Treatment of trigeminal neuralgia in older adults: a narrative review based on literature published between 2005 and 2021

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Background and Objective: Trigeminal neuralgia is a severe orofacial pain disorder mostly occurring in older individuals. Recently, radiofrequency (RF) thermocoagulation and pulsed radiofrequency (PRF) stimulation of various peripheral nerves have been used for the clinical management of trigeminal neuralgia. A previous review focused on the effectiveness and safety of trigeminal neuralgia (TN) treatment via different RF approaches, while we have added a review on comparison of RF thermocoagulation with other surgical procedures. We aimed to perform a narrative review regarding the utility and efficacy of RF thermocoagulation, PRF, and other surgical procedures for trigeminal neuralgia treatment.

Methods: This study entailed a narrative review of relevant studies on the effectiveness of RF, PRF, and other surgical procedures for TN. We also investigated the indications for nerve blocks for medically compromised patients taking anticoagulants and antiplatelet drugs. We conducted a PubMed search using only English for studies published between April 2005 and September 2021 on trigeminal neuralgia treatment via RF thermocoagulation and PRF using the following search terms: "(Trigeminal Neuralgia OR Orofacial Pain) AND (Radiofrequency thermocoagulation OR Pulsed Radiofrequency) AND (Elderly Patients OR Medically Compromised Patients) AND (2005/04/01:2021/9/01[Date - Entry])".

Key Content and Findings: We identified 204 potentially relevant articles; 24 studies were selected based on our inclusion criteria, including two systematic reviews on interventional treatment for trigeminal neuralgia and four randomized controlled trials (RCTs) on the treatment site. The main findings of this review suggested that PRF combined with RF thermocoagulation has greater safety and efficacy than PRF alone. PRF combined with RF thermocoagulation could provide analgesia for medically compromised patients with trigeminal neuralgia undergoing surgery. The pain recurrence rate of RF thermocoagulation was 80%, 75%, and 73% after 1 year, 3, and 5 years, respectively, with microvascular decompression (MVD) yielding a higher 5-year pain relief rate than RF thermocoagulation. Finally, 68 ℃ was a good choice for RF thermocoagulation of V2/V3 for trigeminal neuralgia treatment.

Conclusions: This review could inform clinical decisions; we recommend combining PRF with RF thermocoagulation RF when drug therapy is unavailable or insufficient.

Keywords: Radiofrequency thermocoagulation; pulsed radiofrequency (PRF); trigeminal neuralgia; medically compromised patients

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Introduction

The first edition of the International Orofacial Pain Classification was published in Cephalalgia in January 2020 as an international orofacial pain classification/diagnostic standard. Here, trigeminal neuralgia (TN), characterized by paroxysmal pain, was classified into three pathological conditions: classical, idiopathic, and secondary TN (1).

TN is a severe orofacial pain disorder that mostly occurs in older individuals. Specifically, severe paroxysmal pain manifests in the area innervated by the trigeminal nerve. This pain is repetitive and short-term, akin to being stabbed using a knife. A characteristic feature of TN is that innocuous stimuli "trigger" the pain. For example, mouth movements such as tooth brushing, mastication, and speech cause severe pain in the teeth and gingivae, which may prompt repeated dental visits. Undiagnosed patients may undergo irreversible and invasive treatments, including tooth extraction. Therefore, there is a need for collaboration among related specialties, including dentistry/oral surgery, pain clinics, and neurosurgery (2).

Pharmacotherapy comprises the first-line therapy for TN (3). Carbamazepine, an antiepileptic drug, is the drug of choice for TN treatment. Oxcarbazepine, baclofen, and lamotrigine are considered second- and third-line drugs (4). Other therapeutic methods are classified as surgical and non-surgical treatment. Based on international guidelines, surgical treatment is recommended when drug therapy is unavailable or insufficient (3).

Surgical treatments for TN include microvascular decompression (MVD); percutaneous surgery, i.e., radiofrequency thermocoagulation (RF); and low-level radiotherapy, i.e., gamma knife surgery. Surgery is an effective treatment option for TN not improved by carbamazepine (5).

