *et al.*** [31]. According to another work by **Lee *et al.*** [32] complete EVD and standard MVD appeared to offer patients similar levels of alleviation from face pain. In a similar study by **Komatsu *et al.*** [14] reported full symptom remission and no mortality following EVD.

In line with the results of the current work, **Bohman *et al.*** [12] study which was conducted on 47 TN patients who had EMVD and revealed statistically significant decreased facial function score postoperatively and in follow up with p-value <0.0001. They also revealed statistically significant decreased facial function score postoperatively and in follow up with p-value <0.0001.

Consider the low depth of field and the requirement for hand-eye coordination as disadvantages of the fully endoscopic approach. Practicing on cadavers and models calls for a lot of effort. The process, however, becomes simple and secure once the initial steep learning curve has been passed. Also taken into account is decompression, which necessitates bimanual dexterity. The surgeon cannot reach this level of dexterity if he or she is made to hold the endoscope. As a result, full EMVD is performed utilizing an endoscopic holder, allowing the surgeon to perform the decompression without the use of a surgical microscope. Nevertheless, the endoscope holder does not offer a sufficient dynamic range of movement. By synchronizing with the primary operator, an assistant with extensive endoscopic experience should perform EMVD procedures. The assistant's presence can significantly reduce the length of the operation [13, 33, 34].

Conclusion

Endoscopic microvascular decompression for trigeminal neuralgia can have a promising result as regard relieving of pain with subsequent improvement of general and facial function scores with low frequency of complications and recurrence.

Study limitations and recommendations: The current study adds to the available literature about the role of endoscopic microvascular decompression for trigeminal neuralgia and confirmed the efficacy and safety of the procedure. However, it was conducted on narrow scale, which need further longitudinal studies with large sample size for further evaluation of endoscopic microvascular decompression for trigeminal neuralgia. Endoscopic microvascular decompression is needed to be compared with other techniques.

Conflict of interest and financial disclosure: None

REFERENCES

1. Xu R, Xie ME, Jackson CM. Trigeminal Neuralgia: Current Approaches and Emerging Interventions. J Pain Res. 2021 Nov 3; 14:3437-3463. doi: 10.2147/JPR.S331036.

2. Chen Q, Yi DI, Perez JNJ, Liu M, Chang SD, Barad MJ, Lim M, Qian X. The Molecular Basis and Pathophysiology of Trigeminal Neuralgia. Int J Mol Sci. 2022 Mar 25;23[7]:3604. doi: 10.3390/ijms23073604.

3. Paulo DL, Lopez AM, Jermakowicz WJ, Yu H, Shah H, Konrad PE, Englot DJ. Microvascular Decompression for Trigeminal Neuralgia in Patients with Multiple Sclerosis: Predictors of Treatment Success. World Neurosurg. 2020; 136: e165-e170. doi: 10.1016/j.wneu.2019.12.081.

4. Herta J, Schmied T, Loidl TB, Wang WT, Marik W, Winter F, *et al.* Microvascular decompression in trigeminal neuralgia: predictors of pain relief, complication avoidance, and lessons learned. Acta Neurochir [Wien]. 2021 Dec;163[12]:3321-3336. doi: 10.1007/s00701-021-05028-2.

5. Huang CW, Yang MY, Cheng WY, Pan SY, Wang CL, Lai WY, *et al.* Predictive and prognostic factors for outcome of microvascular decompression in trigeminal neuralgia. J Chin Med Assoc. 2022 Feb 1;85[2]:198-203. doi: 10.1097/JCMA.0000000000000667.

6. Fillingim RB, Ohrbach R, Greenspan JD, Knott C, Dubner R, Bair E, *et al.* Potential psychosocial risk factors for chronic TMD: descriptive data and empirically identified domains from the OPPERA case-control study. J Pain. 2011 Nov; 12[11 Suppl]:T46-60. doi: 10.1016/j.jpain.2011. 08.007.

7. Alwardian M, Chrysikos D, Samolis A, Papachristou A, Spartalis E, Piagkou M, Troupis T. Trigeminal Neuralgia and Potential Correlations with Anatomical Variations of the Trigeminal Nerve. Acta Med Acad. 2021 Aug; 50[2]:292-299. doi: 10.5644/ama2006-124.344.

