

Impact of Age on Postoperative Pain Relief Following Microvascular Decompression for Trigeminal Neuralgia

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Abstract

Objective: To investigate the impact of age on postoperative pain outcomes following microvascular decompression (MVD) for trigeminal neuralgia (TN).

Methods: We retrospectively analyzed 135 patients with classic TN who underwent MVD at our hospital between January 2020 and December 2024. Patients were divided into two groups for analysis: those older than 60 years (>60 years group) and those aged 60 years or younger (≤ 60 years group).

Results: There were 85 patients aged 60 years or younger and 50 patients older than 60 years. The mean follow-up period was 35 months. When patients were divided into good pain control (BNI I–II) and poor pain control (BNI III–V) groups, 82.3% of the older patient group had good pain control at most recent follow-up, while 56.3% of the younger patient group had good pain control at most recent follow-up ($P = 0.040$). Univariate regression analysis revealed that age, preoperative drug responsiveness, and intraoperative arterial compression were significantly associated with good pain control; multivariate regression analysis showed that age and intraoperative arterial compression were significantly correlated with good pain control.

Conclusion: For some patients with TN over 60 years old, MVD may achieve good pain prognosis.

Introduction

Trigeminal neuralgia (TN), a distressing condition, predominantly affects middle-aged and elderly individuals. For patients with inadequate response to pharmacotherapy, microvascular decompression (MVD) is a widely accepted surgical method. This current standard treatment for TN evolved through the efforts of numerous neurosurgeons in the 20th century [1]. By the 1990s, Jannetta, utilizing intraoperative microscopy, observed vascular compression in the root entry zone of the trigeminal nerve in patients with TN. In 1967, he published the first case series on MVD for TN [2]. Subsequently, MVD for TN was gradually adopted clinically, achieving favorable outcomes.

However, in recent years, techniques such as percutaneous interventions and stereotactic radiosurgery have been applied to treat TN, particularly in older patients or those with high surgical risks. A meta-analysis comparing MVD and percutaneous balloon compression for TN found comparable short-term and long-term pain relief and similar safety profiles; MVD might be associated with a slightly lower recurrence rate, while percutaneous balloon compression retains advantages for elderly or patients in poor physical condition [3]. In a series of TN patients, Keric et al. demonstrated that MVD was an excellent treatment option independent of patient age; although percutaneous thermocoagulation of the ganglion was effective, it was associated with shorter time to pain recurrence and lower rates of favorable outcomes compared to MVD [4]. Currently, MVD remains the mainstream treatment for TN. Some studies have found that for patients over 70 diagnosed with classic TN, MVD is a durable and effective procedure, with complication rates and short- and long-term outcomes similar to those in younger patients, and MVD can be recommended as the preferred surgical method for elderly patients with TN and neurovascular conflict on magnetic resonance imaging (MRI), and the procedure is safe and effective [5, 6]. Other studies have shown that surgical treatment can improve the daily living ability of

elderly patients, and the score changes indicating improvement after surgery were significantly greater in the elderly group; thus, MVD could be actively recommended for older patients with TN if general anesthesia was feasible [7]. With the increasing elderly population in our country and limited studies on the impact of age on MVD outcomes, it is necessary to explore the influence of age on the clinical efficacy of MVD for TN.

Material and Methods

A retrospective analysis was conducted on patients with classic TN who underwent MVD at our hospital between January 2020 and December 2024. Inclusion criteria were: classic TN; over 30 years; preoperative MRI evidence suggesting neurovascular compression (arterial or venous); tolerance to surgery; and complete follow-up information. A total of 135 subjects were included in the study. We collected demographic and clinical information, including preoperative pain duration, previous surgical history, presence of preoperative trigger points, preoperative medication responsiveness, facial pain distribution, type of intraoperative vascular compression, and complications. The Barrow Neurological Institute (BNI) Pain Scale was used to quantify TN symptoms (Table 1).

All patients included in this study received standardized MVD performed by experienced senior neurosurgeons following a unified institutional surgical protocol. Consistent microsurgical procedures, nerve exposure, and vascular decompression principles were strictly implemented to reduce inter-surgeon operational variability. All patients received identical postoperative management protocols, including routine neurological monitoring, symptomatic supportive care, rehabilitation guidance, and unified long-term follow-up arrangements. Preoperative medication responsiveness was clearly defined in this study. The main routine analgesic drugs for trigeminal neuralgia included carbamazepine and oxcarbazepine. Medication-responsive was defined as pain symptoms being effectively relieved and daily life being well controlled after standard-dose oral medication; medication non-responsive was defined as persistent severe facial pain that could not be adequately controlled by standard conventional medication, or intolerable drug side effects that forced drug discontinuation.

