



Comparative Effectiveness of Cryotherapy and Radiofrequency Ablation for Chronic Rhinitis: A Systematic Review and Meta-analysis

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Objectives. Multiple minimally invasive techniques for chronic rhinitis treatment focus on posterior nasal nerve ablation. We conducted a systematic review and meta-analysis to evaluate the efficacy of cryotherapy and radiofrequency ablation for alleviating symptoms in patients with allergic and nonallergic rhinitis.

Methods. We retrieved studies from PubMed, Scopus, Embase, Web of Science, and Cochrane Database up to July 2023. Data on the impact of cryotherapy and radiofrequency ablation on quality of life and symptom ratings of rhinitis were extracted and evaluated.

Results. An analysis of 12 studies involving 788 patients demonstrated significant improvements in quality of life and rhinitis-related symptoms (nasal obstruction, itching, rhinorrhea, and sneezing) in patients treated with cryotherapy or radiofrequency ablation (symptom score at 24 months and quality of life score at 3 months). However, radiofrequency ablation had a more positive effect on nasal symptoms after 3 months than cryotherapy. Nonallergic rhinitis patients responded more favorably to posterior nerve ablation than patients with allergic rhinitis. Both techniques enhanced disease-specific quality of life during the initial 3 months of treatment (cryotherapy, 84.6%; radiofrequency, 81.6%; $P=0.564$). After 3 months of treatment, a clinical improvement in all nasal symptoms (minimal clinically important difference in the total nasal symptom score: >1.0 points) was seen in 81.8% and 91.9% of patients who underwent cryotherapy and radiofrequency ablation, respectively ($P=0.005$), suggesting that radiofrequency is more likely to lead to clinical improvement.

Conclusion. Rhinitis-associated subjective symptom scores and quality of life may be improved by both cryotherapy and radiofrequency ablation. Ablation was more efficacious than cryotherapy for nasal symptoms in patients with nonallergic rhinitis. To corroborate these findings, further randomized controlled studies directly comparing these two techniques are warranted.

Keywords. Rhinitis; Rhinitis, Allergic; Radiofrequency Ablation; Cryotherapy; Nose

INTRODUCTION

Chronic rhinitis, which encompasses allergic rhinitis, nonallergic rhinitis, and mixed rhinitis, is a widespread disease impacting hundreds of millions of people worldwide [1,2]. Given its high prevalence, the associated medical costs for treatment are substantial, making cost-effective treatment strategies for chronic rhinitis a critical area of research [3].

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It can be challenging to distinguish among allergic rhinitis, which is triggered by immunoglobulin E-mediated inflammation in the nasal mucosa following allergen exposure, nonallergic rhinitis, and mixed rhinitis based on patients' symptoms [1,2]. An accurate diagnosis is crucial in guiding clinicians toward the most appropriate treatment approach. The initial treatment for chronic rhinitis often involves a medical intervention; for instance, a variety of topical treatments are available, such as steroids, anticholinergics, nasal decongestants, and antihistamines [4]. However, treatment adherence is generally low among chronic rhinitis patients [5].

For patients who experience inadequate improvement in chronic rhinitis symptoms or have an aversion to long-term treatment, minimally invasive surgical options may be considered [6]. Surgical techniques such as Vidian neurectomy were initially explored; however, those procedures necessitated general anesthesia and could lead to side effects such as dry eye [4,7]. Less invasive alternative techniques for posterior nasal nerve blocking, including cryotherapy and radiofrequency ablation, have been developed and are performed under endoscopy [4,6,8-15]. One of the novel radiofrequency ablation devices has proximal and distal flexible leaflets that adjust to the patient's anatomy, maximizing access to nerve-rich areas on the lateral wall of the nasal cavity and allowing more posterior insertion [6]. These novel techniques pose fewer risks than Vidian neurectomy, do not have serious side effects, and do not require general anesthesia [4]. Several studies have shown that these methods can improve both quality of life and symptoms in patients with chronic rhinitis [6,15]. Nonetheless, a comprehensive meta-analysis examining the impact of posterior nasal nerve ablation on chronic rhinitis has yet to be conducted, and it remains unclear whether this technique is truly clinically useful.

To the best of our knowledge, this is the first systematic review and meta-analysis comparing the effectiveness of cryotherapy and radiofrequency ablation of the posterior nasal nerve in patients with chronic rhinitis. This analysis also investigated the duration of the therapeutic effect and compared the impact of these pro-

cedures on patients with allergic and nonallergic rhinitis.

MATERIALS AND METHODS

Search strategy and selection of studies

Search terms including ablation, radiofrequency, cryotherapy, minimally invasive surgery, total nasal symptom score (TNSS), Rhinoconjunctivitis Quality of Life Questionnaire (RQLQ) score, posterior nasal nerve, nasal congestion, nasal obstruction, sneezing, itching, chronic rhinitis, nasal surgery, and nasal airway surgery were used to identify studies in PubMed, Scopus, Embase, Web of Science, and the Cochrane Database up to July 2023.

Studies involving all procedures for ablation of the posterior nasal nerve were performed in an office setting were included. However, studies not involving nasal surgery procedures such as cryotherapy or radiofrequency ablation were eliminated after two authors independently reviewed the abstracts and titles of studies published in English. If the abstract and title did not provide sufficient information for a decision, the full manuscript was thoroughly reviewed by the same two authors (YJK and SHH). Prospective or retrospective studies involving patients seeking improvement in rhinitis-related symptoms and quality of life, complaining of severe rhinitis symptoms with or without nasal obstruction, and having a high TNSS score were included. Studies including patients who underwent additional nasal procedures, such as turbinate or sinus surgery, were excluded. Studies including clinically significant anatomic obstructions that limited access to or modified the anatomy of the posterior nose or previous sinonasal surgery, active infection or open wounds in the nasal or sinus cavities were excluded. Additionally, duplicate studies were omitted. Studies lacking quantified outcomes or providing results based on data that are difficult to quantify were also excluded. In total, 12 studies were selected for this systematic review and meta-analysis. The search strategy for the included studies is summarized in Fig. 1 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses [PRISMA] diagram).

