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Original Article

Microvascular Decompression for Trigeminal Neuralgia: Efficacy and Safety.

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ABSTRACT

Background: Trigeminal neuralgia is a disabling facial pain disorder that can become refractory to medical treatment. Microvascular decompression provides direct relief of neurovascular compression and may achieve durable pain control. Evaluating postoperative pain relief and complications is important for assessing its efficacy, safety, and clinical applicability in appropriately selected patients undergoing surgical treatment.

Objective: To assess the efficacy and safety of microvascular decompression (MVD) in patients with trigeminal neuralgia.

Methodology: This prospective cohort study included 40 adults with medically refractory trigeminal neuralgia treated at Hayatabad Medical Complex, Peshawar, from March 2024 to March 2025. All patients underwent microscopic MVD. Postoperative pain was assessed using the Visual Analog Scale, while complications were evaluated at 4-week follow-up.

Results: The mean age was 43.45 ± 14.82 years, and 62.5% were male. The maxillary division (V2) was most frequently involved. Complete postoperative pain relief was achieved in 35 (87.5%) patients. Mild and moderate residual pain occurred in 7.5% and 5.0%, respectively. Nausea was the most frequent complication (25%), followed by diplopia (7.5%), CSF leak (5%), and facial palsy (2.5%).

Conclusion: Microvascular decompression provided substantial short-term pain relief with predominantly minor postoperative complications in patients with medically refractory trigeminal neuralgia.

INTRODUCTION

Trigeminal neuralgia (TN), formerly called tic douloureux, is a chronic pain disorder characterized by brief, electric shock-like pains in areas supplied by the fifth cranial nerve (CN V). Usually unilateral, it can affect one or more divisions of the trigeminal nerve, the largest cranial nerve responsible for facial sensation and the muscles of mastication. The nerve's sensory components converge at the trigeminal ganglia, transmitting touch, pain, and temperature data from the face to the thalamus via the trigemino-thalamic tract. Most cases result from irritation of the nerve root near its entry into the pons, often caused by pressure from adjacent arteries or veins, especially the superior cerebellar artery (80%). Globally, TN affects about 13 people per 100,000 annually, mostly women (ratio 1.5–1.7:1) and typically over age 50, though younger cases occur rarely. Diagnosis relies on clinical evaluation and MRI to identify nerve compression or secondary causes. Treatment begins with medications like carbamazepine, with microvascular decompression (MVD) as the main surgical option, involving moving the vascular loop away from the nerve root. Other surgeries include balloon compression, glycerol rhizolysis, and radiosurgery. This study aims to assess MVD's effectiveness and safety for pain relief, analyze correlations between baseline features, nerve involvement, post-op pain, and complications, and support evidence-based guidelines for treating trigeminal neuralgia.

