# Nasal Reactivity After Radiofrequency Ablation of Peripheral Branches of Posterior Nasal Nerve

Original Investigation

Samy Elwany, Ziad Mandour, Ahmed Aly Ibrahim, Remon Bazak

Department of Otolaryngology, Alexandria Medical School, Alexandria, Egypt

Abstract

**Objective:** Transection or ablation of the posterior nasal nerve (TRPN) has been described as an adjunctive tool to reduce the symptoms of intractable allergic rhinitis (AR). The procedure, however, requires surgical skill and carries the risk of bleeding from the sphenopalatine artery. The aim of the present study is to describe radiofrequency ablation of the peripheral branches of the posterior nasal nerves within the inferior turbinates (RAPN) as an effective easier alternative to TRPN.

**Methods:** The procedure was performed on 24 patients with intractable AR. Nasal reactivity was tested by cold dry air (CDA) provocation before and 12 months after the radiofrequency procedure. Visual analog scale and acoustic rhinometry were used to measure the changes in nasal reactivity subjectively and objectively.

**Results:** Worsening of nasal symptoms following CDA provocation had significantly decreased after the RAPN procedure. Likewise, postoperative decrease in nasal volumes and minimal cross-sectional areas after CDA provocation were significantly less than the corresponding preoperative values.

**Conclusion:** RAPN effectively reduces nasal reactivity in patients with AR. The procedure is simple, minimally invasive, and can be performed under local or general anesthesia.

**Keywords:** Radiofrequency, allergic rhinitis, inferior turbinates, posterior nasal nerve, hyperreactivity

***ORCID IDs of the authors:***

*S.E. 0000-0002-1951-1842;*
*Z.M. 0000-0002-7168-3879;*
*A.A.I. 0000-0003-2735-0636*
*R.B. 0000-0003-3609-2026.*

***Cite this article as:*** Elwany S, Mandour Z, Ibrahim AA, Bazak R. Nasal Reactivity After Radiofrequency Ablation of Peripheral Branches of Posterior Nasal Nerve. *Turk Arch Otorhinolaryngol 2022; 60(4): 181-187.*

**Corresponding Author:**
Samy Elwany;
samy.elwany@alexmed.edu.eg

**Received Date:** 13.10.2022
**Accepted Date:** 29.11.2022



DOI: 10.4274/tao.2022.2022-10-1

## Introduction

Nasal hyperreactivity (NHR) is defined as an increased sensitivity of the nasal mucosa to commonly encountered environmental stimuli. NHR is an important feature of allergic (AR) and non-allergic (NAR) rhinitis (1). A neurogenic origin is believed to be the culprit behind the development of NHR in AR and NAR patients (2).

Patients with AR usually experience provocation of their symptoms by several non-specific physical stimuli such as sudden change in temperature, smoking, or chemical pollutants (3). Cold dry air

(CDA) is a physiologic, safe, and tolerable stimulus for the nasal mucosa that has been proven to be a good diagnostic tool in non-specific hyperreactivity (4). Braat et al. (5) demonstrated that CDA provocations were superior to nasal histamine provocations in distinguishing AR patients from healthy controls.

Resection of the vidian nerve has been used to reduce hypersecretion and hypersensitivity of the nasal mucosa in patients with intractable AR. A major disadvantage of this procedure are the risks of decreased lacrimation and numbness of the palate. Therefore, vidian neurectomy has been largely replaced with the less invasive endoscopic transnasal resection of the posterior nasal nerve (TRPN) which spares nerve supply to the lacrimal glands and palate (6). Mori et al. (7) reported that submucous inferior turbinate surgery improved nasal breathing as well as nasal symptoms induced by the allergic reaction in patients with AR. Ogawa et al. (8) combined submucous turbinectomy with posterior nasal neurectomy in patients with severe AR and achieved good results.

The peripheral branches of the posterior nasal nerves run within the tissues of the inferior turbinate close to the bony concha (Figure 1). Unintended surgical resection of these branches has been suggested as an explanation of improvement of allergic symptoms following inferior turbinate reduction (8). Based on this report, Kobayashi et al. (9) described the resection of posterior nasal nerves within the inferior turbinates and reported that the effects of the procedure were equivalent to those of conventional TRPN. However, surgical identification of these branches is surgically demanding and may be troublesome or incomplete.