Data extraction and risk of bias assessment

Data from the included studies were independently extracted and analyzed in a standardized manner by two authors [16,17]. The quality of life score and disease-specific symptoms were evaluated before cryotherapy or radiofrequency ablation treatment and for up to 24 months posttreatment. The review protocol was registered at the Open Science Framework (<https://osf.io/wf4vk/>).

The cryotherapy and radiofrequency ablation treatment groups were compared with the sham treatment group, during the follow-up period and before and after treatment [4,6,8-15,18,19]. The TNSS is a validated symptom severity rating system that averages the scores for four patient-assessed symptoms: rhinorrhea, nasal congestion, nasal itching, and sneezing. Each symp-

HIGHLIGHTS

- This study compared the effectiveness of cryotherapy and radiofrequency ablation for posterior nasal nerve in chronic rhinitis patients.
- The length of the therapeutic effect was considered, and the effects on patients with allergic and nonallergic rhinitis were compared.
- Both cryotherapy and radiofrequency ablation enhanced subjective symptom scores and quality of life associated with rhinitis.
- Radiofrequency ablation might be more effective than cryotherapy for nasal symptoms, especially for patients with nonallergic rhinitis.

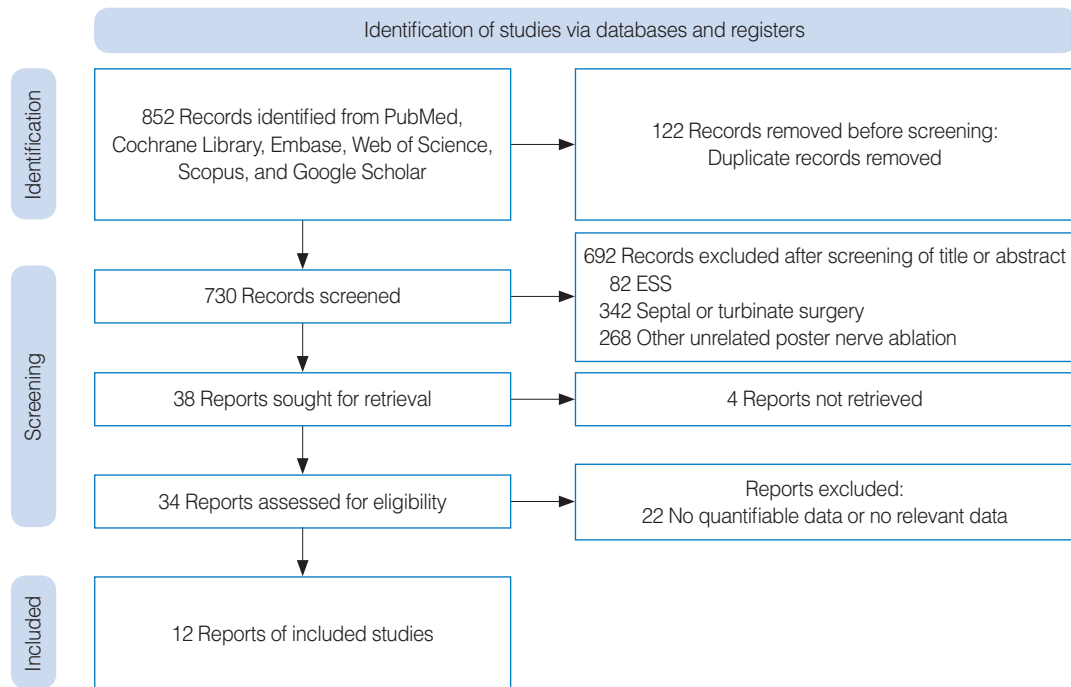


Fig. 1. Flowchart illustrating the article search and selection process. ESS, endoscopic sinus surgery.

tom is rated on a scale of 0–3 (0=none, 1=mild, 2=moderate, or 3=severe). Based on the patient's assessment of their symptoms during the previous 12 or 24 hours, the maximum TNSS is 12 points. The minimal clinically important difference (MCID) for the TNSS was set at 1 point. Response to treatment was considered as a reduction in total TNSS score of $\geq 30\%$ (strict good response), and an at least 1-point reduction from baseline (clinical response) [20]. Another outcome of interest was the change from baseline in the RQLQ score. The validated 14-item RQLQ assesses impairments in five domains: activities, practical issues, nose symptoms, eye symptoms, and other symptoms. Each item is scored on a 7-point scale (0=no impairment, 6=maximal impairment). The MCID for the mini RQLQ is 0.4 or 0.5 points. The *P*-value, patient count, and grading scale data were extracted pre- and post-therapy from the included studies.

The Cochrane Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) was used to assess the caliber of non-randomized controlled research, and the results are described in Supplementary Table 1. The ROBINS-I evaluated the quality of studies with seven assessment domains (confounding, selection of participants, classification of interventions, deviation from intended interventions, missing data, measurement of the outcomes, and selection of the reported results). Each assessment domain level and overall judgment are graded as low, moderate, serious, and critical risk of bias. The risk of bias in randomized controlled studies was assessed using the Cochrane Risk of Bias tool, as illustrated in Supplementary Table 2.