MATERIAL AND METHODS

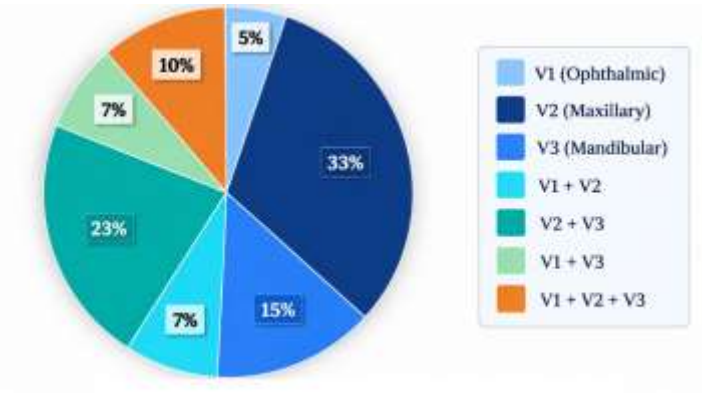
This prospective cohort study was conducted in the Department of Neurosurgery, Hayatabad Medical Complex (HMC), Peshawar, from March 2024 to March 2025. Ethical approval was obtained from the Scientific Research Board (SRB), Khyber Girls Medical College (KGMC), before the study began. The sample size was calculated based on postoperative pain-free outcome as the primary outcome. Previous studies reported immediate pain relief rates of 85–97% following microvascular decompression (MVD) for trigeminal neuralgia. An expected proportion of 90% at a 95% confidence level yielded a minimum sample size of 35 patients. To account for potential dropouts, we enrolled 40 patients using consecutive non-probability sampling. Patients aged ≥18 years of either sex with trigeminal neuralgia diagnosed according to International Classification of Headache Disorders, 3rd edition (ICHD-3) criteria, refractory to pharmacological treatment, and considered suitable for MVD were included. Patients with secondary trigeminal neuralgia due to tumors, multiple sclerosis, brainstem lesions, or other intracranial space-occupying lesions; bilateral or atypical facial pain; previous surgical treatment; severe comorbidities; inadequate follow-up; or refusal to participate were excluded. All participants underwent detailed clinical and neurological assessment and high-resolution brain MRI with and without gadolinium to exclude secondary causes and assess neurovascular compression. Microscopic MVD was performed under general anesthesia by the same senior neurosurgeon with more than five years of cranial base surgical experience. A standard retromastoid craniectomy was performed, followed by cerebellopontine angle exposure, identification of the trigeminal nerve root entry zone, and decompression of the offending vascular structure. Postoperatively, patients were monitored in the neurosurgical intensive care unit for at least 24 hours. Pain was assessed using the Visual Analog Scale (VAS), with scores of 0, 1–3, and 4–6 categorized as no, mild, and moderate pain, respectively. Postoperative complications, including cerebrospinal fluid leak, facial palsy, diplopia, and nausea, were assessed at approximately four weeks. Data were analyzed using SPSS version 25. Continuous variables were expressed as mean ± standard deviation and categorical variables as frequencies and percentages. Relative risks and chi-square tests were used to assess associations, with $p<0.05$ considered statistically significant.

RESULTS

The study included 40 patients, with a mean age of 43.45 ± 14.82 years. Most participants were male (25, 62.5%), while 15 patients (37.5%) were female. Regarding the comorbidities, six (15.0%) had a history of type II diabetes mellitus, and 13 patients (32.5%) were diagnosed with hypertension. Cardiovascular disease was present in only 2 patients (5.0%). (Table 1) Analysis of the trigeminal nerve branches involved showed that the maxillary division (V2) was most frequently affected, seen in 13 (32.5%) cases. Only the mandibular division (V3) was involved in 6 patients (15%), and the ophthalmic division (V1) was solely involved in 2 patients (5%). Combinations of nerves involved included V1 + V2 in 3 patients (7.5%), V2 + V3 in 9 patients (22.5%), V1 + V3 in 3 patients (7.5%), and V1 + V2 + V3 in 4 patients (10%) (Fig 1). Postoperative pain assessment using the

