Retrospective Study

A Retrospective Comparison of Low-Temperature Plasma Ablation and Radiofrequency Thermocoagulation of the Thoracic Nerve Root for Refractory Postherpetic Neuralgia

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Background: Radiofrequency thermocoagulation (RFT) of the thoracic nerve root is commonly employed in treating medication-refractory thoracic post-herpetic neuralgia (PHN). However, RFT procedures' suboptimal pain relief and high occurrence of postoperative skin numbness present persistent challenges. Previous single-cohort research indicated that the low-temperature plasma coblation technique may potentially improve pain relief and reduce the incidence of skin numbness. Nevertheless, conclusive evidence favoring coblation over RFT is lacking.

Objectives: To compare the clinical outcomes associated with coblation to those associated with RFT in the treatment of refractory PHN.

Study Design: Retrospective matched-cohort study.

Setting: Affiliated Hospital of Capital Medical University.

Methods: Sixty-eight PHN patients underwent coblation procedures between 2019 and 2020, and 312 patients underwent RFT between 2015 and 2020 in our department. A matched-cohort analysis was conducted based on the criteria of age, gender, weight, pain intensity, pain duration, side of pain, and affected thoracic dermatome. Pain relief was assessed using the numeric rating scale (NRS), the Medication Quantification Scale (MQS) Version III and the Neuropathic Pain Symptom Inventory (NPSI), which were employed to indicate pain intensity, medication burden, and comprehensive pain remission at 6, 12, and 24 months. Numbness degree scale scores and complications were recorded to assess safety.

Results: We successfully matched a cohort of 59 patients who underwent coblation and an equivalent number of patients who underwent RFT as a PHN treatment. At the follow-up time points, both groups' NRS, MQS, and NPSI scores exhibited significant decreases from the pre-operation scores ($P < 0.05$). The coblation group's NRS scores were significantly lower than the RFT group's at the sixth and the twenty-fourth months ($P < 0.05$). At 24 months, the MQS values in the coblation group were significantly lower than those in the RFT group ($P < 0.05$). Furthermore, the coblation group's total intensity scores on the NPSI were significantly lower than the RFT group's at the 12- and 24-month follow-ups ($P < 0.05$). At 6 months, the coblation group's temporary intensity scores on the NPSI were significantly lower than the RFT group's ($P < 0.05$). Notably, the occurrence of moderate or severe numbness in the coblation group was significantly lower than in the RFT group at 6 and 12 months ($P < 0.05$). No serious adverse effects were reported during the follow-up.

Limitations: This analysis was a single-center retrospective study with a small sample size.

Conclusion: In this matched cohort analysis, coblation achieved longer-term pain relief with a more minimal incidence rate of skin numbness than did RFT. Further randomized controlled trials should be conducted to solidify coblation's clinical superiority to RFT as a PHN treatment.

Key words: Post-herpetic neuralgia (PHN), neuropathic pain, thermocoagulation, plasms-mediated technology, clinical outcomes

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Postherpetic neuralgia (PHN), one of the most frequent complications of herpes zoster (HZ), is characterized by persistently and intense painful conditions, affecting around 5% to 30% of HZ patients (1,2). Notably, PHN heightens sensitivity to abnormal sensations, predominantly in the thoracic region (3-5). The most common symptom of PHN is long-lasting intense pain, affecting nearly half of the afflicted patients for over a year and, in some cases, persisting for more than a decade (6). Consequently, the enduring pain significantly disrupts patients' sleep patterns and daily life, imposing a significant health burden, especially among older individuals (7,8).

Currently, PHN treatment approaches encompass both pharmacological and interventional methods (9,10). The first-line treatments are pharmacological (11,12). For patients resistant to pharmaceutical treatments, interventional methods, such as nerve blocks, radiofrequency, neurolysis, and nerve stimulation, are employed (13-16). Despite the application of these various therapeutic interventions, approximately 50% of PHN patients endure recurring episodes that pose significant challenges (17,18). Furthermore, such approaches have limitations, including suboptimal outcomes, prolonged treatment periods, and increased risk of complications (19,20).

