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ORIGINAL RESEARCH–SINONASAL DISORDERS

Midterm outcomes of outfracture of the inferior turbinate

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ABSTRACT

OBJECTIVE: A variety of medical and surgical treatment alternatives exists for the management of inferior turbinate hypertrophy, indicating a lack of consensus on the optimal technique. The purpose of the present study was to evaluate the inferior turbinate objectively by means of radiologic methodology during the early and late periods in patients treated with inferior turbinate outfracture.
STUDY DESIGN: Case series with planned data collection.
SETTING: Tertiary referral center.
SUBJECTS AND METHODS: Eighty inferior turbinates of 40 patients (28 males, 12 females) who underwent surgery because of septum deviation and inferior turbinate hypertrophy were included in this prospective clinical study. All patients were evaluated by paranasal sinus computed tomography preoperatively and at one and six months postsurgery. The angle and the distance between the inferior turbinate and the lateral wall of the nasal fossa and the area lateral to the inferior turbinate bone were measured on the coronal plane anterior posteriorly at five different anatomic levels.
RESULTS: Statistically significant reductions were noted in the angle and distances in all sections one and six months postoperatively when compared with the preoperative measurements ($P < 0.005$).
CONCLUSION: Compared with the preoperative status, those patients who underwent turbinate outfracture procedures displayed a reduction in the angle and the distance between the inferior turbinate bone and the lateral wall of the nasal fossa and the area lateral to the inferior turbinate bone one month following surgery. Ongoing outcomes of this treatment method have been objectively shown.

Inferior turbinate hypertrophy and septum deviation are two coexistent pathologies that are leading causes of nasal airway obstruction.[1] It has been suggested that turbinate hypertrophy (a pathology caused by allergic, infectious, inflammatory, vasomotor, and medicamentous etiologies) is the most frequent cause of symptomatic nasal obstruction.[2,3]

A wide variety of medical and surgical treatment alternatives exists for the management of inferior turbinate hypertrophy, indicating a lack of consensus on the selection of the appropriate indication and optimal technique. These include both medical methods (including steroids and sclerosing solution injections, topical $AgNO_3$, and intranasal sprays) and surgical procedures (including total or partial turbinectomy, turbinoplasty, lateral outfracturing, submucosal resection, microdebrider-assisted submucosal resection, microabrasion, laser-assisted turbinoplasty, cryosurgery, infrared light, argon plasma surgery, bipolar and monopolar electrocautery, and radiofrequency volumetric tissue reduction.[4,5] Although most of these techniques provide satisfactory results, their application can prove difficult because of the occurrence of hemorrhage, crusting, dryness, pain, foul odor, hyposmia, scar formation, epiphora, rhinitis sicca, empty nose syndrome, bony necrosis, synechia, and other adverse effects.[6] Additionally, many of the surgical techniques are expensive.

The principle objective of turbinate surgery is to combine more comfortable nasal breathing in the absence of disturbing nasal physiology with the minimal occurrence of adverse effects.[7] Inferior turbinate outfracture provides the most current and conservative surgical method;[8] however, information regarding this procedure is both sparse and somewhat controversial, and it is generally believed that the lateralized inferior turbinate will, in time, medialize.[9-12] The purpose of the present study was to evaluate the inferior turbinate objectively by means of radiologic methodology. The study was performed during the early (1 month) and midterm (6 month) periods in which patients were treated with inferior turbinate outfracture procedures that did not disturb nasal function, physiology, or mucosa and thus did not lead to the occurrence of adverse effects.

Materials and Methods

Following approval from the Haseki Training and Research Hospital local Ethical Board, this prospective study was conducted in the Otolaryngology Clinic of the Istanbul Haseki Training and Research Hospital. Eighty inferior tur-

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binates from 40 patients (28 males, 12 females) who underwent surgery between July 2008 and March 2009 because of nasal septum deviation and inferior turbinate hypertrophy were included. Among those patients between 18 and 50 years of age who were admitted to otolaryngology clinic because of difficulties in nasal breathing, patients diagnosed with a septum deviation and turbinate hypertrophy, and who were recommended to undergo surgery by an otolaryngologist were included in the study after obtaining informed consent. Patients who had previous nasal septum, turbinate, nasal polyp, or sinus surgeries; patients with benign or malignant nasal cavity tumors; and patients who had previously received radiotherapy to the nasal region were excluded. Additionally, patients with inflammatory turbinate disorders, uncontrolled hypertension, bleeding diathesis, unstable cardiac disorders, or those who were currently using oral steroids were also excluded.

