University of Basrah - Basrah Journal of Surgery
Print ISSN: 1683-3589 , Online ISSN: 2409-501X
https://bjsrg.uobasrah.edu.iq

LONG-TERM OUTCOMES OF PERCUTANEOUS GASSERIAN RHIZOTOMY IN TRIGEMINAL NEURALGIA: A RETROSPECTIVE COHORT STUDY

DOI: https://doi.org/10.33762/basjsurg.2025.166869.1150
Document Type : Original Article

Authors
Khalid Shoukr Mahmood [1], Zhyar Sardar Noori [2], Zhir Ali Aziz [2], Muhammad Soran Muhammad [2]
[1] Neurosurgery Department, College of Medicine, University of Sulaimanil, Sulaimani, Iraq.
[2] General medicine and surgery Department, College of Medicine, University of Sulaimanil, Sulaimani, Iraq.

Corresponding author: Zhyar Sardar Noori
Email: zhyar.05001996@univsul.edu.iq

Receive Date: 06 November 2025
Revise Date: 30 November 2025
Accept Date: 29 December 2025
Publish Date: 01 February 2026

Abstract
Background: Trigeminal neuralgia (TN) is a chronic neuropathic pain disorder affecting the trigeminal nerve, often resulting in debilitating, paroxysmal facial pain. While pharmacologic therapies are first-line treatments, many patients eventually require surgical intervention due to poor response or medication intolerance. Percutaneous gasserian rhizotomy (PGR) is a minimally invasive neurosurgical procedure that targets the Gasserian ganglion to provide long-term pain relief.
Aim: To evaluate the long-term outcomes of PGR in patients with TN in terms of pain relief, sensory complications, recurrence, and patient satisfaction over a follow-up period extending up to 10 years
Patients and Methods: We conducted a retrospective cohort study involving 55 patients who underwent Percutaneous gasserian rhizotomy (PGR) for trigmeinal neuralgia (TN). Variables such as age, gender, affected trigeminal branch, Visual Analogue Scale (VAS) pain scores pre- and post-treatment, number of previous PGRs, sensory loss, and long-term outcomes (up to 10 years in some patients) were analized
Results: Preoperatively, 90.9% of patients reported severe pain (VAS ≥9). Post-PGR, a significant reduction in pain was observed, with the mean VAS decreasing from 9.45 (SD = 0.83) to 0.98 (SD = 2.12) at 1 week (p-value < 0.001). Long-term follow-up revealed sustained pain relief, with VAS scores of 1.47 at 1 year, 2.22 at 2 years, and 3.03 at 5 years. Complete sensory loss was observed in only 2 patients and partial sensory loss in 20 patients postoperatively, neither was significantly associated with pain outcomes (p-value = 0.147). At the final assessment, 72.7% of patients had favorable outcomes (no or mild pain).
Conclusion: PGR is a safe and effective long-term treatment for TN, offering substantial and sustained pain relief with a low risk of serious complications. It is particularly valuable in resource-limited settings or for patients unsuitable for more invasive options like microvascular decompression.

Keywords
Trigeminal neuralgia, Percutaneous gasserian rhizotomy, Pain management, PGR
Main Subjects
Neurosurgery

This is an open access article under the CC BY 4.0 license: http://creativecommons.org/licenses/by/4.0/

Introduction

Trigeminal neuralgia (TN) is defined by recurrent, paroxysmal, often-debilitating, unilateral lancinating or shock-like pain in one or more trigeminal divisions [1]. It is usually intermittent in nature but some patients reported continuous less intense baseline pain between attacks [2].

TN is a neuropathic pain, it could be either primary or secondary with three identified etiological categories. The first etiology is classical TN with neurovascular contact (NVC) in which a blood vessel-nerve cross-compression caused by an arterial blood vessel compressing on the trigeminal nerve or root, producing demyelination changes. This may initiate the so-called 'ignition hypothesis' in which a cross circuit between nerve fibers conveying light touch and those relaying pain signals [3]. The nerve may become atrophic, increasing transmission between afferent unmyelinated axons and partially damaged myelinated axons, leading to TN symptoms of intermittent, excruciating, and debilitating pain [4]. This etiology accounts for up to 95% of TN patients [5].

The second etiology is idiopathic TN, with no vascular or other lesion identified. The third etiology is secondary TN caused by irritation to the trigeminal nerve roots by pathologies other than NVC, like aneurysms, cerebellopontine angle tumours, multiple sclerosis or arteriovenous malformations [2,3].

While pharmacologic therapies like Carbamazepine are first-line treatments, additional medications may be employed [2]. For medically refractory TN cases, surgical options explored including microvascular decompression (MVD), percutaneous trigeminal rhizotomies, or stereotactic radiosurgery [1].

MVD is the first-line option in patients with radiological imaging showing vascular compression given it has the highest surgical success rate among TN procedures [1]. Although MVD via craniotomy has classically been employed, however, it is a complex and invasive therapy [6,7]. The MVD procedure needs to be carried out under general anaesthesia, which has its own attendant risks. This treatment option is unsuited for medically compromised, older, and debilitated patients with associated surgical risk factors and co-morbidities.

In such cases, with the absence of a compressive lesion, a relatively less invasive ablative percutaneous procedures offer safe and reliable alternate options [8,9]. In the past decade, percutaneous trigeminal rhizotomy has emerged as an increasingly popular alternative to open surgery given its less-invasive nature [10]. Percutaneous trigeminal rhizotomy is an image-guided procedure that involves ablation of the afferent nociceptive fibers of the trigeminal nerve residing in the Gasserian ganglion [11]. This procedure can involve application of either physical or chemical agents, to cause degeneration of targeted nerve fibres to cause interruption in transmission of nerve signals and also prevents generation of nerve impulses, consequently leading to relief from the episodes of neuralgic pain [12].