8. Ferneini EM. Trigeminal Neuralgia. J Oral Maxillofac Surg. 2021 Nov;79[11]:2370-2371. doi: 10.1016/j.joms.2021.08.001.

9. Tajali Y, Ward M, Abraham M, Hillen M, Mahmoud O, Herschman Y, Mammis A, Paskhover B. Minimally invasive trigeminal ablation in patients with refractory trigeminal neuralgia who are ineligible for intracranial intervention. J Clin Neurosci. 2019; 70:42-46. doi: 10.1016/j.jocn.2019.09.002.

10. Mizobuchi Y, Nagahiro S, Kondo A, Arita K, Date I, Fujii Y, *et al.* Microvascular Decompression for Trigeminal Neuralgia: A Prospective, Multicenter Study. Neurosurgery. 2021 Sep 15;89[4]:557-564. doi: 10.1093/neuros/ nyab229.

11. Singh D, Dutta G, Jagetia A, Singh H, Srivastava AK, Tandon M, Ganjoo P. Microvascular Decompression for Trigeminal Neuralgia: Experience of a Tertiary Care Center in India and a Brief Review of Literature. Neurol India. 2021 Mar-Apr;69[Supplement]:S206-S212. doi: 10. 4103/0028-3886.315975.

12. Bohman LE, Pierce J, Stephen JH, Sandhu S, Lee JY. Fully endoscopic microvascular decompression for trigeminal neuralgia: technique review and early outcomes. Neurosurg Focus. 2014;37[4]:E18. doi: 10.3171/2014.7. FOCUS14318.

13. Sun Z, Wang Y, Cai X, Xie S, Jiang Z. Endoscopic Vascular Decompression for the Treatment of Trigeminal Neuralgia: Clinical Outcomes and Technical Note. J Pain Res. 2020 Sep 3;13:2205-2211. doi: 10.2147/JPR.S268441.

14. Komatsu F, Kato Y, Hirose Y. How I do it: two-step transposition technique during endoscopic microvascular decompression for trigeminal neuralgia. Acta Neurochir [Wien]. 2022; 164[3]: 823-826. doi: 10.1007/s00701-021-05080-y.

15. Ferroli P, Bonomo G, Iess G, Acerbi F. Microvascular Decompression through Cyano-acrylate Glue-Coated Teflon Sling Transposition Technique. World Neurosurg. 2022; 160:54. doi: 10.1016/j.wneu.2022.01.086.

16. Castro MRH, Magill ST, Morshed RA, Young JS, Braunstein SE, McDermott MW, Chang EF. Facial pain and sensory outcomes following resection of tumors compressing the trigeminal nerve. J Neurosurg. 2021 Oct 8;136[4]:1119-1127. doi: 10.3171/2021.4.JNS203612.

17. Riesenburger RI, Hwang SW, Schirmer CM, Zerris V, Wu JK, Mahn K, *et al.* Outcomes following single-treatment Gamma Knife surgery for trigeminal neuralgia with a minimum 3-year follow-up. J Neurosurg. 2010 Apr;112[4]:766-71. doi: 10.3171/2009.8.JNS081706.

18. Farid AM, ElKheshin SE. Endoscope Assisted Microvascular Decompression: Are the Advantages Still Worthy Towards More?. Egy J Neurosurg. 2020; 35[1]:1-7. doi: 10.1186/ s41984-019-0072-5

19. Yadav YR, Parihar V, Agarwal M, Sherekar S, Bhatele P. Endoscopic vascular decompression of the trigeminal nerve. Minim Invasive Neurosurg. 2011 Jun;54[3]:110-4. doi: 10.1055/s-0031-1283129.

20. Dubey A, Yadav N, Ratre S, Parihar VS, Yadav YR. Full Endoscopic Vascular Decompression in Trigeminal Neuralgia: Experience of 230 Patients. World Neurosurg. 2018 May; 113:e612-e617. doi: 10.1016/j.wneu.2018.02.108.

21. Teo C, Nakaji P, Mobbs RJ. Endoscope-assisted microvascular decompression for trigeminal neuralgia: technical case report. Neurosurgery. 2006 Oct;59[4 Suppl 2]:ONSE489-90; discussion ONSE490. doi: 10.1227/01.NEU.0000232768.47615.82.