In this study, patients were divided into two groups according to age: ≤ 60 years group and > 60 years group. In China, 60 years of age is legally recognized as the formal boundary defining the elderly population, and this cutoff has been widely applied in clinical research and surgical risk stratification for middle-aged and elderly patients. Therefore, we adopted 60 years as the standard age stratification threshold in the present analysis.

Since the Barrow Neurological Institute (BNI) pain scale is ordinal, we defined a unified binary clinical endpoint for statistical analysis: good outcome was defined as BNI I–II, and poor outcome was defined as BNI III–V. Binary logistic regression was used for univariate and multivariate analyses to explore independent influencing factors of postoperative prognosis. We first performed univariate regression analysis to examine the association between clinically relevant factors and the outcomes of the two groups. Subsequently, significant variables from the univariate analysis were included in a multivariate

regression analysis to identify factors independently associated with the outcomes. A post-hoc power analysis was conducted using G*Power 3.1 software based on the primary postoperative outcome. The results demonstrated that the statistical power of this study was 87.5%, which exceeded the conventional standard threshold of 80%. This confirmed that the total sample size of 135 patients was adequate for subsequent univariate and multivariate regression analyses, and the multivariate model had no significant risk of overfitting. Regression analyses and visualization of results were performed using R software (R version 4.5.2). A p-value < 0.05 was considered statistically significant. Continuous variables were presented as mean $\pm$ standard deviation (SD), and categorical variables were described as number and percentage (n, %). This study was approved by the institutional ethics review committee.

Table 1
Barrow Neurological Institute (BNI) Pain Scale

BNI Pain Score	Description
I	No pain, not taking any medications
II	Occasional pain, not taking any medications
III	Some pain, adequately controlled with medications
IV	Some pain, not adequately controlled with medications
V	Severe pain or no relief

Results

Demographic and clinical information are presented in Table 2. Of the 135 patients, 50 were in the > 60 years group and 85 were in the $\leq$ 60 years group. The mean age was 65.88 ± 2.94 years in the > 60 years group and 47.44 ± 7.39 years in the $\leq$ 60 years group ($p < 0.001$). Regarding the presence of intraoperative arterial compression, there were 48 patients in the > 60 years group and 64 patients in the $\leq$ 60 years group ($p = 0.004$). The mean preoperative pain duration was 2.98 ± 1.25 years in the > 60 years group and 2.46 ± 1.01 years in the $\leq$ 60 years group ($p = 0.005$). When patients were divided into good pain control (BNI I–II) and poor pain control (BNI III–V) groups, 82.3% of the older patient group had good pain control at most recent follow-up, while 56.3% of the younger patient group had good pain control at most recent follow-up ($P = 0.040$). No statistically significant differences were found between the two groups for other demographic or clinical predictor variables.

The occurrence and quantity of complications in the two groups are shown in Table 3. The overall complication rate was 14% in the > 60 years group and 12% in the $\leq$ 60 years group, with no statistically significant difference between the groups ($p = 0.66$).

We conducted a univariate regression analysis of the relationship between clinical factors and good pain control (BNI I–II) versus poor pain control (BNI III–V) as the outcomes, and found that age ($p = 0.019$), presence of intraoperative arterial compression ($p = 0.015$), and preoperative medication responsiveness

($p = 0.039$) were significantly associated with good pain control outcome (Fig. 1). Other variables showed no significant correlation with the outcome. Subsequently, variables with statistical significance were included in a multivariate regression analysis. This analysis confirmed that older age and the presence of intraoperative arterial compression remained significantly associated with good pain control outcome (Fig. 2).

Table 2
Demographic and Clinical Information

Variable	> 60 (n = 50)/N(%)	≤ 60 (n = 85)/N(%)	P-value
Age (years)	65.88 ± 2.94	47.44 ± 7.39	< 0.001
Gender			0.488
Male	22 (44.0)	44 (51.8)	
Female	28 (56.0)	41 (48.2)	
Facial side			0.838
Left	23 (46.0)	42 (49.4)	
Right	27 (54.0)	43 (50.6)	
Preoperative disease duration (years)	2.98 ± 1.25	2.46 ± 1.01	0.005
Previous TN procedures			0.121
No	40 (80.0)	56 (65.9)	
Yes	10 (20.0)	29 (34.1)	
Intraoperative Arterial Compression			0.004
No	2 (4.0)	21 (24.7)	
Yes	48 (96.0)	64 (75.3)	
Preoperative trigger points			0.584
No	9 (18.0)	11 (12.9)	
Yes	41 (82.0)	74 (87.1)	
Preoperative medication responsiveness			0.093
No	8 (16.0)	26 (30.6)	
Yes	42 (84.0)	59 (69.4)	
Trigeminal branch			0.626
V12	6 (12.0)	11 (12.9)	
V123	7 (14.0)	7 (8.2)	
V2	10 (20.0)	26 (30.6)	
V23	21 (42.0)	31 (36.5)	

