Evaluation of inferior turbinate outfracture outcomes using computed tomography*

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Summary

Background: Outfracture of the inferior turbinate (IT) presents numerous advantages, but it is generally believed that the lateralized IT will resume its original position. The purpose of this study was to evaluate the outcome of IT outfracture objectively using computed tomography (CT).

Methodology: Fifteen patients who underwent bilateral IT outfracture for the removal of pituitary adenomas by the endonasal approach were enrolled. The angles between the lateral wall of the nasal cavity (NC) and IT on both sides were measured from CT scans before and at least 6 months after operation. In addition, we evaluated the effects of variables including age, thickness of IT attachment site and width of the nasal floor, on the angles.

Results: Regardless of the side where a Hardy retractor was placed, the angle between the lateral wall of the NC and IT decreased significantly within 6 months after the outfracture compared to preoperative values on both sides. Other variables showed no significant correlations with the angle between the IT and the lateral wall of the NC.

Conclusion: The outfracture procedure effectively lateralized the IT and it maintained that position for at least 6 months after the operation.

Key words: nasal cavity, turbinates, tomography, X-Ray computed, surgical procedures, operative

Introduction

Symptoms of nasal obstruction frequently arise through infection or hypertrophy of the inferior turbinates (IT). IT hypertrophy could influence the aerodynamic pattern and physiologic functions of nasal airflow [(1)]. Surgical techniques that address these symptoms include electrocauterization, chemocauterization, laser turbinoplasty, radiofrequency coblation, outfracture, turbinectomy and submucosal resection of the turbinate [(2)]. However, the optimal treatment for hypertrophic turbinate and therapeutic effects of the various techniques are controversial.

Killian introduced outfracture of the IT in 1904 to resolve adverse effects of turbinectomy, including postoperative bleeding and pain [(3)]. The IT is first fractured inward and then pushed laterally [(3)]. This relatively simple procedure avoids many complications, including postoperative nasal adhesions, mucosal or submucosal damage and the risk of developing atrophic rhinitis [(4)], and offers numerous advantages over other procedures performed only on the mucosa. Despite these advantages, surgeons may regard outfracture of the IT as ineffective because the IT tends to resume its previous position [(5)]. However, relatively few studies present objective evaluations of turbinate position before and after outfracture [(6,7)]. In this study, we used computed tomography (CT) to compare the position of the IT before and after outfracture. Our findings provide evidence to test the

persistence of changes in IT position following outfracture. In addition, we evaluated factors that may influence outcome of IT outfracture.

Materials and methods

Patients

Fifteen patients (7 men and 8 women) who underwent bilateral IT outfracture during removal of pituitary adenoma by the endoscopic endonasal approach between April 2008 and January 2009 were enrolled in this prospective study. Their ages ranged from 22 to 64 years (mean, 46.6 years). Patients who had undergone turbinate surgery, sinus surgery or septoplasty, and those who showed evidence of sinus infections or severe septal deformities were excluded. The Institutional Ethics Committee of our hospital approved this study and all patients gave informed consent.

Surgical procedure

One surgeon performed all of the surgical procedures using a Boies elevator for outfracture. The IT was fractured inward toward the septum until a crunching sound was heard as a sign of greenstick fracture; then the IT was outfractured toward the lateral wall. IT outfracture was performed before a Hardy retractor was placed directly through the nostril all the way back to the sphenoid ostium on one side (9 on the right side and 6 on the left side). After the completion of all surgical procedures, nasal packing was performed using the same number of strip gauze coated with antibiotic ointment for each patient. The packing was left in place for 2 days.