Visual Analog Scale showed excellent outcomes. 35 patients (87.5%) reported complete absence of pain. Three patients (7.5%) reported mild pain, and 2 patients (5.0%) reported moderate pain. Postoperative complications were observed in a few cases. Cerebrospinal fluid leakage occurred in 2 (5.0%) patients, while diplopia was noted in 3 (7.5%) patients. Nausea was common, affecting 10 (25.0%) patients, while facial palsy was seen in only 1 (2.5%) patient (Table 2). Relative Risk (RR) and chi-square analysis of post-operative pain and baseline characteristics, along with post-operative complications, showed that females had a statistically significantly higher risk of post-operative pain than males (RR = 1.75, p = 0.048). Similarly, patients who were ≥ 45 years also showed a significantly increased likelihood of post-operative pain (RR = 1.50, p = 0.049). For comorbidities, diabetes (RR = 1.90, p = 0.043), hypertension (RR = 1.65, p = 0.049), and cardiovascular disease (RR = 2.10, p = 0.047) were all associated with a statistically significantly higher risk of pain. Regarding the trigeminal nerve branches, V2 involvement alone was taken as the reference group (greatest frequency in the cohort); V1 involvement alone did indicate a higher risk for pain (RR = 1.75) but no statistical significance (p = 0.052); meanwhile, V3 division alone did not have any significant risk for pain (RR = 0.95, p = 0.812). V1 + V2 carried a small, borderline non-significant risk (RR = 1.60, p = 0.065). V2 + V3 (RR = 1.10, p = 0.610), V1 + V3 (RR = 1.25, p = 0.510), and V1 + V2 + V3 (RR = 1.40, p = 0.430) all carried a very slight, non-significant risk. Among the post-operative complications, CSF leak (RR = 2.20, p = 0.041), nausea (RR = 1.70, p = 0.048), and facial palsy (RR = 2.30, p = 0.039) had a statistically significant association; however, diplopia manifested as a non-significant risk (RR = 1.80, p = 0.063) (Table 3). Analysis of post-operative complications by baseline characteristics showed that females (RR = 1.30, p = 0.049) and patients ≥ 45 years (RR = 1.40, p = 0.047) were significantly more prone to complications. Diabetes (RR = 1.85, p = 0.044), hypertension (RR = 1.60, p = 0.047), and cardiovascular disease (RR = 2.20, p = 0.039) were also significantly associated with postoperative complications. Furthermore, V1 involvement alone was associated with a higher risk of complications (RR = 1.70), though this was not statistically significant (p = 0.058). V3 involvement, by contrast, was also risk-free (RR = 1.20, p = 0.421). All the combination involvements: V1 + V2 (RR = 1.25, p = 0.510), V2 + V3 (RR = 1.35, p = 0.360), V1 + V3 (RR = 1.20, p = 0.520), and V1 + V2 + V3 (RR = 1.50, p = 0.410) showed a minute increase in risk, with none of them reaching significance. (Table 4). These findings indicate that while age, gender, and comorbidities significantly influence postoperative pain and complication risk, trigeminal nerve involvement in single or combined divisions showed trends but did not reach statistical significance in this cohort.

Figure 1. Trigeminal Nerve Branch Involvement



Distribution of trigeminal nerve divisions involved among patients undergoing microvascular decompression for trigeminal neuralgia. V1 = ophthalmic division; V2 = maxillary division; V3 = mandibular division.

Table 1. Baseline Characteristics of the Study Participants

Variable	Category	n	%
Diabetes mellitus	Yes	6	15.0
	No	34	85.0
Hypertension	Yes	13	32.5
	No	27	67.5
Cardiovascular disease	Yes	2	5.0
	No	38	95.0

Values are presented as frequency (n) and percentage (%). Percentages are calculated from the total study population (N = 40).

Table 2. Postoperative Pain Outcomes and Complications

Variable	Category	n	%
Pain assessment (VAS)	No pain	35	87.5
	Mild pain	3	7.5
	Moderate pain	2	5.0
Postoperative complications	CSF leak	2	5.0
	Diplopia	3	7.5
	Nausea	10	25.0
	Facial palsy	1	2.5
	No complication	24	60.0

VAS = Visual Analog Scale; CSF = cerebrospinal fluid. Values are presented as frequency (n) and percentage (%). Pain categories were defined as 0 = no pain, 1–3 = mild pain, and 4–6 = moderate pain. Percentages for pain outcomes and complications are calculated from the total study population (N = 40).

Table 3. Association of Postoperative Pain with Demographic, Clinical, and Surgical Variables

Variable	Category	No Pain (n = 35)	Pain (n = 5)	RR	p-value
Gender	Male (n = 25)	23	2	1.00 (Ref)	—
	Female (n = 15)	12	3	1.75	0.048
Age group	≤45 years (n = 21)	19	2	1.00 (Ref)	—
	≥45 years (n = 19)	16	3	1.50	0.049
Diabetes mellitus	Yes (n = 6)	4	2	1.90	0.043
	No (n = 34)	31	3	1.00 (Ref)	—
Hypertension	Yes (n = 13)	10	3	1.65	0.049
	No (n = 27)	25	2	1.00 (Ref)	—
Cardiovascular disease	Yes (n = 2)	1	1	2.10	0.047
	No (n = 38)	34	4	1.00 (Ref)	—
Trigeminal branch	V1 (n = 2)	1	1	1.75	0.052
	V2 (n = 13)	10	3	1.00 (Ref)	—
	V3 (n = 6)	3	3	0.95	0.812
	V1 + V2 (n = 3)	2	1	1.60	0.065
	V2 + V3 (n = 9)	5	4	1.10	0.610
	V1 + V3 (n = 3)	2	1	1.25	0.510
	V1 + V2 + V3 (n = 4)	2	2	1.40	0.430
Postoperative complication	CSF leak (n = 2)	1	1	2.20	0.041
	Diplopia (n = 3)	2	1	1.80	0.063
	Nausea (n = 10)	7	3	1.70	0.048
	Facial palsy (n = 1)	0	1	2.30	0.039