Permanent blocking of the nociceptive afferent pathway has been considered an effective intervention for refractory PHN. Because of its ablation of the spinal nerve root, radiofrequency thermocoagulation (RFT) has attracted a consensus as a recommended treatment for PHN (21). High temperature (80-95°C) RFT offers a minimally invasive and reliable method for nerve destruction, demonstrating significant pain relief (22,23). However, RFT's effectiveness rate stands at 75.6% within one year and 42.1% within 5 years, indicating a compelling necessity to enhance the efficacy of the procedure (15). Moreover, concerns surrounding RFT persist because of its neurologically associated side effects, such as numbness and reduced abdominal muscle strength (15).

The field has seen the introduction of a new thermo-controlled coblation technique that operates differently from radiofrequency by creating a thin plasma field at a relatively low temperature (40–70°C), which disrupts molecular bonds, aiding in the cutting or ablation of tissue (24). Coblation has also shown efficacy in treating various painful conditions such as discogenic pain, cervicogenic headaches, phantom limb pain, stump pain, painful bone diseases, trigeminal neuralgia, and Achilles tendinosis (25-30). In our prior single-cohort study of applying coblation for PHN, high pain relief (75-80%) with only slight or mild postoperative numbness was reported, which suggests that coblation holds promise as a potential replacement for RFT as a clinical treatment for refractory neuralgia (16,31). Thus far, however, few studies that have compared coblation's therapeutic effects to those of RFT provide sufficient evidence that supports the widespread application of coblation.

The main objective of this study was to analyze our most recent experience with coblation and RFT as PHN treatments by conducting a matched-cohort analysis and thereby evaluating the procedures' therapeutic effects and respective side-effect profiles. A uniform set of evaluation metrics for comparing coblation and RFT's respective therapeutic effects was conducted to provide clinical evidence for PHN treatments.

Methods

Study Design

The study received approval from the ethics committee of our hospital, and written informed consent was obtained from all patients. We examined our surgery database to identify patients who received coblation as a thoracic PHN treatment between 2019 and 2020. From this database, we collected data on patient demographics, pain intensity, pain duration, pain side, and presentation. Subsequently, we retrieved data from the same database to identify PHN patients who had undergone RFT between 2015 and 2020. Those patients served as controls.

We identified 68 patients who had received coblation and 312 patients who had undergone RFT. Subsequently, we conducted an exclusion and matching process, pairing coblation patients with RFT patients based on specific criteria: patient characteristics, pain intensity (difference < one on the numeric rating scale [NRS]), pain duration (difference < 3 months), side of pain, and the affected thoracic dermatome. The individual characteristics of patients in both groups were well-balanced in terms of age (difference < 5 years), gender (identical), and weight (variation < 5 kg). Pain intensity was assessed based on the worst pain level experienced within the last 24 hours without using analgesics.

Inclusion Criteria and Exclusion Criteria

Inclusion criteria: (1) presentation of thoracic PHN for more than 3 months; (2) NRS value of pain greater

than 6; (3) PHN involving the thoracic dermatome (T2-10); (4) undesirable pain control with medications and physical therapy; (5) age 40-80 years; (6) treatment with coblation or RFT of the thoracic nerve root for PHN.

Exclusion criteria: (1) refusal to participate; (2) uncooperative behavior or intellectual inability to complete the self-evaluation questionnaires; (3) severe thoracic/lumbar spinal stenosis, compression fractures, or scoliosis; (4) unstable medical illness or severe organ failure or history of drug abuse.

Surgical Techniques

All the procedures were conducted in a sterilized CT room, with all patients receiving continuous low-flow oxygen while their physiological parameters were monitored. Patients were placed in the lateral position with soft pillows under the flank to maintain straight alignment of the thoracic vertebrae. An 18-G trocar for the coblation procedure or a 22-G trocar for the RFT procedure was punctured into the upper third of the corresponding intervertebral foramen (the exit of the affected thoracic nerve root) under CT guidance.

Coblation procedure (16,31): After confirming the needle tip's position via CT scanning, the puncture needle was cautiously withdrawn by 2 to 3 mm. Subsequently, the coblation wand (UNITEC, China America United Technology Co., Ltd.) was inserted and extended approximately 5 mm beyond the trocar. The coagulation mode was utilized to verify if the wand tip had reached the target nerve. A radiofrequency controller was set at 1' (33 watts) for 0.5 seconds to evoke paresthesia and movement within the distribution of the target nerve. A previously used ablation program—100 kHz, 2' (52 watts), 10 sec/cycle, 6 ablations—was used to ablate the target nerve for about one minute. Following the procedure, patients were instructed to remain in bed for 24 hours.