Assessment of outcomes

We compared preoperative ostiomeatal complex (OMU) coronal CT scans with postoperative ones taken at least 6 months after IT outfracture. A high resolution 16-channel CT scanner (LightSpeed 16, GE Medical Systems, Milwaukee, WI, USA) was used. Coronal and axial CT imaging were performed without administration of contrast media, and continuous scans 2.5 mm thick were obtained. The angles between the lateral wall of the nasal cavity and the IT on either the ipsilateral side where a Hardy retractor was placed or the contralateral side were measured on CT scans at a bone setting (width, 1500 Hounsfield units (HU); level, 300 HU). To evaluate the effect of the placement of a Hardy retractor on the measurements, we measured the angles on both sides. The measurements were performed on three consecutive coronal images with well-visualized infundibula, and the mean values were calculated. The angle between the vertical plane of the lateral nasal wall and the attachment of the IT was defined as the deviation angle (Figure 1). We evaluated the effects of some variables such as age, the thickness of the attachment site of the IT and the width of the nasal floor as the intranasal space becomes wider, the IT will be more lateralized after IT outfracture on the ratio of postoperative to preoperative angles which represented the tendency to resume its original position. Two otorhinolaryngologists who were blinded to the patients' information performed all measurements. In addition, subjective symptoms and complications were evaluated.

Statistical analysis

The Wilcoxon signed rank test was used to statistically evaluate the effects of IT outfracture on the angle between the lateral wall of the nasal cavity and the IT. Linear regression analysis was performed to evaluate the effects of other variables on the angle between the lateral wall of the nasal cavity and the IT. All statistical analyses were performed using SPSS Version 11.5 (Statistical Package for the Social Sciences, Chicago, IL, USA). The significance level was set at 0.05 in all analyses.

Results

The mean times from preoperative OMU CT scan to postoperative OMU CT scan were 7.2 months. On the ipsilateral side where a Hardy retractor was placed, the mean angle between the lateral wall of the nasal cavity and the IT before outfracture was 72.2 ± 14.4 degrees, while it was 63.3 ± 9.3 degrees at 6 months after outfracture. On the contralateral side of the nasal cavity, the mean angle decreased from 71.2 ± 13.3 degrees before surgery to 63.1 ± 12.2 degrees at 6 months afterward. Regardless of the side where a Hardy retractor was placed, the angle between the lateral wall of the nasal cavity and the IT decreased significantly in the 6 months following outfracture as compared to preoperative values on both sides ($p < 0.001$ for each, Table 1, Figure 2). It was found that a decrease in the angles, induced through an effective lateralization, was well maintained for up to 6 months after outfracture. In addition, the ratio of postoperative to preoperative angles on the ipsilateral side where a Hardy retractor was placed was 0.9 ± 0.1 and the ratio on the contralateral side was 0.9 ± 0.1. The ratio of postoperative to preoperative angles did not differ significantly between the side

Table 1. Measurement of the angle between the lateral wall of the nasal cavity and the inferior turbinate

	Ipsilateral side*	Contralateral side†
Before outfracture	72.2 ± 14.4	71.2 ± 13.3
6 months after outfracture	63.3 ± 9.3	63.1 ± 12.2
p-value	< 0.001	< 0.001

*Ipsilateral side of the nasal cavity where a Hardy retractor was placed
†Contralateral side of the nasal cavity where a Hardy retractor was placed

Figure 1. Measurement of the angle between the vertical plane of the lateral nasal wall and the attachment of the inferior turbinate. The measurements were performed on three consecutive coronal images with well-visualized infundibula, and mean values were calculated.