In the presented study, we used radiofrequency coagulation for submucosal ablation of the peripheral branches of the posterior nasal nerves within the inferior turbinate without the need to identify them individually as described by Kobayashi (9). We then used the CDA provocation protocol described by van Gerven et al. (3) to evaluate the effect of the radiofrequency procedure on NHR in patients with intractable AR.

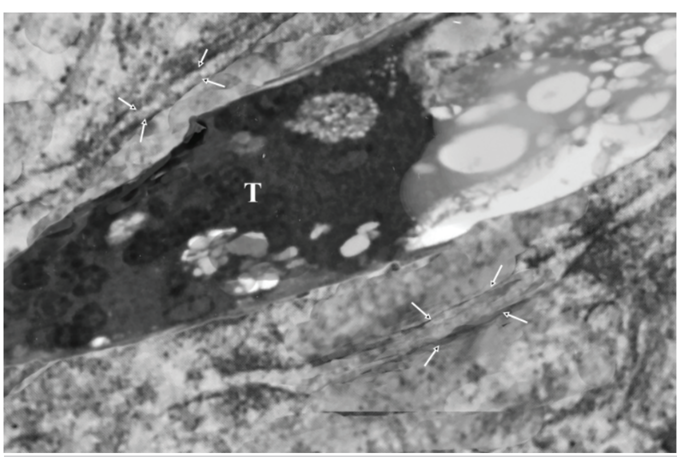

**Figure 1.** Electron micrograph showing the peripheral nerve fibers of the posterior nasal nerves (arrows) running close to the turbinate bone (T) (x860)

## Methods

A sample of 24 patients was set based on sample size calculations assuming 80% power and 5% significance in acoustic rhinometry parameters changes before and after CDA provocation and considering a minimum average reduction of 15%. All patients were between 16 and 42 years of age and had at least two nasal complaints (nasal obstruction, rhinorrhea, or sneezing). All patients had positive skin prick tests, were nonsmokers, and suffered from troublesome intractable AR symptoms for more than five years.

All patients signed the informed consent forms after being informed about the procedure and the CDA provocation test. The consents and the research protocol were approved by the Committee of Medical Ethics of Alexandria University (approval no: 1119-2019, date: January 12, 2019) according to the Helsinki Declaration.

Exclusion criteria included sinonasal infections, severe septal deviation, nasal polyps, previous nasal surgeries, being lost to follow-up, as well as being pregnant or lactating. Local and systemic corticosteroids, antihistamines, or decongestants were stopped one week before every evaluation. Patients who could not stop medications before the tests were also excluded from the study.

Assessment of nasal symptoms by visual analog scale (VAS) and CDA provocation and acoustic rhinometry were performed at the time of the initial evaluation and 12 months after the radiofrequency procedure.

### VAS Scale

All patients were requested to mark their nasal symptoms (nasal obstruction, rhinorrhea, and sneezing) on a VAS (0–10 cm) before and 15 minutes after CDA nasal provocation. The same examiner performed all the tests.

### Acoustic Rhinometry

Nasal volumes (V1 and V2) and minimal cross-sectional areas (MCA1 and MCA2) were measured by acoustic rhinometry (RhinoScan SRE2000, Interacoustics, Assens, Denmark) in both nasal cavities. The method for performing acoustic rhinometry is well described elsewhere (10, 11).

Data for three rhinometric curves were collected for each nostril. Irregular tracings or discrepant measurements were discarded. Values considered for analysis were an average of three measurements taken from three technically acceptable curves. All measurements were performed three times and by the same operator.

The following parameters were recorded:

• The volume of the segment located from 10 to 32 mm from the nostril corresponding to the nasal valve region (V1), and the volume of the segment located between 33 and 64 mm from the nostril, corresponding to the turbinate region (V2).

• Minimal cross-sectional area between 0 and 2.3 cm (MCA1) and between 2.3 and 6.4 cm (MCA2).

### CDA Provocation

Patients were acclimatized to room temperature (20 ˚C) for 15 minutes and were exposed to CDA for 15 minutes. The CDA protocol used is described in the study by van Gerven et al. (12). To avoid diurnal variation and intertest error, all provocations were performed in the morning by a single experienced examiner.

### Surgical Procedure

All procedures were performed under general anesthesia using an Ellman radiofrequency generator (Surgitron EMC, frequency =3.8 MHz and power =140 watts) and a bipolar straight turbinate handpiece with two parallel 5 cm long needles. We used the COAG setting (partially rectified waves) which diffuses the heat more effectively to the sides. Power setting was 20 watts.