RR = relative risk; V1 = ophthalmic division; V2 = maxillary division; V3 = mandibular division; CSF = cerebrospinal fluid. Values are presented as frequencies. The reference category is indicated as Ref. A p-value <0.05 was considered statistically significant. Relative risks and p-values should be verified against the original statistical output, particularly for categories with small numbers.

Table 4. Association of Postoperative Complications with Demographic, Clinical, and Trigeminal Nerve Variables

Variable	Category	Complication (n = 16)	No Complication (n = 24)	RR	p-value
Gender	Male (n = 25)	9	16	1.00 (Ref)	—
	Female (n = 15)	7	8	1.30	0.049
Age group	≤45 years (n = 21)	7	14	1.00 (Ref)	—
	≥45 years (n = 19)	9	10	1.40	0.047
Diabetes mellitus	Yes (n = 6)	4	2	1.85	0.044
	No (n = 34)	12	22	1.00 (Ref)	—
Hypertension	Yes (n = 13)	7	6	1.60	0.047
	No (n = 27)	9	18	1.00 (Ref)	—
Cardiovascular disease	Yes (n = 2)	2	0	2.20	0.039
	No (n = 38)	14	24	1.00 (Ref)	—
Trigeminal branch	V1 (n = 2)	0	2	1.70	0.058

	V2 (n = 13)	8	5	1.00 (Ref)	—
	V3 (n = 6)	4	2	1.20	0.412
	V1 + V2 (n = 3)	2	1	1.25	0.510
	V2 + V3 (n = 9)	4	5	1.35	0.360
	V1 + V3 (n = 3)	2	1	1.20	0.520
	V1 + V2 + V3 (n = 4)	2	2	1.50	0.410

RR = relative risk; V1 = ophthalmic division; V2 = maxillary division; V3 = mandibular division. Values are presented as frequencies. The reference category is indicated as Ref. A p-value <0.05 was considered statistically significant. Relative risks and p-values should be verified against the original statistical output, particularly for variables with very small cell counts.

