



Quality-of-life impact after in-office treatment of nasal valve obstruction with a radiofrequency device: 2-year results from a multicenter, prospective clinical trial

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Background: Insufficiency of the nasal valve is increasingly being recognized as a cause of nasal airway obstruction. The condition is associated with many symptoms, including nasal congestion, sleep disturbance, snoring, and an overall decline in quality of life (QoL). An in-office, minimally invasive radiofrequency treatment of the nasal valve has been associated with improved symptoms of nasal obstruction and patients' QoL for a 6-month period in a noncontrolled, prospective, single-arm study. The purpose of this study was to determine whether the results achieved with radiofrequency treatment at 6 months would be sustained through 24 months.

Methods: Thirty-nine adult patients from an original cohort of 49 patients with severe to extreme Nasal Obstruction Symptom Evaluation (NOSE) Scale scores and dynamic or static internal nasal valve obstruction as the primary or significant contributor to obstruction were studied. Patients received intranasal bilateral radiofrequency treatment in a clinical study with a follow-up to 6 months, and were prospectively evaluated at 12, 18, and 24 months at 8 community-based otolaryngology practices. The patient-reported NOSE Scale score and 21 QoL questions were assessed.

Results: Clinically significant improvement from baseline in NOSE Scale score change demonstrated at 6 months (mean, 55.9; standard deviation [SD], 23.6; $p < 0.0001$) was maintained through 24 months (mean, 53.5; SD, 24.6; $p < 0.0001$). Responders (≥ 15 -point improvement) con-

sisted of 92.3% of participants at 6 months and 97.2% at 24 months. Responses to the QoL questions also showed improvement in patients' QoL.

Conclusion: Treatment of the nasal valve with an in-office, transnasal temperature-controlled radiofrequency procedure was associated with stable and lasting improvement in symptoms of nasal obstruction and QoL through 24 months in this noncontrolled, single-arm study. © 2020 The Authors. International Forum of *Allergy & Rhinology* published by Wiley Periodicals LLC on behalf of American Academy of Otolaryngic Allergy and American Rhinologic Society.

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Key Words:

nasal valve; nasal obstruction; radiofrequency; nasal surgery; nasal congestion; nasal airway surgery; NOSE Scale score

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Chronic nasal obstruction can elicit many symptoms, including nasal congestion, stuffiness, headache, fatigue, sleep disturbance, daytime sleepiness, snoring, and a decline in health-related quality of life (QoL).¹ Nasal obstruction affects up to half of the population and is one of the most frequent causes for otorhinolaryngology patient visits. There has been growing awareness that nasal obstruction may impair various daily and social activities² and result in a degradation of the patient's overall quality of life.³ After correction of their nasal obstruction patients report significantly better sleep function (eg, better night's sleep, lessened waking up during the night, and difficulty falling asleep) as

well as better psychologic function (eg, concentration, productivity, and decreased feelings of frustration).⁴

The causes of nasal obstruction include deviated septum, turbinate hypertrophy, sinonasal polyps, and allergic or nonallergic rhinitis. Previously overlooked, nasal valve dysfunction (NVD) is increasingly being recognized as a cause of nasal obstruction. The internal nasal valve, defined as the area between the cartilaginous septum, the caudal end of the upper lateral cartilage, and the circumferential neighboring structures, such as the inferior turbinates, is the area of the nasal airway accounting for the greatest resistance to airflow.⁵ Surgical procedures that target the nasal valve to correct NVD are collectively referred to as functional rhinoplasty and/or nasal valve repair and include spreader and batten grafts. In their 25-year systematic review of the literature, Rhee et al found substantial evidence to support the efficacy of functional rhinoplasty and/or nasal valve repair.⁶

Recently, Jacobowitz et al⁷ reported 6-month results on an in-office treatment of nasal airway obstruction under local anesthesia using a bipolar, temperature-controlled radiofrequency device to treat the nasal valve as an alternative to over-the-counter devices, such as external nasal dilator strips and internal nasal dilators, or invasive surgical treatments, such as lateral crural strut grafts and batten grafts.⁸⁻¹⁰ In that study of 50 treated patients, all of whom had severe or extreme obstruction at baseline, the average NOSE Scale score decreased by 69% at the 6-month assessment. No device- or procedure-related serious adverse events occurred. Soreness, edema, and crusting resolved by 1 month and patients reported high satisfaction with the procedure.

In this study we sought to determine whether the results achieved at 6 months would be sustained for an extended period of time and to assess the impact of the treatment on measures of patients' QoL.

Patients and methods

Ethical considerations

This study was approved by an institutional review board (Advarra, Inc, Columbia, MD) and was registered with ClinicalTrials.gov (NCT03290300). Written informed consent was obtained from all participants.