RFT procedure (32): After the needle tip's position was confirmed through CT scanning, a corresponding electrode was inserted along the trocar. Sensory (50 HZ) and motor (2 HZ) tests were conducted to locate the thoracic nerve root. After we confirmed that the active electrode had reached the target, the RFT temperature was set at 80°C for 2 cycles of 120 seconds then increased to 90° C for 2 cycles of 120 seconds. The total duration of the procedure was approximately 10 minutes. As with the coblation procedure, patients were advised to remain in bed for 24 hours after the operation.

Assessment of Clinical Outcomes

At 6, 12, and 24 months after the operation, we conducted outpatient/telephone follow-ups or visited patients. Investigators participating in the follow-up activities were blind to the grouping.

(1) NRS: Pain intensity was evaluated before and after treatment, using the NRS. Total scores ranged from 0 (no pain at all) to 10 (worst imaginable pain). Postoperative pain relief of 50% was defined as effective.

(2) Medication burden: The PHN patients' scores on the Medication Quantification Scale (MQS) Version III were evaluated (33). The MQS quantifies medication regimens used by patients and those regimens' respective dosages, generating weighted final scores that represent the overall medication burden.

(3) Neuropathic Pain Symptom Inventory (NPSI): The NPSI was also used to evaluate the compressive pain remission during the follow-up (34). NPSI scores are composed of 10 items, each referring to a specific feature: superficial spontaneous pain, deep spontaneous pain, paroxysmal pain, evoked pain, and paresthesia/dysesthesia. The temporal aspects of continuous and paroxysmal pain were assessed as the duration of spontaneous pain and the number of pain attacks, respectively, over the last 24 hours. The total and temporal intensity scores were calculated separately to evaluate pain remission.

(4) Complications: All complications, such as hemorrhage, infection, pneumothorax, spinal injury, and skin numbness intensity, were also recorded. The skin numbness degree was measured on a rating scale, as follows: 0 = no numbness, I = no obvious numbness and no influence on daily life, II = mild numbness and occasional effects on daily life, III = moderate numbness and frequent effects on daily life, and IV = painful numbness and severe effects on daily life. Numbness exceeding the degree of III (moderate and severe) received special analysis in this study.

Statistical Analysis

GraphPad™ Prism™ software (GraphPad Software, Inc.) was used to analyze the data. Measurement results that met a normal distribution were expressed as the mean ± SD. Student's t-tests and the chi-squared test were employed to compare quantitative data and enumerated data pertaining to patient

demographics and the incidence of numbness. Repeated measurement analysis of variance was used to analyze the changes in pain intensity, medication burden, and NPSI value over the follow-up time. Two-way analysis of variance was performed to compare the differences between the groups at different follow-up time points. Differences of $P < 0.05$ were considered statistically significant.

Results

In our department, coblation treatments for PHN were introduced in 2015. With the maturation of the coblation technique over several years, the percentage of ablations as a surgical treatment for PHN increased from 3% in 2015 to 61% in 2019 and 2020. Through the meticulous application of rigorous exclusion criteria, we successfully assembled and matched a cohort consisting of 59 patients treated with coblation and an equivalent number of 59 patients who underwent RFT for treating thoracic PHN (Fig. 1). For the 2 patients in the coblation group and the 3 patients in the RFT group lost to follow-up, the data from the point of last contact was used instead of the missing time-point data in the statistical analysis.

The characteristics and demographics of the enrolled patients recorded pre-surgery included age, gender, weight, pain duration, pain side, pain intensity, and MQS score. After we compared these factors between the 2 groups, no significant differences were observed in the main baseline variables (all $P > 0.05$) (Table 1).

Pain Intensity

The NRS scores significantly decreased in both groups, reaching their lowest intensity at 6 months post-operation (Fig. 2a). Throughout the observation time points (6, 12, and 24 months), the NRS scores were notably lower than the pre-operation values for both groups ($P < 0.05$). Specifically, at 6 and at 24 months, NRS values in the coblation group were significantly lower than those in the RFT group ($P < 0.05$). Forty-five patients (76.27%) who underwent coblation and 34 patients (57.63%) who underwent RFT achieved more than 50% pain relief at 24 months after the procedure ($P < 0.05$).