Statistical analysis

A meta-analysis of the included studies was conducted using R statistical software (version 3.4.3; R Foundation for Statistical Computing). Mean and standard deviation values were compared between the control group and cryotherapy treatment group for continuous data, with the effect size indicated by the mean difference (MD). MD values were computed in instances when the TNSS and RQLQ scale results and units were consistent across all studies. Odds ratios (ORs) were also calculated. Heterogeneity was evaluated using Cochran's *Q* test and the I^2 test. Publication bias was assessed using Egger's test and a funnel plot. The Duval and Tweedie trim-and-fill method was used to estimate publication bias.

RESULTS

Data from 12 studies involving 788 patients were analyzed, as shown in Fig. 1. Table 1 presents a summary of the characteristics of each study [4,6,8-13,15,18,19]. Since patient information was not fully reported in all included studies, a comprehensive analysis of patient characteristics could not be performed. Table 2 displays a summary of the study bias. Due to the small number of included studies (<10), the Egger test was not conducted and a Begg funnel plot was not generated for most outcomes. However, no evidence of publication bias was found for changes in TNSS 3 months after treatment according to the Egger test and a Begg funnel plot ($P=0.245$).

Table 1. Summary of the included studies

Study	Design	Total number of patients	Age of patients (yr, mean ±SD)	Sex (male:female)	Nonallergic rhinitis:allergic rhinitis number of patients (n)	Nation	Treatment device	Outcome
Hwang et al. (2017) [12]	Prospective observational study	27	53.3±3.3	6:17	14:13	USA	ClariFix device	Total TNSS
Chang et al. (2020) [10]	Prospective, single-arm study	98	58.6±16.2	35:63	70:28	USA	ClariFix device	RQLQ, total TNSS, response rate (TNSS)
Yen et al. (2020) [11]	Prospective, nonrandomized, interventional, post-market feasibility study	30	60.0±15.8	14:16	17:11	USA	ClariFix device	RQLQ, total TNSS
Stolovitzky et al. (2021) [15]	Prospective, single-blinded, randomized controlled, multicenter study	117	57.3±14.8	42:75	NA	USA	RhinAer System	Total TNSS
Ow et al. (2021) [9]	Prospective, single-arm, multicenter study	62	57.1±13.4	22:40	43:19	USA	ClariFix device	Total TNSS
Gerka Stuyt et al. (2021) [18]	Prospective, single-arm study	24	60.04±16.7	12:12	16:8	USA	ClariFix device	Total TNSS
Ehmer et al. (2022) [20]	Prospective, single-arm, multicenter study	50	57.9±11.9	21:29	17:21 (12 Unknown patients)	USA	RhinAer System	Total TNSS, response rate (TNSS)
Lee et al. (2022) [13]	Prospective, single-arm study	126	57.9±13.4	60:66	93:10 (1 Mixed rhinitis patient, 25 unknown patients)	USA	RhinAer System	RQLQ, total TNSS, response rate (RQLQ), response rate (TNSS)
Takashima et al. (2023) [19]	Prospective, patient-blinded, randomized controlled, multicenter study	77	57.3±14.8	28:49	NA	USA	RhinAer System	Total TNSS, response rate (TNSS)
Dei Signore et al. (2022) [8]	Prospective, patient-blinded, randomized, sham-controlled, multicenter study	127	55.2±16.3	77:56	76:57	USA	ClariFix device	RQLQ, total TNSS, response rate (RQLQ), response rate (TNSS)
Reh et al. (2023) [6]	Prospective, single-arm, multicenter study	36	62.8±14.0	17:19	13:23	USA	NEUROMARK System	Total TNSS, response rate (TNSS)
Virani et al. (2023) [4]	Retrospective study	14	59.1±14.8	8:6	10:4	USA	Cryotherapy	RQLQ, total TNSS

SD, standard deviation; TNSS, total nasal symptom score; RQLQ, Rhinoconjunctivitis Quality of Life Questionnaire; NA, not available.

Table 2. Comparison of TNSS score changes from baseline to postoperative follow-up time points between the cryotherapy and radiofrequency ablation groups

Group	Follow-up			Rate of clinical response ^{b)}
	1 mo	3 mo	6 mo	
Cryotherapy	(n=5) MD, 3.5265; 95% CI, 3.3346-3.7185; I ² =0.0%	(n=6) MD, 3.5026; 95% CI, 3.2989-3.7063; I ² =0.0%	(n=2) MD, 3.5388; 95% CI, 2.7585-4.3191; I ² =83.7%	(n=2) 73.7%; 95% CI, 0.6639-0.7998; I ² =0.0%
	(n=1) MD, 4.1000; 95% CI, 3.3362-4.8638; I ² =NA	(n=3) MD, 3.7584; 95% CI, 2.8071-4.7096; I ² =85.6%	(n=1) MD, 5.5000; 95% CI, 4.6863-6.3137; I ² =NA	(n=2) 81.8%; 95% CI, 0.7393-0.8772; I ² =0.0%
Radiofrequency ablation	(n=2) MD, 4.2627; 95% CI, 2.9794-5.5460; I ² =79.0%	(n=4) MD, 4.1399; 95% CI, 3.5476-4.7322; I ² =67.3%	(n=3) MD, 4.8121; 95% CI, 4.4057-5.2185; I ² =27.5%	(n=4) 76.9%; 95% CI, 0.6913-0.8311; I ² =41.3%
	(n=1) MD, 4.8740; 95% CI, 4.3979-5.3500; I ² =0.0%	(n=1) MD, 5.5000; 95% CI, 4.6863-6.3137; I ² =NA	(n=1) MD, 5.5000; 95% CI, 4.6863-6.3137; I ² =NA	(n=4) 91.9%; 95% CI, 0.8788-0.9465; I ² =0.0%
P-value	0.266	0.046	0.040	0.536

TNSS, total nasal symptom score; MD, mean difference; CI, confidence interval; NA, not available.