Participants

This investigation was a prospective, nonrandomized, multicenter, extended follow-up study of the same patients who had participated in and completed the Jacobowitz et al⁷ multicenter trial, which evaluated the safety and efficacy of the novel, temperature-controlled, office-based radiofrequency treatment of the nasal valve through the the study endpoint at 6 months. All patients had baseline NOSE Scale scores ≥ 60 , indicating patients had exhibited significant symptoms of nasal obstruction as demonstrated by NOSE scores in the severe to extreme classes. A baseline NOSE Scale score ≥ 60 also means that the patient scored 3 out

of 4 in severity for each question, indicating that nasal symptoms for each question were "a fairly bad" or "severe" problem for the patient. Additional inclusion criteria were no previous surgery to the nasal valve in the preceding 12 months and the nasal valve was considered the primary contributor to nasal obstruction, as demonstrated by a positive response to the Cottle or modified Cottle maneuvers. Details of inclusion and exclusion criteria were provided by Jacobowitz et al.⁷ All 49 patients from the initial study were invited to enroll in the extended follow-up study.

Treatment and follow-up

Bilateral temperature-controlled radiofrequency (RF) treatment was applied in a single office visit using a VivAer Stylus (Aerin Medical) device with a radiofrequency generator at a setting of 60°C and 4 watts. The stylus treatment tip was positioned onto the mucosa overlying the lower edge of the upper lateral cartilage and 3 nonoverlapping areas on the lateral wall of the nasal valve were treated for 18 seconds on each side (Fig. 1). Tissue temperature was maintained by feedback from the stylus at the treatment temperature at 60°C.

Participants in this follow-up study were to provide self-administered evaluations of the NOSE and QoL measures at 12, 18, and 24 months after the treatment procedure. Follow-up assessments could occur with in-person clinic visits, by telephone, or by mailed response.

Outcome measures

Continued treatment efficacy was assessed using the NOSE Scale, a validated disease-specific, patient-reported outcome measure for nasal obstruction.¹¹ The NOSE Scale consists of 5 items: nasal congestion, nasal blockage, trouble breathing, trouble sleeping, and being unable to get enough air during exercise, each scored using a 5-point (0-4) Likert scale. The 5 item scores are summed and then multiplied by 5 to make a total score range of 0 through 100, where higher scores indicate worse obstruction symptoms. Lipan and Most¹² developed a classification of the severity of symptoms based on the NOSE Scale score to describe mild (range, 5-25), moderate (range, 30-50), severe (range, 55-75), or extreme (range, 80-100) nasal obstruction. The percent of participants responding to treatment was calculated with a responder conservatively defined as a ≥ 15 -point decrease in the NOSE Scale score,⁷ based on 2 studies demonstrating a minimally clinically important difference in NOSE Scale score of approximately 4 to 6.3 points.^{12,13}

Participants were also asked to answer a series of QoL questions to further assess the impact of the treatment on QoL activities, symptoms, and frequency of use of medications and devices to help with relief of nasal congestion that are typically associated with nasal obstruction compared with their status before the procedure (Fig. 2). The questions were not in the form of a validated survey instrument and were not asked before the procedure; therefore, there were no scores assigned to responses nor an analysis

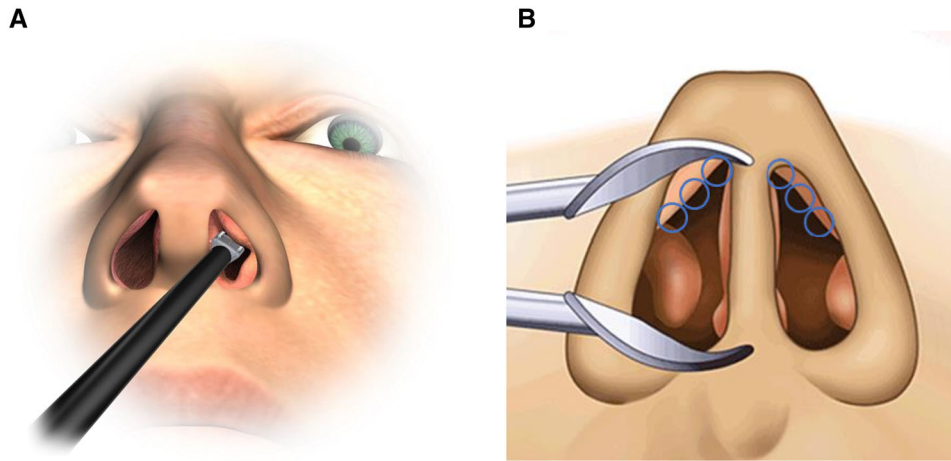


FIGURE 1. (A) Placement of the stylus on the lateral wall of the nasal valve. (B) Nasal valve treatment areas. Treatment was applied to the nasal valve region at the caudal end of the upper lateral cartilage bilaterally in 3 nonoverlapping zones, marked by circles in the figure.