Variable	> 60 (n = 50)/N(%)	≤ 60 (n = 85)/N(%)	P-value
V3	6 (12.0)	10 (11.8)	
Follow up (months)	32.36 ± 13.12	36.53 ± 12.09	0.063

Table 3
Complications in Both Groups

Complication Type	≤ 60 Years Group	> 60 Years Group
Facial Numbness	3	2
Hearing Impairment	1	0
Hyponatremia	0	1
Dizziness	1	0
Headache	1	0
Persistent Incisional Discomfort	2	1
Surgical Site Cerebral Hemorrhage	1	0
Intracranial Infection	1	2
Poor Incision Healing	0	1
Total	10	7

Discussion

The efficacy of surgical treatment for TN patients with neurovascular conflict has been well-established [8]. However, for some elderly patients, surgical intervention may be considered controversial due to concerns regarding anesthetic and surgical risks, sometimes leading to the selection of alternative treatments. Previous studies have already demonstrated favorable clinical outcomes of MVD in the elderly population [9–12]. Some research has identified factors influencing surgical outcomes in younger, gender, preoperative medication response, neurovascular compression characteristics, and duration of preoperative conservative treatment [13–20]. In this study, we primarily focused on the impact of age on postoperative clinical efficacy following MVD for TN.

In our study, patients in the > 60 years group had lower pain scores at the latest follow-up and demonstrated greater improvement in postoperative pain scores compared to the ≤ 60 years group, indicating favorable clinical outcomes in elderly patients. Furthermore, in both univariate and multivariate regression analyses, we identified age and the intraoperative finding of arterial compression as independent factors influencing postoperative pain scores after MVD.

TN has a predilection for the elderly. In older patients, cardiovascular risk factors may contribute to atherosclerosis, potentially altering the natural course of arteries and leading to compression of the trigeminal nerve [21]. Additionally, cerebellar atrophy, more common in the elderly, may increase the exposure of the operative workspace around the trigeminal root entry zone. This could potentially facilitate better anatomical dissection, improving the efficiency and safety of mobilizing the offending arterial compression. Some studies similarly suggest that brain atrophy creates a larger working space, allowing for better dissection and enhancing the efficiency and safety of arterial decompression, potentially making the procedure technically simpler in elderly patients [10, 22]. These factors might partially explain why some degree of brain atrophy in elderly patients could increase the operative workspace, improve the intraoperative identification of the offending artery, and potentially contribute to better patient outcomes.

Although MVD is a crucial treatment for TN, complications can still occur [23, 24]. While our study found no significant difference in the overall postoperative complication rate between the two groups, it is standard practice in all cases to preoperatively assess anesthetic risk and underlying cardiopulmonary conditions. For elderly patients deemed to have high surgical risk, MVD is recommended cautiously, which might influence the observed complication rate in this age group.

In the majority of TN cases, the trigeminal nerve is compressed by an arterial structure. MVD is a widely recommended treatment, with the key principle being the thorough exploration of the trigeminal nerve from the brainstem exit site along its course to identify all potentially related arterial compressions. In recent years, the utilization of the neuroendoscopy, with its ability to provide panoramic view and multi-angle observation, has also achieved favorable results in MVD for TN [25–27]. Therefore, with careful patient selection and perioperative management, MVD can be a safe and effective surgical option for elderly patients as well.

Notably, our data revealed a significantly higher proportion of intraoperative arterial compression in patients over 60 years old (96.0%) compared with younger patients (75.3%, $P = 0.004$). As arterial compression is a well-recognized favorable prognostic factor for MVD, this pathological imbalance represents an important confounding factor. The superior postoperative outcomes observed in the elderly cohort may not be solely attributed to age itself, but may be partially explained by a higher prevalence of favorable vascular compression pathology. Nevertheless, inherent selection bias and pathological imbalance between age groups should be acknowledged, and our findings should be interpreted as an association rather than definitive causality.

