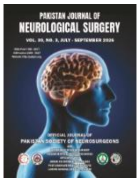

PAKISTAN JOURNAL OF NEUROLOGICAL SURGERY (QUARTERLY) – OFFICIAL JOURNAL OF PAKISTAN SOCIETY OF NEUROSURGEONS

Original Research

Surgical Outcomes of Microvascular Decompression vs. Endoscope-Assisted Microvascular Decompression

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ABSTRACT

Objective: To compare the surgical outcomes of conventional microvascular decompression (MVD) and endoscope-assisted microvascular decompression (EA-MVD) in patients with medically refractory primary trigeminal neuralgia (TN), and to evaluate the additional intraoperative value of endoscopic visualization.

Materials & Methods: This retrospective, single-center study involved 35 patients with primary TN who received MVD from July 2024 to December 2025. Twenty patients were treated with conventional MVD, and 15 with EA-MVD. Postoperative pain relief (Barrow Neurological Institute pain intensity score), recurrence, intraoperative findings, operative time, and postoperative complications were the outcomes.

Results: At discharge, overall satisfactory pain relief (BNI I–II) was obtained in 94.3% of patients, and at final follow-up, in 82.9% of patients. There were no significant differences between the two groups for pain relief, recurrence, or complications ($p>0.05$). Previously unrecognized neurovascular conflicts (33.3%) and incompletion of decompression (20.0%) were identified on EA-MVD and led to further decompression. While the operative time was slightly longer in the EA-MVD group (112.6 minutes vs. 95.4 minutes, $p = 0.02$), there were no significant differences in complication rates.

Conclusion: EA-MVD provides clinical outcomes comparable to those of conventional MVD while improving intraoperative visualization and identification of occult neurovascular conflicts without increasing complications.

Keywords: Trigeminal neuralgia; Microvascular decompression; Endoscope-assisted microvascular decompression; Neurovascular conflict.

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Date of Submission: 05-07-2026
Date of Revision: 14-09-2026
Date of Acceptance: 20-09-2026
Date of Online Publishing: 30-9-2026

Date of Print: 30-9-2026

DOI: 10.36552/pjns.v30i3.1293

INTRODUCTION

Trigeminal neuralgia (TN) is a craniofacial chronic pain disorder that is characterized by sudden, unilateral, electric shock-like paroxysms that are limited to the distribution of one or more divisions of the trigeminal nerve, typically the second (maxillary) and third (mandibular) divisions.[1,2]

While traditionally it was thought that this was a rare disorder, recent global meta-analysis data indicate that it has been underestimated, with a pooled annual incidence of ~25 cases per 100,000 person-years and a pooled annual prevalence >45 per 100,000 individuals.[3,4]

The disorder is definitely expressed in a female predominance, with the majority of series reporting a female-to-male ratio of approximately 1.5–3 to 1 and is most commonly seen after age 40.[1,2,5]

There is now consensus that the pathophysiological mechanism of classic TN is neurovascular compression (NVC) of the trigeminal nerve at or close to its root entry zone (REZ), causing focal demyelination and abnormal ephaptic conduction between adjacent nerve fibres. This vascular compression hypothesis was first introduced by Dandy and then further developed and popularized by the operative microscope, introduced by Jannetta in the 1960s and 1970s, and became the basis for surgical treatment of TN with microvascular decompression (MVD), which is a non-destructive mechanical surgical therapy.[5,6]

The superior cerebellar artery (SCA), the anterior inferior cerebellar artery (AICA), and, less frequently, venous vessels are the most common offending vessels. [5]

Pharmacological treatment is the first-line approach in TN, and carbamazepine and oxcarbazepine are the main treatments of choice. But with time, a significant number of patients develop intolerable side effects or become resistant to medical treatment, and may need surgical referral.[1,2]

The choice of surgical technique is still a matter of debate, but MVD has been consistently demonstrated to provide the best rates of complete and persistent pain relief, without compromising normal nerve function, and is considered the treatment of choice in patients who are medically fit to undergo surgical intervention with a proven or suspected neurovascular conflict.[7,8]