Please indicate your level of agreement with the following statements:
Compared to before I had the Aerin Medical Nasal procedure, I have experienced

		Agree Strongly	Agree	Neither agree or disagree	Disagree	Disagree Strongly
1.	Less difficulty falling asleep					
2.	Less waking up at night					
3.	Better sleep throughout the night					
4.	Waking up feeling rested					
5.	Less fatigue during the day					
6.	Increased productivity					
7.	Increased energy					
8.	Increased ability to focus					
9.	Increased sense of overall well-being					
10.	Less feelings of frustration/restlessness/irritability					
11.	Less feelings of sadness					
12.	Less feelings of embarrassment or self-consciousness that I had to breathe through my mouth instead of my nose					
13.	Missing fewer activities with family and friends					
14.	Missing fewer days at work					

Compared to before you had the procedure, how often do you suffer from the following conditions?

		Very Rarely/ Never	Rarely	Occasionally	Frequently	Very Frequently
1.	Headaches					
2.	Sinus infections					
3.	Sore throat					
4.	Post nasal drip					

Compared to the time prior to when you had the procedure, how often have you used each of the following products to help you with nasal congestion/difficulty breathing through your nose?

		Much less frequently	Less frequently	About the same	More Frequently	Much More Frequently
1.	Oral medications (antihistamines, oral decongestants)					
2.	Nasal sprays (nasal steroids, inhaled decongestants)					
3.	Nasal breathing strips (for example, BreatheRight® Strips)					

FIGURE 2. Quality-of-life survey.

of change. Results are reported as percentages of categorical responses.

Participants could continue their preprocedure concurrent treatments during the follow-up period, including topical and oral medications and nasal dilators, with relative usage queried in the QoL survey at each follow-up visit.

Statistical analysis

Demographic and baseline characteristics of the enrolled and nonenrolled participants were compared using *t* tests for continuous data (after finding insufficient evidence of non-normality in the measures) and Fisher's exact test for categorical measures. Mean NOSE scores and 95%

confidence intervals (CIs) were calculated at baseline and each follow-up evaluation to show the time-course progression of improvement across study visits. The longitudinal NOSE score data were analyzed with a linear mixed effects model to test for an overall change over time, and Tukey-Kramer multiple comparisons with adjusted p values were used to test for differences in mean NOSE scores between visits. This method accounts for the repeated and correlated measurement of participants' NOSE scores from visit to visit and for missing observations, which produces adjusted means when data are missing and adjusted CIs for means and differences in means from visit to visit. The NOSE score mean change was calculated as the mean of participants' baseline score minus follow-up visit score. A positive change indicates a decrease (improvement) in NOSE score. Individual NOSE item responses were summarized by assigning values of 0 to 4 to the rating categories and computing the mean (95% CI) and median at each study visit. Formal statistical comparisons were not planned and are not presented. The number and percent of treatment responders (≥ 15 -point improvement [decrease] in NOSE score from baseline to each follow-up visit) were calculated. Statistical analysis was performed using SAS/STAT version 14.1 (SAS Institute, Inc, Cary, NC).

Results

Patients

Forty-nine of the 50 participants in the original 6-month trial were eligible for this follow-up study (Fig. 3). Thirty-nine participants from 8 sites in the 6-month trial chose to enroll in the follow-up study. The first 12-month follow-up visits were on October 30, 2017, and the last 24-month follow-up was on February 13, 2019. Three participants enrolled after the window for the 12-month visit had closed and were first evaluated at 18 months. All 39 participants had evaluations at 18 months and 36 of the 39 completed the 24-month follow-up.

Administration of the NOSE Scale and QoL questionnaire at 12 months was conducted in person for 15 (41.7%) participants and by mail-in questionnaires for 21 (58.3%). All NOSE and QoL questionnaire responses were obtained either by mail or by phone for both the 18- and 24-month evaluations, with most returned by mail.

Demographics and other baseline characteristics of the study population are presented in Table 1. The mean pretreatment NOSE score was 80.8 (SD, 10.7) and the mean NOSE score at the 6-month endpoint of the original trial was 24.9 (SD, 21.3). There were 3 nonresponders (decrease in NOSE score < 15 points from baseline) at the end of the original trial, all of whom enrolled in the current study.

Characteristics of the 10 participants from the original study that chose not to enroll in this follow-up study were compared with the 39 participants and generally exhibited similar characteristics (Table 1). The nonenrollees