There are three commonly performed methods: balloon compression, glycerol injection, and radiofrequency ablation [10,8]. The choice between percutaneous gasserian glycerol rhizotomy (PGGR), percutaneous balloon compression (PBC), and percutaneous radiofrequency rhizotomy (PRF) is dependent on medical comorbidities, distribution of pain, previous treatment success, and patient preference [8,13] as each procedure has a slightly different side effect profile. There are reports of higher risks of mastication weakness or diplopia with percutaneous balloon compression (PBC), higher risk of facial numbness with percutaneous radiofrequency rhizotomy (PRF), and higher risk of corneal numbness with percutaneous gasserian glycerol rhizotomy (PGGR) [8,13,14]. It has also been reported that there is a greater risk of the trigeminal depressor response and hypotension and bradycardia seen with PBC, making it less appropriate for some patients with cardiovascular disease [15]. Furthermore, PBC is generally performed under general anaesthesia.

Moreover, Gamma Knife Surgery and Radiofrequency therapy are not appropriate for patients who are claustrophobic, who cannot tolerate an awake procedure or who are unable to cooperate with localization or in whom MRI imaging is contraindicated [3].

PGGR offers a better alternative and a safer treatment option in such patients. However, this is a technically challenging procedure and there are critical structures within millimeters of the foramen ovale such as the carotid artery, other cranial nerves, as well as the brain. Complications may include facial hematoma, carotid cavernous fistula, cranial nerve palsy, stroke, and intracranial bleeding [16,17].

Chemical rhizotomy using anhydrous glycerol is a popular technique which was introduced by Håkanson in 1981 [18]. Glycerol is a trivalent alcohol and a known chemoneurolytic agent which preferentially injures large myelinated fibres [19]. The mechanism of action of PGGR is by virtue of glycerol's hypertonicity, and more specifically, a rapid rate of change of intracellular osmolarity upon its injection, which results in axonal demyelination and fragmentation.

The beneficial effects of glycerol are limited to the site of injection whereby axonolysis and demyelination are found to be restricted to the outer zone of the nerve. Glycerol readily penetrates the cell membrane and seems to possess distinct cytoprotective properties to cells [19].

Glycerol selectively attacks partially damaged trigeminal axons and after their elimination, the evoked potentials appeared normalized. Glycerol may also downregulate central neuronal hyper-excitability, often without signs of significant additional nerve damage [20], focal demyelination, axonal swelling, and neuronal loss [21], axonal destruction with retrograde (Wallerian) degeneration. Its surfactant property altered the axon cell membrane, inhibiting propagation of ephaptic impulses without necessarily destroying the nerve fibre [18].

Furthermore, there are numerous other drawbacks and complications of this percutaneous chemoneurolysis procedure, such as intraoperative instillation or spillage of the agent outside the Meckel's cave; inadvertent damage to critical neurovascular structures in the immediate vicinity, such as the internal carotid artery, foramen lacerum, or jugular foramen; penetration of adjacent vital anatomic structures such as the inferior orbital fissure [22,23], incorrect placement of the cannula lateral to the trigeminal fossa in the subdural space medial to the temporal lobe, can result in intracranial haemorrhage [24].

Post-procedural complications include transiency of efficacy of the procedure; troublesome side effects such as significant muscle weakness, sensory loss, and facial dysesthesias [25].

During PGGR, correctly negotiating and inserting the needle into the foramen ovale and accurately placing it at Meckel's cave is the key step which dictates success or failure of the procedure.

While PGR has been employed for several decades, there is a need for comprehensive studies evaluating its long-term efficacy and safety. This study aims to assess the long-term outcomes of PGR in patients with TN,

focusing on pain relief, recurrence rates, and procedure-related complications over a 10-year follow-up period.

Material and methods

We conducted a retrospective cohort study involving 55 patients who underwent PGR for trigeminal neuralgia. Variables such as age, gender, BMI, Smoking habit, affected trigeminal side and divisions, Visual Analogue Scale (VAS) pain scores pre- and post-treatment, number of PGRs, sensory loss, and long-term outcomes (up to 10 years in some patients) were analyzed.

The main variable we considered was assessing pain before and after the operation, for this purpose we used 2 types of pain scale. Numerical pain scale and Verbal pain scale.

For the Numerical pain scale, so called visual analogue score (VAS), we assessed it retrospectively via asking the patient to score the pain they had before the procedure and at 1-week, 1-month, 3-month, 6-month, 12-month, 2-year, 5-year, 10-year after the procedure, Numerical pain scale ranges from 0 to 10, with 0 representing no pain and 10 representing the worst possible pain. VAS scores were recorded at multiple postoperative intervals. Due to varying follow-up durations, the number of patients contributing data declined at later timepoints (only 50, 37, and 26 patients had data available at 2-, 5-, and 10-year, respectivley).

For the verbal pain scale, we only asked the patients to assess their pain generally after the procedure, verbal pain scale typically includes a series of descriptive terms or phrases that individuals can choose from to convey their pain intensity. The scale may vary slightly in wording, but it generally includes categories such as: no pain: the individual reports no pain, mild pain: the pain is present but is described as mild or annoying, moderate pain: the pain is more noticeable and may be described as moderate or uncomfortable, severe pain: the pain is intense and may be described as severe or excruciating, and worst possible pain: the individual describes the pain as the worst they can imagine.