Long-term outcome data from Barker et al, showed sustained pain relief in most patients in follow-up >1 decade, and subsequent evaluation of large single- and multi-institutional series including over 1,000 patients confirmed good long-term efficacy with acceptable complication rates.[6,8,9]

Comparative studies have also demonstrated that the MVD is the more effective and lasting treatment for pain as compared to percutaneous procedures, although only in younger and healthier surgical candidates.[10]

Despite these favorable results, the conventional microscope-based MVD has been identified as having some drawbacks. The operating microscope's rigid optical characteristics prevent parts of the trigeminal root — such as areas obscured by neural or vascular structures, and the cisternal portion close to the porus trigeminus — from being fully seen, which may be sufficient to avoid detection of an offending vessel or result in an incomplete decompression, even though an apparently satisfactory microscopic view has been achieved.[11,12]

This limitation has led to increasing interest in endoscope-assisted MVD (EA-MVD), in which a rigid endoscope is used to give a panoramic, angled view of the entire trigeminal root from the brainstem to Meckel's cave. In early series, previously unrecognized neurovascular conflicts and additional decompression targets were discovered in a clinically significant number of cases with the assistance of the endoscope.[11,13]

In most of the studies and meta-analyses comparing endoscopic/microscopic MVD to conventional microscopic MVD, the success rates for pain relief have been comparable, and the overall complication rates have been similar, with some studies reporting lower rates of postoperative headache and a tendency for endoscopic assistance to reduce the recurrence rate, but those findings have not been statistically significant in the majority of studies.[12,14]

The literature, however, is somewhat inconsistent in surgical technique and patient selection, and outcomes are rarely reported by head-to-head comparisons between standard MVD and EA-MVD in single-surgeon, single-institution cohorts, which to a very large extent eliminates the technical variation among surgeons.[14]

With this controversy in mind, the current study was designed to compare postoperative pain alleviation, intra-operative findings, the incidence of complications, and recurrence between a consecutive single-center series of patients undergoing standard microscopic MVD (SMVD) and endoscope-assisted MVD (EAMVD).

MATERIALS AND METHODS

Study Design & Setting

This retrospective cohort study was carried out at Rizwan Medical Center and General Hospital. This study included patients who underwent microvascular decompression (MVD) for primary TN (PTN) from July 2024 to December 2025.

The Ethical Review Board of Rizwan Medical Center & General Hospital reviewed and approved the study in line with the Declaration of Helsinki (2013) (Approval No. 42). Because of the retrospective study design, the requirement for informed consent was waived by the Institutional Review Board.

Study Population

A total of 35 patients with primary TN who underwent MVD during the study period were included in the study. All consecutive patients who met the criteria for inclusion in the study during the defined time period were included to minimize selection bias. All data were obtained from the medical records, operation notes, follow-up outpatient notes, and neuro-imaging reports from a single surgeon.

Inclusion Criteria

Patients were eligible for inclusion if the clinical diagnosis was primary (classical) trigeminal neuralgia, if they had received an adequate trial of pharmacological therapy (carbamazepine or oxcarbazepine), and if they had undergone their first treatment of MVD during the study period. Patients who had complete clinical history, surgical information, and subsequent information were included.

Exclusion Criteria

Patients with secondary trigeminal neuralgia (e.g., caused by tumor, multiple sclerosis, or AVM), revision MVD, and poor medical history or follow-up were excluded. Patients who received alternative or combined procedures (percutaneous ablative procedures or stereotactic radiosurgery) during the index admission were also excluded.

Preoperative Evaluation

A comprehensive preoperative neurological examination and neuroimaging were performed on each patient, with brain magnetic resonance imaging (MRI) with 3D-FIESTA and 3D-TOF sequences to evaluate for neurovascular contact at the trigeminal root entry zone (REZ). The Barrow Neurological Institute (BNI) Pain Intensity Score was used to determine the severity of the pain patients experienced before surgery. Clinical data that were noted included age, sex, side of nerve involvement, division of nerve involvement, duration of symptoms, and previous ablative procedures.