DISCUSSION

This prospective cohort study analyzed the efficacy and safety of MVD (microvascular decompression) in patients diagnosed with trigeminal neuralgia. Post-operative pain relief was the primary outcome, and 87.5% of patients achieved complete pain resolution. At the same time, only a small proportion experienced mild or moderate residual pain. In the secondary outcome of post-operative complications, nausea was most frequently observed, followed by diplopia and CSF leak, with facial palsy being the least common. The maxillary division of the trigeminal nerve (V2) was most commonly involved, followed by the mandibular (V3) and ophthalmic division (V1). Also, an important finding was that patients with pre-existing comorbidities had a greater likelihood of residual pain.In this study, the mean age of the patients was 43.45 ± 14.82 years, and most patients were male (62.5%). This aligns with previously published literature; Li et al., in their comparative analysis, found that 25 out of the 45 patients in their MVD arm were male.[14] Similarly, Yang et al., in their study, reported that the majority of their patients were male.[15] Similarly, Khan et al. conducted a study in Pakistan which reported that out of 53 patients, thirty were male.[16] In contrast, Haq et al. and Amir et al. reported that the majority of the patients in their cohorts were female.[17,18] Louges et al. documented that 55% of patients in their study were female and 45% were male.[19] This discrepancy in gender distribution could be attributed to regional variations or a smaller sample size. The mean age in our study was similar to Haq et al, with a mean age of 49 years.[17] While the mean age was younger than that reported by Louges et al., which was 54 years (19). The overall rate of complete pain relief in this study was 87.5%, which was consistent with international literature, including Holste et al. This systematic review and meta-analysis of 4000 patients and 46 articles reported a complete long-term pain relief score of 76%.[11] This is also supported by Carlo et al. This meta-analysis included 2100 patients and 9 studies, all of which used the BNI pain scale, with 83% of patients falling in BNI I, which indicates complete pain relief. [12] On the other hand, local literature also supports our results, with Kamboh et all, a cohort of 57 patients, reporting that, on BNI scoring, 98% of patients had short-term complete pain relief. In contrast, 80% of patients had complete pain relief. [13] Similarly, Khokar et al, found that, on BNI scoring, complete pain relief post-operatively was 94%. [20] These results highlight that while endoscopic MVD continues to evolve, microscopic MVD is still providing excellent and reliable outcomes, especially in experienced hands.In this cohort, trigeminal neuralgia most commonly involved the maxillary division (V2) of the trigeminal nerve, mostly in isolation (32.5%), followed by combination with the mandibular division (V2) (22.5%), and then V3 involvement alone (15%). Combinations of V1 + V2 + V3 (10%), V1 + V3 (7.5%), and V1 + V2 (7.5%) were less common, while exclusive V1 involvement (5%) was the least frequent. These results match the meta-analysis of Rosenzweig et al. 1, with only V3 involvement being 10% higher in that study. [21] These figures were a bit different from Worm et al. 1, which had more patients with involvement of multiple branches and fewer patients with V2 involvement alone (13%) and had more patients with V3 trigeminal neuralgia (19%). [22] Anderson et all also report a greater frequency of patients with involvement of nerve combinations and

lower V2 involvement (14%) and again greater V3 involvement (23%). [9] However, all 3 of these studies have V1 involvement as the lowest at 7%, 2%, and 4%, respectively. [9,21,22] In the local literature, Kamboh et al. found V2 involvement to be lower (19%) and V3 to be higher (21%), with combined nerve trigeminal neuralgia higher than in this study. [13] The predominance of V2 involvement, either isolated or in combination, may be attributed to its anatomical position and close relationship to the superior cerebellar artery, which is often the most commonly implicated vessel in neurovascular compression. [21] Additionally, the somatotopic organization of the trigeminal nerve fibers at the root entry zone may also be a predisposing factor for the exposure of the maxillary and mandibular division branches to vascular conflict. Furthermore, this and previous studies suggest that trigeminal neuralgia often involves multiple branches, which may be due to differences in patient selection, disease severity, and intra-operative identification of the neurovascular conflict. This is clinically important as it necessitates intra-operative exploration of the nerve during MVD to ensure adequate decompression and better pain outcomes.Post-operative complications in this study were low (40%) and minor, which highlights the safety of microvascular decompression. The most common complication was nausea (25%), followed by diplopia (7.5%), CSF leak (5%), and facial palsy (2.5%). These results are comparable with Rosenzweig et al., in which diplopia (4%) and facial palsy (3%) were similar, but CSF leak was much higher (17%). [21] On the other hand, Worm et all found CSF leak (5%) to be the same, along with diplopia (3%) and facial palsy (3%). [22] Holste et al also report similar numbers (11). Nausea was not reported widely in the literature. Still, this study found it higher than normal, which may be due to perioperative effects such as anesthesia or cerebellar handling. According to local literature, Amir et al. reported nausea in 34%, higher than in this study. [18] Facial palsy was higher in both Amir et al (13.6%) and Qaisarani et al (24%). CSF leak was more frequent in both (11.4% and 19%, respectively). [18,23] Diplopia reported in Amir et al (13.6%) was also significantly more common than in this study. [18] These variations may reflect differences in surgical expertise, patient selection, and perioperative management across different centers.Our analysis revealed several significant associations between baseline characteristics, postoperative complications, and pain outcomes. Females demonstrated a significantly higher risk of postoperative pain as compared to males (RR = 1.75, p = 0.048). This result is consistent with Worm et al., who found that men were more likely to be pain-free without medication after 5 years (71% vs 49%, p = 0.05) and were also less likely to report pain after continued medication use (10% vs 31%, p = 0.02). [22] Meanwhile, Rosenzweig et al did not find any statistical significance between gender and recurrence or failure of trigeminal neuralgia (X^2 = 0.79; Dof = 1; I^2 = 0%; P = 0.373). [21] Loayza et al also found no significance between gender and long-term residual pain based on the PGIC scale (p = 0.070), and this remained non-significant when patients were stratified according to the severity of neurovascular compression (p = 0.162). [24] These conflicting findings suggest that the role of gender in predicting postoperative pain remains inconclusive. Similarly, patients aged ≥ 45 years were found to have a higher likelihood of persistent postoperative pain in the study (RR = 1.50, p = 0.049). However, limited evidence exists in the literature directly evaluating age as an independent predictor of postoperative pain following microvascular decompression. This may be due to age-related neural changes.Associated comorbidities also had a significant impact on pain outcome, as patients with diabetes (RR = 1.90, p = 0.043), hypertension (RR = 1.65, p = 0.049), and cardiovascular disease (RR = 2.10, p = 0.047) were all at an increased risk of residual pain following MVD. Unfortunately, little to no evidence is available in the literature that compares these comorbidities as independent predictors of postoperative pain. However, these associations may be explained by underlying microvascular changes and impaired neural recovery