Surgical Procedure

All surgical procedures were performed under general anesthesia by the same surgeon using an identical operating technique. Primarily, nasal septum deviations were corrected by using appropriate techniques in patients with septal pathologies. No medicament was infiltrated to the inferior turbinate. Using a Freer elevator, the entire turbinate was first moved medially and superiorly until a crunching sound was heard. Using the same elevator, the whole inferior turbinate was then moved inferiorly and laterally. By holding a large or medium Killian's nasal speculum vertically, each of its blades was inserted in each nostril, and the speculum was forcefully opened to achieve effective and full lateralization of both of the inferior turbinates. The procedure was completed by placing Doyle nasal splints (Medtronic Xomed, Düsseldorf, Germany). Prophylactic oral antibiotic therapy (amoxicillin-clavulanic acid, 1 g, twice daily) and metamizole sodium (500 mg/day) for one week, and nasal irrigation with lactated Ringer saline (1000 mL) for four weeks were recommended in the postoperative period. All patients were examined at follow-up visits on postoperative days one, seven, and 30 and postoperative months three and six. The Doyle nasal splint was removed on the seventh postoperative day.

Evaluation: Computed Tomography Analyses

Paranasal sinus computed tomography was performed on all patients preoperatively and at the first and sixth months postoperatively. Forty sections (2-mm thickness) were obtained in the coronal plane from anterior to posterior and recorded on a compact disc. In the coronal plane, five different coronal plane anatomic levels were used for the assessment as follows: level 1: the foramen incisivum; level 2: the origin of the middle nasal turbinate; level 3: the maxillary sinus ostium; level 4: the midpoint of the third and fifth sections; and level 5: the posterior part of the inferior turbinate bone. Measurements were imaged graphically using the Philips MxLite View version 1.24 (Philips Medical Systems, Inc., Cleveland, OH). The angle and the distance between the inferior turbinate bone and lateral wall of the nasal fossa and the area lateral to the inferior turbinate bone at the inferior meatus were measured from five different anatomic levels and the results recorded (Fig 1).

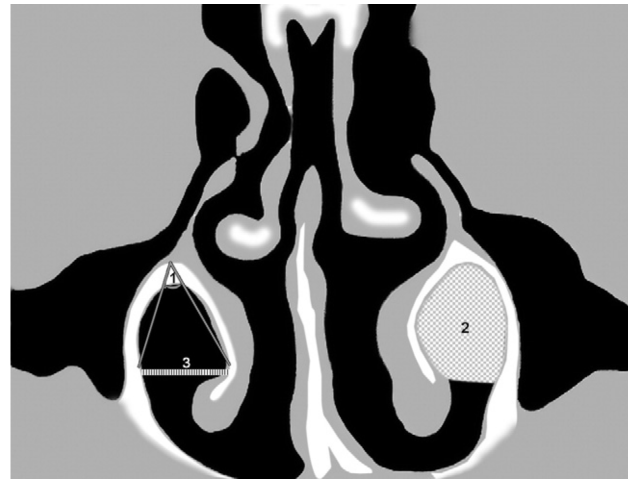

Figure 1 The angle (*1*) and distance (*3*) between the inferior turbinate bone and the lateral wall of the nasal fossa and the measurement of the area (*2*) lateral to the inferior turbinate bone.

Statistical Analyses

Because there were no dependent variables, a paired-sample Student *t* test was used for intergroup comparisons, and a one-way analysis of variance was used for multigroup comparisons. For groups with a normal distribution and a 95% confidence interval with an $\alpha = 0.05$ and a $1\text{-}\beta = 0.80$, $P < 0.05$ was deemed to indicate statistical significance. The Windows SPSS (version 16.0.1; SPSS, Inc., Chicago, IL) and MedCalc (version 11.1.1; MedCalc Software, Turkey) statistical packages were used for all analyses.

