Original Article | Clinical Studies

A novel technique to identify and thermally ablate the greater occipital nerve for patients with occipital neuralgia: a retrospective study with cadaveric and *ex-vivo* validation

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Background: This manuscript presents the challenges of treating various forms of headaches and the potential of interventional techniques targeting the greater occipital nerve (GON) to alleviate the burden on patients. Occipital neuralgia, characterized by stabbing or shooting pain in the base of the skull, is often associated with primary, cervicogenic, or migraine headaches. While occipital nerve blocks offer temporary relief, durable treatment options are limited. Pulsed radiofrequency (PRF) and thermal radiofrequency ablation (TRFA) have shown promise as minimally invasive procedures for long-term treatment. However, GON is not easily identified using ultrasound or fluoroscopic analysis; thereby, minimizing success of proper ablation. Here, the authors provide a percutaneous strategy to localize the GON and maximize lesion performance. We intend to provide an *ex-vivo* description of staggered bipolar radiofrequency (RF) lesioning and include the use of staggered bipolar lesioning of the GON and stimulation of the semispinalis capitis. We also analyzed the effectiveness and side effects from this ablation, retrospectively.

Methods: Patients with chronic refractory GON neuralgia were selected for GON TRFA. A novel double needle technique of sequential electrical stimulation was used to localize the GON and approximate needle to nerve distance. Once the needles were positioned adjacent to the GON, TRFA was performed using a bipolar staggered technique.

Results: Twenty-two patients with GON were treated with TRFA using a novel double needle technique. Seventy-two percent of these patients reported greater than 50% pain relief at both 1 and 6 months following the procedure. The results of our *ex-vivo* study demonstrate that performing TRFA using the parallel needle bipolar approach separated 8 mm apart produced the most desirable lesion dimensions that may correlate with effective ablation of the GON.

Conclusions: This study demonstrates a new localization and ablation technique to treat refractory headaches. However, larger studies are needed to confirm our findings.

Keywords: Radiofrequency ablation (RFA); bipolar; monopolar (MP); double needle; headache

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Introduction

Headaches are the fifth leading cause of emergency department visits, with the greater occipital nerve (GON) being the most commonly implicated nerve for headache pain (1-3). Despite the known burden, many forms of headaches remain refractory to pharmacological treatments and standard nerve blocks; some are complicated by polypharmacy and intolerance (4). Therefore, improvements in interventional techniques targeting the GON may lessen the burden on patients who suffer from headache disorders.

Occipital neuralgia can be a common presentation in conjunction with primary, cervicogenic or migraine headaches (1,3,5). This presentation is classically described as a stabbing or shooting pain that starts at the base of the skull and extends to the vertex of the head, representing the sensory distribution of the GON (6). Occipital nerve blocks (ONB) are widely used as an interventional approach for acute symptomatic relief; however, durable treatment for this condition remains elusive as injections often provide only temporary pain relief. Botulinum toxin injections demonstrate efficacy for migraines, but data for improvement in occipital neuralgia is unclear (7).

Highlight box

Key findings

- The greater occipital nerve (GON) can be reliably located using a double needle technique.

What is known and what is new?

- The GON is known to cause posterior head pain and headaches. There is abundant literature supporting neuromodulation of the GON for posterior headache, including neurostimulation and radiofrequency ablation (RFA). Most RFA procedures are performed with fluoroscopy, which limits the localization of the nerve, thereby potentially decreasing the efficacy of neural targeting RFA.
- Our manuscript defines the occipital nerve as having a motor contributor to semispinalis capitis, thereby allowing for motor stimulation verification. In addition, a double needle approach allows a practitioner to better localize the nerve using independent motor stimulation of each needle. Using bipolar settings on RFA units causes a more complete and uninterrupted burn between two needles. This approach improves the targeting of the GON when performing RFA with fluoroscopy.

What is the implication, and what should change now?

- This introduced procedure may be used to identify any peripheral nerve with greater reliability using double needle localization. Practitioners can use this information to modify and improve the treatment of peripheral neuralgias with current RFA technology.

With advancements in neuromodulation, radiofrequency ablation (RFA) has been cited in the literature as a minimally invasive procedure with the potential to provide an intermediate to long-term treatment option (8). Pulsed radiofrequency (PRF) is often cited for the treatment of occipital headaches (9); however, the lack of strong randomized control trials, speculative translational research, and marginal insurance coverage have limited adoption of this technique. Thermal radiofrequency ablation (TRFA) of the GON is not described in the literature but could be an option for the treatment of chronic refractory headache. A retrospective study by Hoffman *et al.* demonstrated that TRFA of the greater and lesser occipital nerves (LON) provided pain relief for greater than 6 months (10). Recently, Abd-Elsayed *et al.* provided evidence in a retrospective study that using thermal, PRF and TRFA is a safe and effective treatment for patients with chronic headache conditions associated with occipital neuralgias (11). Given the lack of awareness regarding the efficacy of exclusively TRFA for the treatment of occipital headaches, this study offers a novel technique and sound scientific explanation for the treatment of occipital neuralgia related headache.

