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Blue-Laser Posterior Nasal Neurolysis via Dual Layer Nerve Modulation for Chronic Rhinitis

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ABSTRACT

Objective: Chronic rhinitis (CR) may be allergic (AR), nonallergic (NAR), or mixed, and depending on the etiology and severity, patients experience various degrees of rhinorrhea, obstruction, itching, and sneezing. Chronic AR is estimated to impact over 26.3% of the people in Taiwan. Inferior turbinate reduction can improve nasal obstruction symptoms, and posterior nasal nerve neurolysis can reduce symptoms caused by neurogenic hypersecretion. Blue-laser posterior nasal neurolysis via dual-layer nerve modulation provides a precise operation for chronic AR.

Methods: In this retrospective study, conducted at Shuang Ho Hospital in 2025, we compared the efficacy and safety of blue-laser inferior turbinate reduction (BITR) combined with blue-laser posterior nasal nerve neurolysis (BPN3). In total, 42 adult patients with CR who had not responded adequately to at least 3 months of drug therapy (≥ 3 months) were included. The primary outcomes were the 24-h reflective Total Nasal Symptoms Score (rTNSS) and the Nasal Obstruction Symptoms Evaluation (NOSE) scale score, which were compared and analyzed at the baseline, and 1 and 6 months postoperatively.

Results: At 1 month, all patients exhibited significant improvements. Mean rTNSS had decreased from 7.9 ± 2.1 to 1.7 ± 1.6 (-78.5%) and NOSE scores improved from 69.3 ± 11.4 to 7.0 ± 6.5 (-89.9%). At 6 months, the mean rTNSS had decreased from 7.9 ± 2.1 to 1.9 ± 1.8 (-76.0%) and NOSE scores had improved from 69.3 ± 11.4 to 6.6 ± 5.3 (-92.0%). Overall, no serious complications occurred during the study period.

Conclusions: BPN3 combined with inferior turbinate reduction provides superior symptom relief, particularly for rhinorrhea, with excellent safety and tolerability. This dual layer nerve modulation operation offers a promising minimally invasive treatment for medication-refractory chronic AR.

Level of Evidence: IV.

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1 | Introduction

Chronic rhinitis (CR) may be allergic (AR), nonallergic (NAR), or mixed, and depending on the etiology and severity, patients experience various degrees of rhinorrhea, obstruction, itching, and sneezing [1]. CR is estimated to impact over 26.3% of the people in Taiwan [1]. Treatment is initially medical and administered via single or multiagent, topical, systemic, or combined approaches. When conservative treatment fails, surgery is indicated. However, a traditional Vidian neurectomy (VN) has some drawbacks, including severe bleeding from the sphenopalatine artery (SPA), crusting, cheek and palate numbness, and significant eye dryness. These complications, together with its technical complexity, pose a challenge to this surgical method. In recent years, office-based posterior nasal nerve (PNN) ablation has emerged as a popular option for patients who fail to respond to medical therapy [2, 3]. Cryotherapy and temperature-controlled radiofrequency (TCRF) neurolysis offer relatively convenient, equally effective treatments and are frequently used in the United States. These procedures offer a relatively convenient option compared with traditional surgical treatments.

To the present, these innovative surgical techniques have not yet been popularized in many Asian countries due to certain legal regulations. Blue laser as indicated for posterior nasal neurolysis has therefore arisen from the needs of the time. Blue-laser posterior nasal nerve neurolysis (BPN3) makes use of a 445-nm blue laser, which is known for its high hemoglobin absorption and targeted tissue interaction. Dual-layer (superficial and deep layers) nerve modulation is achieved by means of BPN3. This article portrays the step-to-step strategy of BPN3, an innovative surgical approach tailored for comprehensive neurolysis as well as minimal thermal tissue damage.

