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EFFECTS OF COMBINED PULSED AND CONVENTIONAL RADIOFREQUENCY FOR THE TREATMENT OF IDIOPATHIC TRIGEMINAL NEURALGIA

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ABSTRACT:
Background: The most frequent approach in treating pain of TN either conventional thermal, pulsed or combined techniques is radiofrequency.
Objectives: Assessment of the efficiency of Gasserian ganglion injury with both conventional radiofrequency (CRF) and pulsed radiofrequency (PRF) during TN.
Patient and methods: 34 individuals with idiopathic TN participated in the clinical study receiving combination of conventional and pulsed radiofrequency (CCPRF). "First lesion at 60 °C for sixty seconds, 2nd lesion at sixty-five°C for Sixty seconds, and 3rd lesion at 70 °C for 60 seconds" was how individuals received treatment by CRF. Then, PRF with a pulse width of 10 ms and a frequency of 4 Hz was given for 360 seconds, repeatedly, at 45 V. The temperature of the needle tips selected as the cut-off is 42 °C. A pain score was determined at a period of two weeks, six months, twelve months, and three years. After the operation, the likelihood of complications and the probability of recurrence were assessed.
Results: Significant reduction in both medications doses and VAS in all follow-up time points were noticed. Side effects were tolerable e.g., local pain, headache, masseter spasm and hypothesia and nondistressing numbness was the common adverse effect in 5 (14.7%) patients. Recurrence rates were very low "1 patient out of 29 good responders after 24 months (3.44 %) and 3 patients out of 29 after 36 months (10.3%)".
Conclusion: Patients who obtained PRF together with CRF had significant pain relief and decreased painkiller use. Therefore, CCPRF has few postoperative effects and is successful in managing TN discomfort.
Keywords: conventional radiofrequency, pulsed radiofrequency, The Gasserian ganglion and trigeminal neuralgia.

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INTRODUCTION:

Trigeminal neuralgia (TN) is a prevalent unilateral condition with rapid onset and quick cessation of transient electric shock-like symptoms that affect just a portion of the trigeminal nerve [1]. Patients' everyday activities may be impacted by chronic pain. Chronic pain patients often experience emotional disturbances such stress and desperation [2].

Patients with TN often express one-sided, intense pain that feels like an electric shock and may be brought on by slight pressure. But some people remain to have accidental, spontaneous, mostly continuous face discomfort.

Radiofrequency (RF) injury is one of the methods used frequently for reducing pain. The major benefits of RF seem to be its efficacy, substantial efficacy of pain alleviation, absence of adverse effects, and decrease of oral medication—all without the risky risks associated with surgical operations [3].

The most popular method for treating refractory TN is thermocoagulation RF (TRF). It refers to the impact of elevated-frequency current at extreme temperatures on the gasserian ganglia. The fundamental mechanism was caused by nonmyelinated fibers which carry epicritic stimulation and prevent the transmission of electric activity, as well as high temperatures that damage the nerve's ability to transmit pain signals [4].

The application of brief bursts of high-frequency current to nerve tissue using pulsed radiofrequency (PRF) is a unique treatment approach that has lately been utilized by pain specialists [5].

Regarding the use of PRF for TN, there are different views [6]. Combining PRF with CRF could improve CRF's effectiveness and decrease the requirement for long-duration CRF (LCRF) and its related adverse effects [7]. Combining of conventional and pulsed radiofrequency (CCPRF) provided equivalent pain relief to PRF therapy alone in individuals suffering chronic pain.

In comparison to conventional RF, certain studies have shown PRF to be a somewhat successful therapy for TN, while others have determined it to be useless. New PRF forms, such as those using the most recent guiding systems, 3D computed tomography (CT), and modified PRF neuromodulation, have been studied for their impact on unexplained TN [8].

The objective of this study was to assess the efficacy of radiofrequency CRF in combination with PRF injury of the Gasserian ganglion during TN.

PATIENTS AND METHODS:

This retrospective study examined thirty-four individuals who received CCPRF at the National Cancer Institute (NCI) pain clinic from May 2014 to October 2019 and received a diagnosis with unexplained TN in line with the International Headache Society. Before collecting information about patients in retrospectively, the local ethics committee gave their approval.