Anatomical considerations of the GON

The GON is one of the three major occipital nerves in the human body. The occipital nerves are composed of a group of nerves that originate from cervical (C) (C2) and C3 spinal nerves that also include the LON and the third occipital nerve (TON). GON arises from the medial branch of dorsal ramus of C2 spinal nerve to innervate the cutaneous fibers of the posterior scalp up to the vertex of the skull, ear, and skin above the parotid gland. It also provides motor innervation to the semispinalis capitis and inferior oblique muscles (*Figure 1*) (12,13). The most common site of compression of this nerve is variable in nature although most described to be at the penetration of the aponeurosis of the trapezius (14).

A traditional approach to access the GON typically involves using the external occipital protuberance and mastoid process to approximate the locations of both the GON and the occipital artery (OA) in the suboccipital region (15). An alternative landmark is at the superior nuchal line (1), where studies have shown a consistent relationship between the OA and GON lying more superficially and decreasing the concern of needle insertion into deeper structures. We report a novel approach for GON localization using motor stimulation of the

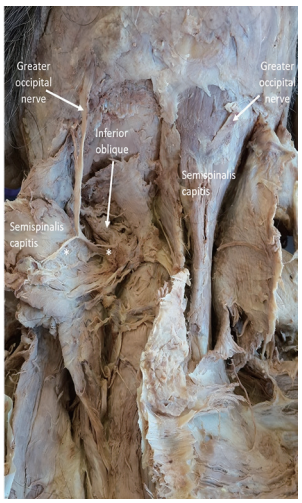


Figure 1 Anatomical dissection of the peri-occipital region displaying the GON and the associated motor fibers to the splenius capitis. * represents branches of the GON innervating the semispinalis capitis. GON, greater occipital nerve.

semispinalis capitis and an innovative ablation method, guided by the landmarks of our gross dissection (*Figure 1*).

Methods

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Montefiore Medical Center Institutional Review Board (IRB) approved this study (IRB No. 2021-13151). We retrospectively analyzed patient charts from Montefiore Medical Center, Department of Pain Medicine to extract relevant information. No consent form was taken as the study was retrospective in nature.

In this study, we demonstrate a method to target the GON and create a substantial lesion size while limiting surrounding tissue damage. Patients were selected for this procedure if they met the diagnosis of occipital neuralgia based on the international headache criteria for occipital neuralgia (16). In addition, they must have failed at least three oral medication treatments and demonstrated transient improvement with a GON anesthetic block (>50% improvement).

GON was identified using manual technique and verified with electrostimulation verification. Subsequently, two Stryker Venom® needles (Lot: 6000102430/23D27-1 Ref: 0406-660-125, Stryker, Kalamazoo, MI, USA) were placed on either side of the GON and placed in a staggered position. TRFA was performed for 90 seconds at 80 degrees Celsius using a bipolar setting (*Figure 2*). The validation for this technique is described below.

Electrical stimulation localization of the GON

The purpose of localization is to identify the GON with electrophysiological monitoring using a novel dual needle localization technique and then performing TRFA.

The general location of GON is first established by standard manual technique (1). A study by Lainé *et al.* demonstrated identification of GON with landmarks noting one thumb's breadth or 2 cm lateral to the external occipital protuberance and approximately at the base of the thumb nail or 2 cm inferior (17). Vanterpool *et al.* further emphasized the nerve location at the superior nuchal line with the nerve noted to be more superficial and lateral at this location laying directly on top of the bony protuberance of the superior nuchal line (1). Once the area is identified, initial needle placement and injection of the area proceed in a similar fashion as described by Hoffman *et al.* (10). This area is anesthetized with 3–4 cc of 1% lidocaine using a 1.5-inch 25-gauge hypodermic needle. A tract of local anesthetic is delivered in line with the GON. Thereafter, a 100-mm TRFA needle with a 10-mm active tip is bent commensurate to the patient's cervical lordosis (*Figure 3*). This needle is then inserted until the tip reaches the occiput. A second TRFA needle is then inserted 1–1.5 cm medial to the entry of the first. The end position of the TRFA needles at this point are inferior to the juxtaposition of the OA and GON so thermal risk to the OA is minimal (*Figures 2*,*3*) (1). Motor stimulation is checked with the first needle. Successful approximation is achieved when there is motor activity at 1 volt or less (suggestive of semispinalis capitis and inferior oblique stimulation) (*Figure 2*). The second needle is then stimulated and repositioned until the distal tips of the first and second needles are 1 cm apart and generate similar motor responses. This dual activity suggests that the GON is positioned in between the needles (*Figure 2*). If there is a motor response with only one needle, then the second needle must be moved to collocate the GON. Sensory stimulation was not performed, as the subcutaneous anesthesia tract was found to decrease the reliability of a patient mediated response to the stimulation.