TN treatment using RF involves blockade of pain signal conduction either by nerve destruction through high temperatures (up to 90 ℃) or modulation of the nociceptive function of the trigeminal nerve at temperatures not exceeding 42 ℃. Although TN disappears immediately after RF, this is accompanied by desensitization of the nerve area. Patients have reported a gradual decrease in hypoesthesia, which is simultaneously accompanied by the return of severe pain (3). The efficacy durations for infraorbital and mandibular nerve blocks are 1–1.5 and 2–3 years, respectively (6). Previous studies have provided detailed descriptions of the temperature conditions (7-9).

A high proportion of older individuals take anticoagulants and antiplatelet drugs (10). Shortening the surgery duration is necessary for the safe administration of trigeminal nerve block in patients taking anticoagulants and antiplatelet drugs. There has been a previous review on the effectiveness and safety of TN treatment through different RF approaches. However, few studies have investigated trigeminal nerve blocks in medically compromised patients or compared nerve blocks and MVD (7-9). Therefore, there is a need for studies comparing RF with other surgical procedures, investigating the RF effectiveness according to the temperature setting or pain control period, and assessing the feasibility of trigeminal nerve blocks in patients taking anticoagulants and antiplatelet drugs.

The research questions of the present narrative review were as follows. Does RF or PRF yield adequate nerve blockade in TN? How does nerve block compare to other surgical procedures? Is it safe to administer trigeminal nerve block to patients taking anticoagulants and antiplatelet drugs? How do the efficiency and safety differ across temperature settings for nerve blocks? We present the following article in accordance with the Narrative Review reporting checklist (available at https://joma.amegroups.com/article/view/10.21037/joma-22-2/rc).

Methods

Study selection

We performed a PubMed search of studies published from April 2005 to September 2021. We used the following search terms: (Trigeminal Neuralgia OR Orofacial Pain) and (Radiofrequency OR Pulsed Radiofrequency) and (Elderly Patients OR Medically Compromised Patients) and (2005/04/01:2021/9/01[Date-Entry]). Two hundred and four studies were found. Review articles, meta-analysis, original studies published in English were included but case reports, protocols, short communications, personal opinions, letters, conference abstracts or laboratory research were excluded. N Noma and K Takizawa screened full-text article independently and all disagreements were resolved through consensus with K Ozasa, R Tanaka, Z Yan and A Young (*Table 1*).

Results

The PubMed search yielded 204 potentially relevant studies. After reading the titles and abstracts of the articles, we included 24 articles. Among them, nine investigated RF combined with PRF or other treatments, eight investigated

Table 1 The search strategy summary

Items	Specification
Date of search	1/12/2021
Databases and other sources searched	PubMed
Search terms used	(Trigeminal Neuralgia OR Orofacial Pain) AND (Radiofrequency OR Pulsed Radiofrequency) AND (Elderly Patients OR Medically Compromised Patients)
Timeframe	[2005/04/01:2021/9/01 (Date-Entry)]
Inclusion and exclusion criteria	We included review articles, meta-analyses, and original studies published in English. We excluded case reports, protocols, short communications, personal opinions, letters, conference abstracts, or laboratory research
Selection process	NN and KT independently screened the full-text articles, with disagreements being resolved through consensus with RT, KO, ZY, and AY

whether RF is a viable treatment option and temperature setting for TN, seven focused on MVDs with other surgical procedure.

Discussion

Comparison of RF thermocoagulation with pulsed radiofrequency (PRF) stimulation

None of the four included randomized controlled trials (RCTs) (9,11-13) compared RF with sham treatment or treatments other than nerve block. However, they compared the treatment site (trigeminal ganglion *vs.* peripheral branches of the trigeminal nerve) and RF combined with PRF and RF alone. Therefore, only the analgesic effect could be evaluated as the outcome.

Compared with PRF alone, RF compared with PRF showed higher safety and efficacy (7,9). Therefore, it is recommended that PRF is combined with RF as an analgesic method for TN (9,11-13).

High short-term and long-term pain relief rates were reported for percutaneous RF rhizotomy of the trigeminal ganglion and RF of the peripheral branches of the trigeminal nerve, respectively (7,14). RF combined with PRF is a relatively new treatment method for TN, especially in the V1 branch. This procedure (RF at 62–75 ℃ combined with PRF at 42 ℃) has improved long-term efficacy (85–92% and 70–92% 1- and 2-year efficacy rate, respectively) and a reduced incidence of adverse effects (8,9,15); however, this approach remains controversial (16). Further clinical trials are warranted to evaluate the effectiveness of RF combined with PRF for TN treatment (*Figure 1*).