Every participant received a brain MRI/MRA in order to rule out secondary neuralgia and were all on an effective analgesic schedule for at least a two-week period previous to the the action (which consists of at minimum 2 analgesics, including anticonvulsants), with a visual analogue score (VAS) for pain of at least seven or higher for a period of at least three months.

Patients with significant mental or psychological illnesses, drug abuse histories, excessive intracranial pressure, and histories of MVD, SGK, balloon compression, RF therapy, or glycerol injection—as well as those who could have secondary TN—were excluded from the study.

The following data were collected from all included patients:

1. Basic characteristics data: age, gender, baseline drugs, affected branch and side.

2. 2. VAS is an index for assessing pain both prior to and following surgery (at two weeks, six, twelve, twenty-four, and thirty-six months). Results depend on self-reported measurements of symptoms that are documented with a single handwritten indicate placed at one point along a line of ten centimeters indicating a range between each of the two concludes of the scale: "zero pain" on the scale's left end (0 cm) and "worst pain" on the opposite end (10 cm). Centimeter measures are made from the scale's starting point (left side) to the individuals' signs and are translated into degrees of discomfort [9].
3. 3. Functional enhancement: after receiving pain therapies, this self-reported study of the main result was carried out. No or little change (0% to 25%), mild increase (25-50%), moderate enhancement (50% to 75%), and significant improvement (> 75%) are the four categories, accordingly. [10].
4. 4. 2 weeks following intervention, the Patients' Global Impression of Change (PGIC) scale. It was created especially to evaluate how individuals felt before and after therapy (i.e., whether they were "feeling better" or "feeling worse"). There are seven possible results on the verbal scale: "very much improved," "much improved," "minimally improved," "no change," "minimally worsened," "much worsened," and "very much worsened." The subjective "much improved" and "very much improved" evaluations have been shown to reflect a relatively significant and large improvement [11].
5. Consumption of analgesics in form of Carbamazepine (Tegretol), equi-analgesic doses or adjuvant analgesics (Pregabaline "Lyrica"), Duloxetine (Cymbalta) and Baclofen (Lioresal): pre-procedure and post-procedure (after 2 weeks).
6. 6. Specific occurrences involving an unexpected return to medical treatment, a requirement for further therapeutic treatments, or the experience of uncommon, severe pain in the ipsilateral trigeminal division.
7. 7. Complications include a facial hematoma, discomfort at the puncture site, dystonia, hypothesis/anaesthesia, anaesthesia dolorosa (painful numbness), masseter weakness, corneal anaesthesia and loss of corneal reflex, keratitis, CSF rhinorrhoea, cavernous-carotid fistula, palsies of cranial nerves III, IV, and VI, and meningitis.

Technique of the study:

In the preparation room intravenous (I.V) line 18G inserted after ensuring patient fasting, ceftriaxone I.V drip was given 1/4 hour before the procedure after rolling out hypersensitivity as it has good cerebrospinal fluid penetration.

The individual was then attached to American society of anesthesiologists (ASA) standard equipment in the surgical area (ECG, noninvasive blood pressure monitoring, and pulse oximetry), and O2 was supplied through a nasal prong. To enable the submental view via fluoroscopy, the patient was positioned supine with a little extension of the neck. By administering 0.75 mg/kg propofol shots during the needle path through the oval foramen and throughout the TRF periods of time, along with 1 g/kg fentanyl and 1 g/kg dexmedetomidine (precedex-Pfizer), before local anesthesia infiltration at the location of the puncture, the ASA standard minimal sedation was supplemented. The Gasserian ganglion was examined using the traditional Hartle process utilizing C-arm fluoroscopy and confirmed with a CT scan after the skin had been properly sterilized and draped. The impacted branch is then parathesized at 0.1–0.2 V (50 Hz), maintaining consideration that the ophthalmic roots are posteromedial and the mandibular section of the Gasserian ganglion is ventrolateral. This is done using an RF needle (with 22 G, 100 mm length, five millimeters active tip, curved, sharp Baylis). Masseter contraction at 0.1–0.3 V results in motor pre-stimulation (2 Hz). The Baylis Generator, an RF power source, is used for RF treatment as follows: traditional RF First lesions for sixty seconds at sixty degrees Celsius, second lesion at 65 degrees Celsius, and third lesion for seventy degrees Celsius. Each time, the corneal reflex is evaluated and the targeted dermatome is also given hypotheses and analgesics. Last but not least, PRF with a pulse width of 10 milliseconds and a frequency of 4 Hz is administered for 360 seconds repeatedly at 45 V. After recording the sensory and motor post-stimulation, the cut-off needle tip temperature is set at forty-two degrees Celsius. Before needle removal, one milliliter of 1% lidocaine and half a milliliter of four milligrams per milliliter dexamethasone were administered.