Statistical analysis

Data analysis was performed using JMP software (version 19.3, SAS Institute Inc., Cary, NC, USA, 1989–2023). A

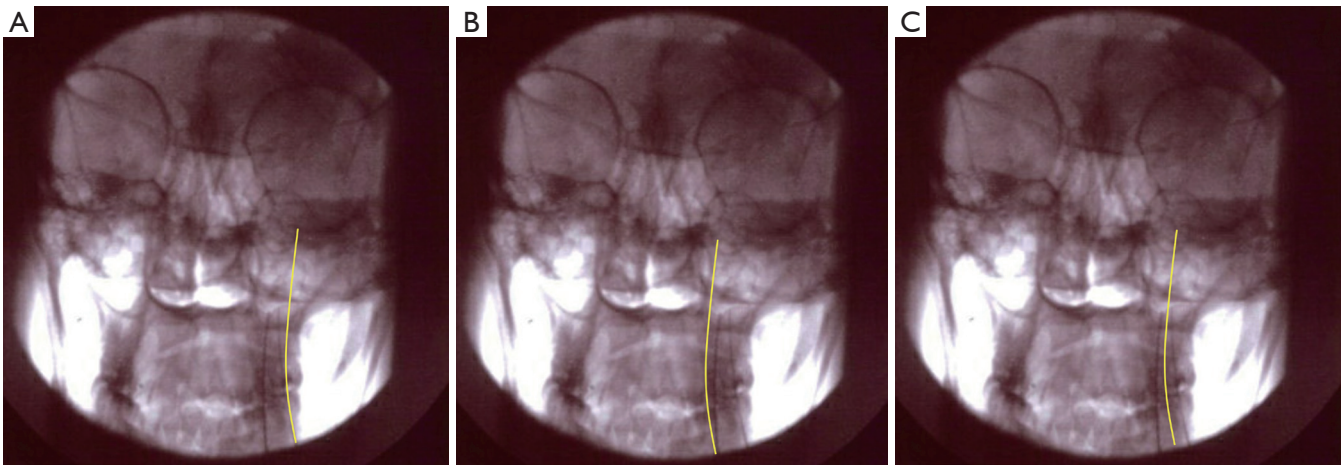


Figure 2 Fluoroscopic image demonstrating intra-operative staggering of TRFA probes and relative positioning of the GON to the probes. Note that in (A) and (B) GON stimulation is localized to the needle stimulation of right and left needles, respectively. However, in (C) ideal position is noted where both needles elicit a GON response because they are equidistant from the GON. Yellow line represents the GON. TRFA, thermal radiofrequency ablation; GON, greater occipital nerve.

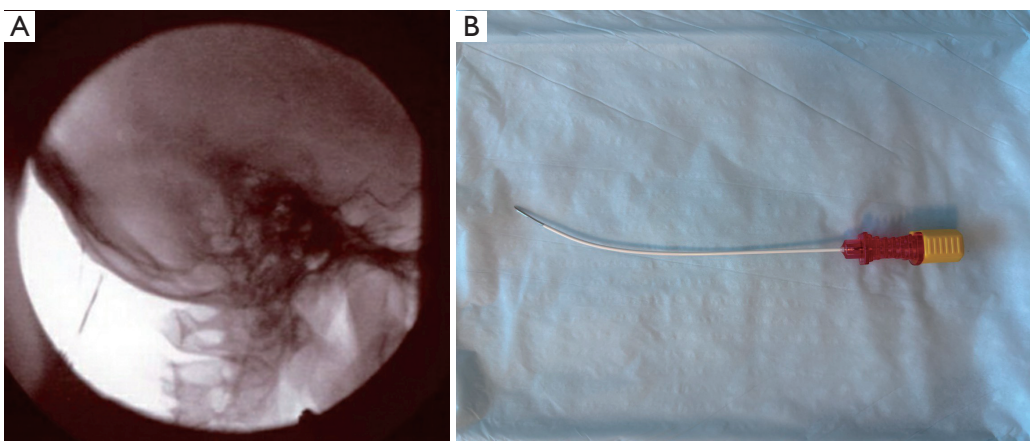


Figure 3 Lateral projection demonstrates end needle position on lateral view contacting the base of the skull (A). The needle is bent commensurate with cervical lordosis (B).

t-test was used to measure the difference in size of lesions between each two groups. An analysis of variance and Tukey-Kramer test was performed to compare multiple groups. P values <0.01 were considered statistically significant.

Results

Ex-vivo TRFA lesion size assessment

In order to determine the best strategy for creating a lesion of a potential neural target, we tested dual needle lesioning characteristics. Staggered needle positioning and inter-needle spacing were the two tested variables. Organic chicken breast was used as the RFA substrate to conform to standard TRFA *ex-vivo* technique. All lesions were performed at 90 seconds at 80 degrees Celsius. Stryker Venom® 20-gauge 10-mm active tip needles were used. Lesion sizes were compared in eight groups: (I) non-staggered monopolar (NSMP); (II) non-staggered bipolar (NSBP); (III) staggered monopolar (SMP) and (IV) staggered bipolar (SBP); these four groups were then subcategorized to assess 8-mm spacing and 10-mm spacing.