Results

The study population consisted of 28 males and 12 females. Their mean age was 28.8 ± 7.80 (range, 18-48) years. Septum surgery was performed together with turbinate outfracture in 32 patients; turbinate outfracture alone was performed in eight patients because of the presence of moderate or mild turbinate hypertrophy. No procedure-related complication (such as hemorrhage, fever, excessive edema, crusting, excessive pain, necrosis, hypotension, or hypertension) was observed in any patient in the early or late postoperative periods. Additionally, the nasolacrimal canals in all patients were followed by coronal computed tomography, and clinical findings were inquired about in the postoperative period. No complaint or complication was noted. All patients orally reported clinical improvement in nasal breathing during the postoperative follow-up visits. Radiographic signs of acute sinusitis were found one month post-

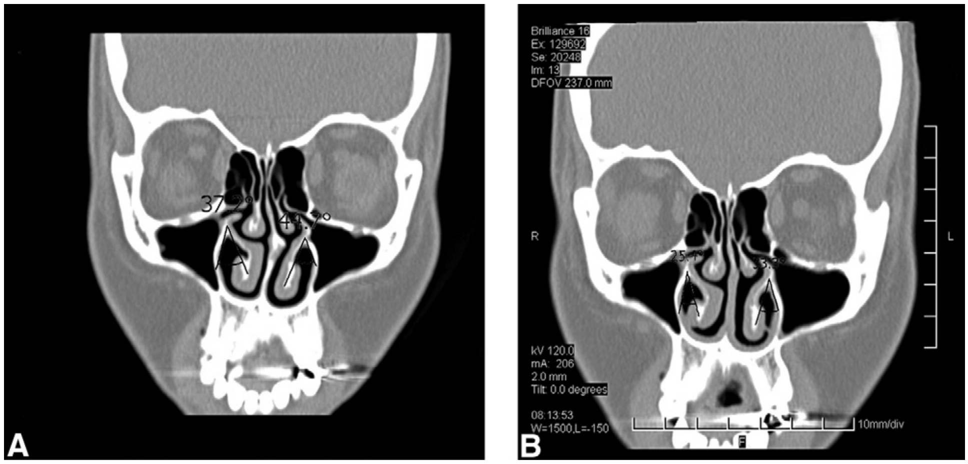

Figure 2 (**A**) The preoperative and (**B**) the six-month postoperative angle between the inferior turbinate bone and the lateral wall of the nasal fossa.

operatively in four patients; these patients did not have any clinical complaint and were treated by medical methods.

Both the angle and the distance between the inferior turbinate bone and the lateral wall of the nasal fossa, and the area lateral to the inferior turbinate bone measured one and six months postoperatively, were statistically lower than the preoperative inferior turbinate measurements at five different levels (Figs 2-4). The angle between the inferior turbinate bone and the lateral wall of the nasal fossa and the area lateral to the inferior turbinate bone measured at six months postoperatively was statistically lower than those measured at one-month postoperatively at five different levels (Fig 5). When comparing the distances between the inferior turbinate bone and the lateral wall of the nasal fossa, there was no statistically significant difference between the measurements at the sixth postoperative month and the first postoperative month at the five different levels.

The greatest change in the area lateral to the inferior turbinate bone was noted at level 2 and the smallest change noted at level 1. The smallest reduction in the distance between the inferior turbinate bone and the lateral wall of the nasal fossa was noted at level 5, and the greatest reduction was noted at level 2. All measurements of the angle and the distances preoperatively and at the first and sixth months postoperatively are presented in Table 1.

Discussion

Inferior turbinate outfracture was first performed by Killian in 1904 as an alternative to turbinectomy, allowing the avoidance of its complications and adverse effects. It is widely believed that the inferior turbinate lateralized by turbinate outfracture will medialize and that the symptoms will, in time, reoccur.[9-12] The present study was designed to test this hypothesis objectively using radiologic methods within the context of evidence-based medicine.