The affected sides and divisions of trigeminal nerve were also assessed via asking the patient which side & area of their face was affected. We assessed sensory loss through conducting clinical neurological examination of touch sensation and asking whether the patients had any sensory loss at all and if yes was it partial or complete, so the options were no sensory loss, partial sensory loss, complete sensory loss.

We asked the patients to assess their general outcome by choosing one of the following options: excellent, good, fair, or poor.

Statistical anlysis

Data were coded and recorded in the Microsoft Excel program then statistical assessments were performed using IBM SPSS Statistics Version 29.

Descriptive statistics were used to summarize the demographic and clinical characteristics of the patient population. Frequencies and percentages were calculated for categorical variables. Continuous variables were described using means and standard deviations. Visualizations such as bar charts and histograms were generated to aid in the interpretation of the results.

A Repeated Measures Analysis of Variance (ANOVA) was performed to assess the changes in pain scores (measured by the Visual Analogue Scale, VAS) over time at multiple follow-up points post-PGR. The VAS scores were recorded at baseline (pre-intervention), 1-week, 1-month, 3-month, 6-month, 12-month, 2-year, 5-year, and 10-year. The analysis was used to test for significant time effects on pain relief, with a focus on assessing the long-term efficacy of the procedure.

An independent samples t-test was conducted to compare pain relief outcomes (VAS scores) between two groups. Chi-square tests were utilized to examine the associations between categorical variables. Pearson correlation analysis was performed to assess the relationship between continuous variables. The correlation coefficient (r) was calculated to evaluate the strength and direction of any linear relationships between these variables. The significance level for all tests was set at p-value < 0.05. All analyses were conducted with a confidence interval of 95%.

Results

The study included 55 patients suffering from trigeminal neuralgia. Table I and II presents a detailed breakdown of the demographic characteristics. Of the total participants, 60% were female (n = 33), and 40% were male (n = 22). The age distribution of the cohort ranged from 34 to 79 years, with a mean age of 55.65 years (SD = 10.47). Age distribution analysis (Figure 1) reveals that the majority of patients (70.9 %) were within the age group ≥50 years.

In terms of clinical characteristics, 52.7 % of patients presented with right-sided trigeminal neuralgia (n = 29), while the remaining 47.3% (n = 26) had left-sided involvement. Involvement of V2-3 divisions of trigeminal nerve was the most common

pain distribution site with 40%, followed by V2 involvement only in 20%.

Table I: Patient Demographics (categorical variables).

Varables		Frequency	Percentage
Gender	**Male**	22	40 %
	Female	33	60 %
Age	**≥50**	39	70.9 %
	<49	16	29.1 %
Duration	**≥5**	28	50.9 %
	<5	27	49.1 %
Side	**Right**	29	52.7 %
	Left	26	47.3 %
V1 only		2	3.6
V2 only		11	20.0
V3 only		6	10.9
V1-2		8	14.5
V2-3		22	40.0
V1-2-3		6	10.9
Sensory loss	**No loss**	33	60 %
	Partial	20	36.4 %
	Complete	2	3.6 %
VAS – before PGR	**≥9**	50	90.9 %
	<8	5	9.1 %
Previous PGR history	**None**	45	81.8 %
	Previous PGR(s)	9	16.4 %
	Previous Gamma	1	1.8 %
Smoking	**Non-smoker**	43	78.2 %
	Smoker	12	21.8 %
Final result	**No pain**	30	54.5 %
	Mild pain	10	18.2 %
	Moderate pain	11	20 %
	Severe pain	3	5.5 %
	Worst possible pain	1	1.8 %
Outcome	**Excellent**	36	65.45 %
	Good	14	25.45 %
	Fair	4	7.27 %
	Poor	1	1.82 %

Table II: Patient Demographics (continuous variables).

Variables	Range	Mean	Standard deviation
Age in Years	34-79	55.6545	10.46903
Duration in Years	0-31	5.9982	5.92342
Number of PGRs	1-4	1.3091	0.66312
VAS Before PGR	6-10	9.4545	0.83485
VAS 1 Week later	0-10	0.9818	2.12124
VAS 1 Month later	0-10	0.8727	2.13485
VAS 3 Months later	0-9	0.7636	1.79468
VAS 6 Months later	0-9	0.8545	2.04955
VAS 1 Year later	0-10	1.4727	2.69330
***VAS 2 Year later**	0-10	2.2200	3.05921
***VAS 5 Year later**	0-10	3.0270	3.13126
***VAS 10 Year later**	0-10	2.3846	3.18844
BMI	18.4-51.9	27.9862	6.89020

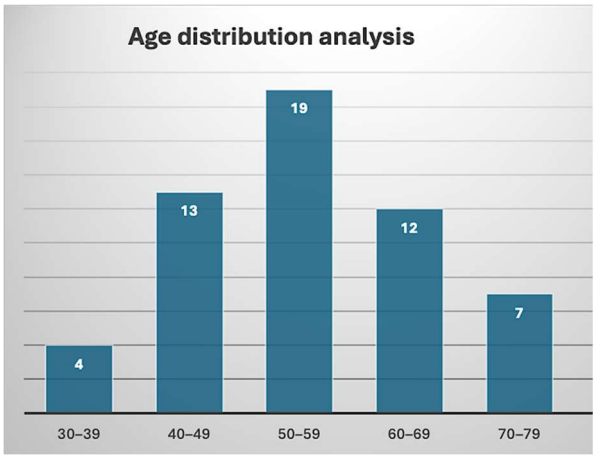


Figure 1: Bar chart of Age distribution analysis reveals that the majority of patients (70.9 %) were within the age group ≥50 years.