Each individual were taken to the recovery area, where ice packs were used to treat facial ecchymosis and vital signs were checked.

Neurological assessment (pain, headache, pupil size, etc.,) was done and discharged after 2 hours and instructed with written instruction for contact with one of the physicians for any emergency.

SAMPLE SIZE CALCULATION:

Using PASS 2021 Power Assessment and Sample Size Software (2021), the necessary sample size has been determined. Kaysville, Utah, USA: NCSS, LLC; ncss.com/software/pass. The operation's effectiveness is determined by a pain score decrease of over fifty percent within two weeks after the surgery. Data from our neighborhood institutions, we expected a success rate of about 80%. We predicted that a sample size of twenty-eight individuals receiving RF for trigeminal neuralgia would result in twenty-two successful procedures (positive group) and Six unsuccessful procedures (negative group) according to the expected rate. This number of samples would have 82% power for determining a variance of.35 among the area under the ROC curve (AUC) under the null hypothesis of five and an AUC under the alternative hypothesis of.85, which is regarded as a clinically relevant effect size for the predictive value of the SI. A two-sided z-test with a threshold for statistical significance of P <.05. was used in these computations. We enrolled thirty-four individuals, anticipating a five percent attrition rate.

STATISTICAL METHODS

The IBM Corp. Armonk, New York-based SPSS Statistics version 24 was used for the statistical study. Mean and standard deviation are used to portray generally distributed numerical data, whereas median and range of values are used to present skewed data. The presentation of categorical information uses counts and percentages. Skewed numerical data are compared using the Mann-Whitney U-test

Correlations between normally distributed numerical variables are examined using the Pearson correlation. ROC curve analysis is used to examine the predictive value of the motor index. We used multiple measurement analysis of variance (ANOVA) to evaluate variance among groups and look at how pain levels changed during the follow-up period. We applied logarithmic transformation to the pain scores as they did not follow the normal distribution. The Greenhouse-Geisser method was used to correct the degrees of freedom since the Mauchy test revealed the assumption of sphericity was not fulfilled for the pain scores. All p-values for pair-wise comparisons are corrected using the Tukey post-hoc test. Statistical significance is defined as two-tailed P-values <.05

RESULTS:

Baseline characteristics shown in **Table 1**.

Non-distressing numbing was the most prevalent side effect in Five (14.7%) individuals, and there were no occurrences of anesthesia dolorosa, infections, or cranial nerve palsies. Recurrence rates were very low "1 patient out of 29 good responders after 24 months (3.44 %) and 3 patients out of 29 after 36 months (10.3%)". **Table 2** shows incidence of procedure-related adverse events.

There was a significant reduction in both medications' doses and VAS in all follow-up time points. The functional capacity revealed only 5/34 patients' poor responders (14.7 %) and 29/34 patients' good responders (85.3%) of which 36.7% reported excellent improvement. Most cases reported much improved 12 (35.3%) in PGIC followed by minimally improved and very much improved while no patient reported very much worsened. Main outcome measures are shown in **Table 3.**

Figure 1. displays the proportion of individuals who had a poor, fair, good, or outstanding response after two weeks**.**

The percentage of patients with good or excellent response and those with less than good response at 2 weeks is shown in **Figure 2.**