Surgical Technique

Surgery was done under general anesthesia by a single surgeon using a standard retrosigmoid craniotomy. All patients were categorized into two surgical groups depending on the visualization technique that the operating surgeon used, that is:

Group A: Standard Microvascular Decompression (MVD): The operating microscope was the only device used to provide visualization throughout the decompression procedure, and there was no help from an endoscope.

Group B: Endoscope-Assisted MVD (EA-MVD): The operating microscope was used as the primary visualization device; an adjunct rigid endoscope was used at the end of microsurgical decompression to check for possible residual or hidden neurovascular conflicts and to confirm decompression.

The trigeminal nerve root was exposed from the brainstem to the porus trigeminus, and the offending vessel(s) were identified and mobilized away from the REZ in both groups; in both cases, a Teflon pledget was placed between the nerve and the vessel to keep the area decompressed. Microscopic decompression completed in the EA-MVD group was followed by the insertion of a 0- and 30-degree rigid endoscope to examine areas not fully visualized by the microscope, and further decompression was undertaken if a missed or incompletely mobilized vessel was detected.

Outcome Measures

The primary outcome was postoperative pain relief measured by the BNI Pain Intensity Score at discharge, at 3 months, and at last follow-up. The outcome was considered satisfactory with a BNI grade of I or II. Surgical failure was considered to be BNI Grade IV at discharge, or V. Recurrence was considered to be any return to BNI grade III or above following a previous satisfactory result.

Secondary outcomes included intraoperative findings (type of offending vessel identified, use of endoscopy to find hidden areas of conflict, and/or areas where decompression was incomplete), postoperative complications (transient postoperative facial numbness, postoperative headache, aseptic meningitis, cerebrospinal fluid leak, permanent neurological deficit, and mortality).

Follow-up

The mean follow-up period was 8.6 ± 2.9 months. The assessment was done mainly clinically at the time of discharge, at 3 months, and at the last outpatient follow-up. Recurrence or complications were treated with the standard clinical approaches, and further treatment (repeat MVD, radiosurgery, or medical therapy) was provided as clinically indicated.

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) was used for the statistical analysis. The mean ± SD values were used for continuous variables, and frequencies and percentages were used for categorical variables. The independent-samples t-test was used to compare continuous variables, such as operative time, between the MVD group and the EA-MVD group. As the number of subjects in the study was small with a low number of cells, Fisher's exact test was used to compare categorical variables. McNemar's test for paired proportions was used to analyze changes in satisfactory pain relief (BNI Grade I–II) from discharge to final follow-up. A two-sided p-value < 0.05 was considered statistically significant.

RESULTS

Demographic and Baseline Characteristics

A total of 35 patients with primary trigeminal neuralgia (TN) were included in this retrospective, single-center study from July 2024 to December 2025. Mean age was 54.6 ± 11.3 years (range 31–74), with a female predominance (23/35, 65.7%). The average duration of symptoms before referral was 3.8 ± 1.9 years, and all had a history of failure with traditional medical therapy (carbamazepine or oxcarbazepine). In 21 patients (60.0%), the right side was involved. In 32 patients (91.4%), Neurovascular contact was confirmed preoperatively by MRI (3D-FIESTA/3D-TOF), and in the remaining 3 cases (8.6%), neurovascular contact was not demonstrated on the MRI, but neurovascular conflict was identified intraoperatively. The baseline (pre-operative) BNI pain intensity score was Grade V for all patients.