The needles were inserted submucosally in the posterior half of the inferior turbinate and deeply pushed along and close to the medial surface of the turbinate bone toward its posterior end or tail (Figure 2). The average application duration of the radio waves was 5 seconds. The application was stopped once visual blanching of the mucous membrane occurred to limit damage to the overlying mucosa. Typically, three parallel applications were done from superior to inferior. No packing was needed, and all patients were discharged on the same day. The safety profile of the device/procedure was excellent, and there were no safety concerns.

### Statistical Analysis

Statistical analysis was performed using the GraphPad Prism software (GraphPad Software, Inc., San Diego, CA. USA). Volume is expressed in cubic centimeters and the results for each group are presented as an average ± standard deviation. The measurements before and after CDA nasal provocation were compared using a paired Student's t-test and a chi-square test. Values of $p<0.05$ were considered significant.

## Results

The study included 24 patients (11 male and 13 female) with a mean age of 33.5 years. The baseline demographics and characteristics of the patients are shown in Table 1. The procedure was performed smoothly in all patients and their 6-month postoperative follow-up periods were uneventful. None of the patients reported headache or other significant adverse events in the immediate postoperative period.

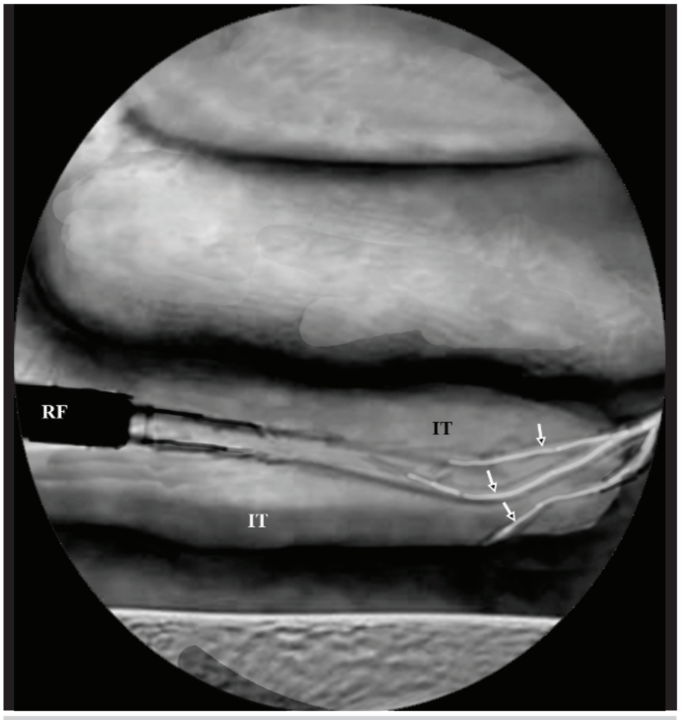


**Figure 2.** Radiofrequency ablation of the peripheral inferior turbinate branches of the posterior nasal nerves. The needles of the radiofrequency probe (RF) are inserted submucosally to ablate the branches of posterior nasal nerve (arrows) within the inferior turbinate (IT)

**Table 1.** Baseline demographics and characteristics of patients

| Data | n=24 |
|---|---|
| **Sex** | |
| Male | 11 |
| Female | 13 |
| Age, years | 33.5+/-2.8 |
| **Medications used** | |
| Oral antihistamines | 24 |
| Nasal steroids | 24 |
| Nasal antihistamines | 13 |
| Nasal decongestants | 24 |
| Oral decongestants | 9 |
| Oral steroids | 7 |
| Oral leukotriene inhibitors | 5 |
| Nasal anticholinergics | 1 |
| Previous nasal surgeries | 0 |

N: Number of patients

The patients had significant reductions in mean VAS scores for all nasal symptoms and for total score (Table 2). The mean total VAS score was reduced by 44.2% (percentage difference) and the drop was statistically significant (p=0.0082). CDA provocation increased the mean total VAS scores by 19.9% before surgery and only 10.5% after surgery (Table 3).