It has previously been demonstrated that, in patients with inferior turbinate hypertrophy, the turbinate bone hypertrophy accompanies mucosal growth.[13] It is not known whether interventions focusing only on the turbinate bone

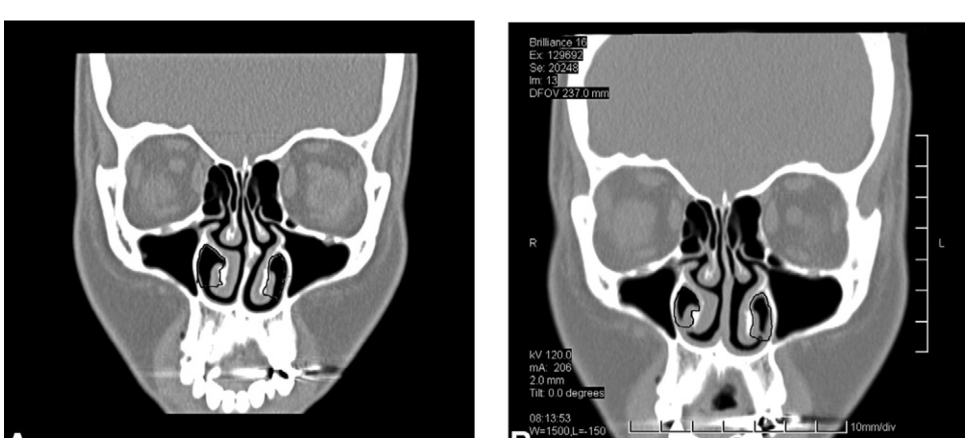

Figure 3 (**A**) The preoperative and (**B**) the six-month postoperative area of the inferior nasal meatus between the inferior turbinate bone and the lateral wall of the nasal fossa.

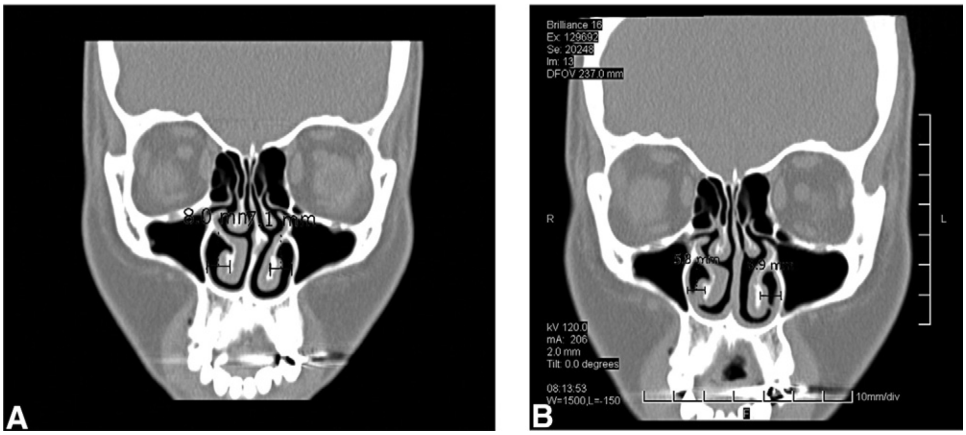

Figure 4 **(A)** The preoperative and **(B)** the six-month postoperative distance between the inferior turbinate bone and the lateral wall of the nasal fossa.

will reduce nasal obstruction sufficiently.[14] Because mucosal and bone hypertrophy coexist in turbinate hypertrophy, mucosal procedures and treatment regimes that focus on the turbinate bone should be performed together for successful results. The positions of the turbinate mucosa and the bony structure are changed by the outfracture of the bony structure responsible for mechanically holding the turbinate in a certain position. An efficient treatment method addressing both the bone and mucosa was used in the current study.

The anterior portion of the inferior turbinate is the main determinant of nasal resistance. Poiseuille's law states that the laminar flow rate of air along a pipe is proportional to the fourth power of the pipe's radius.[15] Because small changes in the cross-sectional area of the nasal airway affect nasal airflow dramatically, surgical procedures targeting the inferior turbinate provide effective results. As the structure of the inferior turbinate bone arches medially and flattens posteriorly, the greatest changes in the area lateral to the inferior turbinate bone were observed at levels 2 and 3, whereas the smallest change in the distance between the inferior turbinate bone and the lateral wall of the nasal fossa was observed at level 5. Similarly, the greatest differences between the pre- and postoperative angle measurements at levels 2 and 3 are indicative of the concave structure of the turbinate bone. A persistent effect is achieved when this structure is flattened or even becomes convex (Fig 6).