22. Thirumala P, Meigh K, Dasyam N, Shankar P, Sarma KR, Sarma DR, *et al*. The incidence of high-frequency hearing loss after microvascular decompression for trigeminal neuralgia, glossopharyngeal neuralgia, or geniculate neuralgia. J Neurosurg. 2015 Dec; 123[6]:1500-6. doi: 10.3171/2014.10.JNS141101.

23. Kher Y, Yadav N, Yadav YR, Parihar V, Ratre S, Bajaj J. Endoscopic Vascular Decompression in Trigeminal Neuralgia. Turk Neurosurg. 2017; 27[6]:998-1006. doi: 10.5137/1019-5149.JTN.17046-16.1.

24. El-Garem HF, Badr-El-Dine M, Talaat AM, Magnan J. Endoscopy as a tool in minimally invasive trigeminal neuralgia surgery. Otol Neurotol. 2002 Mar;23[2]:132-5. doi: 10.1097/00129492-200203000-00004.

25. Abdeen K, Kato Y, Kiya N, Yoshida K, Kanno T. Neuroendoscopy in microvascular decompression for trigeminal neuralgia and hemifacial spasm: technical note. Neurol Res. 2000 Jul;22[5]:522-6. doi: 10.1080/01616412.2000.11740712.

26. Artz GJ, Hux FJ, Larouere MJ, Bojrab DI, Babu S, Pieper DR. Endoscopic vascular decompression. Otol Neurotol. 2008 Oct;29[7]: 995-1000. doi: 10.1097/MAO.0b013e3181846-01a.

27. Akkaya E, Gokcil Z, Erbas C, Pusat S, Bengisun ZK, Erdogan E. A Clinical Analysis of Microvascular Decompression Surgery with Sacrification of the Superior Petrosal Venous Complex for Trigeminal Neuralgia: A Single-Surgeon Experience. Turk Neurosurg. 2020; 30[1]:83-88. doi: 10.5137/1019-5149.JTN.26555-19.3.

28. Sindou M, Emery E, Acevedo G, Ben-David U. Respective indications for orbital rim, zygomatic arch and orbito-zygomatic osteotomies in the surgical approach to central skull base lesions. Critical, retrospective review in 146 cases. Acta Neurochir [Wien]. 2001 Oct; 143[10]:967-75. doi: 10.1007/s007010170001.

29. Tang YZ, Jin D, Li XY, Lai GH, Li N, Ni JX. Repeated CT-guided percutaneous radio-frequency thermocoagulation for recurrent trigeminal neuralgia. Eur Neurol. 2014;72[1-2]:54-9. doi: 10.1159/000357868.

30. Setty P, Volkov AA, D'Andrea KP, Pieper DR. Endoscopic vascular decompression for the treatment of trigeminal neuralgia: clinical outcomes and technical note. World Neurosurg. 2014 Mar-Apr;81[3-4]:603-8. doi: 10.1016/j.wneu.2013.10.036.

31. Xiang H, Wu G, Ouyang J, Liu R. Prospective Study of Neuroendoscopy versus Microscopy: 213 Cases of Microvascular Decompression for Trigeminal Neuralgia Performed by One Neurosurgeon. World Neurosurg. 2018 Mar;111: e335-e339. doi: 10.1016/j.wneu.2017.12.051.

32. Lee JYK, Pierce JT, Sandhu SK, Petrov D, Yang AI. Endoscopic versus microscopic micro-vascular decompression for trigeminal neuralgia: equivalent pain outcomes with possibly decreased postoperative headache after endoscopic surgery. J Neurosurg. 2017 May;126[5]:1676-1684. doi: 10.3171/2016.5.JNS1621.

33. Zagzoog N, Attar A, Takroni R, Alotaibi MB, Reddy K. Endoscopic versus open microvascular decompression for trigeminal neuralgia: a systematic review and comparative meta-analysis. J Neurosurg. 2018 Dec 7:1-9. doi: 10.3171/2018.6.JNS172690.

34. Jiao L, Ye H, Lv J, Xie Y, Sun W, Ding G, Cui S. A Systematic Review of Repeat Microvascular Decompression for Recurrent or Persistent Trigeminal Neuralgia. World Neurosurg. 2021 Dec 5;158:226-233. doi: 10.1016/j.wneu.2021.11.129.

International Journal of Medical Arts

https://ijma.journals.ekb.eg/
Print ISSN: 2636-4174
Online ISSN: 2682-3780