Comparison of RF thermocoagulation with other surgical procedures

The analgesic effects of MVD, RF, and radiosurgery were compared. The proportion of patients requiring postoperative medication was similar between MVD and RF, while MVD was superior to radiosurgery (17). Compared with radiosurgery, MVD yielded a higher pain relief rate after 5 years (18).

Sanchez-Mejia *et al.* reported that compared with MVD or RF, radiosurgery involved lower retreatment rates (19). Radiosurgery was more likely to be the final treatment for recurrent TN, irrespective of the initial treatment.

Compared with radiosurgery, MVD involved a higher improvement rate in the quality of life (QOL) (20). The postoperative pain recurrence rates of MVD and radiosurgery were 11% and 25%, respectively, with no between-method difference in the time to recurrence (20). For RF, the pain recurrence rate was 80%, 75%, and 73% after 1 year, 3, and 5 years, respectively (21). Among the three treatment methods, MVD showed the lowest rate of recurrence that required a repeat procedure. Although RF yielded immediate relief, it was associated with high rates of facial numbness and recurrence. Compared with MVD, RF was used more commonly in patients requiring secondary treatment (retreatment) for postoperative pain recurrence (22).

Koopman *et al.* reported that compared with percutaneous RF, MVD and partial sensory rhizotomy were associated with a lower risk of undergoing a repeat procedure; however, they were more prone to complications requiring rehospitalization (23). Hitchon *et al.* conducted a 15-year retrospective review of the treatment experience of 195 TN cases (24). They found that RF showed the highest recurrence rate of TN (64%) (*Figure 2*).

Study (reference#)	Treatment	Age (years)	Sex (female/male)	Time of follow up	Outcome
7 Hong T (2020)	RFT PRF	NL	NL	NL	RF treatment is a safe, effective, and minimally invasive procedure of TN. we recommend low-temperature RFT (60–75 ℃) for treatment of TN. the therapeutic effects of PRF are controversial, whereas PRF (≤75 ℃) combined with RFT can improve long-term effects and decrease the incidence of complications
8 Zhao W X (2015)	A1 (PRF + RFT): 20 patients A2 (Sham Test + RFT): 20 patients B1 (PRF + RFT): 20 patients B2 (Sham Test + RFT): 20 patients A : RFT at 70 ℃ B : RFT at 75 ℃	59.3	46/34	1 day, 1-2 weeks, 1 month, 3 and 6 months	There was no significant difference in visual analogue scores among groups with RFT at 70° or 75 ℃, with or without PRF. Compared to the use of RFT at 75 ℃ alone, the combination of PRF and RFT helped eliminate postoperative complications, such as facial numbness, masticatory muscle weakness, and decreased corneal reflex, indicating that it could be useful for surgically treating trigeminal neuralgia
9 Elawamy A (2017)	PRF: 11 patients CRF: 12 patients Combine: 20 patients	55.75±11.23	6/6 5/6 13/7	1 week,1 month and 6 months, 1 and 2 years	The response associated with reduction of dose of concomitant carbamazepine stopped completely among CCPRF and CRF groups. CCPRF showed significant reduction in VAS scores, excellent pain relief, and better patient satisfaction rates compared with the other groups
11 Zakrzewska JM (2011)	CRF: 20 patients PRF: 20 patients	NL	NL	1 day, 3 and 6 months	If the radiofrequency was given as pulsed treatment(which causes the tip of the needle to heat up intermittently and not continuously) the original pain in all participants returned by three months. The continuous radiofrequency treatment then had to be applied, and these participants then achieved pain control comparable to those who had received continuous radiofrequency throughout
12 Sridharan K (2017)	NL	NL	NL	NL	Conventional radiofrequency (both standalone and in combination with pulsed radiofrequency was found to be better than pulsed radiofrequency alone. Sumatriptan and combined continuous and pulsed radiofrequency thermocoagualtion have the highest probability of being the best treatments in the respective group of interventions
13 Bharti N (2019)	Peripheral nerve: 19 patients Gasserian ganglion: 18 patients	54.40±10.07 54.55±12.16	12/8 9/11	1 year and 2 weeks, 1 month, 2 and 3 months	There was a significant reduction of pain scores after the procedure in both the groups. But peripheral group required more medications as compared to the ganglion group at 2 months interval
14 Dessy R Emril (2010)	NL	NL	NL	NL	PRF cannot be recommended as the standard therapy for rhizolysis of the trigeminal nerve. After percutaneous RF rhizotomy, initial pain relief can be achieved in 98% of patients, as high as that obtained with MVD. Among the various interventional pain therapies, RF rhizotomy offers the highest rate of complete pain relief
15 Yao P (2016)	CRF only: 28 patients CRF + PRF: 28 patients	55.6±10.4 56.1±12.4	16/12 15/13	Once per month during the first 6 months and thereafter once every 3 months during the next 2.5 years	The pain relief rate was higher in group (CRF + PRF) patients than in group (CRF only), but the difference was not statistically significant The mean scores of HRQoL in group (CRF + PRF) patients were higher than that in group (CRF only) patients
16 Xuanying Li (2012)	SCRF group LCRF group PCRF group Total: 60 patients	NL	NL	Baseline, 7 days, 3 and 6 months, 1 year	The efficacy in pain relief was most significant on the seventh day after treatment and there were no significant differences between groups. The intensity of facial dysesthesia was mildest in the SCRF group and most severe in the PCRF group on the seventh day after the procedure, but most persistent in the LCRF group