associated with chronic systemic disease. These findings highlight a potentially underexplored area in the literature and warrant further investigation.Regarding the branch of the trigeminal nerve involved, the ophthalmic division (V1) and the combined V1 + V2 involvement always showed a higher risk for post-operative pain (RR = 1.75 and RR = 1.60, respectively). Still, neither reached statistical significance (p = 0.052 and p = 0.065, respectively). In contrast, the mandibular division (V3) and its combinations (V2 + V3, V1 + V3) showed no significant risk of pain (RR = 0.95, 1.10, and 1.25; p = 0.812, 0.610, and 0.510, respectively). However, when all three nerves were involved (V1 + V2 + V3), there was a slight trend towards pain (RR = 1.40), which was again non-significant (p = 0.430). Although studies such as Worm et al., Rosenzweig et al., and Andersen et al. have described the distributions of these nerve involvements, they have not evaluated these distributions as interdependent predictors of pain outcomes. [9,21,22] Meanwhile, Loayza et al. have shown that pain outcome is more strongly related to the severity of neurovascular compression (p = 0.001) than to the specific nerve division involved. [24] These findings suggest that, while nerve involvement patterns might provide an important anatomical insight, they may not independently predict pain outcomes, explaining the lack of significance in this study.Post-operative complications like cerebrospinal fluid (CSF) leakage (RR = 2.20, p = 0.041), nausea (RR = 1.70, p = 0.048), and facial palsy (RR = 2.30, p = 0.039) were minor. Still, they posed an increased significant risk for post-operative pain, while diplopia showed a non-significant trend towards increased pain (RR = 1.80, p = 0.063). Again, Rosenzweig et al., Worm et al., Anderson et al., and Loayza et al. have quoted overall complication rates. However, no association of these rates with complications has been reported, making this a novel concept in this study and highlighting that the relationship between postoperative complications and pain persistence may be an underexplored aspect of surgical outcomes in trigeminal neuralgia. [9,21,22,24] Secondary analysis of the baseline characteristics in relation to the postoperative complications revealed that females significantly developed more complications than males (RR = 1.30, p = 0.049). Patients aged ≥45 were also found to be at an increased significant risk for complications (RR = 1.40, p = 0.047). Existing literature presents inconsistent findings regarding the role of age in post-op complications, with Keric et al stating that increasing age is attributed to a higher complication rate but finding no associations. [25] Meanwhile, Herta et found that fewer minor complications occurred in older patients (p = 0.0009), but the complication rates were the same for all ages for major complications. [26] Menna et al also support this by stating that there was no difference in the complication rates between older and younger patients. [27] Current literature offers little evidence of a strong, consistent association between gender and post-operative complication rates; as analyzed by Loayza et al, sex mainly affects pain outcomes rather than complication risk. [24] The increased susceptibility in females may reflect variations in biological response or perioperative factors. These findings highlight the need for further studies to define better demographic predictors of postoperative complications in MVDs for trigeminal neuralgia.Analysis further demonstrated that associated comorbidities were also significantly associated with a higher risk of postoperative complications. Patients with diabetes (RR = 1.85, p = 0.044), hypertension (RR = 1.60, p = 0.047), and cardiovascular disease (RR = 2.20, p = 0.039) all showed a higher likelihood of developing complications following microvascular decompression. These results are partially consistent with Min et al., who found that hypertension was the only comorbidity significantly associated with post-op complications [OR = 0.482, P = 0.007]; however, diabetes was not predictive of post-operative complications. [28] On the other hand, Cote et al and Mehta et al both found that diabetes was a positive predictor for the rate of reoperation after MVD (p < 0.04 and p = 0.017, respectively), indirectly suggesting a potential role in adverse postoperative outcomes. [29,30] No literature has found any risk of complications