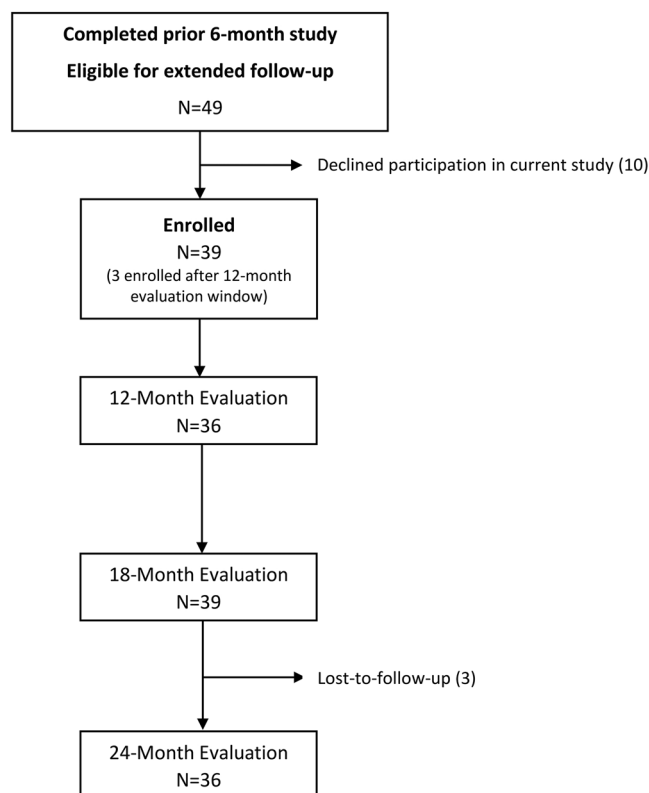


FIGURE 3. Enrollment and disposition of patients.

tended to be more overweight than the study participants based on the mean body mass index (BMI) of the 2 groups (30.2 vs 27.7). The mean NOSE score at 6 months for the nonenrollees (24.0) was similar to the NOSE score of the study participants (24.9). None of the differences observed reached a detectable level of statistical significance ($p < 0.05$).

There were no long-term safety issues related to the procedure reported and no deaths occurred during the follow-up period.

NOSE Scale score

The overall visit effect was highly significant in the analysis model ($F = 53.4$, $p < 0.0001$). The mean pretreatment NOSE score of 80.8 (SD, 10.7) improved from an average of 55.9 (SD, 23.6) points to 24.9 (SD, 21.3) points (68.7% improvement) at the 6-month original study endpoint. The improvements in mean NOSE score were maintained in this study at the 12-, 18-, and 24-month evaluations with means of 27.5 (SD, 22.5; 65.2% improvement), 32.7 (SD, 31.0; 59.6% improvement), and 26.5 (SD, 23.8; 66.5% improvement), respectively (Table 2 and Fig. 4). The mean NOSE scores at all follow-up visits were statistically significantly better (lower) ($p < 0.0001$) than the baseline mean NOSE score. There were no statistically significant differences ($p > 0.05$) among the follow-up mean NOSE scores at the different follow-up time-points.

TABLE 1. Demographics and other baseline characteristics

Measure	Enrolled (N = 39)	Nonenrolled (N = 10)	Test
Sex, n (%)			Fisher's exact, $p = 0.15$
Male	19 (48.7)	8 (80.0)	
Female	20 (51.3)	2 (20.0)	
Age (years)			t test, $t = 0.98$, $p = 0.33$
Mean	51.7	47.3	
SD	12.8	12.1	
Median	54.0	44.5	
Minimum-maximum	24-78	31-71	
Weight (pounds)			t test, $t = -1.85$, $p = 0.07$
Mean	182.7	207.5	
SD	35.9	44.4	
Median	189.0	204.5	
Minimum-maximum	118-278	125-295	
Body mass index, n (%)			Fisher's exact, $p = 0.15$
Normal (18.5 to <25)	12 (30.8)	1 (10.0)	
Overweight (25 to <30)	17 (43.6)	5 (50.0)	
Obese (≥ 30)	10 (25.6)	4 (40.0)	
Mean	27.65	30.21	t test, $t = -1.39$, $p = 0.17$
SD	5.13	5.33	
Median	27.4	28.8	
Minimum-maximum	18.5-42.7	23.6-41.1	
Race, n (%)			Fisher's exact, $p = 0.15$
Declined available choices	0 (0.0)	1 (10.0)	
White	39 (100)	9 (90.0)	
Ethnicity, n (%)			Fisher's exact, $p = 0.20$
Hispanic or Latino	2 (5.1)	0 (0.0)	
Not Hispanic or Latino	37 (94.9)	10 (100)	
Baseline NOSE Scale score			t test, $t = 1.71$, $p = 0.09$
Mean	80.8	74.5	
SD	10.7	8.6	
Median	80.0	75.0	
Minimum-maximum	60-100	60-85	
6-month NOSE Scale score			t test, $t = 0.12$, $p = 0.91$
Mean	24.9	24.0	
SD	21.3	17.3	
Median	20.0	22.5	
Minimum-maximum	0-90	0-55	

(Continued)

TABLE 1. Continued

Measure	Enrolled (N = 39)	Nonenrolled (N = 10)	Test
6-month responder, n (%)			Fisher's exact, $p > 0.99$
Yes	36 (92.3)	10 (100)	
No	3 (7.7)	0 (0.0)	

Abbreviations: NOSE = Nasal Obstruction Symptom Evaluation; SD = standard deviation.