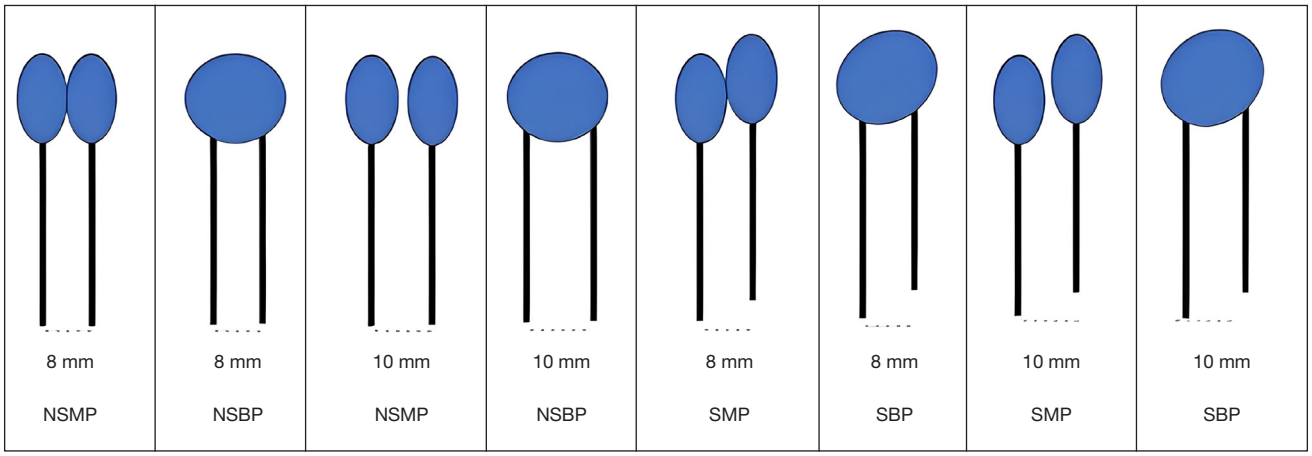


Figure 4 Diagrammatic representation of lesion sizes assessed in our study. NSMP, non-staggered monopolar; SMP, staggered monopolar; SBP, staggered bipolar; NSBP, non-staggered bipolar.

Each TRFA session was performed 4 times for statistical precision (*Figure 4*).

Various probe settings and configurations were tested. TRFA was performed with monopolar (MP) 20-gauge, 10-mm active tip needles 8 and 10 mm apart. The process was repeated with bipolar TRFA. During these tests, the two probes were placed parallel to each other. A staggered/parallel configuration was also used, again with probes in parallel alignment and 8 and 10 mm from each other; in the staggered trials one probe tip was positioned 5 mm lower than the other. This configuration was repeated with both bipolar and MP settings.

Non-staggered lesions were wide ovoid, while the staggered lesions were in the shape of a tilted ovoid (*Figure 4*). The length and width of all lesions were measured in millimeters (*Table 1*).

The lesion between the needles were also evaluated for all cohorts to determine whether the RFA lesions were complete or incomplete.

Table 1 displays average lesion sizes by length (mm) × width (mm). The widest lesions were created by NSMP 10 mm cohort, while lesion widths created by NSMP 8 mm cohort were notably smaller in comparison.

Lesion lengths created by NSBP probes had comparable lengths to their MP counterparts when spaced 8 mm apart; averaging 15 mm for NSMP, and 14.5 mm for NSBP. However, NSMP produced wider lesions, averaging 13.25 mm for NSMP and 9.75 mm for NSBP.

The SBP8 probes created lesions that were as wide as the NSBP cohort; however, lesion lengths were longer in the NSBP group when compared to the SBP cohort (14.5 versus 11.25 mm, respectively).

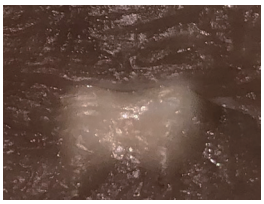
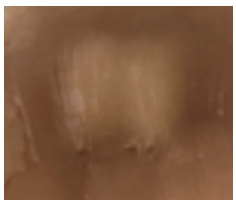
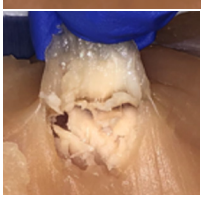
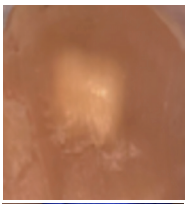
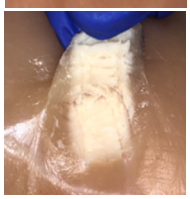
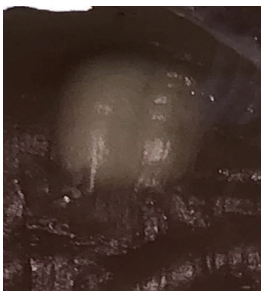
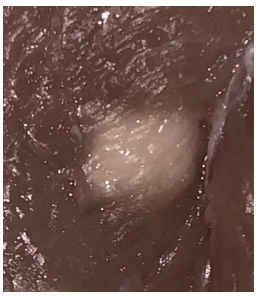
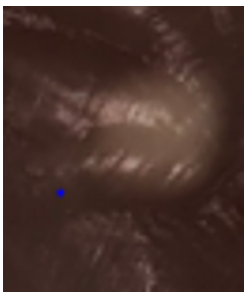
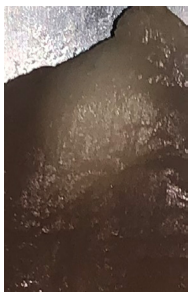
Our data demonstrates that the configuration with both the longest and narrowest ablation involved NSBP 8 mm probes setting. Furthermore, bipolar ablations completely coagulated the tissue between them, whereas MP probes incompletely lesioned in between as depicted in *Figure 4*. Probes spaced 10 mm apart created wider lesions than the 8-mm cohorts. Staggered needle placement produced shorter lesions than the non-staggered set.