Table II outlines the duration of symptoms, which averaged 5.99 years (SD = 5.92) before patients sought Percutaneous gasserian Rhizotomy (PGR) treatment. Notably, 50.9 % of the patients

reported symptom durations exceeding 5 years, emphasizing the chronic nature of the disease in this cohort.

The Visual Analogue Scale (VAS) was used to assess pain severity prior to the intervention. As shown in Table 2, the mean VAS score before PGR for the cohort was 9.45 (SD = 0.83), indicating a uniformly severe pain level across patients before PGR. Over 90% of patients reported VAS scores of 9 or higher, further reinforcing the significant burden of pain associated with trigeminal neuralgia.

Pain relief outcomes were assessed at multiple intervals post-PGR, including 1-week, 1-month, 3-month, 6-month, 12-month, 2-year, 5-year, and 10-year (Not all patients reached long-term timepoints due to limited follow-up duration). A Repeated Measures ANOVA demonstrated a significant reduction in VAS scores across time, with an overall p-value of < 0.001 for time effects, indicating highly significant sustained pain relief following PGR intervention.

As shown in Table 3, 4 and figure 2, the VAS scores dropped from 9.45 pre-intervention to 0.98 at 1-week post-PGR (p-value < 0.001). This rapid reduction in pain was largely maintained at subsequent follow-ups. At 1-year, the mean VAS score increased slightly to 1.47 but remained significantly lower than baseline (p-value < 0.001). Even at the 10-year follow-up, patients reported a mean VAS score of 2.38 (SD = 3.19), suggesting durable long-term pain relief.

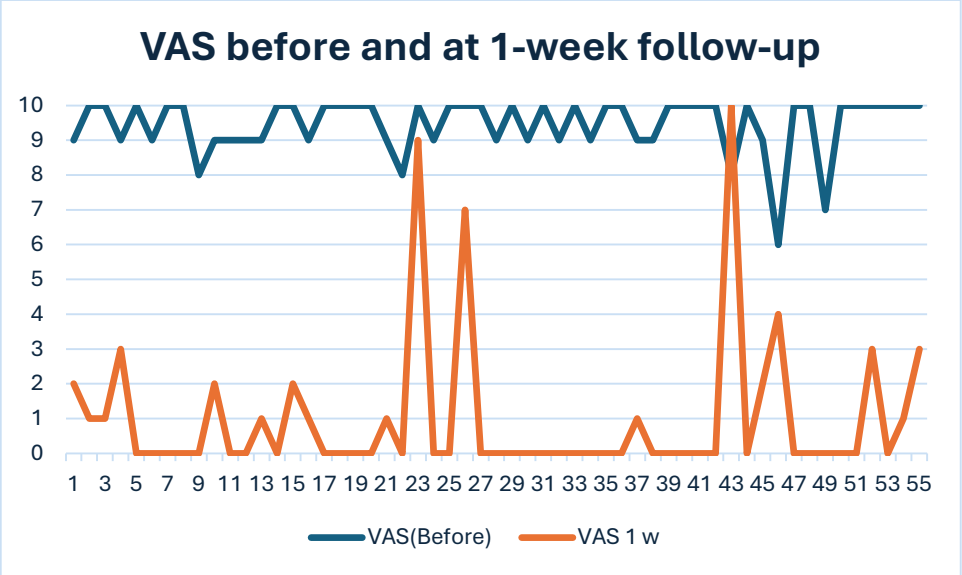
Table III: VAS before and after PGR. Using Paired sample t-test to compare VAS mean before and at different time points after PGR (p-value is significant at <0.05).

Variables	Mean	Std. Deviation	p-value
VAS Before	9.4545	0.83485	0.000
VAS 1 Week later	0.9818	1.52366	
VAS 1 Month later	0.8727	1.52164	
VAS 3 Months later	0.7636	1.24035	
VAS 6 Months later	0.8545	1.60432	
VAS 1 Year later	1.4727	2.34422	
VAS 2 Year later	2.2200	2.95609	
VAS 5 Year later	3.0270	3.11226	
VAS 10 Year later	2.3846	3.18844	

Sensory loss is a potential side effect of PGR. In this cohort, 60% of patients (n = 33) did not experience any sensory loss, while 36.4% (n = 20) reported partial sensory loss, and 3.6% (n = 2) had complete sensory loss. Interestingly, chi-square analysis (Table IV) showed that patients who experienced sensory loss were not significantly more likely to have worse pain outcomes (p-value = 0.147), suggesting that sensory loss does not directly correlate with poorer long-term pain relief.

Table IV: Sensory loss, past surgical history, smoking, and final result cross table (p-value is significant at <0.05).