Figure 1 Comparison of radiofrequency thermocoagulation with the pulsed high-frequency method (7-9,11-16). RFT, radiofrequency thermocoagulation; PRF, pulsed radiofrequency; NL, not listed; RF, radiofrequency; TN, trigeminal neuralgia; CRF, continuous radiofrequency thermocoagulation; CCPRF, combined continuous and pulsed radiofrequency; VAS, visual analogue scale; MVD, microvascular decompression; HRQoL, health-related quality of life; SCRF indicates 75 ℃ CRF for 120 to 180 s; LCRF indicates 75 ℃ CRF for 240 to 300 s; PCRF indicates 42 ℃ PRF for 60 s.

Trigeminal nerve block in patients taking anticoagulants and antiplatelet drugs

Many older individuals with TN are usually undergoing anticoagulants or antiplatelet therapy, which increases the risk of bleeding during invasive microsurgical or percutaneous procedures (25). Additionally, numerous patients with TN have other comorbidities. There have been no RCTs on whether trigeminal ganglion block is safe for patients taking anticoagulants or antiplatelet drugs and whether their risk of bleeding is comparable to patients not taking these medications. There have been no case reports of hemorrhagic complications resulting from the trigeminal ganglion block (26).

Currently, international guidelines do not mention trigeminal ganglion block (26). Deep nerve blocks are classified as medium-risk procedures based on anatomical characteristics that impede compression hemostasis or high-risk factors for bleeding (advanced age, history of bleeding disorders, and anticoagulant use). Accordingly, trigeminal ganglion block is considered a high-risk procedure in patients taking other drugs/anticoagulants and in patients with liver cirrhosis or advanced renal disease (27).

Therefore, caution is necessary when administering the trigeminal ganglion nerve block to prevent bleeding events; however, there have been no reports of bleeding complications. Several international guidelines indicate that peripheral nerve blockade can be performed without stopping non-steroidal anti-inflammatory drugs, including aspirin. However, the trigeminal ganglion block is a deep nerve block involving a risk of persistent bleeding (26). Therefore, trigeminal ganglion block should be ideally performed with an appropriate drug holiday for all antiplatelets and anticoagulants.