Comparing the length of lesions in different groups revealed length of lesions were significantly larger in lesions which were made by NSMP 8 mm compared to length of lesions from SMP 8 or 10 mm and SBP 10 mm or regular needles with 10 mm between probes (P=0.0001). The length of lesions created by the NSBP 8 mm were significantly larger than lesions from SBP 10 mm and SMP 8 or 10 mm (*Figure 5*). There were no significant differences between the other lesions' length.

Figure 6 shows the distribution of lesions' width; subsequent analysis revealed resultant lesions with NSMP 10 mm had significantly larger width than lesions from any bipolar needles (staggered or non-staggered) and SMP 8 or 10 mm (P<0.0001). Of note, lesions' width from NSMP 8 mm were significantly larger than SMP 8 or 10 mm. Lesions' width from other needles were not significantly different.

Analyzing the surface area (SA) revealed lesions' SA from either NSMP 8 or 10 mm are significantly larger than any other lesion's SA (P=0.0001). Although there was tendency

Table 1 Demonstrates *ex-vivo* analysis of lesioning (length × width) with staggered/non-staggered as well as unipolar *vs.* bipolar techniques

Spacing	NSMP (mm × mm)	NSBP (mm × mm)	SMP (mm × mm)	SBP (mm × mm)
Lesion at 8 mm	15×13.25	14.5×9.75	9.0×8.0	11.25×10
			 	 
Lesion at 10 mm	12.75×19	10.75×11.5	9.0×11.0	9.25×9.5
				
Area between needles completely coagulated	No	Yes	No	Yes

NSMP, non-staggered monopolar; SMP, staggered monopolar; SBP, staggered bipolar; NSBP, non-staggered bipolar.

for larger SA from NSMP 10 mm compared to NSMP 8 mm (P=0.03), difference is not significant for our P value cut-off (<0.01). There was no significant difference in lesions' SA with either SMP or SBP. There were no other significant differences between the lesions' SA (*Figure* 7).

Clinical cases

Retrospectively, 22 patients with documented occipital neuralgia diagnosis who ablations using this novel GON localization approach paired with bipolar lesioning were performed for them were selected. There were three male patients and 19 females. The age range of our patient population was 40–65 years old (mean: 51). Eighteen reported at least 50% improvement (72%) of frequency and intensity of headaches 1 and 6 months after the procedure. No other new interventions were administered during the post procedure period. Two patients did not note any improvements (9%) in 1 month. Three patients were lost to follow-up.

The relief was noted in both severity and frequency of headaches. Improvement was defined as greater than 50% relief in symptoms. Three patients had post TRFA neuritis, although were noted to prefer this outcome over their original headache presentation. This complication presented consistently as a burning sensation at the posterior occiput. This symptom improved with a GON block with steroid one week following the TRFA.

Discussion

Greater occipital neuralgia is a disabling condition which has mixed success with various treatment modalities. A commonly performed interventional pain strategy PRF