2 | Methods

2.1 | Study Design and Participants

This retrospective study was performed with approval from the Taipei Medical University Joint Institutional Review Board (IRB) (TMU-JIRB No.: N202509008). Forty-two patients with CR and nasal congestion (including AR only), who were resistant to medical management were recruited. Patients were treated in a local medical office for more than 3 months. All include patients had tried intranasal steroid and antihistamine nasal sprays for more than 3 months, but symptoms were only partially relieved. The 24-h reflective Total Nasal Symptom Score (rTNSS) was chosen to measure symptom severity and treatment outcomes. All patient filled out the 24-h rTNSS questionnaire, and results were as follows: rhinorrhea in three, nasal congestion in one, nasal itching in one and sneezing in three were reported with scores of 0 (*absent*); 1 (*mild*); 2 (*moderate*); and 3 (*severe*). The rTNSS is the sum of scores for the symptoms of nasal congestion, sneezing, nasal itching, and rhinorrhea on the preoperative day, and 30 and 180 days following the procedure, using a 4-point scale (0–3), where 0 indicates no symptoms, 1 indicates mild symptoms that are easily tolerated, 2 is an awareness of bothersome but tolerable symptoms, and 3 is reserved for severe, hard-to-tolerate symptoms that interfere with daily activities. All patients received an

immunoglobulin E (IgE) test, and AR was confirmed. Due to the above-mentioned troubling symptoms, all patients wished to undergo the surgical intervention. After shared decision making, all patients underwent posterior nasal neurolysis. This study was approved by Taipei Medical University IRB (no. N202509007). Informed consent was obtained from all individual participants included in the study.

2.2 | Patient Selection

Candidates for BPN3 were adults (18–65 years) with CR symptoms for >3 months refractory to pharmacotherapy. Key inclusion criteria included a total 24-h rTNSS of >5, with moderate-to-severe rhinorrhea and mild-to-severe congestion.

2.3 | BPN3 Surgical Technique

The procedure was performed under local anesthesia. A 445-nm blue laser system (TruBlue, A.R.C. Laser, Germany) with a 400- μ m fiber was used. The technique is often combined with blue-laser inferior turbinate reduction (BITR) (Video 1).

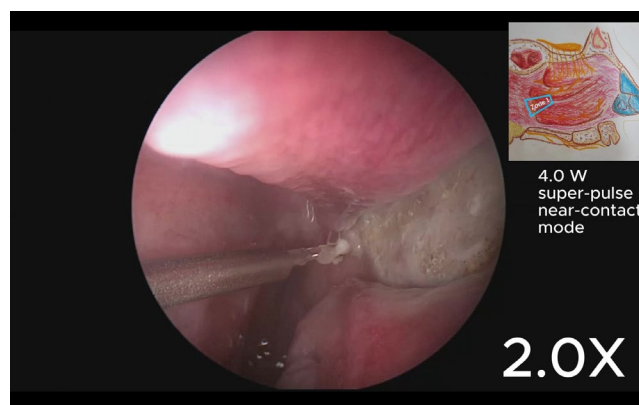
2.3.1 | Step 0: Visualization and Exposure

A 0° rigid endoscope was used. The middle turbinate was gently medialized to expose the posterior middle meatus and the region adjacent to the sphenopalatine foramen.

2.3.2 | Step 1–3: Superficial Nerve Modulation (Surface Plexus)

The first phase targeted the superficial nerve plexus on the mucosal surface. The laser was set to 4.0 W in super-pulse mode (100 ms on, 100 ms off) and applied in the near-contact mode (Figure 1).

- Target zone 1: Lateral wall of the posterior middle meatus.
- Target zone 2: Posterior end of the middle turbinate.



VIDEO 1 | Five surgical steps of blue-laser posterior nasal neurolysis via dual layer nerve modulation. Video content can be viewed at <https://onlinelibrary.wiley.com/doi/10.1002/lto.270468>.

- Target zone 3: Posterior end of the inferior turbinate.
- Endpoint: The laser was applied until visible surface blanching and tissue contraction were achieved, carefully avoiding carbonization.