^{a)}>30% reduction in the total TNSS. ^{b)}≥minimal clinically important difference (1 point) in the total TNSS.

Changes in rhinitis-related measurements following posterior nasal nerve ablation

Three months after posterior nasal nerve ablation, the good response rate (>30% reduction in the total TNSS) was 75.3% (95% confidence interval [CI], 71.08%–79.05%; $I^2=0.0\%$). The clinical response rate was 89.9% (95% CI, 83.91%–93.83%; $I^2=51.0\%$) at 3 months post-ablation (Fig. 2).

TNSS decreased relative to baseline at 1 month (MD, 3.6585; 95% CI, 3.2652–4.0517; $I^2=56.2\%$), 3 months (MD, 3.8148;

95% CI, 3.4710–4.1586; $I^2=62.6\%$), 6 months (MD, 4.2749; 95% CI, 3.6218–4.9280; $I^2=88.2\%$), and 12 months (MD, 4.3061; 95% CI, 3.7283–4.8840; $I^2=77\%$). This indicates a significant reduction in rhinitis-related symptoms after posterior nasal nerve ablation, with changes from the baseline TNSS during the follow-up period exceeding the MCID of 1 (Fig. 2).

The device type (radiofrequency ablation vs. cryotherapy devices) was not considered in the overall analysis (Table 2), which could explain the significant heterogeneity (>50%) in some re-

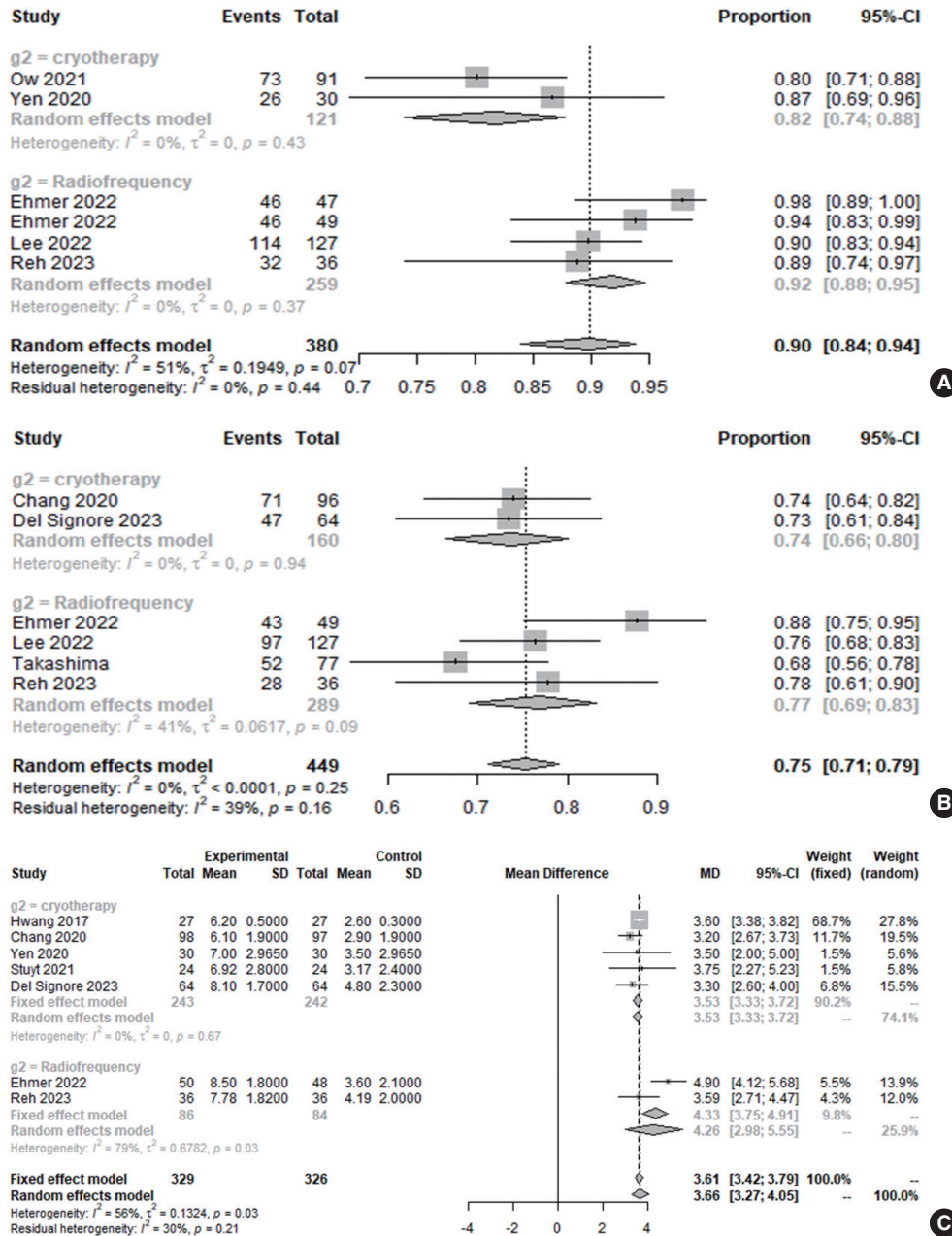


Fig. 2. Rates of clinical response (total nasal symptom score [TNSS] ≥ minimal clinically important difference [MCID] of 1 point; A) and good response (>30% decrease in total TNSS; B) after 3 months. MDs in TNSS scores between baseline and 1 month (C).