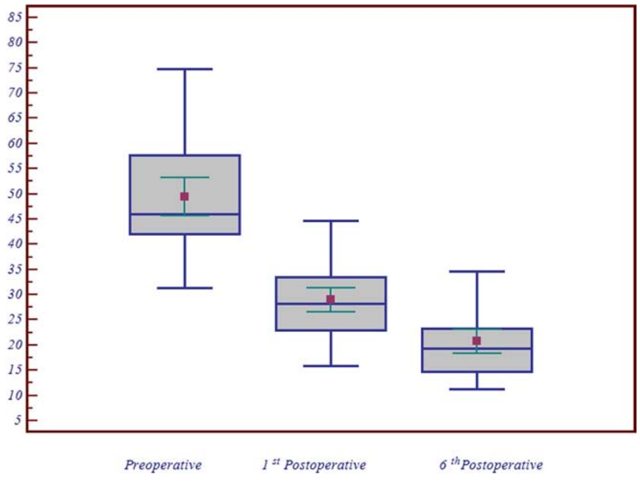

Figure 5 The preoperative and one- and six-month postoperative level 2 reductions within 95% confidence intervals in the angle between the inferior turbinate bone and the lateral wall of the nasal fossa compared with the preoperative values.

Complications of inferior turbinate hypertrophy treatment include hemorrhage, crusting, dryness, adhesions, hematomas, discharge, necrosis, foul odor, perforation, and synechia. These complications are associated with invasive surgical techniques and are observed at occurrence rates ranging from 14 percent to 75 percent.[16] Because the mucosal structure was not disturbed in the present study, we noted no occurrence of these complications.

In a human cadaver study, Abou-Sayed et al[1] performed baseline measurements through the insertion of a silicon mold into the nose. They performed lateralization to the septum and turbinate using a midsize septum speculum and repeated the measurements with the silicon mold. They demonstrated enlargement of the maximal internal nasal diameter and achieved a seven-fold increase in the intranasal airflow, according to Poiseuille's law, through this technique (referred to as a "closed septoturbinotomy") involving lateralization of the septal cartilage and the bony structure of the turbinate. Turbinate lateralization has been characterized as minimally invasive and reported to dramatically expand the nasal airway in many cases. Long-term results, however, have not been reported.[3]

In a randomized double-blind study, Nassif Filho et al[9] compared the effects of submucosal cauterization of the inferior turbinate with or without outfracture and reported that using the outfracture technique was an effective, safer, and more conservative method. A long-term study by Passali et al[17] compared the inferior turbinate outfracture method, which they termed as "lateral displacement," with

Table 1
Paranasal computed tomography measurement results in the study population

Anatomic levels	Changes in angle (°)			Changes in area (m^2)			Changes in distance (mm)		
	Pre op	1st post op	6th post op	Pre op	1st post op	6th post op	Pre op	1st post op	6th post op
Level 1	41.4700 ± 10.8971	25.9530 ± 9.3291	18.8420 ± 5.4991	14.172 ± 3.870	8.300 ± 2.140	6.652 ± 1.420	7.1280 ± 1.0860	5.867 ± 1.512	5.249 ± 1.705
Level 2	49.4830 ± 11.8752	28.9650 ± 7.4641	20.7300 ± 7.3204	43.671 ± 11.20	32.562 ± 8.010	28.689 ± 7.450	8.0770 ± 1.4058	6.726 ± 2.069	6.928 ± 2.350
Level 3	53.7380 ± 11.4163	34.7880 ± 5.8629	23.6420 ± 6.7041	33.630 ± 10.19	27.380 ± 6.700	23.310 ± 6.820	7.9340 ± 1.4530	6.628 ± 1.891	6.863 ± 2.042
Level 4	55.5450 ± 12.1183	39.2280 ± 10.2347	27.3600 ± 6.9109	25.430 ± 9.710	21.170 ± 6.810	17.801 ± 2.780	6.4510 ± 1.0270	4.009 ± 1.411	4.725 ± 1.741
Level 5	55.3600 ± 11.2858	43.3100 ± 10.2310	31.0150 ± 7.9220	15.927 ± 3.210	10.660 ± 2.0120	8.580 ± 1.190	5.8750 ± 1.3120	3.702 ± 2.345	3.651 ± 1.930
P value	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	>0.05