2.3.3 | Steps 4 and 5: Deep Nerve Modulation (Main Trunks)

The second phase targeted the deeper main branches of the PNN [4]. The laser setting was adjusted to 2.5 W in super-pulse mode (100 ms on, 100 ms off). The fiber was used in contact mode and inserted submucosally (Figure 2).



FIGURE 1 | Zones 1–3: Superficial nerve modulation (surface plexus).



FIGURE 2 | Zones 4 and 5: Deep nerve modulation (main trunks).

- Target zone 4: Submucosal tissue at the posterior end of the middle turbinate.
- Target zone 5: Submucosal tissue at the posterior end of the inferior turbinate.
- This step ensured ablation of deep-seated nerve trunks that may have escaped superficial treatment.

2.4 | BITR Surgical Technique

2.4.1 | Step 1: BITR (Figure 3)

- Target zone 6: Submucosal tissue at the anterior of the inferior turbinate.

Following PNN neurolysis, BITR was performed to address nasal obstruction [5]. A laser fiber was inserted into the submucosal layer of the anterior one-third of the inferior turbinate. The blue laser was set to 2.5 W in the super-pulse contact mode, which develops a longitudinal channel for coagulative debulking while attaining mucosal preservation.

3 | Results

3.1 | Participant Characteristics

All patients completed the procedures. Fifteen patients were successfully treated in the office under local anesthesia, and 27 were treated with general anesthesia in the operating room (Table 1). The procedure was easy to perform and had a high success rate combined with BITR. Following the procedure, pain was minimal. No laser safety events were recorded. No headaches, facial pain, eye dryness, palatal numbness, or ear blockage were recorded at any follow-up visit. No patient was using any anticholinergic medications or nasal sprays 6 months after surgery. Complications with



FIGURE 3 | Zone 6: Anterior one-third of the inferior turbinate.

TABLE 1 | Participant demographics and baseline characteristics ($N = 42$).

Characteristic	Value
	BITR + BPN3 ($N = 42$)
Age (years), average $\pm$ SD	39.8 $\pm$ 11.1
Gender	
Male	25 (59.5%)
Female	17 (40.5%)
Race	
Asian	42 (100%)
Black or African American	0
White	0
Other	0
rTNSS (mean $\pm$ SD)	7.9 $\pm$ 2.1
NOSE (mean $\pm$ SD)	69.3 $\pm$ 11.4
Medication use	
Antihistamines	38 (90.5%)
Decongestants	32 (76.2%)
Oral leukotriene inhibitors	6 (14.3%)
Intranasal steroid sprays	31 (73.8%)
Intranasal anticholinergic sprays	5 (11.9%)

Abbreviations: BITR, blue-laser inferior turbinate reduction; BPN3, blue-laser posterior nasal nerve neurolysis; NOSE, Nasal Obstruction Symptoms Evaluation; rTNSS, reflective Total Nose Symptoms Score; SD, standard deviation.

TABLE 2 | Changes from the baseline in the total rTNSS and total NOSE scores.

	BITR+BPN3
Baseline rTNSS (mean $\pm$ SD)	7.9 $\pm$ 2.1
1-month postsurgery	1.8 $\pm$ 1.7
6-month postsurgery	1.9 $\pm$ 1.8
Baseline NOSE (mean $\pm$ SD)	69.3 $\pm$ 11.4
1-month postsurgery	7.0 $\pm$ 6.5
6-month postsurgery	6.6 $\pm$ 5.3

Abbreviations: BITR, blue-laser inferior turbinate reduction; BPN3, blue-laser posterior nasal nerve neurolysis; NOSE, Nasal Obstruction Symptoms Evaluation; rTNSS, reflective total nose symptoms score; SD, standard deviation.

crusts were minor and transient. Postoperatively, all patients filled out the rTNSS questionnaire again 1 and 6 months after surgery. The questionnaire results showed substantial improvement.