Sensory loss	Final result					Total	p-value
	No pain	Mild pain	Moderate	Severe pain	Worst		
No loss	23	4	3	2	1	33	0.147
Partial loss	6	6	7	1	0	20	
Complete loss	1	0	1	0	0	2	
Total	30	10	11	3	1	55	
Past Surgical History							
None	25	9	8	2	1	45	0.726
Previous PGR	5	1	2	1	0	9	
Previous	0	0	1	0	0	1	
Total	30	10	11	3	1	55	
Smoking status							
Non-smoker	22	8	9	3	1	43	0.803
Smoker	8	2	2	0	0	12	
Total	30	10	11	3	1	55	
Comorbidities							
Asthma	1	0	0	0	0	1	0.211
Brain tumor	0	1	0	0	0	1	
Cardiomyopathy	0	0	1	0	0	1	
Diabetes Melitus	3	0	1	1	0	5	
Stroke	0	1	0	0	0	1	
Hypertension	2	0	1	0	0	3	
Rheumatoid	0	1	0	0	0	1	
Multiple	1	0	1	0	1	3	
None	23	7	7	2	0	39	
Total	30	10	11	3	1	55	
Number of PGRs							
1	22	8	9	3	1	43	0.986
2	6	1	1	0	0	8	
3	1	1	1	0	0	3	
4	1	0	0	0	0	1	
Total	30	10	11	3	1	55	



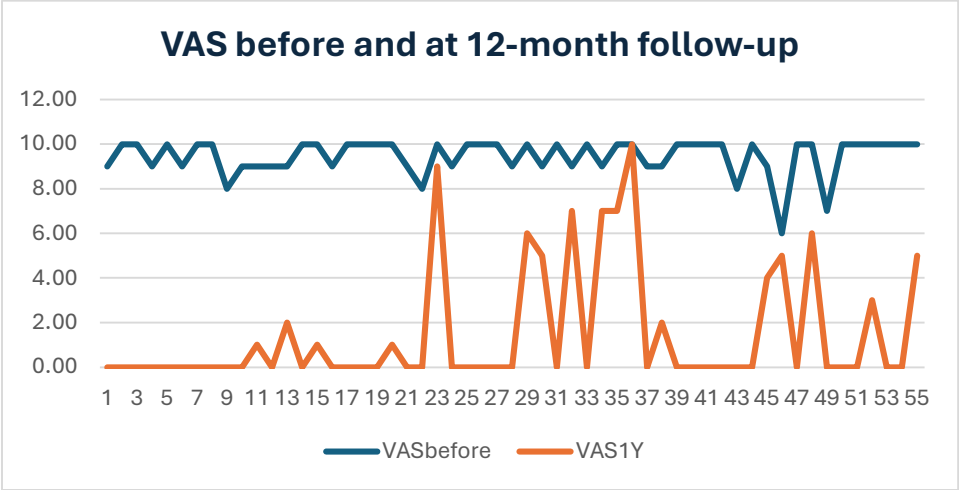


Figure 2:Above is line graph showing VAS scores dropped from mean of 9.45 pre-intervention to 0.98 at 1-week post-PGR (p-value < 0.001). Below line graph is compared to 12-month follow-up.

The final pain outcomes were categorized as no pain, mild pain, moderate pain, and worst pain, as shown in Table I. The majority of patients (72.7%) achieved good outcomes, defined as either no or mild pain, while 20% reported moderate pain, and 7.3% continued to experience severe pain. Further analysis of treatment success using chi-square (Table 4) revealed no significant association between the number of previous PGRs and final pain outcomes (p-value = 0.726). This finding suggests that undergoing multiple PGR procedures does not necessarily impact the final long-term pain relief achieved by patients (Figure 3).

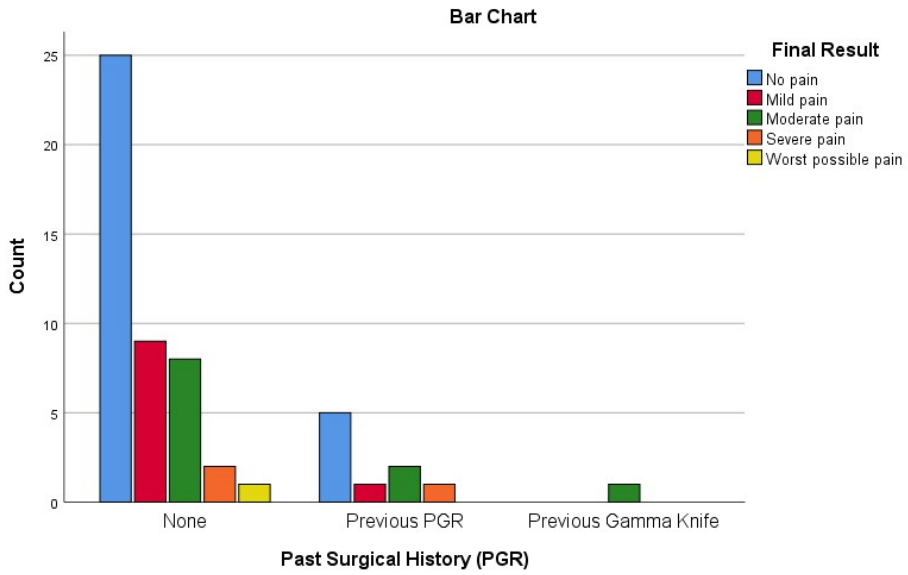


Figure 3: Previous PGRs, gamma knife and final pain outcomes cross table

Smoking status was examined to assess its potential impact on pain relief following PGR. An independent samples t-test revealed no significant difference in VAS scores between smokers and non-smokers at any follow-up period ($p > 0.05$). Chi-square test performed (Table 4) and no statistical significant association was found (p-value = 0.803).

Comorbidities, including diabetes mellitus and hypertension, were present in 14.5% of patients, as detailed in Table 4. Notably, 9% of patients had diabetes mellitus, while 5.5% had hypertension. A chi-square test indicated no significant association between comorbidities and pain relief outcomes (p-value > 0.05), though patients with multiple sclerosis, a rarer comorbidity, did show a trend toward poorer outcomes.