Medication Burden

MQS scores decreased significantly at all observation time points ($P < 0.05$, Fig. 2b). Specifically, at the 12- and the 24-month follow-ups, the MQS values in the coblation group were significantly lower than those in the RFT group ($P < 0.05$). By the 24-month mark, 19 patients (32.20%) in the coblation group and 11 patients (18.64%) in the RFT group had ceased using medication ($P = 0.14$).

NPSI Scores

At each follow-up time point, both groups' total intensity and temporal intensity scores were significantly reduced from their pre-surgery scores, indicating the effectiveness of the treatments administered to all patients ($P < 0.05$, Table S1 and S2). Notably, at the 12- and 24-month follow-ups, the coblation group's total intensity scores were significantly lower than the RFT group's ($P < 0.05$). Furthermore, at 6 months, the coblation group had significantly lower temporary intensity scores than did the RFT group ($P < 0.05$) (Fig. 3).

Numbness

Twenty-two (37.3%) patients in the coblation group and 33 (55.9%) patients in the RFT group had different degrees of numbness on the affected skin at 6 months after surgery. However, only 8 (13.56%) patients who underwent coblation reported skin numbness that exceeded the degree of II within the affected nerve distribution area at 6 months. Subsequently, this number dropped to 2 (3.39%) patients at 12 months and 0 patients at the 24-month follow-up. In contrast, 39 (66.1%) patients in the RFT group experienced numbness at 6 months, which dropped to 15 (25.42) patients at 12 months and 3 (5.08%) patients at 24 months (Table 2). Obviously, the occurrence of moderate or severe numbness in the coblation group was significantly lower than in the RFT group at 6 and at 12 months ($P < 0.05$). The numbness gradually dissipated within 2 years, resulting in no significant differences in skin numbness between the 2 groups at the 24-month mark.

Complications

No major complications were noted during or after either procedure. The primary adverse events during the operations encompassed puncture pain, tachycardia, and hypertension. However, these issues demonstrated an improving trend post-surgery. Importantly, no patients withdrew from treatment due to these adverse events. Furthermore, there were no instances of infection, spinal injury, exacerbation of pain, pneumothorax, or other severe adverse effects following the procedures. Moreover, no cases of mortality were associated with the procedures.

Discussion

In this retrospective matched cohort study, we compared clinical outcomes associated with the relatively new coblation technique to those associated with RFT, the traditional method for treating PHN. Our primary objective was to provide solid clinical evidence in favor of applying the coblation technique as a PHN treatment. In this study, 76.27% of patients who underwent coblation and 57.63% of those who underwent RFT achieved effective pain relief at 24 months, indicating