3.2 | Symptom Improvements

At 1 month after operation, all patients exhibited significant improvement (Table 2). Mean rTNSS decreased from 7.9 $\pm$ 2.1 to

1.7 $\pm$ 1.6 (−78.5%) and NOSE scores improved from 69.3 $\pm$ 11.4 to 7.0 $\pm$ 6.5 (−89.9%). At 6 months after the operation, the mean rTNSS had further decreased from 7.9 $\pm$ 2.1 to 1.9 $\pm$ 1.8 (−76.0%) and NOSE scores had improved from 69.3 $\pm$ 11.4 to 6.6 $\pm$ 5.3 (−92.0%) (Table 2).

4 | Discussion

Rheiner Clarifix neuromark is a patented surgical instrument produced by Hwang et al. [6], who reviewed that their office-based cryotherapy of the PNN region is safe and well tolerated by patients. Symptom scores significantly decreased by 7 days postprocedure, and substantial decrements were noted at 30, 90, 180, and 365 days after the procedure. In fact, high prevalence of AR persists at greater than 20% in Asia [1]. However, to the disappointment of many, such products have not yet been approved in Taiwan and many Asian countries. To ease this situation in countries without associated patency, we proposed that application of blue laser for posterior nasal neurolysis may be a promising solution. This surgical technique is superior to other conventional PNN ablation approaches, due to the 445-nm blue laser's photoangiolytic properties, which achieve bloodless yet accurate tissue ablation in the vascular-rich posterior nasal region.

The recent anatomical literature pointed out that PNN fibers are not only found at the sphenopalatine foramina, but are also extensively distributed across the posterior middle meatus and turbinates [6, 7]. Our novel technique named dual-layer nerve modulation emerged to meet such somatic challenges. Previous research also pointed out that the surgical path and location are another key point to success [6]. Gorelik et al. discussed a modified technique to improve the efficacy of in-office PNN ablation based on the discovery of the extensive nerve distribution [7]. In particular, apart from traditional access, another three sites located posterior to the middle nasal turbinate are to be ablated, and cryotherapy is to be performed at a specific point which is postero-inferior to the attachment of the middle nasal turbinate. Ablation and cryotherapy in such multiple and comprehensive approaches are believed to enhance the success rate of outpatient operations.

Inspired by the above-mentioned research, we proposed an innovative surgical technique named dual-layer nerve modulation, which strategically targets both the superficial and deep nerve plexuses. In the first phase of this surgical method, superficial nerve modulation is achieved through precise tissue damage by means of the near-contact mode to the superficial nerve plexus located 1–3 mm below the mucosal surface. The second phase focuses on the deeper main branches of the PNN, and fibers in contact mode are inserted submucosally. The combination of the first and second surgical phases constructs dual-layer nerve modulation, addressing the complicated branching pattern of the PNN without neglecting the need for ablation of deep-seated nerve trunks [7].

In fact, traditional surgical approaches may miss accessory branches or superficial plexuses of the PNN. The dual-layer nerve modulation strategy has emerged to meet the demand of comprehensive denervation of both the mucosal surface receptors and deeper nerve trunks. In real-life practice, superficial nerve blanching (in near-contact, higher power) together

with deep submucosal coagulation (in contact, lower power) can be attained by applying the dual-layer nerve modulation strategy.

Furthermore, traditional surgical methods have some drawbacks. For example, cryotherapy requires specific probe placement, while the probe tip for nerve radiofrequency ablation is rather large. These problems are highlighted in patients with inferior turbinate hypertrophy in the posterior end, posing many surgical difficulties in the limited space. Comparatively speaking, the tiny 400- μ m fiber tip we applied offers superior maneuverability in narrow nasal anatomized patients. Smooth access and effective treatment can be delivered to the posterior aspect of the middle and inferior turbinates.

5 | Conclusions

In the face of treating refractory CR, BPN3 attains both safety and effectiveness. By integrating superficial blanching (near-contact, higher power) with deep submucosal coagulation (contact, lower power), the dual-layer nerve modulation strategy ensures a more complete denervation of both mucosal surface nerve receptors and the underlying deeper trunks and plexus.

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Disclosure

The authors declare that no generative artificial intelligence technologies were used in the writing, data analysis, or preparation of this manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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