Table 1: *Baseline Characteristics (n = 35).*

Variable	Values
Mean Age (years)	54.6 ± 11.3
Female	23 (65.7%)
Mean Symptom Duration (years)	3.8 ± 1.9
Right-Sided	21 (60.0%)
V2/V3 Division	25 (71.4%)
NVC on Preoperative MRI	32 (91.4%)
Preoperative BNI Grade V	35 (100%)

Table 2: *Pain Relief Outcomes by Group (Fisher's exact test).*

Outcome	MVD (n=20)	EA-MVD (n=15)	p-value
Satisfactory at Discharge	18 (90.0%)	15 (100%)	0.50
Satisfactory at 3 Months	17 (85.0%)	14 (93.3%)	0.62
Satisfactory at Final Follow-Up	16 (80.0%)	13 (86.7%)	0.68
Recurrence	4 (20.0%)	2 (13.3%)	0.68
Mean Operative Time (min, t-test)	95.4 ± 18.2	112.6 ± 20.4	0.02*

**Significant; longer operative time in the EA-MVD group reflects the added endoscopic inspection step.*

Primary Outcome: Postoperative Pain Relief

Of the patients at discharge, 94.3% (33/35) had satisfactory pain relief (BNI Grade I-II), decreasing to 82.9% (29/35) at final follow-up (mean 8.6 ± 2.9 months). This decrease was statistically significant (McNemar's test p = 0.04). At all follow-up time points, there were no significant differences between the MVD and EA-MVD group in terms of pain relief or recurrence (Table 2). An independent-samples t-test was used to compare the mean operative time of the EA-MVD group with that of the MVD group, which was significantly longer (112.6 ± 20.4 minutes vs. 95.4 ± 18.2 minutes, p = 0.02).

Table 3: *Intraoperative Findings (Fisher's exact test).*

Finding	MVD (n=20)	EA-MVD (n=15)	p-value
NVC Confirmed / Teflon Used	18 (90.0%)	15 (100%)	0.50
SCA as Offending Vessel	13 (65.0%)	10 (66.7%)	1.00
AICA as Offending Vessel	4 (20.0%)	3 (20.0%)	1.00
Venous Compression	2 (10.0%)	2 (13.3%)	1.00
Multiple Offending Vessels	4 (20.0%)	4 (26.7%)	0.70
Hidden Conflict Found on Endoscopy	N/A	5 (33.3%)	–
Additional Decompression After Endoscopy	N/A	3 (20.0%)	–

Table 4: *BNI Grade Distribution (n = 35).*

Grade	Discharge	3 Months	Final Follow-Up
I–II (Satisfactory)	33 (94.3%)	31 (88.6%)	29 (82.9%)
III	0 (0%)	2 (5.7%)	4 (11.4%)
IV–V	2 (5.8%)	2 (5.8%)	2 (5.8%)

Intraoperative Findings

Neurovascular conflict was found intraoperatively in 33/35 patients (94.3%), and the most involved vessel was the superior cerebellar artery (65.7%). There was no significant difference in vessel-detection rates or in vessel type between groups (Table 3). In group B, previously unrecognized conflicts were found in 5/15 cases (33.3%), and in 3/15 cases (20.0%) another decompression was performed which otherwise would have been overlooked under microscopic view alone.

BNI Score Over Time

Satisfactory outcome (Grade I–II) decreased gradually from 94.3% at discharge to 88.6% at 3 months to 82.9% at final follow-up (Table 4). Patient-level paired transition data are needed to perform pairwise comparisons at the interim intervals, which do not exist here; pairwise comparisons at the overall interval (reported above) were significant by McNemar's test (p = 0.04).

Postoperative Complications

The overall complication rate was 11.4% (4/35), all managed conservatively without re-intervention, permanent deficit, or mortality (Table 5). No significant between-group difference was found. Transient numbness resolved within 4–10 weeks with observation; headache resolved within 2–3 weeks with analgesics; aseptic meningitis resolved fully within 3 weeks on IV antibiotics and anti-inflammatory therapy.

Pain Recurrence

The time to recurrence (return to BNI Grade III or higher) for the 6 patients was 7.6 ± 2.8 months with no statistically significant difference between groups (4/20 MVD versus 2/15 EA-MVD; Fisher's exact test, p = 0.68; see Table 2). Four relapses were treated with medication and two relapses were referred for repeat MVD or radiosurgery. Due to the small number of recurrence events, further statistical comparisons between subgroups were not performed.