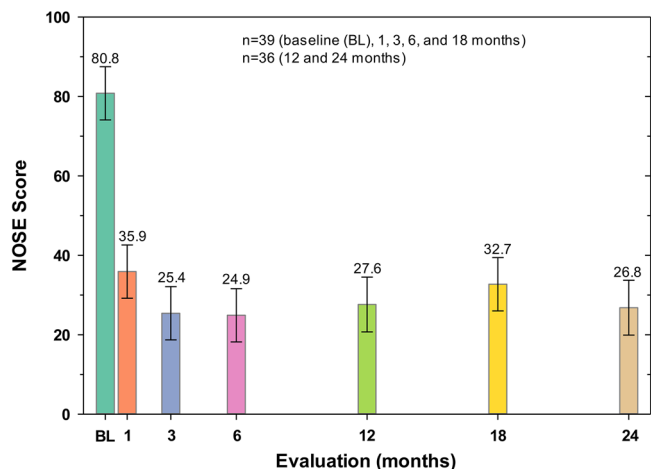


FIGURE 4. Mean NOSE Scale score with 95% confidence interval (adjusted) by evaluation. All follow-up mean scores are statistically significantly lower than baseline ($p < 0.0001$) and there are no statistically significant differences ($P > .05$) among the follow-up mean scores. NOSE = Nasal Obstruction Symptom Evaluation.

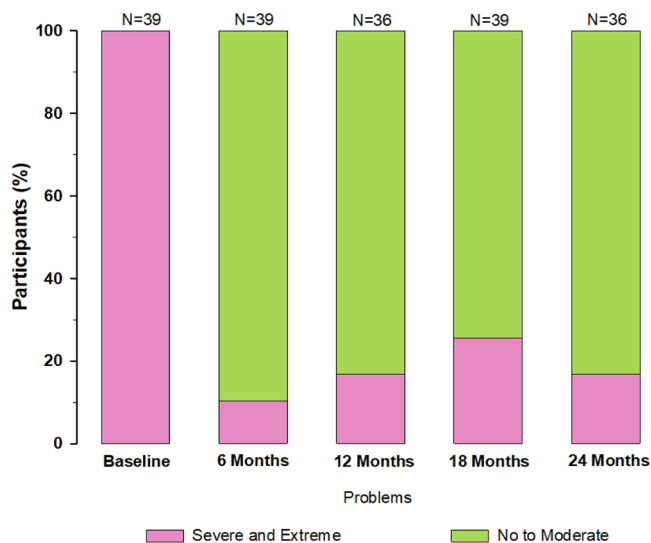


FIGURE 5. NOSE Scale score severity ratings distribution (%) by evaluation. NOSE = Nasal Obstruction Symptom Evaluation.

Pretreatment nasal obstruction was categorized as either severe (46%) or extreme (54%) for all participants. At 24 months, with 36 of 39 participants evaluated, only 17% remained in the severe and extreme categories (6 participants: 5 severe and 1 extreme) (Fig. 5).

Using the definition of responder of ≥ 15 -point improvement in NOSE score, the percent of responders was 92.3%, 94.4%, 87.2%, and 97.2% of participants at the 6-month original study endpoint and 12, 18, and 24 months, respectively.

Each of the 5 components of the NOSE Scale (nasal congestion, nasal blockage, trouble breathing, trouble sleeping, and being unable to get enough air during exercise) demonstrated clinically and statistically significant improvement from baseline in both the original 6-month study endpoint and at each of the 12-, 18-, and 24-month extended follow-up evaluations of this study. Improvement of at least 1 severity category was found in at least 75% of participants for each of the 5 components at all follow-up evaluations (Fig. 6). The percentage of participants reporting fairly bad or severe symptoms in each of the NOSE components went from $\geq 80\%$ at baseline to $\leq 20\%$ at 24 months (Fig. 7). With numeric scores from 0 to 4 assigned to the categorical ratings, the mean score for individual items on the NOSE Scale ranged from 3.1 (SD, 0.8) to 3.4 (SD, 0.6) at baseline (Fig. 8). All components showed a marked decrease at the 6-month endpoint and remained at decreased levels through the 24-month follow-up of this study (Fig. 8), with means ranging from 0.8 (SD, 1.0) to 1.5 (SD, 1.4).

Quality of life

Participants' opinions of the benefits and answers to QoL questions since the procedure were generally favorable based on the 21-item QoL survey. A few participants chose not to respond to certain items or found them not applicable to their circumstances. Respondents at the 12-, 18-, and 24-month evaluations indicated improvements with sleep, with 78% agreeing or strongly agreeing that they had less difficulty falling asleep at 24 months. In addition, the percentages agreeing or strongly agreeing that they had less waking at night, had better sleep throughout the night, and woke up feeling rested at 24 months were 69%, 72%, and 61%, respectively (Table 3).

More than 50% of respondents also agreed or strongly agreed that they felt less fatigue during the day and increased sense of overall well-being at their 24-month evaluation (Table 3).