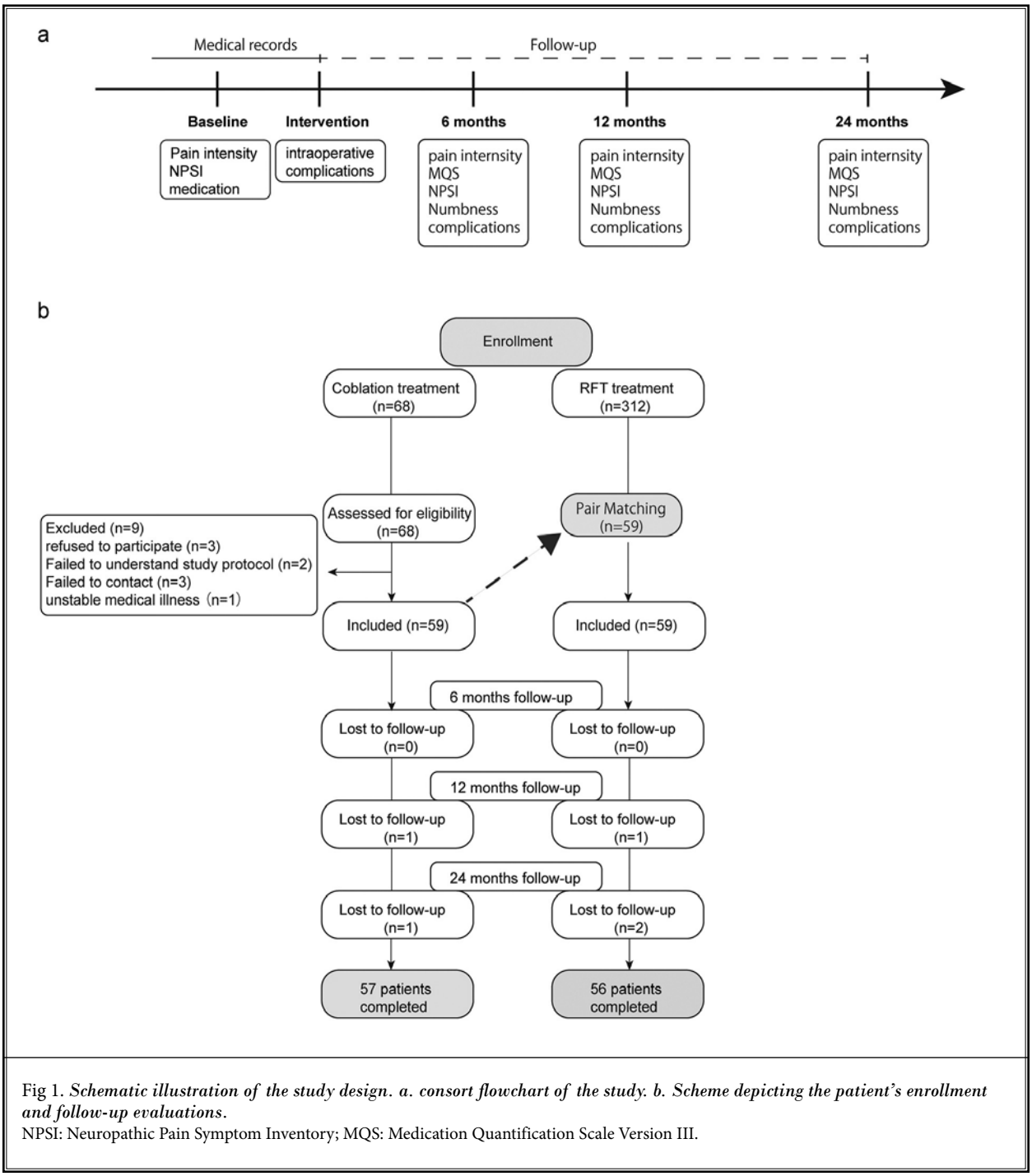

Fig 1. *Schematic illustration of the study design. a. consort flowchart of the study. b. Scheme depicting the patient's enrollment and follow-up evaluations.*
NPSI: Neuropathic Pain Symptom Inventory; MQS: Medication Quantification Scale Version III.

Table 1. *Patient demographics, pain characteristics, and comparisons between variables.*

Characteristics	Coblation Group	RFT Group	*P*-value
No. of Patients	59	59	
Age, mean (SD) (range), y	61.2 (8.7) (40-78)	59.6 (8.56) (42-77)	0.316
Gender, female (n%)	21 (35.6)	21 (35.6)	> 0.999
Weight (kg), mean (SD)	66.7 (14.3)	68.2 (15.4)	0.585
Pain duration, mean (SD), m	18.9 (12.1)	19.7 (16.4)	0.763
Side affected, Right, n (%)	36 (61.0)	36 (61.0)	> 0.999
Pain intensity, NRS, mean (SD)	7.65 (1.47)	7.48 (1.22)	0.496
MQS, mean (SD)	11.2 (6.47)	12.6 (5.43)	0.206

MQS: Medication Quantification Scale Version III; kg: kilogram.

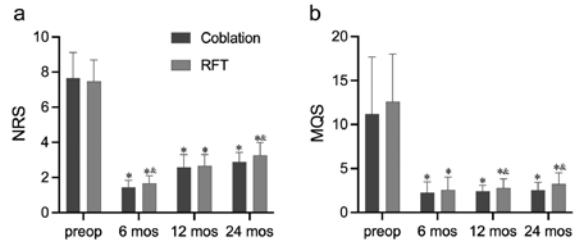

Fig. 2. *Comparison of numerical rating scale (NRS) and Medication Quantification Scale (MQS) Version III scores at pre-operation and 3 follow-up time-points. Results are expressed as mean ± SD.*
RFT: radiofrequency thermocoagulation; preop: pre-operation; mos: months. * $P < 0.05$, follow-up time point vs. pre-operation in each group. & $P < 0.05$, RFT group vs. coblation group.