Table 1: Baseline characteristics of the study population

Variable	Value
Age (years)	57 ± 12
sex (Male)	17 (50.0%)
Involved division	
V1	1 (2.9%)
V2	3 (8.8%)
V3	8 (23.5%)
V1 & V2	6 (17.6%)
V2 & V3	16 (47.1%)
Baseline VAS	77 (75:81)
Medications before RF	
Carbamazepine	31 (91.2%)
Pregabalin	24 (70.6%)
Duloxetine	15 (44.1%)
Baclofen	14 (41.2)
Medication doses before RF	
Carbamazepine (mg/day)	600 (400 to 800)
Pregabalin (mg/day)	150 (0:150)
Duloxetine (mg/day)	0 (0:60)
Baclofen (mg/day)	0 (0:25)

Data are presented as mean±SD, frequency (%) or median (IQR). RF: rheumatoid factor

Table 2: Incidence of procedure-related adverse events

Variable		Value
Adverse events (n= 34)	**CSF leak**	1 (2.9%)
	TMJ pain	2 (5.9%)
	Headache	2 (5.9%)
	Hypoesthesia	2 (5.9%)
	Masseter spasm	1 (2.9%)
	Numbness	5 (14.7%)
	Vomiting	1 (2.9%)
	Local pain	1 (2.9%)
	Local swelling	1 (2.9%)
Recurrence rate (n= 29)	**After 24 months** **After 36 months**	1 (3.44%) 3 (10.3%)

Data are presented as frequency (%) or median (IQR). CSF: cerebrospinal fluid.

Table 3: Main outcome measures

Variable		Value
VAS scores after RF		
2 weeks		22 (15 to 34)
6 months		23 (18 to 33)
12 months		26 (18 to 38)
24 months		28 (20 to 37)
36 months		32 (27 to 41)
Reduction in VAS at 2 weeks		67.6 ± 19.1
Medications after RF	**Carbamazepine**	31 (91.2%)
Pregabalin		22 (64.7%)
Duloxetine		15 (44.1%)
Baclofen		11 (32.4%)
Medication doses after RF	**Carbamazepine (mg/day)**	100 (100 to 100)
Pregabalin (mg/day)		50 (0 to 50)
Duloxetine (mg/day)		0 (0 tot 20)
Baclofen (mg/day)		0 (0 to 5)
Initial response at 2 weeks	**Poor (0-25% improvement)**	2 (5.9%)
Fair (25.1% - 50% improvement)		3 (8.8%)
Good (50.1 - 75% improvement)		18 (52.9%)
Excellent (>75% improvement)		11 (32.4%)
Response at 2 weeks	**Less than good response**	5 (14.7%)
Good/Excellent response		29 (85.3%)
PGIC	**Minimally improved**	8 (23.5%)
	Very much improved	12 (35.3%)
	Much improved	8 (23.5%)
	No change	3 (8.8%)
	Minimally worsened	1 (2.9%)
	Much worsened	2 (5.8%)
	Very much worsened	0 (0%)

Data are presented as mean ± SD, frequency (%) or median (IQR). PGIC = patients' global impression of change. VAS: Visual Analogue Scale. RF: rheumatoid factor