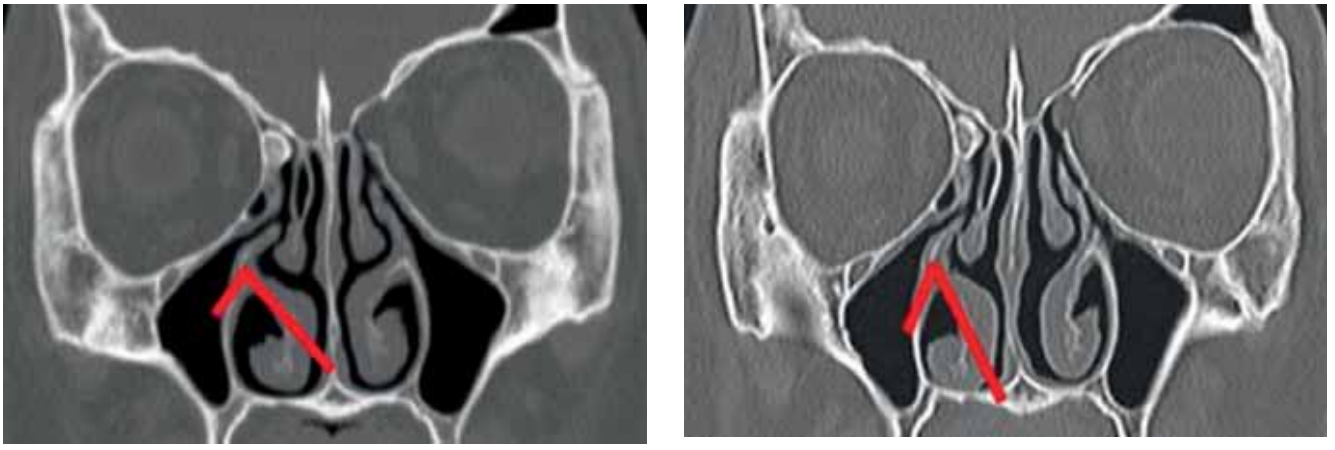

Figure 2. Inferior turbinate positions (left) before and (right) at 6 months after outfracture.

where a Hardy retractor was placed and the side where a Hardy retractor was not placed ($p = 0.975$). This result implied that the placement of a Hardy retractor did not affect the extent of lateralization.

Concerning factors affecting the angle between the lateral wall of the nasal cavity and the IT, the patient's age, thickness of the IT attachment site and width of the nasal floor showed no significant correlations with the ratio of postoperative and preoperative angles ($p > 0.05$, for each, Table 2).

Among 15 patients, 4 patients were suffering from nasal obstruction before surgery. All of the 4 patients who were suffering from nasal obstruction experienced subjective improvement in nasal breathing and no patient developed complications such as bleeding, pain, crusting or synechia in the 6 months after outfracture.

Discussion

This study produced an objective CT analysis of the durability of IT lateralization after the outfracture procedure. We found that IT outfracture could significantly decrease the angle between the IT and the lateral wall of the nasal cavity and widen the nasal airway, and that the IT maintained that position for at least 6 months.

Since Hartman introduced the first surgical procedure for IT reduction in the 1890s, other techniques have followed, including turbinectomy, laser cautery, electrocautery, cryotherapy, and submucosal resection with or without outfracture [3,8-11]. For the choice of an adequate surgical treatment, identify the reason of IT hypertrophy is important [12]. The surgical approach to the IT is limited to either erectile submucosal tissue or the bony turbinate: the reduction of bone size creates a wide nasal airway, while surgical procedures for submucosal tissue create scars that prevent the submucosal engorgement in patients with allergic rhinitis. It is extremely important that the surgical procedure cause minimal interference with physiological functions of the turbinate. Various studies have explored the benefits of each of these techniques [13-15]. Chemocauterization or turbinoplasty, which reduces thickening of the mucosa, may destroy mucosal cilia and glandular tissue, and cause postoperative synechia and crusting. Turbinectomy may effectively relieve nasal obstruction,

Table 2. Factors affecting the angle between the lateral nasal wall and the inferior turbinate.

A	The ratio between postoperative and preoperative angles of IT on the nasal cavity with placement of a Hardy retractor (Mean ± SD, 0.9 ± 0.1)			
	Mean ± SD	p value	Correlation coefficient	95% CI
Age (yrs)	46.6 ± 13.6	0.208	-0.345	-0.006 ~ 0.001
Thickness of IT attachment site (mm)	1.1 ± 0.2	0.341	0.264	-0.119 ~ 0.319
Width of nasal floor (mm)	18.2 ± 2.5	0.273	0.303	-0.009 ~ 0.031
B	The ratio between postoperative and preoperative angles of IT on the nasal cavity without placement of a Hardy retractor (Mean ± SD, 0.9 ± 0.1)			
	Mean ± SD	p value	Correlation coefficient	95% CI
Age (yrs)	46.6 ± 13.6	0.449	0.212	-0.002 ~0.004
Thickness of IT attachment site (mm)	1.1 ± 0.3	0.153	-0.388	-0.244 ~ 0.043
Width of nasal floor (mm)	15.9 ± 2.2	0.971	-0.010	-0.019 ~ 0.019

CI = confidence interval; IT=inferior turbinate

but may be more likely than other techniques to cause crusting, bleeding and intense postoperative pain [13].