The results of acoustic rhinometry evaluation are presented in Tables 4 and 5. Acoustic rhinometric measurements showed an increase in all studied acoustic rhinometry parameters after the radiofrequency procedure, indicating a wider nasal airway. All acoustic rhinometry parameters decreased after CDA provocation. This drop (% difference) was significantly less after surgery. The preoperative total percentage difference after CDA provocation for MCA1, MCA2, and V1, V2 were 37.0%, 40.0%, and 24.7%, 28.0%, respectively. On the other hand, the postoperative total percentage difference after CDA provocation for the same parameters were 16.2%, 13.1%, and 12.7%, 11.7%, respectively (Figure 3). The differences between preoperative and postoperative values were statistically significant ($X^2$=5.9, p=0.0292).

## Discussion

Resection of posterior nasal nerves has been reported as an effective procedure to treat AR unresponsive to medical therapy. Since the procedure interrupts both of parasympathetic and afferent sensory nerve fibers, it is expected to decrease rhinorrhea, sneezing, as well as nasal reactivity to noxious stimuli.

Ikeda et al. (13) combined inferior turbinoplasty with TRPN and reported satisfactory results in patients with resistant AR and NAR with eosinophilia (NARES). They named the procedure functional inferior turbinosurgery. Likewise, Ogawa et al. (8) used a similar combination of inferior turbinoplasty and TRPN and reported satisfactory results in patients with perennial AR. Mori et al. (7) mentioned that surgically induced damage to peripheral posterior nasal nerve fiber during turbinoplasty might be a major factor in improving allergic symptoms after submucous turbinectomy. Kobayashi et al. (9) compared submucosal resection of peripheral branches of the posterior nasal nerve within the inferior turbinate with classical TRPN and did not find significant difference in the improvement in symptom scores between the two groups, although transection of the posterior nasal nerve near the sphenopalatine foramen denervates a wider area of the nasal mucosa also including part of the middle turbinate. This is most likely due to the dominant role of the inferior turbinate in normal nasal breathing and reactivity (14, 15).

Nevertheless, submucosal selective identification of all peripheral posterior nasal nerves branches within the inferior turbinate can be surgically demanding, and some branches may be frequently missed. In the presented study, we used the radiofrequency probe to coagulate the inferior turbinate tissue where the peripheral posterior nasal nerves branches normally pass submucosally close to the bony concha obviating the need for individual identification of the branches. Although TRPN denervates a wider area of the nasal mucosa, it is a more surgically demanding procedure that typically requires general anesthesia, and often the exposure and the coagulation of the sphenopalatine artery. Also, some of the branches arising through separate foramina may be missed. On the other hand, the radiofrequency ablation of the peripheral branches of the posterior nasal nerves within the inferior turbinates (RAPN) procedure is a short procedure that is technically easy, minimally invasive, and can be performed under local or general anesthesia. Furthermore, there is practically no risk of postoperative hemorrhage as may occur from the sphenopalatine artery during TRPN. RAPN delivers results comparable to TRPN and can also be combined with complete radiofrequency turbinoplasty if needed.

**Table 2.** Preoperative and postoperative VAS scores and acoustic rhinometry parameters without CDA provocation

| Parameter | Preoperative | Postoperative | p-value |
|---|---|---|---|
| VAS score | 28.95 | 18.47 | 0.0082* |
| MCA1 $cm^2$ | 0.32 | 0.40 | 0.1216 |
| MCA2 $cm^2$ | 0.36 | 0.57 | 0.0241* |
| V1 $cm^3$ | 1.59 | 2.00 | 0.1302 |
| V2 $cm^3$ | 2.85 | 4.16 | 0.0027* |

*p<0.05 is considered statistically significant. VAS: Visual analog scale, CDA: Cold dry air, MCA: Minimal cross-sectional area, V: Nasal volume

**Table 3.** Comparison of preoperative and postoperative VAS scores before and after CDA provocation

| | Preoperative Mean (SD) | | Postoperative Mean (SD) | |
|---|---|---|---|---|
| | Before CDA | After CDA | Before CDA | After CDA |
| Itching | 6.22 (1.71) | 8.1 (1.08) | 5.43 (0.98) | 4.83(1.10) |
| Sneezing | 7.13 (1.23) | 9.19 (1.12) | 4.61 (1.03) | 5.90 (1.21) |
| Rhinorrhea | 7.45 (1.62) | 9.20 (1.03) | 5.01(1.06) | 6.00 (1.43) |
| Nasal obstruction | 8.15 (0.98) | 8.89 (1.65) | 3.42 (0.89) | 3.79 (0.94) |
| Total nasal score | 28.95 | 35.38 | 18.47 | 20.52 |
| % difference (total) | 19.9 | | 10.5 | |