Less frequent or much less frequent use of oral medications and nasal sprays was reported by $>60\%$ of respondents, and $>80\%$ reported decreased use of nasal breathing strips (Table 3).

TABLE 2. NOSE Scale severity and mean score

NOSE score	Baseline		Evaluation							
			6 Months		12 Months		18 Months		24 Months	
	n	%	n	%	n	%	n	%	n	%
Extreme (80-100)	21	53.8	1	2.6	1	2.8	4	10.3	1	2.8
Severe (55-75)	18	46.2	3	7.7	5	13.9	6	15.4	5	13.9
Moderate (30-50)	0	0.0	10	25.6	9	25.0	7	17.9	10	27.8
Mild (5-25)	0	0.0	21	53.8	16	44.4	18	46.2	13	36.1
No problems (0)	0	0.0	4	10.3	5	13.9	4	10.3	7	19.4
Number evaluated	39	100	39	100	36	100	39	100	36	100
Mean	80.8		24.9		27.5		32.7		26.5	
SD	10.7		21.3		22.5		30.1		23.8	
95% CI	77.3-84.2		18.0-31.8		19.9-35.1		22.9-42.4		18.5-34.6	
Median	80.0		20.0		22.5		20.0		22.5	
Minimum-maximum	60-100		0-90		0-85		0-100		0-80	
Adjusted mean from analysis	80.8		24.9		27.6		32.7		26.8	
Adjusted 95% CI from analysis	74.1-87.5		18.2-31.6		20.7-34.2		26.0-39.4		19.9-33.7	
Change from baseline ^a										
Mean	—	—	55.9		53.3		48.1		53.5	
SD	—	—	23.6		25.2		30.2		24.6	
95% CI	—	—	48.2-63.6		44.8-61.9		38.3-57.9		45.2-61.8	
Median	—	—	60.0		57.5		55.0		57.5	
Minimum-maximum	—	—	0-95		0-95		-10 to 90		-20 to 90	
Adjusted mean change from analysis	—	—	55.9		53.2		48.1		53.9	
Adjusted 95% CI from analysis	—	—	44.4-67.4		41.4-64.9		36.6-59.6		42.2-65.7	

^aBaseline score – follow-up score. Change represents a decrease in NOSE score. Abbreviations: CI = confidence interval; NOSE = Nasal Obstruction Symptom Evaluation; SD, standard deviation.

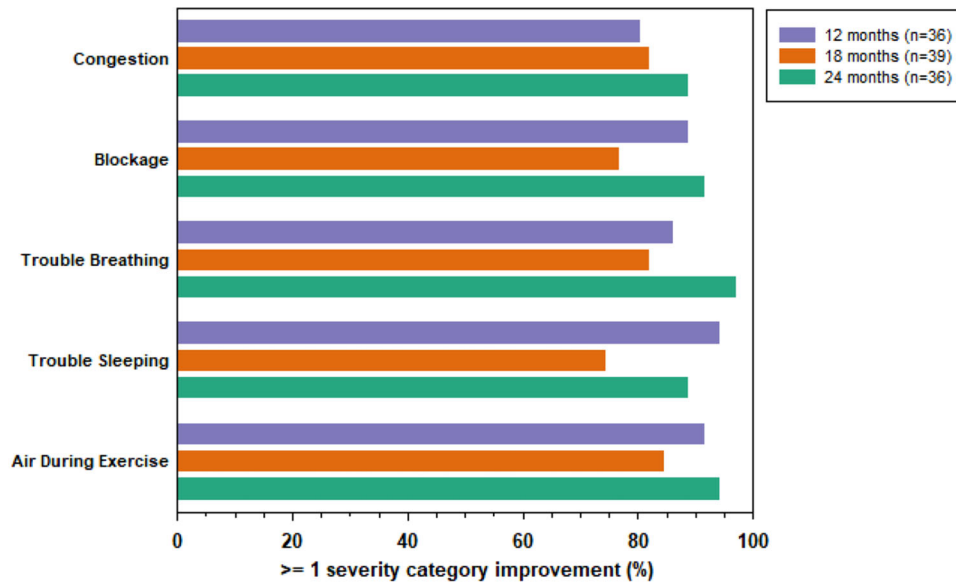


FIGURE 6. Percent of participants with ≥ 1 severity category improvement on the NOSE Scale score components. NOSE = Nasal Obstruction Symptom Evaluation.