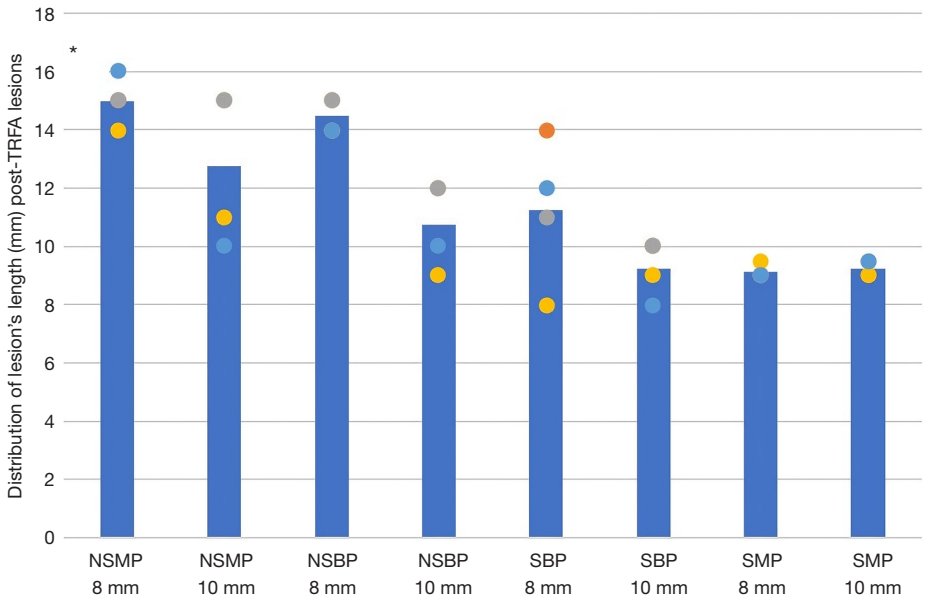


Figure 5 Distribution of lesion's length (mm) post-TRFA lesions. * denotes NSMP 8 mm lesion length > SMP 8 mm, SMP 10 mm, or SBP 10 mm (P=0.0001). Of note, the length of lesions created by the NSBP8 were significantly larger than lesions from SBP 10 mm and SMP 8 or 10 mm. There were no significant differences between the other lesions' length. Bars are the mean measures, and each circle represents one measurement, different colors represent a separate set of measurement. N=4. TRFA, thermal radiofrequency ablation; NSMP, non-staggered monopolar; SMP, staggered monopolar; SBP, staggered bipolar; NSBP, non-staggered bipolar.

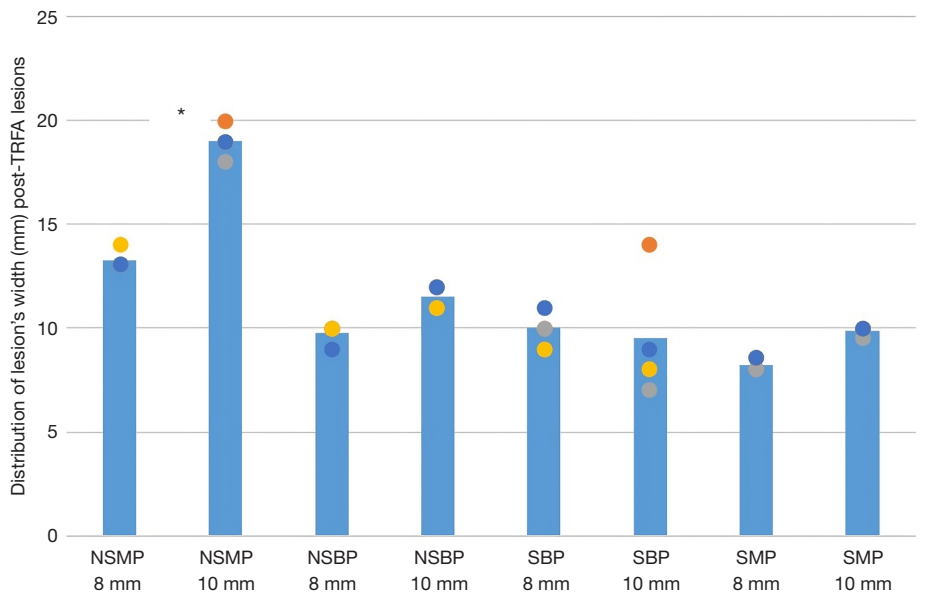


Figure 6 Distribution of lesion's width (mm) post-TRFA lesions. * indicates that NSMP 10 mm had significantly larger width than lesions from any bipolar needles (staggered or non-staggered) and SMP 8 or 10 mm (P<0.0001). Of note, lesions' width from NSMP 8 mm were significantly larger than SMP 8 or 10 mm. Lesions' width from other needles were not significantly different. Bars are the mean measures, and each circle represents one measurement. Different colors represent a separate set of measurement. N=4. TRFA, thermal radiofrequency ablation; NSMP, non-staggered monopolar; SMP, staggered monopolar; SBP, staggered bipolar; NSBP, non-staggered bipolar.