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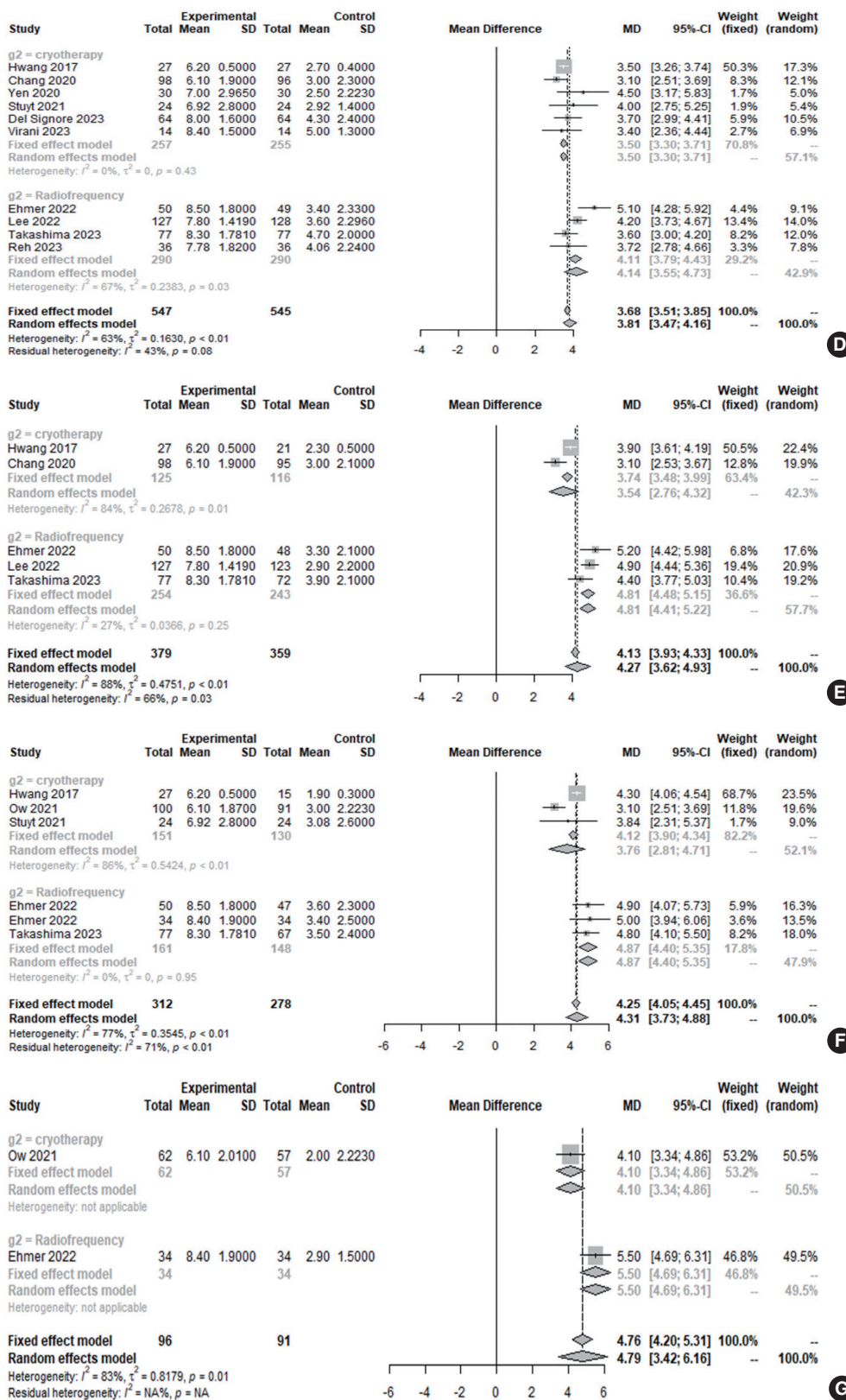


Fig. 2. (Continued) MDs in TNSS scores between baseline and 3 months (D), 6 months (E), 12 months (F), and 24 months (G) after treatment (total: individuals per group). CI, confidence interval; SD, standard deviation; MD, mean difference; NA, not available.

sults among the studies. Radiofrequency ablation devices were used in five studies of refractory rhinitis, while cryotherapy devices were employed in seven studies. Symptoms improved significantly in patients with refractory rhinitis using both device types. The effect sizes varied significantly at 3 months postoperatively between the two device types, with radiofrequency ablation devices having a more beneficial effect on rhinitis-related symptom scores. This trend persisted throughout the first 24 postoperative months, although each subgroup in this analysis included only one study; therefore, this finding should be interpreted cautiously. Moreover, the clinical response rates (\geq MCID [1 point] in the total TNSS) at 3 months after cryotherapy and radiofrequency ablation were 81.8% (95% CI, 73.93%–87.72%; $I^2=0.0\%$) and 91.9% (95% CI, 87.88%–94.65%; $I^2=0.0\%$), respectively. There was a significant difference in the clinical response rates between the two device types ($P=0.005$).

Three months after posterior nasal nerve ablation, the clinical response rate was 82.6% (95% CI, 77.26%–86.86%; $I^2=0.0\%$). After 3 months of treatment, there was no significant difference in the clinical response rate according to whether patients underwent cryotherapy (84.6%; 95% CI, 74.83%–91.05%; $I^2=0.0\%$) or radiofrequency ablation (81.6%; 95% CI, 74.89%–86.82%;

$I^2=0.0\%$; $P=0.564$).