Study (reference #)	Comparison	Number of studies	Age (years)	Sex (Female/male)	Time to follow up	Outcome
17 Sharma R (2018)	MVD 350 patients GKT 370 patients	5 studies	MVD: 55.5 GKT: 68.32	MVD: 148/222 GKT: 149/201	MVD: 5 years GKT: 7.6 years	The success rate of MVD significantly better than GKT immediately and at all durations of follow-up till 5 years More complication in MVD
18 Wang D (2018)	MVD 316 patients SRS 364 patients (1st time only)	1 study (680 patients)	MVD: 63 SRS: 72	MVD: 66 SRS: 65	MVD: 59±35 months SRS: 59±45 months	MVD is more effective than SRS in providing long-term pain-free benefits in patients with idiopathic TN. Limitations of MVD include the need for a hospital stay and an increased incidence of complications
19 Sanchez-Mejia R (2005)	MVD 18 patients RF 5 patients RS 9 patients	1 study (32 patients)	69.1±12.3	13/19	NL	Lower retreatment rates were seen with patients who initially underwent radiosurgery compared with MVD or radiofrequency ablation. Radiosurgery was more likely to be the final treatment for recurrent TN regardless of the initial treatment
20 Gubian A (2017)	MVD RS	53 studies (13,805 patients)	NL	NL	NL	MVD is a valid first-line treatment option for young patients free of comorbidities. First-line RS can be advised in patients with a higher surgical risk
22 Li Y (2019)	MVD 835 patients RF 1,328 patients	9 studies (2163 patients)	50–76.2 y/o	NL	16 months–14 years	MVD was associated with a greater rate of freedom from pain and lower incidences of facial numbness, but greater postoperative complications and total costs compared to RF
23 Koopman JSHA (2011)	PRT 672 patients PSR 39 patients MVD 87 patients	1 study (799 patients)	PRT 67.3 PSR 58.0 MVD 57.8	NL	2 years	The RR for repeat procedures for PSR was 0.21 and for MVD was 0.13 compared with PRT . For complications, the RR of PSR was 5.36 and of MVD was 4.40. Sex, urbanization, and comorbidity did not influence prognosis, but hospital and surgical volume did. In conclusion, although PSR and MVD are associated with a lower risk of repeat procedure than PRT, they seem to be more prone to complications requiring hospital readmission
24 Hitchon PW (2016)	MVD 79 patients RF 36 patients SRS 80 patients	1 study (195 patients)	MVD 57±14 RF 75±15 SRS 73±13	122/73	32±46 months	A second surgical procedure was necessary in 2, 23, and 18 patients initially treated with MVD, RF, and SRS respectively . In the patients treated with MVD, RF, and SRS, the average number of procedures per patient necessary to achieve pain control was 1.1, 2.0, and 1.3 respectively . There were 7 complications in the patients treated with MVD but no deaths. Numbness was present in 13, 18, and 29 patients treated with MVD, RF, and SRS respectively

Figure 2 Comparison of radiofrequency thermocoagulation with the pulsed high-frequency method (17-20,22-24). MVD, microvascular decompression; GKT, gamma knife therapy; SRS, stereotactic radiosurgery; TN, trigeminal neuralgia; RF, radiofrequency thermocoagulation/rhizotomy; RS, radiosurgery; NL, not listed; PRT, percutaneous radiofrequency thermocoagulation; PSR, partial sensory rhizotomy; RR, relative risk.

The strengths of gamma knife surgery include the immediate analgesic effect and the low recurrence rate. Gamma knife surgery may be the ideal option for recurrent medically refractory TN in patients with advanced age or medical comorbidities, especially patients on a long-term regimen of anticoagulants or antiplatelet therapy (*Figure 3*).

RF thermocoagulation: temperature settings

There remain no specific standard temperature settings for RF, which vary widely across studies (60–95 ℃) (28-30). High-temperature RF often causes serious complications, including severe facial numbness, ptosis, diplopia, keratitis, corneal ulcers, abducens nerve damage, transient vision loss and blindness, mandibular deviation, hearing loss, masticatory muscle weakness, cerebrospinal fluid leakage, and death. Tang *et al.* examined the optimal temperature for computed tomography (CT)-guided RF for TN treatment (28). They observed no significant differences in the rate of excellent pain relief across the various RF temperature setting used in 1,161 procedures. However, most patients experienced no facial numbness (which gradually resolved if it occurred); additionally, patients treated at 75 ℃ exhibited a lower rate of grade IV facial numbness/dysesthesia than those treated at other temperatures. In a prospective study with a 15-year follow-up, Taha *et al.* reported that 99% of patients with TN (n=154) achieved initial pain relief after one session of percutaneous stereotactic rhizotomy (29). Moreover, dysesthesia, mild initial hypalgesia, dense hypalgesia, and analgesia were observed in 23%, 7%, 15%, and 36% of the patients, respectively (29).