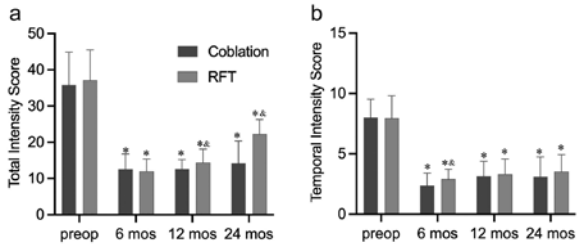

Fig. 3. *Comparison of total intensity scores and temporal intensity scores on the NPSI at pre-operation and 3 follow-up time points. Results are expressed as mean ± SD.*
RFT: radiofrequency thermocoagulation; preop: pre-operation; mos: months. * $P < 0.05$, follow-up time point vs. pre-operation in each group. & $P < 0.05$, RFT group vs. coblation group.

Table 2. *Number of patients with moderate or severe numbness of affected skin.*

Follow-up Time	Coblation	RFT	*P*-value
6 months, mean (SD)	8 (13.56)	39 (66.1)	< 0.0001*
12 months, mean (SD)	2 (3.39)	15 (25.42)	0.001*
24 months, mean (SD)	0 (0)	3 (5.08)	0.244

*$P < 0.05$

the efficacy of both techniques as treatments for PHN. Notably, our results revealed coblation's superiority to RFT. The former method is associated with more sustained pain relief over the long term, a reduced medication burden, and decreased incidence of moderate or severe numbness in the area corresponding to the affected nerve distribution. Our findings suggest that coblation may offer advantages over RFT as an effective percutaneous intervention for PHN.

PHN is associated with severe pain that is described as excruciating and causes serious impairments to the patient's daily functioning and quality of life (35). This condition is challenging due to its neuropathic alteration of ganglia plasticity, increase in sensitization, and amplification of pain signals, leading to persistent pain with hyperalgesia and allodynia (36). Thus, investigating the optimal interventional procedures for PHN has been a longstanding issue, especially for medication-recalcitrant patients. Although PHN treatments have been used for over 4 decades, there is no clear evidence regarding the optimal interventional procedure or discerning safety differences (37).

Interventional procedures that ablate the nociceptive afferent pathway by destroying the affected nerve root have been considered effective interventions for treatment-refractory PHN (38). Notably, several cohorts of PHN patients who underwent chemical or physical ablation interventions have been reported (32,39-41). Among these techniques, RFT, a less invasive and more effective and controllable procedure, has gained widespread acceptance as a treatment for PHN patients who are refractory to medical therapy (22,23,42). Importantly, the heat produced by the radiofrequency needle used in RFT is thought to selectively destroy the pain fibers (AC and C fibers) through thermocoagulation exceeding 65° C (43). The success rate of the pain relief following an RFT procedure has been reported to be only 50-60% (15,44). Thus, there is an urgent need to enhance the effectiveness of pain relief in PHN treatments. Furthermore, the side effects of nerve injury at high temperatures, such as numbness and decreased muscle strength, cannot be neglected. Varying degrees of skin numbness and de-

creased muscle strength have become bottleneck issues for the RFT procedure (22). Additionally, the fear of life-impacting numbness has been the biggest impediment to this method's acceptability (15). The incidence rate of numbness after an RFT procedure has been reported as 100% immediately after surgery, 50-80% at 6 months, and 26-68% at 24 months (15,22). Therefore, investigating a new ablative PHN treatment that improves the pain relief rate and prevents numbness is, as stated previously, urgently necessary.

Coblation utilizes bipolar radiofrequency to generate a 0.2 mm plasma field, breaking target tissue into small pieces at temperatures of 40–70°C (24). The treatment advantages for PHN patients involve maintaining a low temperature in the active wand area to minimize thermal damage to adjacent tissues and achieving complete vaporization and deactivation of the target nerve tissue (24,45). The coblation technique has achieved excellent clinical outcomes in treating refractory neuralgia conditions, such as phantom limb pain, thoracic neuropathic pain, cervicogenic headache, and trigeminal neuralgia (26,28,30,31,46). The short-term clinical outcomes of a cohort of PHN patients who underwent coblation demonstrated a 75-80% pain relief rate and only mild numbness at the 6-month follow-up. However, this outcome cannot be compared directly to the previous reported RFT results due to the use of different and heterogeneous clinical outcome measures, which hampers generalization. Therefore, we conducted this long-term retrospective study to contribute additional evidence supporting coblation as a PHN treatment.