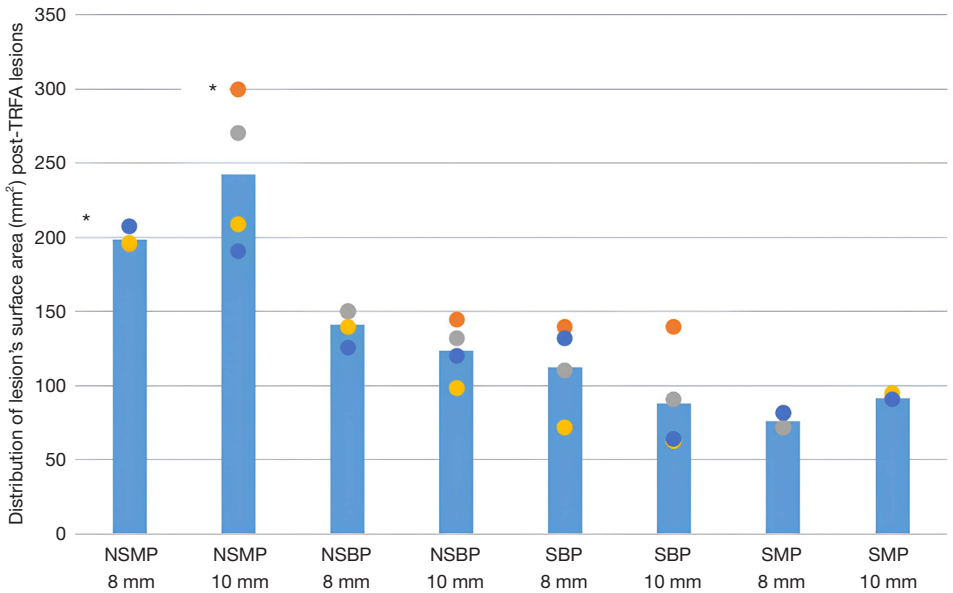


Figure 7 Distribution of lesion's surface area (mm^2) post-TRFA lesions. * indicates that the SA from either NSMP 8 or 10 mm are significantly larger than any other lesions' SA (P=0.0001). Bars are the mean measures, and each circle represents one measurement. Different colors represent a separate set of measurement. N=4. TRFA, thermal radiofrequency ablation; NSMP, non-staggered monopolar; SMP, staggered monopolar; SBP, staggered bipolar; NSBP, non-staggered bipolar; SA, surface area.

ablation, which has an ill established scientific foundation and, thus, limited insurance coverage (4,8,10,11). Despite this, practitioners continue to perform PRF presumably because of the need for a non-pharmacologic treatment with minimal procedural risk. We describe here a TRFA lesion using double needle electrical stimulation localization. In our case series, we demonstrated efficacy and safety. Most payers have coverage policies for TRFA of peripheral nerves, so we also submit that this method of GON RFA is reimbursable, unlike the PRF alternative. In addition, the authors submit that the durability of this procedure may make it more cost effective than most multimodal pharmaceutical treatments currently offered; however, a more robust cost analysis evaluating workdays lost, quality of life, and alternative treatments, needs to be performed for validation.

This study describes a novel GON localization technique and provides *ex-vivo* validation for ablation characteristics which translated into strong clinical outcomes. Proper GON localization was verified with motor testing by cadaveric dissection (*Figure 1*). The bipolar ablation method was also validated by our *ex-vivo* ablation analysis.

The results of our study demonstrate that performing TRFA using the parallel needle bipolar approach separated 8 mm apart produced the most desirable lesion dimensions that may correlate with effective ablation of the GON. We submit that the longest and narrowest lesion with the most complete inter-needle ablation was the best because it ensured complete coagulation of the GON while minimizing surrounding tissue destruction. The average lesion dimensions of the NSBP approach produced a length of 14 mm and diameter of 9.75 mm when the inter-probe distance was 8 mm. As the inter-probe distance of this technique was increased to 10 mm, a noted decrease in the average length of the lesion was produced at 10.75 mm and an increase in the diameter to 11.5 mm, suggesting that a tighter distance between the TRFA probes in the BP8 was superior when compared to a distance of 10 mm. An SBP 8 mm produced relatable results although with a reduction in average length of lesion to 11.25 mm despite maintaining a desired minimal diameter average of 10 mm. The results demonstrated MP setting to produce the greatest length when compared to the remainder of the techniques although with the largest unwanted diameter. The MP8 produced an average diameter of 13.25 mm and was increased to an average of 19 mm at a probe distance of 10 mm. However, this increase in lesion diameter also resulted in incomplete lesioning between the probes, suggesting

that GON between them may have been left unaffected. Clinically, this may translate into minimal coagulation of the GON with greater surrounding tissue damage when MP TRFA is performed with the double needle technique.

TRFA lesion characteristics depend, in part, on the size and type of needle, and lesion time. We demonstrated here that double needle TRFA requires bipolar-MP and spacing consideration. In general, TRFA needles have 5 to 7 mm ablation diameter representing 1 to 1.5 times the diameter of the electrode (18). In comparison, cooled TRFA may lead to increased local tissue damage due to the ability to extend the circumferential diameter to 1.5 cm (19). Cooled TRFA, however, has limited representation in the literature in the treatment of occipital neuralgias despite one case report presented by Vu *et al.* in 2014 (20). Our study demonstrates the use of a parallel bipolar TRFA technique to accurately identify the neural target while controlling the size of lesion based on needle spacing distance.

The authors submit that precise localization of the GON with double needle electrical stimulation, followed by SBP lesioning with interpolar distance of 8 mm created the narrowest and most complete lesions, minimizing unwanted necrotic tissue. However, further investigation is needed to determine if other RFA systems with bipolar TRFA functionality would reproduce our findings. In addition, a larger controlled case series is needed to verify the clinical outcomes described here.