This study has limitations, including its inherent retrospective selection bias and relatively small sample size. Furthermore, several important but uncollected variables were not included in the present analysis, including the severity of neurovascular compression, the exact number of offending vessels, detailed classification of venous and mixed compression patterns, inter-surgeon experience variability, differences in microsurgical techniques, and the application of neuroendoscopy. All these factors are clinically relevant to postoperative MVD prognosis. The absence of these detailed indicators may bring

potential residual confounding and limit the generalizability of the results. Future studies should prospectively collect these parameters to further validate our conclusions.

Conclusion

Older age was associated with better postoperative pain outcomes in this selected cohort. In the present cohort, elderly patients over 60 years with classic TN achieved good pain control after MVD compared with younger counterparts, and arterial compression was also correlated with postoperative pain prognosis. Given the retrospective design, absence of formal preoperative risk stratification, and potential selection bias toward relatively healthier elderly candidates, our findings should be interpreted with caution. For carefully selected elderly patients with classic TN, acceptable general anesthesia tolerance, and confirmed neurovascular compression on MRI, MVD may serve as a safe and effective alternative surgical option. Routine generalization to all elderly individuals is not recommended based on the current evidence.

Abbreviations

MVD: Microvascular decompression

TN: Trigeminal neuralgia

BNI: Barrow Neurological Institute

MRI: Magnetic resonance imaging

Declarations

Acknowledgements

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This study received no specific funding.

Data availability

No datasets were generated or analysed during the current study.

Clinical trial number

Not applicable.

Author Contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by YC and LL. YX and RC wrote the manuscript. ZQ and LL supervised the study. All authors read and approved the final manuscript.

Ethics approval and consent to participate

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of The First Affiliated Hospital of Bengbu Medical University. Informed consent was obtained from all participants prior to the study. The ethical approval number is 2022KY064.

Consent for publication

Written informed consent for publication was obtained from all participants.

Competing interests

All authors declare no competing interests.