As shown in Fig. 3, the RQLQ score decreased relative to baseline at 3 months after posterior nasal nerve ablation (MD, 1.5542; 95% CI, 1.4015–1.7069; $I^2=0.0\%$). There was no statistically significant difference in the RQLQ score change at 3 months post-treatment between cryotherapy (MD, 1.5131; 95% CI, 1.3169–1.7093; $I^2=0.0\%$) and radiofrequency ablation (MD, 1.6175; 95% CI, 1.3742–1.8607; $I^2=0.0\%$; $P=0.513$). The Egger test was not performed, and a Begg funnel plot was not generated, due to the insufficient number of studies included (<10). Notably, there was a significant improvement in quality of life following both treatments. In particular, the RQLQ score improved from baseline during the follow-up period (MCID >0.4).

Changes in subdomains of TNSS after cryotherapy and radiofrequency ablation

The TNSS consists of the sum of four symptom scores for rhinorrhea, nasal congestion, nasal itching, and sneezing. In some of the included studies, the changes in the individual subdomain scores were reported. For both device types, all subdomains (nasal congestion score, itching, rhinorrhea, and sneezing) improved significantly from baseline in patients with refractory rhinitis dur-

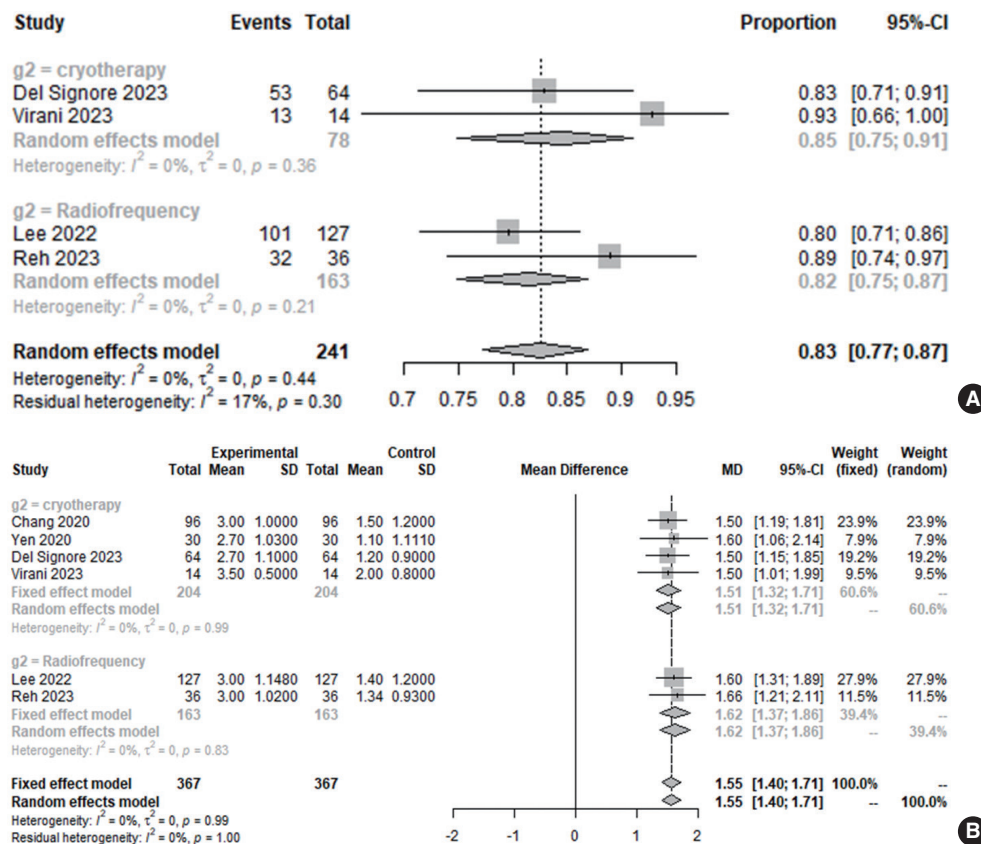


Fig. 3. Rate of clinical response (total Rhinoconjunctivitis Quality of Life Questionnaire [RQLQ] score \geq minimal clinically important difference [MCID] of 0.4 or 0.5 point) at 3 months (A) and changes in RQLQ score at 3 months (B) after cryotherapy and radiofrequency ablation (total number of participants per group). CI, confidence interval; SD, standard deviation; MD, mean difference.

Table 3. Subgroup analysis according to the subdomain of nasal symptoms in patients who underwent cryotherapy or radiofrequency ablation