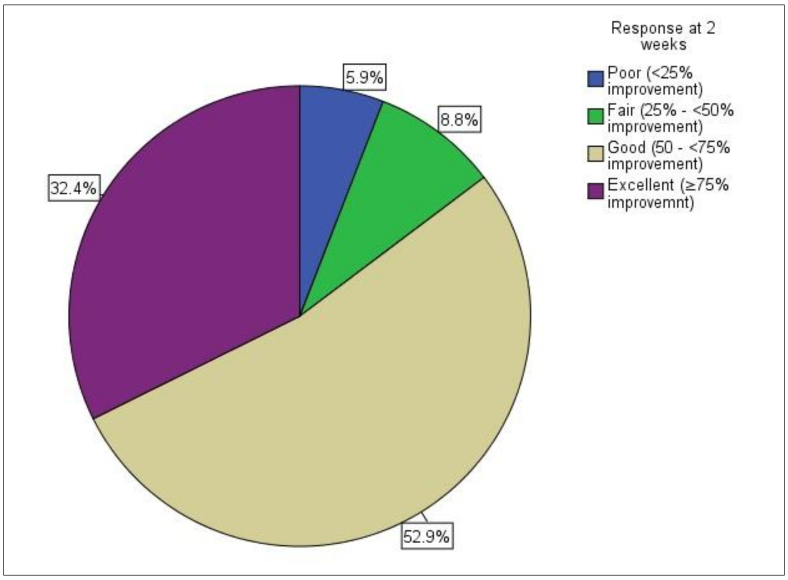

Figure 1: Pie chart showing the percentage of patients with poor, fair, good or excellent response at 2 weeks

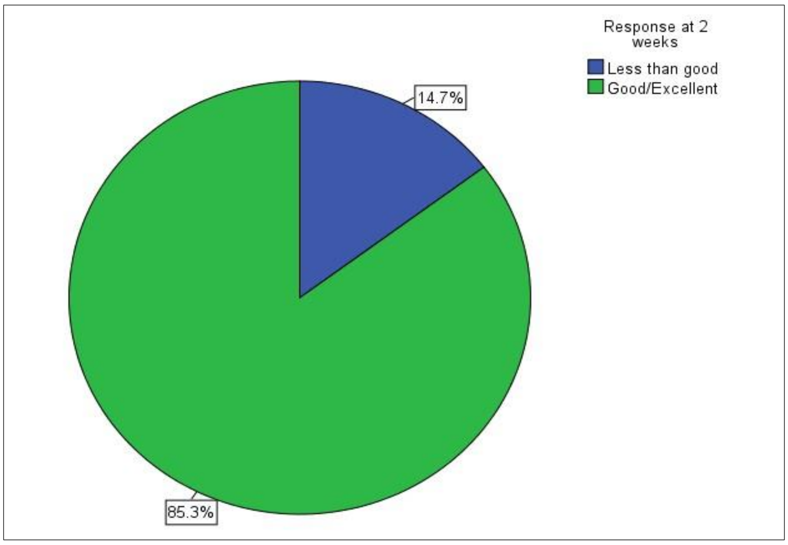

Figure 2: Pie chart showing the percentage of patients with good or excellent response and those with less than good response at 2 weeks

DISCUSSION:

TN is considered to be the most aggravating pain that humans have ever experienced, and several medications and surgical treatments have been used to manage it. Although there are many options, the outcomes are not entirely satisfactory. Clinical management is a problem when it comes to managing pain in individuals with unexplained TN. Interventional processes, such as glycerol injection, percutaneous balloon microdecompression, rhizotomy, thermocoagulation with RF, microvascular decompression, and gamma knife radiosurgery, have many benefits, including being relatively simple and rapid and having a low incidence of adverse events. However, these benefits are balanced by a risk of occurrences that rises over time. [12].

In our study the median age of patients enrolled 57 years old and mean 57 ± 12, this is higher than Elawamy et al. that their study showed the mean of age of their patients was 52.60 ± 9.78 [7]. but the same mean of age reported by Eissa et al. [13].

The main divisions treated of fifth cranial nerve were V2 and V3 "either isolated 3 (8.8%) and 8 (23.5%) respectively or together 16 (47.1%) ", this is comparable to pain distribution reported by Almor et al. observed that the lower division of the trigeminal nerve—2nd and 3rd divisions—were often the source of pain. [14].

Current work has revealed that CCPRF of Gasserian ganglion has a good potential in relieving refractory pain of TN. This was demonstrated by significant reduction in VAS scores (up to 36 months follow up) as well as in doses of used drugs. In addition, functional capacity scale showed only 5/34 patient's poor responders (14.7 %) and 29/34 patients' good responders (85.3%) of which 36.7% reported excellent improvement. Low recurrence rate was also achieved up to 24 and 36 months follow up (3.44% and 10.3% respectively) and this is similar to El Hossieny et al. studies that demonstrated a lower rate of recurrence in individuals receiving CRF and PRF [12].