VAS: Visual analog scale, CDA: Cold dry air, SD: Standard deviation

**Table 4.** Comparison of preoperative and postoperative MCA1 and MCA2 values before and after CDA provocation

| | MCA1 | | | | | |
|---|---|---|---|---|---|---|
| | **Preoperative (cm²) mean (SD)** | | | **Postoperative (cm²) mean (SD)** | | |
| **Group** | **Right** | **Left** | **Total** | **Right** | **Left** | **Total** |
| Before CDA provocation | 0.35 (0.11) | 0.29 (0.18) | 0.32 (0.12) | 0.43 (0.14) | 0.37 (0.13) | 0.40 (0.11) |
| After CDA provocation | 0.24 (0.15) | 0.20 (0.12) | 0.22 (0.17) | 0.36 (0.11) | 0.32 (0.15) | 0.34 (0.18) |
| | **% difference** | | | **% difference** | | |
| | 37.2 | 34.7 | 37.0 | 15.0 | 11.7 | 16.2 |
| | **MCA2** | | | | | |
| | **Preoperative (cm²) mean (SD)** | | | **Postoperative (cm²) mean (SD)** | | |
| **Group** | Right | Left | Total | Right | Left | Total |
| Before CDA provocation | 0.38 (0.21) | 0.34 (0.19) | 0.36 0.18) | 0.58 (0.22) | 0.59 (0.12) | 0.57 (0.16) |
| After CDA provocation | 0.25 (0.15) | 0.23 (0.16) | 0.24 (0.16) | 0.49 (0.17) | 0.51 (0.15) | 0.50 (0.11) |
| | **% difference** | | | **% difference** | | |
| | 41.2 | 38.5 | 40.0 | 16.8 | 14.5 | 13.1 |

MCA: Minimal cross-sectional area, CDA: Cold dry air, SD: Standard deviation

**Table 5.** Comparison of preoperative and postoperative V1 and V2 values before and after CDA provocation

| | V1 | | |
|---|---|---|---|
| | **Preoperative mean (SD)** | | |
| | **Before CDA** | **After CDA** | **% difference** |
| V1 (cm³) right | 1.58 (0.31) | 1.26 (0.31) | 22.5 |
| V1 (cm³) left | 1.60 (0.56) | 1.22 (0.51) | 26.9 |
| V1 (cm³) total | 1.59 (0.41) | 1.24 (0.39) | 24.7 |
| | **Postoperative mean (SD)** | | |
| | **Before CDA** | **After CDA** | |
| V1 (cm³) right | 2.01 (0.54) | 1.75 (0.41) | 13.8 |
| V1 (cm³) left | 1.99 (0.34) | 1.78 (0.32) | 11.1 |
| V1 (cm³) total | 2.0 (0.39) | 1.76 (0.36) | 12.7 |
| | **V2** | | |
| | **Preoperative** | | |
| | **Before CDA** | **After CDA** | **% difference** |
| V2 (cm³) right | 2.59 (0.91) | 1.95 (0.51) | 28.1 |
| V2 (cm³) left | 3.11 (0.67) | 2.34 (0.61) | 28.2 |
| V2 (cm³) total | 2.85 (0.59) | 2.15 (0.63) | 28.0 |
| | **Postoperative** | | |
| | **Before CDA** | **After CDA** | |
| V2 (cm³) right | 4.10 (0.71) | 3.71 (0.51) | 9.9 |
| V2 (cm³) left | 4.22 (8.68) | 3.69 (0.62) | 13.4 |
| V2 (cm³) total | 4.16 (0.57) | 3.70 (0.60) | 11.7 |