Both the angle and the distance between the inferior turbinate bone and lateral wall of the nasal fossa, and the area lateral to the inferior turbinate bone measurements at five different levels preoperatively, and at one and six months postoperatively (mean ± standard deviation) are shown (n = 80).

different techniques, including submucosal resection with lateral displacement, submucosal resection without lateral displacement, electrocautery, cryotherapy, laser cautery, and turbinectomy for the management of inferior turbinate hypertrophy resistant to medical treatment with postoperative one-, two-, three-, and four-year follow-up data. They found that, compared with all other techniques, the greatest airway opening was noted in patients treated by submucosal resection with lateral displacement. The lowest long-term postoperative complication rate was also reported in this group.[17]

It has been reported in an epidemiologic study that more than 20 percent of the patients in European countries complain of chronic nasal obstruction because of turbinate hypertrophy.[18] In contrast to other surgical interventions, inferior turbinate mucosa and physiology are not disturbed with the turbinate outfracture technique, which is a simple and easily applied procedure without major complications and risks.[19] Thus, the turbinate outfracture technique does not disturb mucociliary function of the inferior turbinate mucosa. Additionally, the function of the autonomic nervous system, which provides vasoconstriction and dilatation of the turbinate, is also preserved.

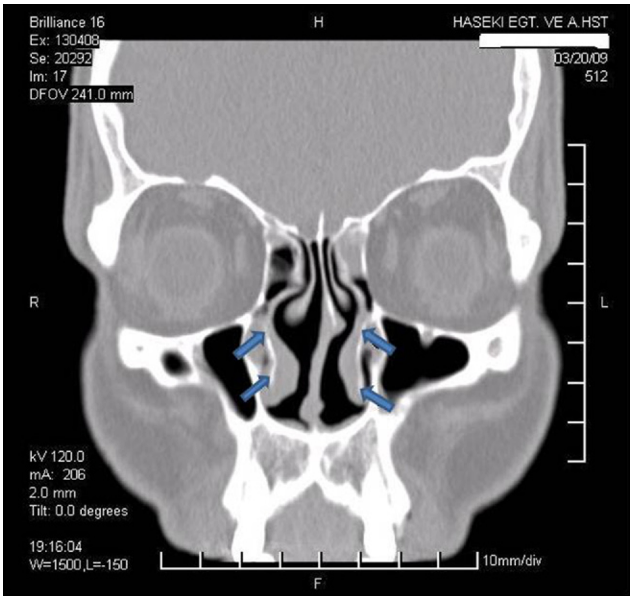

Figure 6 The six-month postoperative level 2 (origin of the middle nasal turbinate); opening of the nasal passage by the flattening of the arch structure of the inferior turbinate bone, closing to the medial wall of the maxillary sinus, and being on the same plane with the medial wall of the maxillary sinus at the turbinate (*arrows*).

As most of the current patient group displayed coexisting septum deviation and turbinate hypertrophy, septum surgery combined with turbinate outfracture provided maximum clinical efficacy. Turbinate interventions are often performed in addition to septum surgery in patients with septum deviation. In the present study, effective clinical and radiologic improvements were maintained for at least six months in patients with mild or moderate turbinate hypertrophy by performing turbinate outfracture. The continuing improvement from the first to sixth month period following intervention can be attributed to healing, elimination of the edema, and shrinkage of the turbinate because of postoperative nasal irrigation with lactated Ringer saline for 4 weeks treatment. Being a minimally invasive procedure that spares the nasal mucosa, providing for a persistent nasal airway opening, the inferior turbinate outfracture is a simple, fast, effective, and safe method that can be used in the treatment of turbinate hypertrophy.

Conclusion

Compared with the preoperative status, the angle and the distance between the inferior turbinate bone and the lateral wall of the nasal fossa and the area lateral to the inferior turbinate bone were observed to be reduced in the early (1 month) and midterm (6 months) periods in patients who underwent turbinate outfracture procedures, showing the effectiveness of this procedure. Additionally, the belief regarding medialization of turbinate in patients who underwent the turbinate lateralization procedure was shown to be invalid for the first 6 months postoperatively. The current study thus demonstrates that this method is an effective and safe treatment alternative in patients with nasal obstruction.