Nasal symptom	3 mo	6 mo	12 mo
Nasal congestion (overall)	(n=10) MD, 1.1608; 95% CI, 1.0982-1.2234; I ² =48.6%	(n=6) MD, 1.3208; 95% CI, 1.1723-1.4694; I ² =65.0%	(n=4) MD, 1.3808; 95% CI, 1.2762-1.4854; I ² =0.0%
Cryotherapy	(n=5) MD, 1.1547; 95% CI, 1.0800-1.2294; I ² =43.8%	(n=3) MD, 1.2165; 95% CI, 0.9531-1.4799; I ² =78.5%	(n=2) MD, 1.3865; 95% CI, 1.2644-1.5086; I ² =0.0%
Radiofrequency ablation	(n=5) MD, 1.1752; 95% CI, 1.0604-1.2901; I ² =61.2%	(n=3) MD, 1.4287; 95% CI, 1.2659-1.5915; I ² =28.1%	(n=2) MD, 1.3652; 95% CI, 1.1626-1.5679; I ² =0.0%
P-value	0.769	0.179	0.860
Itching sensation (overall)	(n=9) MD, 0.6846; 95% CI, 0.4997-0.8696; I ² =73.5%	(n=5) MD, 0.7819; 95% CI, 0.4777-1.0861; I ² =85.9%	(n=3) MD, 0.8628; 95% CI, 0.4600-1.2656; I ² =80.0%
Cryotherapy	(n=4) MD, 0.4836; 95% CI, 0.2544-0.7128; I ² =60.7%	(n=2) MD, 0.4879; 95% CI, 0.0966-0.8792; I ² =81.0%	(n=1) MD, 0.5000; 95% CI, 0.2171-0.7829; I ² =NA
Radiofrequency ablation	(n=5) MD, 0.8276; 95% CI, 0.6680-0.9873; I ² =33.6%	(n=3) MD, 0.9528; 95% CI, 0.8020-1.1036; I ² =1.1%	(n=2) MD, 1.0488; 95% CI, 0.7698-1.3277; I ² =31.2%
P-value	0.016	0.030	0.007
Rhinorrhea (overall)	(n=10) MD, 1.2696; 95% CI, 1.1918-1.3474; I ² =46.9%	(n=6) MD, 1.4103; 95% CI, 1.3166-1.5040; I ² =29.9%	(n=4) MD, 1.2242; 95% CI, 0.9363-1.5122; I ² =71.7%
Cryotherapy	(n=5) MD, 1.2632; 95% CI, 1.1339-1.3926; I ² =0.0%	(n=3) MD, 1.3000; 95% CI, 1.1589-1.4411; I ² =0.0%	(n=2) MD, 0.9560; 95% CI, 0.4204-1.4915; I ² =71.3%
Radiofrequency ablation	(n=5) MD, 1.2732; 95% CI, 1.1759-1.3705; I ² =70.6%	(n=3) MD, 1.4973; 95% CI, 1.3720-1.6227; I ² =31.8%	(n=2) MD, 1.4124; 95% CI, 1.1823-1.6425; I ² =42.4%
P-value	0.904	0.041	0.125
Sneezing (overall)	(n=9) MD, 0.7830; 95% CI, 0.6500-0.9161; I ² =52.5%	(n=5) MD, 0.8228; 95% CI, 0.6192-1.0264; I ² =74.3%	(n=3) MD, 0.9605; 95% CI, 0.7840-1.1370; I ² =48.9%
Cryotherapy	(n=4) MD, 0.6994; 95% CI, 0.5056-0.8932; I ² =40.3%	(n=2) MD, 0.5919; 95% CI, 0.3965-0.7872; I ² =31.6%	(n=1) MD, 0.6400; 95% CI, 0.2711-1.0089; I ² =NA
Radiofrequency ablation	(n=5) MD, 0.8371; 95% CI, 0.6653-1.0088; I ² =53.9%	(n=3) MD, 0.9672; 95% CI, 0.8345-1.0999; I ² =0.0%	(n=2) MD, 1.0557; 95% CI, 0.8547-1.2567; I ² =0.0%
P-value	0.297	0.002	0.052

MD, mean difference; CI, confidence index; NA, not available.

Table 4. Comparison of TNSS score changes from baseline to 1, 3, 6, and 12 months postoperatively between the allergic rhinitis and nonallergic rhinitis groups

Comparison	1 mo	3 mo	6 mo	12 mo
Allergic rhinitis	(n=4) MD, 3.7013; 95% CI, 3.2926–4.1100; I ² =0.0%	(n=4) MD, 3.2099; 95% CI, 2.7770–3.6428; I ² =1.9%	(n=3) MD, 3.4686; 95% CI, 2.7457–4.1915; I ² =32.0%	(n=3) MD, 3.7962; 95% CI, 3.2554–4.3370; I ² =0.0%
Nonallergic rhinitis	(n=4) MD, 3.7634; 95% CI, 3.4361–4.0907; I ² =70.1%	(n=4) MD, 3.9594; 95% CI, 3.0611–4.8577; I ² =76.2%	(n=3) MD, 4.4472; 95% CI, 3.0608–5.8337; I ² =91.0%	(n=3) MD, 4.8981; 95% CI, 4.4682–5.3280; I ² =0.0%
P-value	0.816	0.141	0.220	0.002

TNSS, total nasal symptom score; MD, mean difference; CI, confidence interval.

ing all follow-up periods. Interestingly, the effect sizes of itching sensation during all follow-up periods and the effect sizes of rhinorrhea and sneezing at 6 months varied significantly postoperatively between the two device types, with radiofrequency ablation devices having a more beneficial effect on rhinitis-related symptom scores (Table 3).

Changes in TNSS following posterior nasal nerve ablation depending on the type of rhinitis

The majority of patients in all the analyzed studies had refractory rhinitis (allergic or nonallergic). In the four studies that assessed changes in TNSS scores according to the type of rhinitis, significant TNSS changes were observed in both the allergic rhinitis and nonallergic rhinitis groups from baseline throughout the follow-up period after posterior nasal nerve ablation (Table 4).

At 3 months postoperatively, the effect sizes started to differ between the allergic rhinitis and nonallergic rhinitis groups, and this difference became statistically significant by 12 months postoperatively. Patients with refractory rhinitis experienced relief from symptoms irrespective of allergy status. However, the response was more favorable in the nonallergic rhinitis group.

Risk of bias

Most non-randomized controlled studies were classified as having a low to moderate risk of bias because of the inherent nature of prospective studies. By contrast, a single study was rated as having a serious risk of bias as there might have been some unknown confounding factors among all participants due to its retrospective design, which finally contributed to a serious risk of bias in confounding (Supplementary Table 1). Two randomized controlled trials were classified as having some concerns because they presented deviations in the blinding of outcome assessment. Supplementary Table 2 shows the risk of bias (RoB 2.0) assessment of the included studies.