Patient matching was performed based on characteristics, pain intensity, duration, pain location, and the affected thoracic dermatome, a rationale for this comparative study. In the RFT group, our treatment yielded a pain relief rate of 57.63% at 24 months and a skin numbness rate of 55.9% at 6 months, aligning with previous studies (15,22). However, 76.27% of the patients who received coblation experienced effective pain relief, suggesting coblation outperformed RFT in relieving pain. Pain intensity was also compared between the 2 groups to assess pain relief efficacy. At the 6 and 24 months, the coblation group demonstrated significantly lower NRS scores than did the RFT group, indicating that coblation treatment offered prolonged analgesic effects for PHN patients. We further evaluated patients' medication burden using the MQS. Notably, this tool helps assess the correlation between drug dosage and the patient's clinical response, enabling a standardized dosage comparison across various medications (47). The coblation group's decrease in medication burden compared to the RFT group serves as additional evidence highlighting coblation surgery's superior analgesic effectiveness. Furthermore, at 6 months, the temporary intensity scores in the coblation group significantly decreased, and at the 12- and 24-month follow-ups, total intensity scores in the coblation group were significantly lower than those in the RFT group. These findings indicate the advantages associated with the coblation technique, the rapid disappearance of spontaneous pain followed by a prolonged period of persistent pain remission for patients. Our results demonstrate solidly that the coblation procedure leads to higher pain relief and a lower medication burden, making coblation a PHN treatment that should be prioritized over RFT.

The side effects of both procedures were assessed. While RFT was less invasive, it also exhibited a higher frequency of postoperative ablative nerve-distributed skin numbness. We utilized a rating scale to measure the degree of numbness, which would provide a more accurate reflection of the patient's discomfort than would previous RFT reports. The coblation group showed fewer incidences of moderate or severe numbness at 6 and at 12 months than did the RFT group, indicating a shorter-term post-surgery incidence of numbness in the coblation group. The patients who received coblation accepted the subsequent skin numbness more easily. These results align with a prior study on coblation treatment for trigeminal neuralgia, which similarly showed a noteworthy reduction in numbness within the coblation group compared to the RFT group (30). Fortunately, the skin numbness gradually disappeared at 24 months, resulting in no significant differences in skin numbness between the 2 groups. No instances of mortality or life-threatening morbidities were observed in the patients analyzed in this study. Together, our results suggest that coblation surgery is a safe and effective treatment for patients with PHN, capable of priority clinical results comparable to those associated with the RFT procedure.

Limitations

The inherent limitations of retrospective studies temper the conclusions drawn from this matched cohort comparison. The use of follow-up data may also lead to the potential for recall bias. Moreover, all cases originated from a single center, underscoring the need for examination in larger trials involving multiple centers. Despite these limitations, this retrospective study

establishes a robust foundation for subsequent multicenter randomized controlled trials.

Conclusion

In the present study, both RFT and coblation of the thoracic nerve root emerge as relatively safe and effective surgical options for PHN treatment. Our findings suggest that coblation achieved longer-term pain relief with a minimal incidence rate of skin numbness compared to RFT. Given coblation's clinical superiority to RFT, the former should be considered a practical treatment option for PHN. A randomized trial or a larger, multi-institutional matched analysis could provide evidence of optimal percutaneous procedures for treatment-refractory PHN.

Ethical Approval

This study was approved by our hospital's institutional review board. All study patients signed a consent form for this study.

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Author Contributions

YT designed the study, JB and AW drafted the article, and LY and JN were responsible for the data collection. YT and JB carried out the statistical analyses and revised the article. All authors read and approved the final article.