Patients underwent between 1 to 4 PGR procedures. The majority 78.2% (n=43) had undergone only one PGR, with 8 patients (14.5%) having undergone two PGRs and 4 patients (7.3%) having three or more procedures. Despite this, no significant association was found between the number of PGRs and final outcomes, as the chi-square test (p-value > 0.05) indicated that repeated interventions did not influence pain relief success in a linear fashion (Table 4).

Discussion

The current study demonstrates that PGR is an effective and durable treatment option for patients with medically refractory TN. The significant reduction in VAS scores from 9.45 to 0.98 post-procedure indicates substantial pain relief, which was sustained over to 10-year follow-up period. These findings align with previous studies reporting high initial pain relief rates and favorable long-term outcomes following PGR [10,26]. It is reported that pain relief for all modalities of PGR ranges between 90% and 97% in the immediate post-operative time period and is durable with 54-66% of patients experiencing continued relief at three-year follow-ups [26].

The recurrence rates for PGR vary significantly in the litereture with range between 50-90% [27,28]. Few studies have compared the reasons for these varying rates, but some poor predictors of success have been found including atypical TN features, no CSF return in surgery, male, cluster symptoms, duration of symptoms, and carbamazepine failure [28]. The recurrence rate observed in this cohort is consistent with literature indicating that while PGR provides immediate pain relief, some patients may experience pain recurrence over time. Factors contributing to recurrence may include incomplete nerve fiber damage or nerve regeneration with time.

In the current study female to male ratio is 3:2 which indicate that women are more likely to have trigmenial neuralgia. This is in accordance with the broad litereture which report it nearly twice as common in women [29,30].

Age distribution analysis reveals that the majority of patients were within the age group ≥50 years. This demographic distribution aligns with existing literature indicating that trigeminal neuralgia most commonly affects individuals over the age of 50 [31].

Involvement of V2-3 divisions of trigeminal nerve was the most common pain distribution site with 40%, followed by V2 involvement only in 20%. This is consistent with other studies on trigeminal neuralgia which reported about third of patient had maxillary-mandibular mixed involvement [30]. However, most of the published studies have revealed that the mandibular division (V3) was most commonly involved and that the ophthalmic division (V1) was less commonly presented, like the findings of the current study [30].

Wherase more involvement of V2 than V3 is reported in another study [32]. No specific reason could be attributed to higher or lower involvement of nerve branches in the disease.

Likewise, as noted in the current study, the right side (52.7%) of the face is more commonly affected than the left, possibly because of the narrower foramen rotundum and foramen ovale on the right side [30,33].

It is reported by Kouzounias et al.[15] that with PGR, 50% recurrence time was 16 months. Another study reported that patients did not have a shorter time interval of pain recurrence in patients whom had already received one injection. In their group, the mean time interval to repeat injection was 22 months, which did not decrease with repeat glycerol rhizotomy [29].

The current study has demonstrated that PGR can be performed multiple times without any associated increased morbidity. More importantly, patients tolerated the procedure well and were able to have it performed multiple times with beneficial effects, some patients up to four times. Another study reported up to six times repeated PGRs [29].

Patients with multiple sclerosis and trigeminal neuralgia are difficult to treat. PGR, in one series, is effective in reducing their pain. Of those requiring repeat PGR within 6 months, 22.9% had multiple sclerosis demonstrating the difficulties in management of patients with multiple sclerosis. Moreover, age distribution also plays cardinal rule of subjecting patients under 40 years of age who complain of neuralgia-like pain in the face to a detailed neurological assessment to exclude associated diseases like multiple sclerosis [30].

In the current study, no association was found between smoking and VAS score at any follow-up period. This result contrasts with some studies that have suggested smoking may affect nerve recovery [34]; however, the current analysis did not find smoking to be a determining factor in pain relief outcomes.

Procedure-related complications were minimal, with facial numbness being the most common adverse effect. This side effect is typically transient and well-tolerated by patients. Only one patient experienced severe shock during the procedure. The low incidence of serious complications underscores the safety profile of PGR, making it a suitable option for patients who are poor candidates for more invasive

procedures like microvascular decompression.

Comparatively, other percutaneous techniques such as radiofrequency thermocoagulation and balloon compression have shown similar efficacy but may carry different risk profiles. The choice of procedure should be individualized based on patient characteristics, preferences, and the expertise of the surgical team.

Limitations of this study include its retrospective design and the relatively small sample size. Furthermore, VAS scores were recorded at multiple postoperative intervals. Due to varying follow-up durations, the number of patients contributing data declined at later timepoints. Future prospective studies with larger cohorts are warranted to validate these findings and further elucidate the long-term efficacy and safety of PGR in TN management.

Conclusion

PGR is a safe and effective long-term treatment for TN, offering substantial and sustained pain relief with a low risk of serious complications. It is particularly valuable in resource-limited settings or for patients unsuitable for more invasive options like microvascular decompression. The current study findings reinforce the role of PGR as a durable intervention, with over 70% of patients reporting excellent or good long-term outcomes.

Acknowledgement: None
Conflict of interest : Authors declare no conflict of interest
Financial support: No Financial Support For this Work

Author contributions are confirmed as follows:
1.Khalid Shoukr Mahmood, 2. Zhyar Sardar Noori, 3. Zhir Ali Aziz, 4. Muhammad Soran Muhammad
Concept and Design: 1, 2,
Data Collection and Analysis: 1, 2, 3, 4
Responsibility for Statistical Analysis: 1, 2,
Writing the Article: 1, 2
Critical Review: 1, 2, 3, 4
Final Approval of the Article: 1, 2

Each author believes that the manuscript represents honest work and certifies that the article is original, is not under consideration by any other journal, and has not been previously published. Availability of Data and Material: The corresponding author is prompt to supply datasets generated during and/or analyzed during the current study on wise request.