The literature has historically supported needle placement parallel to the nerve when performing TRFA to adequately cover the common anatomic locations of the target neural structures. This was demonstrated by Govind *et al.* as a revised technique of percutaneous radiofrequency neurotomy of the TON (21). The electrodes in this study were placed at each target point and distanced no more than two electrode diameters from where the nearest adjacent electrode had been placed. This strategy ensured the gap between electrodes was not greater than the width of one electrode thereby producing lesions contiguous and overlapping lesions with no region between electrode placements that could escape coagulation (10). Govind performed third occipital TRFA at the vertebral level with different trajectories to maximize lesion size for greater ablation area. Therefore, our technique cannot be directly compared. However, Govind is the only other study which described TRFA of an occipital nerve with improved clinical outcomes. We expanded on this idea by performing TRFA directly at the distal fibers of the GON, while also describing a localization method and comparing more current TRFA methods. Our results demonstrated on poultry lesions established that a parallel bipolar approach of at least 8 mm provides the desired coagulation and overlap. This demonstration displays a promising translation to the clinical setting when performing GON TRFA to adequately capture the neural structure and avoiding potential complications including surrounding tissue swelling and disrupting nearby vascular structures.

In the clinical setting, 72% of patients who underwent this technique for refractory headaches were found to have improvement of their original headaches. In three patients the procedure was complicated by occipital neuritis, a known potential sequela of RFA of the occipital nerves. This pain has been described as burning, tingling or numbness. This is likely secondary to the known focal tissue destruction that can occur between 60 and 80 degrees Celsius with the risk of deafferentation pain syndrome, neuritis and paresthesias (22). Most of the patients in our sample preferred this outcome to their original headache and were adequately treated with a local corticosteroid and lidocaine mixture. The longevity of pain relief for these patients appears to be promising with our technique. The authors believe that the low rate of post-procedural pain was due to 8-mm spacing, which decreased peri-GON tissue destruction. The high relative rate of pain relief was likely due to the accuracy of localization with the double needle technique.

The result of this study provides support for TRFA as a treatment of occipital neuralgia. The majority of cited literature describes PRF ablation, which is controversial. TRFA results in temperature related neural disruption and inhibition of axonal signal propagation. PRF delivers its therapy in short bursts of high-amplitude current in between long pauses that allow for the dissipation of heat. The histological preservation of neural tissue and without a validated agreement on mechanism of action categorizes this procedure as 'investigational' by most insurance carriers and is deemed by most payors as a non-covered procedure (10). The popularity of PRF for occipital neuralgia treatment is presumably due to the safety reported in clinical data. TRFA has recently been demonstrated to have promising results in treating occipital neuralgia refractory to conservative management. Hoffman *et al.* demonstrated a statistically significant reduction in patient-reported pain scores following TRFA for occipital neuralgia with an average reported length of relief greater than 6 months (10). Furthermore, in a retrospective analysis, Alaa Abd-Elsayed *et al.* demonstrated the safety and efficacy of TRFA in

treating occipital neuralgias using TRFA in a lesion mode at 80 degrees Celsius for 180 seconds with improvement in 90.3% of patient's headaches and minimal reported side effects (23).

Our study provides a novel GON dual needle localization and ablation technique. Though our clinical findings are supported by *ex-vivo* analysis, we recognize the need for a larger scale randomized clinical trial for validation of our findings.

Limitations

There are a number of limitations that may have impacted the results of this study. The basic sciences design demonstrating TRFA lesions on poultry meat presents limitations when translating the findings in the clinical setting. Despite the use of organic poultry without added preservatives and sodium, the composition of poultry is variable and dissimilar to human tissue and may distort the thermal distribution of the lesion. Although TRFA needles were changed before each burn on poultry meat, there is a potential for poultry protein to coagulate at the needle tip that can disrupt lesion size. The small sample size also limits the generalizability and power of the data provided in both the laboratory and clinical settings. Larger scale demonstration of the techniques and lesion size would improve the power and translation to patient outcomes. In general, the literature available supporting TRFA for the treatment of occipital neuralgia is limited including the lack of a prospective, randomized control trial to demonstrate conclusive evidence of the effectiveness. The need for well-designed randomized control trials including a larger patient sample size is needed to further support the TRFA technique of the GON described in this study for occipital neuralgia.

Conclusions

We describe a novel and promising approach to treat GON related headaches. Clinical studies to date provide abundant data regarding PRF. We provide an alternate and scientifically sound approach with TRFA using a parallel bipolar technique to target and ablate the GON while minimizing surrounding tissue damage. Though large-scale studies evaluating different available needle and probe combinations are required to create the best practice approach for TRFA of the GON, the authors believe that this manuscript creates a foundation for future investigation.

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Footnote

Data Sharing Statement: Available at https://atm.amegroups.com/article/view/10.21037/atm-24-72/dss

Peer Review File: Available at https://atm.amegroups.com/article/view/10.21037/atm-24-72/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://atm.amegroups.com/article/view/10.21037/atm-24-72/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Montefiore Medical Center Institutional Review Board (No. 2021-13151). No consent form was taken as the study was retrospective in nature.

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