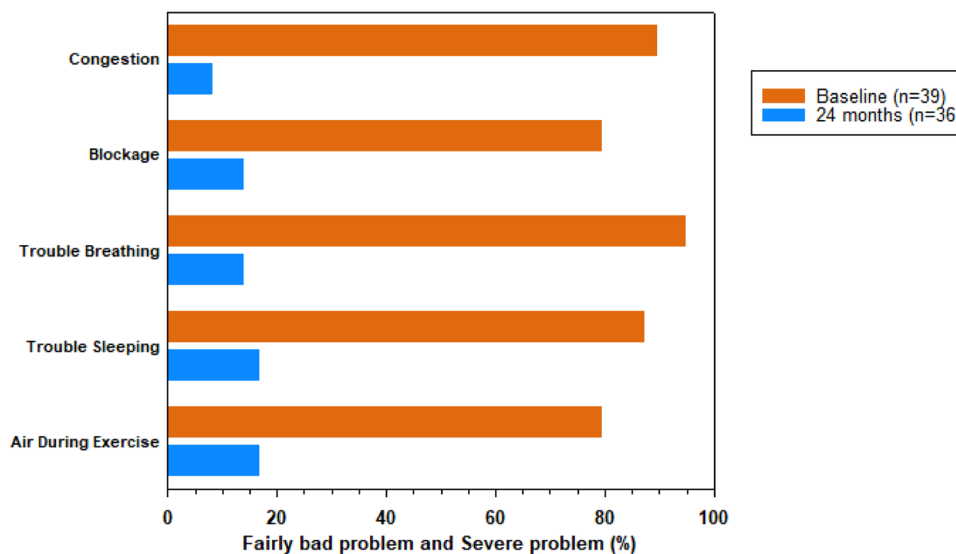


FIGURE 7. NOSE Scale components ratings of fairly bad problem and severe problem (%) at baseline and 24 months. NOSE = Nasal Obstruction Symptom Evaluation.

Discussion

Surgical interventions, such as spreader grafts that target the nasal valve, are well established to improve the symptoms of nasal obstruction.¹ However, these surgeries are invasive and involve a risk of complications. A novel device for office-based transnasal treatment of the nasal valve with temperature-controlled radiofrequency was recently introduced.⁷ In the initial publication, 46 of 50 participants who received this nasal valve treatment were shown to have significant improvement in symptoms of nasal obstruction at 6-month follow-up.⁷ In this study we sought to demonstrate long-term efficacy by following the same participants up to 24 months postprocedure. Although 10 of the partic-

ipants in the 6-month follow-up study chose not to enroll for additional follow-up, we believe the 39 enrolled participants are representative of the original study population based on comparable baseline characteristics and the fact that the enrolled participants included all 3 nonresponders from the 6-month study.

Effect of nasal valve RF treatment on nasal obstruction symptoms

This study, which also analyzed the responder percentage at time-points out to 24 months, has demonstrated that the significant clinical improvement at the 6-month original

TABLE 3. Number and percent of participants reporting the 2 most favorable categorical responses to items on the QoL survey

QoL survey item	12 Months		24 Months	
	n	%	n	%
Experience since the procedure (<i>agree</i> or <i>strongly agree</i>):				
Less difficulty falling asleep	25	69.4	28	77.8
Less waking up at night	20	55.6	25	69.4
Better sleep throughout the night	23	63.9	26	72.2
Waking-up feeling rested	18	50.0	22	61.1
Less fatigue during the day	20 ^a	57.1	19	52.8
Increased productivity	13	36.1	21	58.3
Increased energy	18	50.0	22	61.1
Increased ability to focus	11	30.6	22	61.1
Increased sense of overall well-being	18	50.0	23	63.9
Less feelings of frustration	17	47.2	18	50.0
Less feelings of sadness	12	33.3	17	47.2
Less feelings of embarrassment	20	55.6	16	44.4
Missing fewer activities with family and friends	12	33.3	17	47.2
Missing fewer days at work	9 ^a	25.7	15	41.7
Conditions experienced (<i>rarely</i> or <i>very rarely/never</i>):				
Headaches	22	61.1	28	77.8
Sinus infections	28	77.8	33	91.7
Sore throat	30	83.3	30	83.3
Postnasal drip	19	52.8	21	58.3
Use of (<i>less</i> or <i>much less frequently</i>):				
Oral medications	23	63.9	24	66.7
Nasal sprays	26	72.2	23	63.9
Nasal breathing strips	22 ^b	64.7	29	80.6

*Thirty-six of the 39 participants responded to the survey at 12 and 24 months.

^aThirty-five respondents.

^bThirty-four respondents.

Abbreviation: QoL = quality of life.

study endpoint showed a durable effect at the 24-month follow-up time-point. Both the 6-month study primary (mean improvement in NOSE score) and secondary (responder percent) efficacy endpoints were met at the extended 12-, 18-, and 24-month evaluations, with a mean NOSE score improvement of 53.5 points (67% mean improvement). The significant efficacy and high percentage of responders are also demonstrated by the fact that the percentage of participants with NOSE scores in the severe or extreme categories declined from 100% to 10%. Improvement in mean NOSE score also exceeded the 25- to 30-point change that some investigators have suggested as a success criterion for nasal intervention.^{14,15}

In addition, improvement was demonstrated in each of the 5 individual domains on the NOSE Scale (nasal congestion, nasal blockage, trouble breathing, trouble sleeping, and being unable to get enough air during exercise). These findings suggest an association with broad and significant improvement in measures of general and nasal obstruction-related QoL after the procedure.