References

1. Piper KF, Flores-Milan G, Cruz AM, Kumar JI, Loveren HV. A Nod for Meckel: A Novel Surgical Position Utilizing Meckel's Cave Anatomy for Percutaneous Glycerol Rhizotomy in Trigeminal Neuralgia. J Neurol Surg B Skull Base. 2024;85(2):156-60. https://doi.org/10.1055/s-0043-1764323. PMid:38449584 PMCid:PMC10914462
2. Headache Classification Committee of the International Headache Society (IHS) The International Classification of Headache Disorders, 3rd edition. Cephalalgia. 2018;38(1):1-211. https://doi.org/10.1177/0333102417738202
3. Jeyaraj P. Efficiency and Efficacy of Real-Time Fluoroscopic Image-Guided Percutaneous Gasserian Glycerol Rhizotomy (PGGR), for Intractable Cases of Trigeminal Neuralgia. J Maxillofac Oral Surg. 2022;21(4):1053-64. https://doi.org/10.1007/s12663-021-01682-2 PMid:36896085 PMCid:PMC9989047
4. Devor M, Amir R, Rappaport ZH. Pathophysiology of trigeminal neuralgia: the ignition hypothesis. Clin J Pain. 2002;18(1):4-13. https://doi.org/10.1097/00002508-200201000-00002. PMid:11803297
5. Maarbjerg S, Wolfram F, Gozalov A, Olesen J, Bendtsen L. Association between neurovascular contact and clinical characteristics in classical trigeminal neuralgia: A prospective clinical study using 3.0 Tesla MRI. Cephalalgia. 2015;35(12):1077-84. https://doi.org/10.1177/0333102414566819. PMid:25616608
6. Cohen-Gadol AA. Microvascular decompression surgery for trigeminal neuralgia and hemifacial spasm: naunces of the technique based on experiences with 100 patients and review of the literature. Clin Neurol Neurosurg. 2011;113(10):844-53. https://doi.org/10.1016/j.clineuro.2011.06.003. PMid:21752534
7. Koopman J, de Vries LM, Dieleman JP, Huygen FJ, Stricker BHC, Sturkenboom M. A nationwide study of three invasive treatments for trigeminal neuralgia. Pain. 2011;152(3):507-13. https://doi.org/10.1016/j.pain.2010.10.049. PMid:21239113
8. Cheng JS, Lim DA, Chang EF, Barbaro NM. A review of percutaneous treatments for trigeminal neuralgia. Neurosurgery. 2014;10 Suppl 1:25-33; discussion https://doi.org/10.1227/NEU.0000000000001687. PMid:24509496
9. Montano N, Papacci F, Cioni B, Di Bonaventura R, Meglio M. Percutaneous balloon compression for the treatment of trigeminal neuralgia in patients with multiple sclerosis. Analysis of the potentially prognostic factors. Acta Neurochir (Wien). 2012;154(5):779-83. https://doi.org/10.1007/s00701-012-1301-9. PMid:22350443
10. Staudt MD, Rivera M, Miller JP. Percutaneous procedures for trigeminal neuralgia. Diagnosis and Management of Head and Face Pain: A Practical Approach: Springer; 2018. p. 221-33. https://doi.org/10.1007/978-3-319-90999-8_18
11. Wang JY, Bender MT, Bettegowda C. Percutaneous Procedures for the Treatment of Trigeminal Neuralgia. Neurosurg Clin N Am. 2016;27(3):277-95. https://doi.org/10.1016/j.nec.2016.02.005. PMid:27324995
12. Pickett GE, Bisnaire D, Ferguson GG. Percutaneous retrogasserian glycerol rhizotomy in the treatment of tic douloureux associated with multiple sclerosis. Neurosurgery. 2005;56(3):537-45; discussion -45.