associated with various cardiovascular diseases. These findings highlight the potential importance of optimizing comorbidities to reduce postoperative morbidity.This study has certain limitations which must be considered before interpreting the results. First, the sample size (n = 40) was small, limiting the generalizability of the findings and reducing statistical power to detect smaller associations. Second, this was a single-center cohort study, leaving the door open to institutional bias and limiting external validity. Third, the follow-up period was short (pain and complications assessed at 4 weeks after surgery), which limits evaluation of long-term pain, reoperation, and delayed complications. Finally, certain variables, such as the degree of neurovascular compression, type of offending vessel, duration of symptoms, and intra-operative findings, were not analyzed; these could have been confounders that may have affected certain outcomes.

CONCLUSION

Microvascular decompression remains an effective and safe surgical modality for the management of trigeminal neuralgia, demonstrating a high rate of complete pain relief with a low incidence of mostly minor post-operative complications. This study goes further to underscore the potential influence of patient-related factors like age, gender, and comorbidities on both pain outcomes and complication risks. Trigeminal nerve involvement patterns provided important anatomical insight but were not independent predictors of postoperative pain or complication risk. The outcomes appear more closely linked to the underlying neurovascular pathology. Additionally, the observed association between postoperative complications and persistent pain suggests a potentially underrecognized factor influencing surgical success. This study contributes to the existing literature by identifying clinically relevant predictors of outcomes following microvascular decompression. It therefore emphasizes the importance of careful patient selection, peri-operative optimization, and meticulous surgical techniques to achieve optimal results.

Ethical Approval

Ethical approval was obtained from the Institutional Review Board/Ethics Committee of Hayatabad Medical Complex, Peshawar, before the study began. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and applicable institutional guidelines.

Informed Consent

We obtained written informed consent from all participants before enrollment. For participants who were unable to provide consent because of their clinical condition, consent was obtained from an authorized family member or legally acceptable representative, where applicable.

Conflict of Interest

The authors declare no conflicts of interest related to this study or its publication.

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Data Availability Statement

The data generated and/or analyzed during the current study are not publicly available because they contain potentially identifiable clinical information but may be available from the corresponding author on reasonable request, subject to institutional and ethical restrictions.

Authors' Contributions (ICMJE)

Imran Khan: Conception and design, supervision of data collection, interpretation of findings, critical revision of the manuscript, and final approval of the final version.

Muhammad Ali Noman: Conception and design of the study, supervision, interpretation of the results, critical revision of the manuscript, and final approval of the version to be published.

Mohammed Danial: Data collection, clinical assessment, literature review, manuscript drafting and revision, and final approval of the manuscript Literature review, data collection, manuscript drafting, manuscript revision, and final approval of the manuscript.

All authors agree to be accountable for all aspects of the work and ensure that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors confirm that they meet the authorship criteria of the International Committee of Medical Journal Editors (ICMJE). All authors made substantial contributions to the conception or design of the study, acquisition or interpretation of data, participated in drafting or critically revising the manuscript for important intellectual content, approved the final version to be published, and agree to be accountable for all aspects of the work.

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