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Supplemental Table 1. *NPSI evaluation in the coblation group at pre-operation, 6 months, 12 months and 24 months post-operation, and comparisons between variables.*

		Pre-operation	6 months	*P*	12 months	*P*	24 months	*P*
Total intensity score	Burning (Superficial) spontaneous pain (0-10), mean (SD)	7.64 (1.34)	2.17 (1.60)	< 0.0001	2.30 (1.61)	< 0.0001	3.40 (1.18)	< 0.0001
	Pressing (Deep) spontaneous pain (0-10), mean (SD)	4.47 (0.90)	2.03 (1.76)	< 0.0001	2.23 (1.50)	< 0.0001	2.67 (1.66)	< 0.0001
	Paroxysmal pain (0-10), mean (SD)	7.93 (1.15)	2.07 (1.60)	< 0.0001	2.67 (1.50)	< 0.0001	2.97 (2.14)	< 0.0001
	Evoked pain (0-10), mean (SD)	8.07 (1.21)	3.70 (4.62)	< 0.0001	2.50 (1.35)	< 0.0001	2.70 (2.05)	< 0.0001
	Paresthesia/dysesthesia (0-10), mean (SD)	7.70 (1.23)	2.60 (1.61)	< 0.0001	2.90 (1.87)	< 0.0001	2.50 (2.16)	< 0.0001
	Total, mean (SD)	35.80 (9.10)	12.57 (4.21)	< 0.0001	12.6 (2.63)	< 0.0001	14.23 (6.11)	< 0.0001
Temporal intensity score	Duration of spontaneous pain last 24 hours (1-5), mean (SD)	3.50 (0.84)	1.23 (0.44)	< 0.0001	1.50 (0.46)	< 0.0001	1.38 (0.57)	< 0.0001
	Number of pain attacks last 24 hours (1-5), mean (SD)	4.80 (0.45)	1.10 (0.44)	< 0.0001	1.76 (0.76)	< 0.0001	1.84 (0.66)	< 0.0001
	Total, mean (SD)	8.0 (1.53)	2.38 (1.02)	< 0.0001	3.16 (1.22)	< 0.0001	3.10 (1.64)	< 0.0001

NPSI: neuropathic pain symptom inventory

Supplemental Table 2. *NPSI evaluation in the coblation group at pre-operation, 6 months, 12 months and 24 months post-operation, and comparisons between variables.*

		Pre-Surgery	6months	*p*	12 months	*p*	24months	*p*
Total intensity score	Burning (Superficial) spontaneous pain (0-10), mean (SD)	7.78 (1.02)	2.17 (1.60)	< 0.0001	2.30 (1.61)	< 0.0001	3.40 (1.18)	< 0.0001
	Pressing (Deep) spontaneous pain (0-10), mean (SD)	5.27 (1.25)	2.13 (1.63)	< 0.0001	2.43 (1.78)	< 0.0001	4.30 (1.15)	< 0.0001
	Paroxysmal pain (0-10), mean (SD)	7.73 (1.19)	2.37 (2.07)	< 0.0001	3.20 (2.36)	< 0.0001	4.30 (1.78)	< 0.0001
	Evoked pain (0-10), mean (SD)	8.30 (1.23)	2.47 (2.51)	< 0.0001	2.93 (2.05)	< 0.0001	5.07 (2.06)	< 0.0001
	Paresthesia/dysesthesia (0-10), mean (SD)	8.03 (0.97)	3.03 (2.26)	< 0.0001	3.20 (2.36)	< 0.0001	4.60 (1.21)	< 0.0001
	Total, mean (SD)	37.12 (8.35)	12.03 (3.35)	< 0.0001	14.43 (3.68)	< 0.0001	22.27 (4.01)	< 0.0001
Temporal intensity score	Duration of spontaneous pain last 24 hours (1-5), mean (SD)	3.29 (0.69)	1.31 (0.50)	< 0.0001	1.63 (0.75)	< 0.0001	1.33 (0.63)	< 0.0001
	Number of pain attacks last 24 hours (1-5), mean (SD)	4.66 (0.43)	1.60 (1.34)	< 0.0001	1.68 (0.55)	< 0.0001	1.82 (0.97)	< 0.0001
	Total, mean (SD)	7.95 (1.87)	2.91 (0.81)	< 0.0001	3.31 (1.27)	< 0.0001	3.55 (1.39)	< 0.0001

NPSI: neuropathic pain symptom inventory; RFT: radiofrequency thermocoagulation