Follow-up of these patients continues to evaluate its persistent effectiveness over the long term.

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Fadlullah Aksoy, drafting the article or revising it critically for important intellectual content and analysis and interpretation of data; **Yavuz Selim Yıldırım,** drafting the article or revising it critically for important intellectual content and analysis and interpretation of data; **Bayram Veyseller,** analysis and interpretation of data; **Orhan Ozturan,** revising it critically for important intellectual content; **Hasan Demirhan,** statistical analyses.

Disclosures

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References

1. Abou-Sayed HA, Lesavoy MA, Gruber RP. Enlargement of nasal vault diameter with closed septoturbinotomy. Plast Reconstr Surg 2007;120: 753–9.
2. Passali DP, Passali FM, Damiani V, et al. Treatment of inferior turbinate hypertrophy: a randomized clinical trial. Ann Otol Rhinol Laryngol 2003;112:683–8.
3. Farmer SE, Eccles R. Understanding submucosal electrosurgery for the treatment of nasal turbinate enlargement. J Laryngol Otol 2007; 121:615–22.
4. Jackson LE, Kock RJ. Controversies in the management of inferior turbinate hypertrophy: a comprehensive review. Plast Reconstr Surg 1999;103:300–12.
5. Kizilkaya Z, Ceylan K, Emir H, et al. Comparison of radiofrequency tissue volume reduction and submucosal resection with microdebrider in inferior turbinate hypertrophy. Otolaryngol Head Neck Surg 2008;138:176–81.
6. Egeli E, Demirci L, Yazici B, et al. Evaluation of the inferior turbinate in patients with deviated nasal septum by using computed tomography. Laryngoscope 2004;114:113–7.
7. Hol MK, Huizing EH. Treatment of inferior turbinate pathology: a review and critical evaluation of the different techniques. Rhinology 2000;38:157–66.
8. Buyuklu F, Cakmak O, Hizal E, et al. Outfracture of the inferior turbinate: a computed tomography study. Plast Reconstr Surg 2009; 123:1704–9.
9. Nassif Filho AC, Ballin CR, Maeda CA, et al. Comparative study of the effects of submucosal cauterization of the inferior turbinate with or without outfracture. Braz J Otorhinolaryngol 2006;72:89–95.
10. O'Flynn PE, Milford CA, Mackay IS. Multiple submucosal out-fractures of interior turbinates. J Laryngol Otol 1990;104:239–40.
11. Thomas PL, John DG, Carlin WV. The effect of inferior turbinate outfracture on nasal resistance to airflow in vasomotor rhinitis assessed by rhinomanometry. J Laryngol Otol 1988;102:144–5.
12. Fradis M, Goldz A. Inferior turbinectomy versus submucosal diathermy for inferior turbinate hypertrophy. Ann Otol Rhinol Laryngol 2000;109:1040–5.
13. Akoglu E, Karazincir S, Balci A, et al. Evaluation of the turbinate hypertrophy by computed tomography in patients with deviated nasal septum. Otolaryngol Head Neck Surg 2007;136:380–4.
14. Churchill SE, Shackelford LL, Georgi JN, et al. Morphological variation and airflow dynamics in the human nose. Am J Hum Biol 2004;16:625–38.
15. Powell NB, Zonato AI, Weaver EM, et al. Radiofrequency treatment of turbinate hypertrophy in subjects using continuous positive airway pressure: a randomized, double-blind, placebo-controlled clinical pilot trial. Laryngoscope 2001;111:1783–90.
16. Porter MW, Hales NW, Nease CJ, et al. Long-term results of inferior turbinate hypertrophy with radiofrequency treatment: a new standard of care? Laryngoscope 2006;116:554–7.
17. Passali D, Lauriello M, Anselmi M, et al. Treatment of hypertrophy of the inferior turbinate: long-term results in 382 patients randomly assigned to therapy. Ann Otol Rhinol Laryngol 1999;108:569–75.
18. 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.
19. Wengraf CL, Gleeson MJ, Siodlak MZ. The stuffy nose: a comparative study of two common methods of treatment. Clin Otolaryngol Allied Sci 1986;11:61–8.