The recurrence rate is used as an indicator of the efficacy of high-temperature RF for TN, which ranges from 7.8% to 42.7%, with a follow-up period of 11.6 to 15 years (31,32). However, the included studies had several limitations. First, they did not determine whether patients used pain medication after the procedures. Second, they included patients with secondary TN caused by other diseases, including brain tumors, who had unsuccessfully undergone other invasive interventions. Nonetheless, there was no significant difference between the long-term pain relief rates of high- and low-temperature RF.

The short-term mild facial numbness after RF treatment is associated with the temperature used for RF. Zhao *et al.* examined the complications of combining RF and PRF for TN treatment (8). Patients either received RF at 70 or 75 ℃; further, each group was classified into two subgroups receiving percutaneous RF (240 s) with or without PRF (42 ℃,

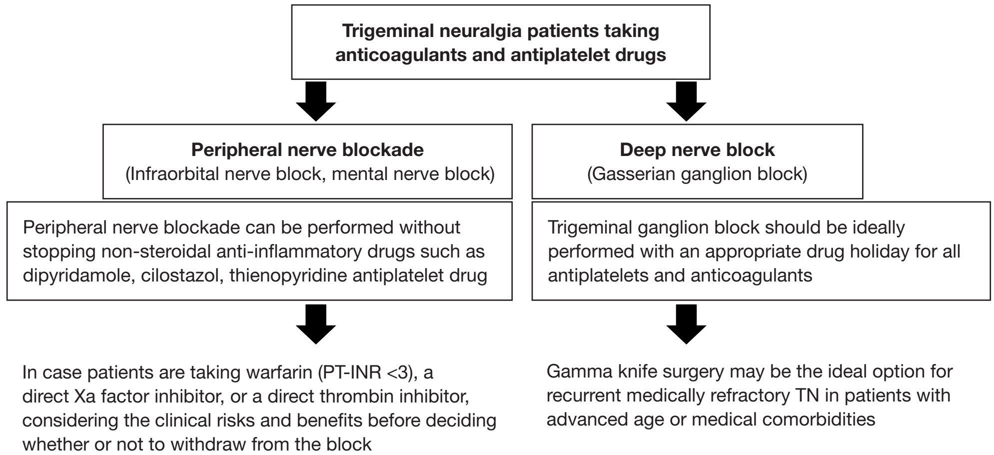

Figure 3 Flowchart with TN patients with anticoagulants and antiplatelet drugs. TN, trigeminal neuralgia; PT-INR, prothrombin time-international normalized ratio.

Study (reference#)	Method	Number of patients	Age (years)	Sex (Female/male)	Time to follow up	Outcome
8 W-X Zhao (2015)	RFT at 70 ℃ RFT at 75 ℃ 2 subgroups, percutaneous RFT (240 s) with or without PRF (42 ℃, 2 Hz, 240 s)	80 patients	NL	NL	6 months	Decreased corneal reflex was relieved to a significantly greater extent in groups receiving PRF than those without. Thus, compared to the use of RFT at 75 ℃ alone, the combination of PRF and RFT helped eliminate postoperative complications, such as facial numbness, masticatory muscle weakness, and decreased corneal reflex
15 Yao P (2016)	CRF(A) CRF plus PRF(B)	56 patients	A: 55.6±10.4 B: 56.1±12.4	A: 16/12 B: 15/13	3 months–2.5 yeras	All the patients in either group achieved satisfactory pain relief at discharge. After treatment, patients completely pain free in group A and group B accounted for 81.6%, 92.0% at 1 year, 68.4%, 92.0% at 2 years, and 68.4%, 83.6% at 3 years, respectively
28 Tang YZ (2016)	RFT (65, 70, 75, 80, 85 ℃)	1,161 patients (65 ℃: 8, 70 ℃: 239, 75 ℃: 790, 80 ℃: 119, 85 ℃: 5)	61.5±12.5	675/462	46±31 months	There were no significant differences in the rate of excellent pain relief according to the radiofrequency temperature used. However, more patients experienced with no facial numbness or facial numbness gradually resolved and those patients treated at 75 ℃ had a lower rate of grade IV facial numbness/dysesthesia than other groups
29 Taha JM (1995)	PSR (percutaneous stereotactic radiofrequency rhizotomy)	154 patients	NL	NL	15 years	99% of the patients obtained initial pain relief after one PSR. Timing of pain recurrence varied according to the degree of sensory loss. The median pain-free survival rate was 32 months for patients with mild hypalgesia and more than 15 years for patients with either analgesia or dense hypalgesia. Of the 100 patients followed for 15 years after one or two PSR procedures, 95 patients (95%) rated the procedure excellent (77 patients) or good (18 patients). The authors estimated using Kaplan-Meier analysis that the 14-year recurrence rate was 25% in the total group
30 Kosugi S (2015)	PRT	89 patients	38-88	59/30	6 years	The remaining 6 procedures were performed for V1 + V2 TN and V1 + V2 + V3 TN. Immediate success rates of PRT for V2 TN, V2 + V3 TN, and V3 TN were 100%, 86.6%, and 100%, respectively, whereas the durations pain-free for V2 TN and V2 + V3 TN were significantly shorter than that for V3 TN
31 Fraioli MF (2009)	RFT	158 patients	52–39	NL	3.6 years	Complete pain relief was obtained immediately after the procedure in all patients and selective anesthesia in the third division was achieved in all of them, except for 2 patients in whom unwanted first and second division anesthesia/hypoesthesia also occurred. Other significant complications were transient sixth cranial nerve palsy in 1 patient and masseter muscle dysfunction, which improved during follow-up, in another one
32 Kanpolat Y (2001)	RF-TR	1,600 patients	15–99	NL	25years	Acute pain relief was accomplished in 97.6% of patients. Complete pain relief was achieved at 5 years in 57.7% of the patients who underwent a single procedure. Pain relief was reported in 92% of patients with a single procedure or with multiple procedures 5 years after the first rhizotomy was performed