Overall, good pain relief was obtained in the vast majority of patients with the two techniques, with the endoscopic technique showing that pathology was present in one-third of patients without the addition of more complications, but with a slightly longer operating room time. These findings represent early postoperative outcomes and should be interpreted cautiously because the follow-up period was relatively short for assessing long-term recurrence after MVD. Larger prospective studies with extended follow-up are required.

Table 5: *Postoperative Complications (Fisher's exact test).*

Complication	MVD (n=20)	EA-MVD (n=15)	p-value
Transient Facial Numbness	1 (5.0%)	1 (6.7%)	1.00
Postoperative Headache	1 (5.0%)	0 (0%)	1.00
Aseptic Meningitis	0 (0%)	1 (6.7%)	0.43
Total Complications	2 (10.0%)	2 (13.3%)	1.00

DISCUSSION

In this retrospective, single-center study, microvascular decompression (MVD) for primary trigeminal neuralgia (TN) was associated with satisfactory pain relief at discharge in 94.3% and after a mean follow-up of 8.6 months in 82.9% of patients. These results corroborate earlier reports that suggest that MVD is an effective treatment for medically refractory TN. Other studies have reported long-term relief in most patients who presented with clear neurovascular conflict in the median follow-up period of 7.2 years after surgery and 4.7 years following pure MVD.[15,16]

Our follow-up period was much shorter, but the early recurrence rate of 17.1% was similar to that seen in larger series. There was no difference between microscopic MVD and endoscope-assisted MVD (EA-MVD) groups for pain relief or recurrence at any follow-up time. The results confirm the results of previous comparative studies. A study by Bohman et al, (2014) showed that fully endoscopic MVD yielded pain outcomes equivalent to those of microscopic MVD, and another study by Shu et al, (2024) showed a comparable pain improvement at 12 months post-operatively between EA-MVD and microscopic MVD. Similarly, Li et al, (2025) did not identify any significant differences in remissions or BNI scores after surgery between the two methods. A meta-analysis conducted by Zagzoog et al, (2019) also showed similar pain results, reinforcing the idea that the use of endoscopic assistance does not affect the overall analgesic outcome of decompression.[17,20]

The main benefit of EA-MVD in the present study was the better intra-operative visualization. Additional neurovascular conflicts were found on the endoscopy and led to further decompression in another 20.0% of EA-MVD cases. These results concur with others that endoscopy was used to achieve better visualization of the trigeminal nerve and offending vessels, and the panoramic and angled views were advantageous with endoscopy.[19,20.] It makes this visualization more efficient, which could be a factor that helps reduce reported recurrence rates in some endoscopic series, as suggested by Zagzoog et al.[17.] Our results, although not statistically significant, indicate that endoscopy might offer a better chance at completing the decompression, while maintaining immediate pain outcomes.

Operative time was significantly longer in the EA-MVD group than in the microscopic MVD group (112.6 ± 20.4 vs. 95.4 ± 18.2 minutes; p = 0.02). A similar increase in operative time was reported by Shu et al.[18.] On the other hand, Li et al, did not observe any overall difference or even shorter procedures with endoscopy in selected cases without any clear evidence of neurovascular conflict initially.[19]

These differences may be due to surgeon experience, patient selection, and the extent of use of the endoscope during surgery.

The overall rate of complications was low (11.4%), and no permanent neurological deficits, CSF leak, or fatalities were reported; no significant difference was found between the surgical groups. This is similar to a meta-analysis, which showed that there were no significant differences in complication rates between microscopic and endoscopic MVD.[20]

There was a numerically lower recurrence rate in the EA-MVD group (13.3% vs. 20.0%), but this was not statistically significant. Previously unrecognized vascular compression and poor decompression were common reasons for reoperation for recurrent TN, which further suggests the possible benefit of an endoscopic examination (Weng et al., 2025).[22]

These findings should be interpreted with caution because of the limited sample size and short follow-up duration.