13. Asplund P, Blomstedt P, Bergenheim AT. Percutaneous Balloon Compression vs Percutaneous Retrogasserian Glycerol Rhizotomy for the Primary Treatment of Trigeminal Neuralgia. Neurosurgery. 2016;78(3):421-8; discussion 8. https://doi.org/10.1227/NEU.0000000000001059. PMid:26465639 PMCid:PMC4747977
14. Texakalidis P, Xenos D, Tora MS, Wetzel JS, Boulis NM. Comparative safety and efficacy of percutaneous approaches for the treatment of trigeminal neuralgia: A systematic review and meta-analysis. Clin Neurol Neurosurg. 2019;182:112-22. https://doi.org/10.1016/j.clineuro.2019.05.011. PMid:31121470
15. Kouzounias K, Lind G, Schechtmann G, Winter J, Linderoth B. Comparison of percutaneous balloon compression and glycerol rhizotomy for the treatment of trigeminal neuralgia. J Neurosurg. 2010;113(3):486-92. https://doi.org/10.3171/2010.1.JNS091106 PMid:20187700
16. Gatto LAM, Tacla R, Koppe GL, Junior ZD. Carotid cavernous fistula after percutaneous balloon compression for trigeminal neuralgia: Endovascular treatment with coils. Surg Neurol Int. 2017;8:36. https://doi.org/10.4103/sni.sni_443_16. PMid:28458950 PMCid:PMC5369261
17. Cohen DT, Bragin I, Hwang R, Oselkin M. Cone beam CT with flat panel detector and biplane fluoroscopy-guided percutaneous trigeminal nerve rhizotomy using three-dimensional needle trajectory planning. Cureus. 2022;14(5). https://doi.org/10.7759/cureus.25538
18. Håkanson S. Trigeminal neuralgia treated by the injection of glycerol into the trigeminal cistern. Neurosurgery. 1981;9(6):638-46. https://doi.org/10.1227/00006123-198112000-00005
PMid:7322329
19. Linderoth B, Lind G. Retrogasserian glycerol rhizolysis in trigeminal neuralgia. Schmidek and sweet operative neurosurgical techniques: Elsevier; 2012. p. 1393-408. https://doi.org/10.1016/B978-1-4160-6839-6.10123-6
20. Bennett MH, Lunsford LD. Percutaneous retrogasserian glycerol rhizotomy for tic douloureux: Part 2. Results nd implications of trigeminal evoked potential studies. Neurosurgery. 1984;14(4):431-5. https://doi.org/10.1227/00006123-198404000-00007. PMid:6728145
21. Lunsford LD, Bennett MH, Martinez AJ. Experimental trigeminal glycerol injection. Electrophysiologic and morphologic effects. Arch Neurol. 1985;42(2):146-9. https://doi.org/10.1001/archneur.1985.04060020060016. PMid:3977642
22. Koizuka S, Saito S, Tobe M, Sekimoto K, Obata H, Koyama Y. Technical communication: percutaneous radiofrequency mandibular nerve rhizotomy guided by high-speed real-time computed tomography fluoroscopy. Anesth Analg. 2010;111(3):763-7. https://doi.org/10.1213/ANE.0b013e3181e5e8d6. PMid:20686002
23. Xu SJ, Zhang WH, Chen T, Wu CY, Zhou MD. Neuronavigator-guided percutaneous radiofrequency thermocoagulation in the treatment of intractable trigeminal neuralgia. Chin Med J (Engl). 2006;119(18):1528-35. https://doi.org/10.1097/00029330-200609020-00005
24. Besi E, Boniface DR, Cregg R, Zakrzewska JM. Comparison of tolerability and adverse symptoms in oxcarbazepine and carbamazepine in the treatment of trigeminal neuralgia

and neuralgiform headaches using the Liverpool Adverse Events Profile (AEP). J Headache Pain. 2015;16:563. https://doi.org/10.1186/s10194-015-0563-z. PMid:26335440 PMCid:PMC4558989
25. Tatli M, Satici O, Kanpolat Y, Sindou M. Various surgical modalities for trigeminal neuralgia: literature study of respective long-term outcomes. Acta Neurochir (Wien). 2008;150(3):243-55. https://doi.org/10.1007/s00701-007-1488-3. PMid:18193149
26. Cohen DT, Bragin I, Hwang R, Oselkin M. Cone Beam CT With Flat Panel Detector and Biplane Fluoroscopy-Guided Percutaneous Trigeminal Nerve Rhizotomy Using Three-Dimensional Needle Trajectory Planning. Cureus. 2022;14(5):e25538. https://doi.org/10.7759/cureus.25538
27. Jho HD, Lunsford LD. Percutaneous retrogasserian glycerol rhizotomy. Current technique and results. Neurosurg Clin N Am. 1997;8(1):63-74. https://doi.org/10.1016/S1042-3680(18)30338-3. PMid:9018706
28. North RB, Kidd DH, Piantadosi S, Carson BS. Percutaneous retrogasserian glycerol rhizotomy. Predictors of success and failure in treatment of trigeminal neuralgia. J Neurosurg. 1990;72(6):851-6. https://doi.org/10.3171/jns.1990.72.6.0851. PMid:2338568
29. Harries AM, Mitchell RD. Percutaneous glycerol rhizotomy for trigeminal neuralgia: safety and efficacy of repeat procedures. Br J Neurosurg. 2011;25(2):268-72. https://doi.org/10.3109/02688697.2011.558946. PMid:21545328
30. Bangash TH. Trigeminal neuralgia: frequency of occurrence in different nerve branches. Anesth Pain Med. 2011;1(2):70-2. https://doi.org/10.5812/aapm.2164. PMid:25729659 PMCid:PMC4335746
31. Shankar Kikkeri N, Nagalli S. Trigeminal Neuralgia. StatPearls. Treasure Island (FL): StatPearls Publishing. Copyright © 2025, StatPearls Publishing LLC.; 2025.
32. Shah SA, Murad N, Salaar A, Iqbal A. Trigeminal neuralgia: analysis of pain distribution and nerve involvement. Pakistan Oral Dent J. 2008;28(1):37-41.
33. Cruccu G, Biasiotta A, Galeotti F, Iannetti GD, Innocenti P, Romaniello A, Truini A. Diagnosis of trigeminal neuralgia: a new appraisal based on clinical and neurophysiological findings. Suppl Clin Neurophysiol. 2006;58:171-86. https://doi.org/10.1016/S1567-424X(09)70067-4. PMid:16623330
34. Shepherd J, Li S, Herring E, Labak CM, Miller JP. Tobacco Use and Trigeminal Neuralgia: Clinical Features and Outcome After Microvascular Decompression. Neurosurgery. 2025;96(3):667-72. https://doi.org/10.1227/neu.0000000000003192. PMid:39324787

Cite this article: Mahmood, K., Noori, Z., Aziz, Z., Muhammad, M. Long-Term Outcomes of Percutaneous Gasserian Rhizotomy in Trigeminal Neuralgia: A Retrospective Cohort Study. *Basrah Journal of Surgery*, 2026; 32(1): 4-22. doi: 10.33762/basjsurg.2025.166869.1150