There were no reports of anesthesia dolorosa, meningitis, distressing hypothesia and loss of corneal reflex and keratitis. The incidence of affordable side effects was reasonable [CSF leak = 2.9%, TMJ pain = 5.9 %, headache (transient) = 5.9%, non-annoying numbness = 14.7% and local pain only 2.9%].These current results are comparable with Kanpolat reports of complications rate in their study which were dysthesia (1%), anesthesia dolorosa (0.8%), In addition to masseter paralysis (4.1%), keratitis (0.6%), decreased corneal reflex (5.7%), and transitory third- and fourth-degree cranial nerve palsies (0.8%) [15].

The current results are better compared to old reports of Taha and Tew who documented TRF adverse effects in 6205 cases of RF rhizotomy as follow: facial numbness in 98%, anesthesia dolorosa in 1.5% of cases [16]. while Erdine also reported corneal reflex loss (7%), motor weakness (24%) and facial numbness (6-26%) [17].

In our study PGIC showed that many cases reported much improved 12 (35.3%) in PGIC followed by minimally improved and very much improved while no patient reported very much worsened. in the same context Ali et al. [13] assessed the effectiveness of mixed CRF with PRF on reducing pain for idiopathic TN and found that, according to the PGIC, substantial enhancement was noted for fifteen individuals, essential enhancement for three individuals, slight improvement for a single individual, and no difference for two individuals twelve months after the operation.

The favorable results of the current work in the form of significant VAS reduction and pain relief (good-to-excellent response), low complications and recurrence rates could be attributed to several factors. Firstly, technical precision by using combined fluoroscopy plus short-time 3D - CT guidance to control both direction and depth of RF needle tip at junction of V3 and Gasserian ganglion" proper lesioning target" and lower stimulation parameters (sensory threshold of 0.1- 0.2V and motor one of 0.1-0.3 V) to enhance A**δ** and C fibers selective destruction at the semilunar Gasserian ganglion.

Secondly, combining PRF "with its beneficial effected of the generated electromagnetic field in inhibiting pro-inflammatory cytokines and other inflammatory mediators and augmenting anti-inflammatory cytokines" together with neurodestructive effects of TRF. Maximizing the neuromodulator effects of PRF by using a current of 45 V, pulse with a frequency of 4 Hz, pulse width of 10 ms, and increasing the duration of therapy time to six minutes per session as indicated by Chua et al. [18] and limiting the lesioning temperature to 70 °C [19]. This combined technique has been suggested by several physicians to improve long term efficacy " up to 85-92% after 1 yr and 70-92% after 2 yrs "and simultaneously to minimize adverse effects particularly in V1 treatment [13, 20, 21].

CONCLUSION:

Combined conventional and pulsed radiofrequency give a reasonable therapeutic rationale for trigeminal neuralgia, especially if 3D-CT guidance is done in the approach with effective pain management and minimizes the intake of painkillers by individuals with unexplained TN.

Conflict of interest: Nil
Acknowledge: Nil

REFERENCES:

1. Srivastava R, Jyoti B, Shukla A, Priyadarshi P. Diagnostic criteria and management of trigeminal neuralgia: A review. Asian Pac J Health Sci. 2015;2:108-18.
2. Hulaihel A, Gliksberg O, Feingold D, Brill S, Amit BH, Lev-ran S, et al. Medical cannabis and stigma: a qualitative study with patients living with chronic pain. Journal of Clinical Nursing. 2023;32:1103-14.
3. Wu H, Zhou J, Chen J, Gu Y, Shi L, Ni H. Therapeutic efficacy and safety of radiofrequency ablation for the treatment of trigeminal neuralgia: a systematic review and meta-analysis. J Pain Res. 2019;12:423-41.
4. Huang B, Xie K, Chen Y, Wu J, Yao M. Bipolar radiofrequency ablation of mandibular branch for refractory V3 trigeminal neuralgia. J Pain Res. 2019;12:1465-74.
5. Wan C, Dao-song D, Song T. High-voltage, long-duration pulsed radiofrequency on gasserian ganglion improves acute/subacute zoster-related trigeminal neuralgia: a randomized, double-blinded, controlled trial. Pain physician. 2019;22:361.
6. Goda Mohamed AM, El-Aaser NM. Percutaneous thermocoagulation versus pulsed radiofrequency techniques in management of refractory trigeminal neuralgia. Zagazig University Medical Journal. 2021;27:257-66.
7. Elawamy A, Abdalla EEM, Shehata GA. Effects of Pulsed Versus Conventional Versus Combined Radiofrequency for the Treatment of Trigeminal Neuralgia: A Prospective Study. Pain Physician. 2017;20:E873-e81.
8. Fang L, Ying S, Tao W, Lan M, Xiaotong Y, Nan J. 3D CT-guided pulsed radiofrequency treatment for trigeminal neuralgia. Pain Pract. 2014;14:16-21.
9. Delgado DA, Lambert BS, Boutris N, McCulloch PC, Robbins AB, Moreno MR, et al. Validation of Digital Visual Analog Scale Pain Scoring With a Traditional Paper-based Visual Analog Scale in Adults. J Am Acad Orthop Surg Glob Res Rev. 2018;2:e088.
10. Costandi S, Garcia-Jacques M, Dews T, Kot M, Wong K, Azer G, et al. Optimal Temperature for Radiofrequency Ablation of Lumbar

Medial Branches for Treatment of Facet-Mediated Back Pain. Pain Pract. 2016;16:961-8.

11. Perrot S, Lantéri-Minet M. Patients' Global Impression of Change in the management of peripheral neuropathic pain: Clinical relevance and correlations in daily practice. Eur J Pain. 2019;23:1117-28.
12. Hossieny K. Impact of combining pulsed and thermal radiofrequency on long-term therapy of idiopathic trigeminal neuralgia: A prospective study. Egyptian Journal of Anaesthesia. 2020;36:78-82.
13. Ali Eissa AA, Reyad RM, Saleh EG, El-Saman A. The efficacy and safety of combined pulsed and conventional radiofrequency treatment of refractory cases of idiopathic trigeminal neuralgia: a retrospective study. J Anesth. 2015;29:728-33.
14. Almor ES, Abo Shosha M, Hassan M, Rashad MEA, Elmaghraby M, Ramzy M. Radiofrequency Management of Trigeminal Neuralgia. The Egyptian Journal of Hospital Medicine. 2018;73:7475-80.
15. Kanpolat Y, Savas A, Bekar A, Berk C. Percutaneous controlled radiofrequency trigeminal rhizotomy for the treatment of idiopathic trigeminal neuralgia: 25-year experience with 1,600 patients. Neurosurgery. 2001;48:524-32; discussion 32-4.
16. Taha JM, Tew JM, Jr. Comparison of surgical treatments for trigeminal neuralgia: reevaluation of radiofrequency rhizotomy. Neurosurgery. 1996;38:865-71.
17. Erdine S, Raj PP, Lou L, Staats PS, Waldman SD, Racz G, et al. Interventional pain management: image-guided procedures: Saunders Elsevier Philadelphia; 2008.
18. Chua NH, Halim W, Beems T, Vissers KC. Pulsed radiofrequency treatment for trigeminal neuralgia. Anesth Pain Med. 2012;1:257-61.
19. van Kleef M, van Genderen WE, Narouze S, Nurmikko TJ, van Zundert J, Geurts JW, et al. 1. Trigeminal neuralgia. Pain Pract. 2009;9:252-9.
20. Ding Y, Li H, Hong T, Zhu Y, Yao P, Zhou G. Combination of Pulsed Radiofrequency with Continuous Radiofrequency Thermocoagulation at Low Temperature Improves Efficacy and Safety in V2/V3 Primary Trigeminal Neuralgia. Pain Physician. 2018;21:E545-e53.
21. Yao P, Hong T, Zhu YQ, Li HX, Wang ZB, Ding YY, et al. Efficacy and safety of continuous radiofrequency thermocoagulation plus pulsed radiofrequency for treatment of V1 trigeminal neuralgia: A prospective cohort study. Medicine (Baltimore). 2016;95:e5247.