The NOSE Scale score improvement demonstrated in this study is comparable to that reported by Rhee et al¹⁴ and in other meta-analyses and systematic reviews of invasive surgical treatments for nasal obstruction. For comparison, the mean NOSE score change was 42 to 50 points for septorhinoplasty procedures as compared with

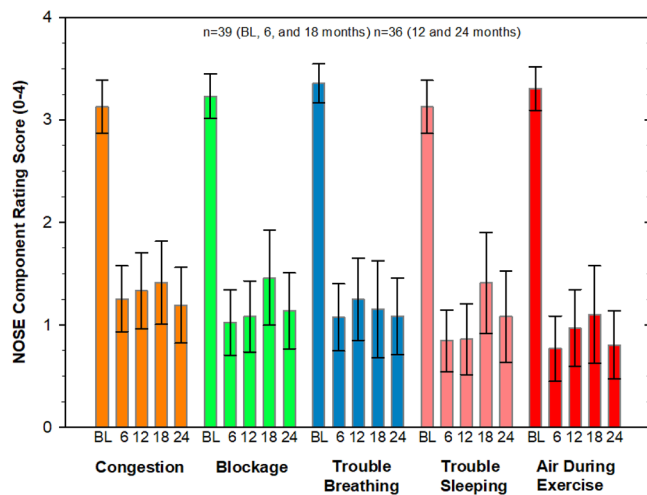


FIGURE 8. NOSE Scale components mean scores with 95% confidence interval by evaluation. NOSE = Nasal Obstruction Symptom Evaluation.

the 53.5-point improvement at the 24-month follow-up shown in the current study.^{14,16,17}

In this work we evaluated subjective reported symptom change and no biopsy was performed, so the effect of treatment on tissue cannot be definitively shown. However, the mechanism of action of treatment can be inferred. In nasal airway mucosa, an underlying network of collagen and elastin fibers provides scaffolding for the mucosa and determines its degree of firmness and elasticity. RF-induced heating has been shown to induce tissue tightening through effects on this fiber network. Heating by RF energy causes 2 main tissue effects on nasal airway tissue: contraction and tightening, through the immediate effects on existing collagen proteins and the induction of new collagen production.¹⁸ The device utilized was designed to cause these tissue tightening effects within the submucosal layer of the nasal valve. The tightened submucosal layer likely accounts for the immediate and longer term contour changes in the treatment area, which results in greater airflow according to Poiseuille's law, and tissue stiffening, which likely results in greater resistance of the nasal valve to negative pressure on inhalation.


The demonstrated NOSE score improvement, high responder percentage, broad QoL improvements, and durability out to 24-month follow-up demonstrates an association between treatment of the nasal valve with an in-office, temperature-controlled RF device, and nasal obstruction symptom relief similar to surgery in patients with NVD and nasal obstruction.

Limitations of the study

The main limitations of this study are the single-arm, non-randomized design and lack of a control group. Based on

the study design utilized, the observed association of treatment and NOSE score could be due to a placebo effect.¹⁹ Future studies will utilize a single-blinded, randomized, sham-controlled approach and larger sample sizes. Another limitation is the lack of objective measures of nasal obstruction and nasal airflow. However, there are numerous studies in the literature that showed a poor correlation between objective measures of nasal resistance and airflow and the symptoms of nasal obstruction.^{20,21} The NOSE Scale is a validated survey that measures the reduced QoL attributed to nasal obstruction. Therefore, the NOSE Scale score is generally used as a primary outcome in studies of therapy for nasal obstruction. Another limitation is that the extended follow-up study enrolled 39 of the 50 original participants in the original 6-month clinical study (49 were eligible for enrollment). Comparison of demographic characteristics of original study participants who chose to enroll with those who did not enroll did not reveal any signs of symptomatic bias. All of the original sites were represented in this study. An initial concern that participants with less improvement or satisfaction with the procedure would choose not to enroll did not appear to take place. Baseline and 26-week NOSE Scale scores for those enrolled in the follow-up study were slightly worse than for those that did not enroll, and all 3 of the nonresponders at the 6-month endpoint of the original study enrolled in this follow-up study, indicating that bias toward enrollment of the most improved study participants was unlikely. However, for consideration of worst case, if the 10 unenrolled participants from the original study and the 3 lost to follow-up in this study are all considered nonresponders, then the overall 24-month responder percent is 71.4%.

Conclusion

Transnasal temperature-controlled radiofrequency treatment of the nasal valve in select patients presenting with nasal obstruction was safe and was associated with durable improvements in symptoms of nasal obstruction as measured by the NOSE Scale score and nasal obstruction-related QoL over 2 years in this uncontrolled study. It will be necessary to confirm the results of this study in additional patients as part of a planned randomized, controlled trial that may help determine the relative true treatment effect vs potential placebo effects. 

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