DISCUSSION

Given the low adherence to pharmacological treatment among patients with chronic rhinitis, the need for an effective surgical

technique is evident [2,4]. Although studies on surgical treatments have confirmed their positive impact on chronic rhinitis, comprehensive summaries of these findings are lacking. Our study aimed to address this gap by comparing the effects of cryotherapy and radiofrequency ablation in patients with chronic rhinitis, taking into account their allergy type (allergic and nonallergic rhinitis). In our study, rhinitis-related symptom scores and quality of life were found to be improved by cryotherapy and radiofrequency ablation, with ablation being more effective for nonallergic rhinitis patients. This statistically significant result from a comprehensive meta-analysis will provide a helpful basis for clinicians when selecting this treatment for uncontrolled or refractory chronic rhinitis, leading to clinically meaningful improvements in symptoms and quality of life measures.

Treatment strategies may vary depending on the type of chronic rhinitis [2,6]. For instance, intranasal steroids are typically recommended for the treatment of allergic rhinitis, either alone or in combination with other therapies [12]. Nonallergic rhinitis, in contrast, can be managed with intranasal steroids, antihistamines, or ipratropium [21]. However, even with conservative care, disease-specific quality of life and chronic rhinitis symptoms may not improve significantly [4].

Previous surgical interventions for refractory or uncontrolled chronic rhinitis, such as Vidian neurectomy and botulinum toxin injections, have shown limitations and adverse effects [14,22–26]. In contrast, cryotherapy and radiofrequency ablation specifically target the posterior nasal nerve [4,6]. The parasympathetic nerves of the nasal mucosa, comprising both autonomic and sensory fibers of the posterior nasal nerve, play a pivotal role in regulating mucus secretion from the submucosal gland and blood flow to alleviate stromal edema, thus effectively managing the symptoms of chronic rhinitis [27]. These parasympathetic nerve fibers innervate the middle and inferior meatus of the nasal cavity [28]. Radiofrequency ablation targets the posterior lateral nasal nerve and the parasympathetic nerve of the pterygopalatine ganglion [6]. Ablation can involve a proximal or distal approach from the choana to the middle meatus [6]. Further studies focusing on the mechanism of radiofrequency ablation are needed in light of our finding that radiofrequency ablation was more effective than cryotherapy for treating nasal symptoms in patients with nonallergic

rhinitis.

Cryotherapy selectively targets the postganglionic parasympathetic fibers of the Vidian nerve through the posterior nasal nerve, avoiding complications such as dry eye typically associated with Vidian neurectomy [29]. However, it is essential to note that due to anatomical variations, the symptoms of chronic rhinitis sometimes do not significantly improve following posterior nasal nerve ablation [30].

Virani et al. [4] suggested that the effectiveness of cryotherapy for both allergic and nonallergic rhinitis could be attributed to the mediating role of the posterior nasal nerve. Similarly, Ikeda et al. [31] proposed that cryotherapy might be effective in various types of chronic rhinitis due to its ability to significantly reduce gland density and inflammatory cell infiltration in the nasal mucosa.

The studies included in our meta-analysis, which analyzed 788 patients, consistently reported that both cryotherapy and radiofrequency ablation had positive effects on chronic rhinitis, with significant improvements in quality of life and rhinitis-related symptoms. Chang et al. [10] reported that the impact of cryotherapy became evident 6 months after treatment initiation and persisted for more than 9 months. An improvement was also reported 3 months after the procedure in a study on radiofrequency ablation [6]. In our study, both techniques enhanced disease-specific quality of life during the initial 3 months posttreatment. After 3 months, clinical improvement in all nasal symptoms was seen in 81.8% and 91.9% of patients who underwent cryotherapy and radiofrequency ablation, respectively. Most studies reported that mild discomfort was the only adverse effect [6]. Posttreatment experiences might include anxiety, temporary pain, headache, nasal obstruction, dry eye, or ear discomfort [8].

Our study has some limitations. First, the potential use of other oral or topical medications before or after treatment, which were not documented in the medical charts, cannot be ruled out. Second, bias related to the funding available for the devices used for radiofrequency ablation and cryotherapy is another potential issue. Further research free from industry sponsorship and conflicts of interest is necessary. Third, future research should aim to distinguish among allergic rhinitis, nonallergic rhinitis, and mixed rhinitis. While our results underscore the effectiveness of radiofrequency ablation and cryotherapy for nonallergic rhinitis, more detailed studies are required to validate this conclusion. Considering the lack of universal diagnostic criteria for chronic rhinitis, the patient group may have been heterogeneous. Fourth, since no randomized controlled studies have compared cryotherapy and radiofrequency ablation under identical conditions, more research on this topic is needed. Most of the existing studies were single-arm rather than randomized controlled studies, leading to potential bias. Fifth, given the relatively extended duration of chronic rhinitis, long-term follow-up studies of surgical treatment will be important. Lastly, there is a need for more studies that directly compare surgical treatment with other topical nasal treatments.

Cryotherapy and radiofrequency ablation can potentially improve the condition and quality of life of patients with chronic rhinitis. However, the most significant improvement in nasal symptoms tended to be observed in patients with nonallergic rhinitis who underwent radiofrequency ablation. Further randomized controlled studies with long-term follow-up that directly compare cryotherapy and radiofrequency ablation are needed to validate our findings.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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Conceptualization: SHH. Data curation: GS, YJK. Formal analysis: SHH. Funding acquisition: SHH, YJK. Methodology: SHH, GS. Project administration: SHH. Visualization: SHH. Writing—original draft: YJK, SHH. Writing—review & editing: YJK, GS.

SUPPLEMENTARY MATERIALS

Supplementary materials can be found online at <https://doi.org/10.21053/ceo.2023.01214>.

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