V: Nasal volume, CDA: Cold dry air, SD: Standard deviation

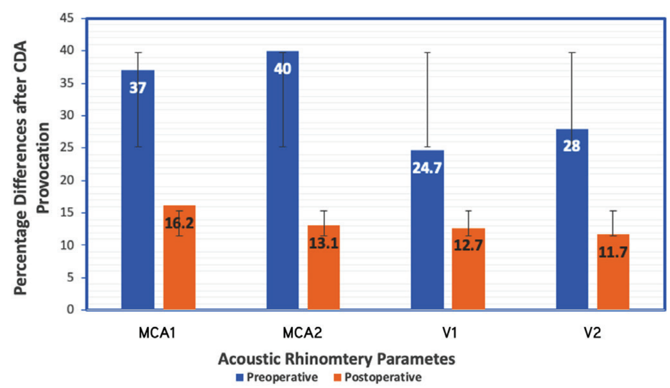


**Figure 3.** CDA-induced changes (percentage difference) before and after RAPN procedure. The drop of all parameters was significantly less 12 months after the procedure ($p<0.05$)
CDA: Cold dry air, RAPN: Radiofrequency ablation of the peripheral inferior turbinate branches of the posterior nasal nerves, MCA: Minimal cross-sectional area, V: Nasal volume

The results of our study demonstrated a significant and clinically noticeable reduction in symptom severity from the minimally invasive radiofrequency procedure. Patients' VAS scores were significantly decreased at 12 months postoperatively. A more important observation is the reduction of the nasal mucosal response. Radiofrequency submucous coagulation of the inferior turbinate tissues has been frequently used to reduce the size of the turbinates in patients with AR and NAR. The procedure reduces the size of the turbinate, by scar formation, resulting in improvement of nasal breathing while preserving the mucociliary mechanism of the turbinate. It also decreases the number of nasal glands and vessels, and therefore has also been thought reduce rhinorrhea and congestion (9, 16-20). Ablation of the peripheral branches of posterior nasal nerves within the inferior turbinate, as described above, further reduces nasal reactivity and sneezing in these patients.

The limitations of this study include the lack of a control arm, and the 12-month follow-up period. While the study showed that RAPN effectively reduced nasal reactivity and improved nasal symptoms in patients with AR, further research is needed to establish its durability and long-term outcomes.

## Conclusion

In this study, ablation of the peripheral branches of the posterior nasal nerve has proved to be a safe and efficient technique for reducing nasal reactivity and improving the symptoms of patients with AR unresponsive to medical therapy. The procedure is minimally invasive, easy to perform, and well tolerated by patients. Although this is a preliminary short-term study, the results of the study suggest that RAPN can be one of the treatment options for intractable AR. Further research is required to test the durability of the results.

**Ethics Committee Approval:** The consents and the research protocol were approved by the Committee of Medical Ethics of Alexandria University (approval no: 1119-2019, date: January 12, 2019) according to the Helsinki Declaration.

**Informed Consent:** All patients signed the informed consent forms after being informed about the procedure and the CDA provocation test.

**Peer-review:** Externally peer-reviewed.

**Authorship Contributions**

Surgical and Medical Practices: S.E., Concept: S.E., Design: S.E., Data Collection and/or Processing: Z.M., A.A.I., R.B., Analysis and/or Interpretation: S.E., A.A.I., Literature Search: Z.M., Writing: S.E., R.B.

**Conflict of Interest:** The authors have no conflicts of interest to declare.

**Financial Disclosure:** The authors declared that this study has received no financial support.

**Main Points**

- Interruption of the autonomic supply to the nasal mucosa has been used to improve the symptoms in patients with allergic rhinitis.
- The peripheral branches of the posterior nasal nerve run within the inferior turbinate close to the bony concha.
- Ablation of these branches with radiofrequency energy effectively reduced nasal reactivity and improved the symptoms in the patients.
- The procedure is short, safe, minimally invasive, and much easier to perform than transection of the posterior nasal nerve at the sphenopalatine foramen (TRPN), with comparable results. RAPN can also be performed as an office procedure under local anesthesia.