Inferior turbinate outfracture, comparatively simple and safe, is the procedure performed most often to widen the nasal airflow space. The benefits of IT outfracture are documented. Passali et al. showed that submucosal resection and outfracture of the IT in combination improve postoperative results because reduction and lateralization of the IT are simultaneously achieved [13]. They emphasized that combination of IT outfracture with other procedures may improve outcome without increasing risk of complications [13]. Though IT outfracture is safe and straightforward, it is not usually performed alone because 1) the IT tends to resume its original position [5] and 2) the outfracture technique does not address the hypertrophy of submucosal tissue that most likely triggered the turbinate enlargement.

In fact most therapeutic evaluations of IT outfracture stem from retrospective studies of outfracture combined with other surgical procedures. Little is known of changes in the position of the IT bony skeleton after IT outfracture alone. Few studies meeting all criteria for prospective design use objective methods to evaluate changes in IT position following the outfracture procedure alone. In this study, we did not combine submucosal resection or any other surgical procedure with outfracture of the IT to objectively evaluate positions of the IT before and after the surgery. Recently, Thomas et al. tested the effect of IT outfracture on nasal resistance to airflow using rhinomanometry in patients with vasomotor rhinitis [16]. They reported that IT outfracture effectively reduced resistance to nasal airflow and that eventual renarrowing of the nasal airway did not occur within 6 weeks of outfracture [16]. Until now, only two studies have presented objective radiological evaluations of IT position after performing outfracture [6,7]. Buyuklu et al. used CT to assess the predictability and effectiveness of the procedure in patients with septal deviation [7]. Aksoy et al. evaluated the IT by radiologic methods during the early and late periods in patients who underwent septoplasty and IT outfracture because of septal deviation and IT hypertrophy [6].

However, it has previously been demonstrated that septal deviation may influence the position and the degree of hypertrophy of IT bone. The IT bone becomes thicker and displaced more medially in the nasal cavity in patients with septal deviation [17,18]. For this reason, we excluded patients with septal deviation and enrolled those who underwent IT outfracture during removal of pituitary adenoma through the endoscopic endonasal approach.

Outfracture of the IT is one of the commonly performed procedures during endoscopic endonasal pituitary surgery for good surgical approach. During endoscopic endonasal pituit-

ary surgery, we lateralize the inferior and middle turbinate and resect the inferior one-third of the superior turbinate to expose the natural sphenoid ostium before performing sphenoidotomy. For this reason, the oufracture of the IT was performed regardless of the patients' preoperative subjective symptoms. In this study, we did not show the preoperative information of patients' symptoms and the data of subjective outcomes because the main purpose of this study was to provide objective radiologic evidence to show that the changes in the position of the IT are durable. Although we did not show the data of subjective symptoms, we checked the preoperative and postoperative symptoms including nasal obstruction. All of the patients who complained nasal obstruction before surgery had improved subjective nasal breathing and there were no patients who had worsened subjective nasal breathing after surgery. In addition, we evaluated the effects of various factors that might affect the position of the IT. We found that the IT maintained the post-surgical position for at least 6 months, independently of potentially confounding factors including age, thickness of the IT attachment site, and width of the nasal floor. As we compared preoperative OMU CT scans with postoperative ones taken at least 6 months after IT outfracture, it's hard to mention about any indication whether the reduction in angle measured was less effective with the length of postoperative time that had elapsed. In other previous study, Buyuklu et al. have reported the statistically significant degree of lateralization was observed at all levels in all patients at 9 months after IT outfracture [7]. However, since the main disadvantage of the outfracture procedure is that it does not address underlying mucosal pathologies, it is most useful when applied in combination with procedures such as submucosal turbinoplasty using a coblator or laser, as for example, in patients with a submucosal pathology such as allergic rhinitis.

Conclusion

This evaluation by CT showed that the IT outfracture procedure can effectively lateralize the IT for at least 6 months. These results support IT outfracture as a safe and effective method to widen the nasal airway while preserving the IT mucosa.

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Authorship contribution

Study concept and design: JYM, HJD
Acquisition of data, analysis an interpretation of data: HJC, JYM
Drafting of the manuscript: JYM
Critical revision of the manuscript: HJD, JYM
Study supervision: HJD, SKC, HYK

Conflict of interest

None to declare.

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