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Figures

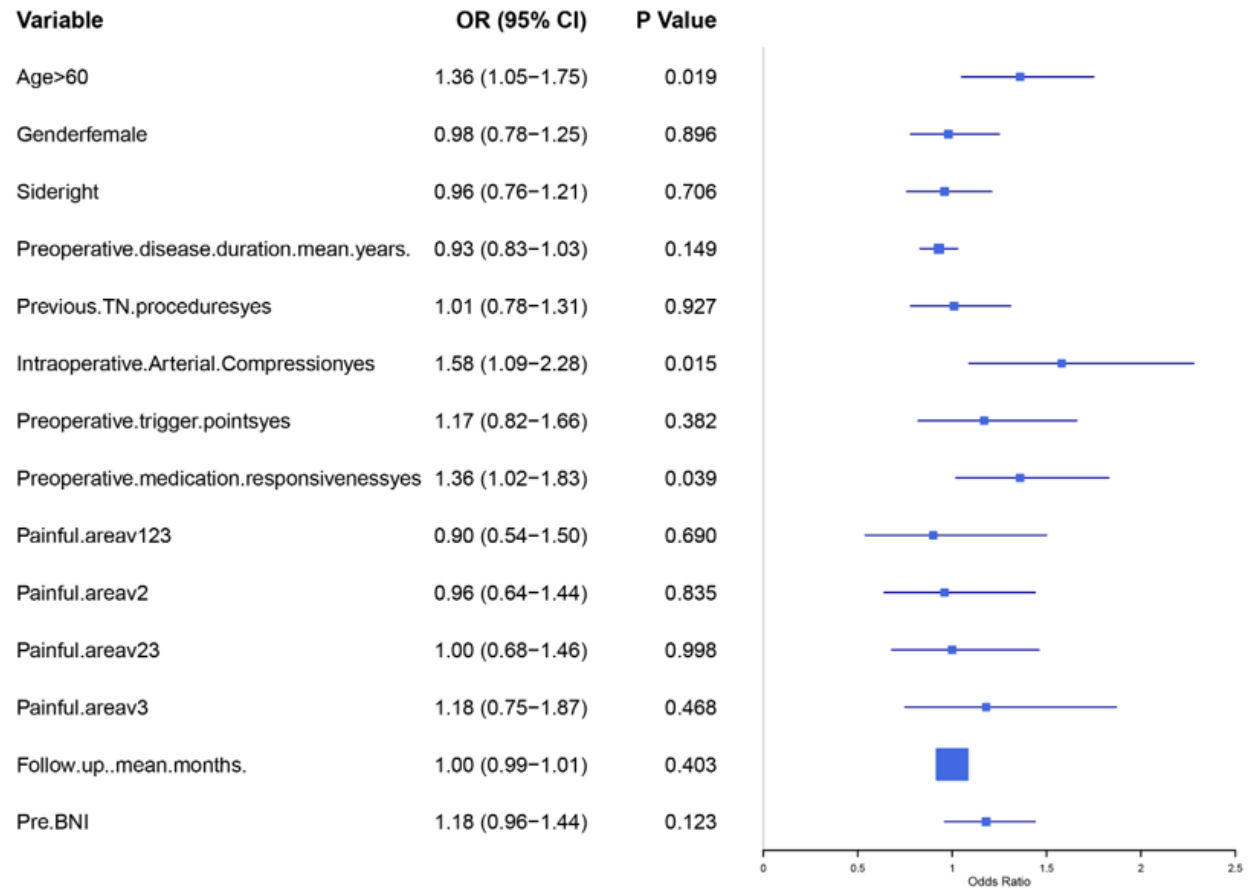


Figure 1

Results of univariate regression analysis: relationship of variables to most recent BNI pain score.

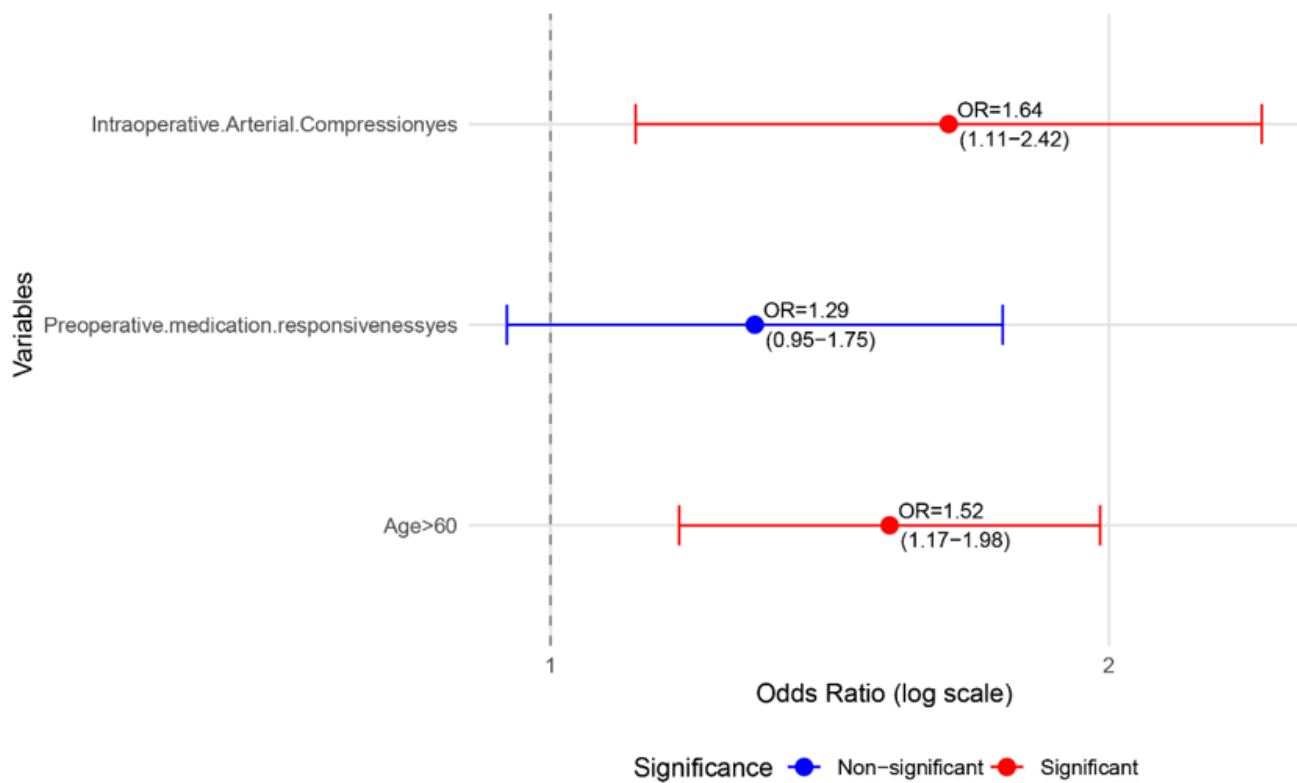


Figure 2

Results of multiple regression analysis: relationship of variables to most recent BNI pain score.