Figure 4 Radiofrequency thermocoagulation: temperature setting (8,15,28-32). RFT, radiofrequency thermocoagulation; PRF, pulsed radiofrequency; NL, not listed; CRF, continuous radiofrequency thermocoagulation; PRT, percutaneous radiofrequency thermocoagulation; TN, trigeminal neuralgia; RF-TR, percutaneous, controlled radiofrequency trigeminal rhizotomy.

2 Hz, 240 s) (8), with patients who received combined RF and PRF treatment showing a more rapid recovery of facial numbness and masticatory muscle weakness. Further, Yao *et al.* assessed postoperative complications and long-term health-related QoL (HRQoL) (15). They observed that the temperature was positively correlated with the incidence rate of facial numbness, masticatory atonia, and corneal hypoesthesia. Further, the highest HRQoL scores were

observed in the group treated at 68 ℃, followed by the groups treated at 65 and 62 ℃, which suggests that 68 ℃ is a good choice for RF of V2/V3 for TN treatment (*Figure 4*).

This review has several limitations. First, since we only used the PubMed database, we did not include all target data. Second, we included a broad range of study designs, with weaker study designs increasing the risk of bias. Third, the sample sizes were not balanced between MVD and nerve block. Regarding the effectiveness of nerve block, the number of patients with and without guidance such as three-dimensional CT varied, which impeded proper evaluation. Finally, the long-term follow-up data regarding the treatment effect were inconsistent across studies. Future high-quality cross-sectional surveys using standard sampling methods and surgical treatment are warranted to elucidate the efficacy of RF, PRF, and other surgical procedures in TN treatment.

Conclusions

This review demonstrated the clinical utility of PRF combined with RF for TN treatment, which is a relatively new approach. This approach can increase the long-term efficacy and minimize the incidence of adverse effects. Compared with RF alone, combined RF and PRF treatment allowed more rapid recovery of postoperative complications, including facial numbness and masticatory muscle weakness. However, gamma knife surgery appears to be more suitable than nerve blockade for patients taking anticoagulants and antiplatelet drugs. We recommend combining PRF with RF when drug therapy is unavailable or insufficient. This review will guide clinicians in making informed decisions. Future studies are warranted to validate these results.

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Footnote

Provenance and Peer Review: This article was commissioned by the Guest Editor (Mythili Kalladka) for the series "Orofacial Pain: Diagnostic and Therapeutic Topicals, Nerve Blocks and Trigger Point Injection" published in *Journal of Oral and Maxillofacial Anesthesia*. The article has undergone external peer review.

Reporting Checklist: The authors have completed the Narrative Review reporting checklist. Available at https://joma.amegroups.com/article/view/10.21037/joma-22-2/rc

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