## References

1. Gerth van Wijk RG, de Graaf-in 't Veld C, Garrelds IM. Nasal hyperreactivity. Rhinology 1999; 37: 50-5. [Crossref]
2. Knipping S, Holzhausen HJ, Riederer A, Schrom T. Allergic and idiopathic rhinitis: an ultrastructural study. Eur Arch Otorhinolaryngol 2009; 266: 1249-56. [Crossref]
3. Van Gerven L, Steelant B, Hellings PW. Nasal hyperreactivity in rhinitis: A diagnostic and therapeutic challenge. Allergy 2018; 73: 1784-91. [Crossref]
4. Togias AG, Naclerio RM, Proud D, Fish JE, Adkinson NF Jr, Kagey-Sobotka A, et al. Nasal challenge with cold, dry air results in release of inflammatory mediators. Possible mast cell involvement. J Clin Invest 1985; 76: 1375-81. [Crossref]
5. Braat JP, Mulder PG, Fokkens WJ, van Wijk RG, Rijntjes E. Intranasal cold dry air is superior to histamine challenge in determining the presence and degree of nasal hyperreactivity in nonallergic noninfectious perennial rhinitis. Am J Respir Crit Care Med 1998; 157: 1748-55. [Crossref]
6. Maniaci A, di Luca M, la Mantia I, Grillo C, Grillo CM, Privitera E, et al. Surgical treatment for the refractory allergic rhinitis: state of the art. Allergies 2021; 1: 48-62. [Crossref]
7. Mori S, Fujieda S, Igarashi M, Fan GK, Saito H. Submucous turbinectomy decreases not only nasal stiffness but also sneezing and rhinorrhea in patients with perennial allergic rhinitis. Clin Exp Allergy 1999; 29: 1542-8. [Crossref]
8. Ogawa T, Takeno S, Ishino T, Hirakawa K. Submucous turbinectomy combined with posterior nasal neurectomy in the management of severe allergic rhinitis: clinical outcomes and local cytokine changes. Auris Nasus Larynx 2007; 34: 319-26. [Crossref]
9. Kobayashi T, Hyodo M, Nakamura K, Komobuchi H, Honda N. Resection of peripheral branches of the posterior nasal nerve compared to conventional posterior neurectomy in severe allergic rhinitis. Auris Nasus Larynx 2012; 39: 593-6. [Crossref]
10. Trindade IE, Gomes Ade O, Sampaio-Teixeira AC, Trindade SH. Adult nasal volumes assessed by acoustic rhinometry. Braz J Otorhinolaryngol 2007; 73: 32-9. [Crossref]
11. Clement PA, Gordts F; Standardisation Committee on Objective Assessment of the Nasal Airway, IRS, and ERS. Consensus report on acoustic rhinometry and rhinomanometry. Rhinology 2005; 43: 169-79. [Crossref]
12. Van Gerven L, Boeckxstaens G, Jorissen M, Fokkens W, Hellings PW. Short-time cold dry air exposure: a useful diagnostic tool for nasal hyperresponsiveness. Laryngoscope 2012; 122: 2615-20. [Crossref]
13. Ikeda K, Oshima T, Suzuki M, Suzuki H, Shimomura A. Functional inferior turbinosurgery (FITS) for the treatment of resistant chronic rhinitis. Acta Otolaryngol 2006; 126: 739-45. [Crossref]

14. Smith DH, Brook CD, Virani S, Platt MP. The inferior turbinate: An autonomic organ. Am J Otolaryngol 2018; 39: 771-5. [Crossref]

15. Thamboo A, Ayoub N, Maul X, Nayak J. The inferior turbinate: role in normal respiration and airway obstruction. Curr Otorhinolaryngol Rep 2021; 9: 383-8. [Crossref]

16. Acevedo JL, Camacho M, Brietzke SE. Radiofrequency Ablation Turbinoplasty versus Microdebrider-Assisted Turbinoplasty: A Systematic Review and Meta-analysis. Otolaryngol Head Neck Surg 2015; 153: 951-6. [Crossref]

17. Lin HC, Lin PW, Friedman M, Chang HW, Su YY, Chen YJ, et al. Long-term results of radiofrequency turbinoplasty for allergic rhinitis refractory to medical therapy. Arch Otolaryngol Head Neck Surg 2010; 136: 892-5. [Crossref]

18. Yu MS, Kang SH, Kim BH, Lim DJ, Kim JY. Radiofrequency turbinoplasty for nonallergic rhinitis in geriatric patients. Am J Rhinol Allergy 2015; 29: e134-7. [Crossref]

19. Prokopakis EP, Koudounarakis EI, Velegrakis GA. Efficacy of inferior turbinoplasty with the use of CO(2) laser, radiofrequency, and electrocautery. Am J Rhinol Allergy 2014; 28: 269-72. [Crossref]

20. Cavaliere M, Mottola G, Iemma M. Comparison of the effectiveness and safety of radiofrequency turbinoplasty and traditional surgical technique in treatment of inferior turbinate hypertrophy. Otolaryngol Head Neck Surg 2005; 133: 972-8. [Crossref]