MVD is the most lasting surgical procedure for medically intractable TN. Despite the increased invasiveness of surgery in the posterior fossa, Tronnier et al, (2001) showed better long-term pain relief with MVD than with radiofrequency rhizotomy.[21]

Overall, the present results indicate that EA-MVD can be considered a supplementary technique that can provide a better view during surgery and can be useful in selected patients to improve the extent of decompression, without affecting the short-term clinical results.

This study has several limitations. First, it was a retrospective, single-center study performed by a single surgeon, which may limit the generalizability of the findings. Second, the relatively small sample size and unequal treatment groups reduced the statistical power to detect differences in outcomes, particularly recurrence and uncommon complications. In addition, treatment allocation was non-randomized, introducing the potential for selection bias. Finally, the mean follow-up duration of 8.6 months primarily reflects early postoperative outcomes and is insufficient to evaluate the long-term durability of pain relief or recurrence after MVD. Therefore, these findings should be interpreted cautiously and considered hypothesis-generating. Larger prospective multicenter studies with longer follow-up are needed to validate these results.

CONCLUSION

Microvascular decompression is a safe and effective surgical option for primary trigeminal neuralgia that is medically refractory and is associated with high rates of pain relief, while being associated with low morbidity. Although operative time was longer, there were no additional complications with endoscopic assistance in improving the intraoperative visualization and the identification of additional neurovascular conflicts that required further decompression. The pain relief and recurrence rates were similar for both microscopic MVD and EA-MVD. Larger prospective studies with longer follow-up are needed to see if the benefits of the intraoperative help from endoscopy translate to long-term benefits.

Abbreviation	Full Term
AICA	Anterior Inferior Cerebellar Artery.
AI	Artificial Intelligence.
AVM	Arteriovenous Malformation.
BNI	Barrow Neurological Institute.
CSF	Cerebrospinal Fluid.
EA-MVD	Endoscope-Assisted Microvascular Decompression.
IRB	Institutional Review Board.
MRI	Magnetic Resonance Imaging.
MVD	Microvascular Decompression.
NVC	Neurovascular Compression.
PTN	Primary Trigeminal Neuralgia.
REZ	Root Entry Zone.
SCA	Superior Cerebellar Artery.
SD	Standard Deviation.
SMVD	Standard Microscopic Microvascular Decompression.
SPSS	Statistical Package for the Social Sciences.
TN	Trigeminal Neuralgia.
TOF	Time-of-Flight.

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Additional Information

Disclosure: Authors report no conflict of interest.

Ethical Review Board Approval: This study was approved (Ref. no. 42) by the Institutional Review Board (IRB) of Rizwan Medical Center and General Hospital, Peshawar.

Human Subjects: Informed consent was waived by the Institutional Review Board.

Conflicts of Interest: The authors declare no conflicts of interest in accordance with the ICMJE uniform disclosure form.

Financial Disclosures: The authors have no financial relationships to disclose relevant to this study.

Funding: This study received no external funding.

Data Availability: Data supporting the findings of this study are available from the corresponding author upon reasonable request.

Use of Artificial Intelligence (AI): (OpenAI) was solely used to assist with language editing, grammar correction, improvement of readability, and manuscript organization. No AI tools were used for study design, data collection, data analysis, interpretation of results, or generation of scientific conclusions. All scientific content was critically reviewed, verified, and approved by the authors, who take full responsibility for the accuracy and integrity of the manuscript.

AUTHORS CONTRIBUTIONS

Role	Contributing Author(s)	Role	Contributing Author(s)
Conceptualization	Kamran Ullah	Data Curation	Kamran Ullah, Rizwan Ullah
Methodology	Kamran Ullah	Writing – Original Draft/Literature Review	Kamran Ullah
Software	Not applicable	Writing – Review & Editing	Kamran Ullah, Rizwan Ullah
Validation	Kamran Ullah, Dr. Rizwan Ullah	Visualization	Kamran Ullah
Formal analysis	Kamran Ullah	Supervision	Rizwan Ullah
Investigation	Kamran Ullah, Dr. Rizwan Ullah	Project administration	Kamran Ullah