Effects of Rhinoplasty on the Internal Nasal Valve

A Comparison Between Internal Continuous and External Perforating Osteotomy

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Abstract: The purpose of the study was to compare the effect of 2 widely used methods of lateral osteotomy on the internal nasal valve (INV) by measuring minimal cross-sectional area using acoustic rhinometry (AR) and computed tomography (CT) in the pre- and postoperative setting.

Thirty adult patients noting nasal deformity requiring rhinoplasty were enrolled. Patients were divided into 3 groups of 10 patients. Patients in group 1 had bilateral lateral osteotomies by the internal continuous technique. In group 2, lateral osteotomies were performed by the external perforating technique. In group 3, osteotomies were performed by the external perforating technique on the left side and by the internal continuous technique on the right side in the same patient. Each patient had their INVs measured pre- and postoperatively at 6 weeks using AR and CT of the nasal bones.

Lateral osteotomy decreases the INV (measured by both AR and CT scan) \((P < 0.009)\). There was no statistically significant difference between the 2 types of osteotomies with respect to the degree of narrowing on the INV (CT-derived \(P = 0.24\) and AR-derived \(P = 0.60\)).

When comparing AR and CT data regarding the INV, we observed a measurable decrease in the nasal airway after lateral osteotomy in all patients. There was no statistically significant difference to conclude that either internal continuous osteotomy or external perforating osteotomy caused more narrowing of the nasal airway.

Key Words: rhinoplasty, spreader graft, septoplasty, osteotomy, rhinometry, internal nasal valve, internal continuous osteotomy, external perforating osteotomy

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Preserving nasal function is a paramount in rhinoplasty. It is known that osteotomy of the nasal bones has the potential for altering the nasal airway.\(^1\)\(^2\) Different techniques of lateral osteotomy may affect the internal nasal valve (INV), the narrowest segment of the nose.

The internal continuous technique of lateral nasal osteotomy is a common technique that increases the mobility of the bony vault to narrow the nose; however, in certain situations this maneuver may compromise the airway.\(^3\)\(^4\) The external perforating technique of osteotomy has been stated as a more direct and precise method that may reduce postoperative edema and ecchymosis while decreasing nasal mucosal damage; authors have stated that this technique may result in a more stable greenstick fracture, which may decrease postrhinoplasty airway narrowing.\(^5\)\(^6\)

Nonetheless, there is no objective consensus whether either lateral osteotomy method has more of an effect on the INV. The purpose of this study was to compare the effect of 2 widely used methods of lateral osteotomy used in rhinoplasty on the INV, by measuring minimal cross-sectional area (MCA) using acoustic rhinometry (AR) and computed tomography (CT).

METHODS

Thirty adult patients were enrolled in the outpatient clinic of a single institution from July 2003 to January 2005. There were 24 men and 6 women, and their age ranged from 20 to 45 years old with a mean of 25.7 ± 5.9 years old. The Ain Shams University Faculty of Medicine Board for Higher Education and Research approved the Institutional Review Board sponsored study, and this study conformed to the Declaration of Helsinki regarding patient research.

Inclusion criteria included consecutive patients with minimal medical history noting nasal deformity requiring rhinoplasty with osteotomies. Exclusion criteria included pregnancy, nasal trauma of <6 months duration, nasal septal perforation, asthma, chronic sinusitis, nasal revision cases, and poorly controlled systemic medical conditions that included ischemic heart disease, severe hypertension, and diabetes mellitus.

Thirty patients were classified into 3 groups of 10 patients. Patients in group 1 (8 men and 2 women) had lateral osteotomies performed by the internal continuous technique bilaterally. Patients in group 2 (7 men and 3 women) had external perforating osteotomies performed bilaterally. Patients in group 3 (9 men and 1 woman), had osteotomies performed by external perforation on the left side and internal continuous on the right side (see Fig. 1). The Eccovision Acoustic Rhinometry System (Hood Laboratories, Pembroke, MA) with an external nasal adapter was used to measure the MCA at the internal valve area, or most narrow segment, of the anterior nasal cavity. Measurements were taken pre- and postoperatively at 6 weeks for all patients. The measurements were done for both nasal passages both before decongestion and 10 minutes after decongestion using 0.05% oxymetazoline hydrochloride nasal spray with 3 sprays per nostril. Decongestion was performed to eliminate mucosal variation attributed to the nasal cycle. For each patient, an appropriately sized external nasal adaptor was selected and a thin layer of ointment was applied to prevent acoustic leakage between the nostril and the adaptor. In particular, care was taken not to distort the external nasal valve anatomy and position during measurements. Measurements were repeated and averaged over 3 readings.

Axial and coronal CT scans of the nasomaxillary complex were performed pre- and postoperatively at 4 weeks using a spiral...
CT scanner (General Electric Hi speed DX/I) with tube voltage 140 kV and current of 220 mA. The window width was 4000 Hounsfield units, and the window level was centered at 600 Hounsfield units. Axial CT scans parallel to the floor of the nose were obtained with 1-mm collimation, 2-mm slice thickness with 1-mm overlap, and reconstructed with 1-mm intervals using bone algorithms. The sagittal reconstructed image 0.5 cm from the nasal septum was obtained. Using a previous protocol measuring the INV area as described by Cakmak et al., the angle between the hard palate and the plane of MCA was selected for the coronal reconstructed images, which was parallel to the plane of the nasal valve and nearly 50 degrees; this plane is perpendicular to the acoustic axis using this standard protocol for measuring MCA.

Figure 2 depicts the plane perpendicular to the acoustic axis for measuring MCA.

For each patient, the cross-sectional area of the air passage after decongestion at a range of 1 to 2 cm from the vestibular opening was defined as the outer margin of the air passage (see Fig. 3); this smallest measured area was recorded for each nasal passageway and was defined as the CT-derived INV or MCA of the nasal valve (MCA CT).

All patients underwent septoplasty through a hemitransfixion incision followed by an open transcolumellar rhinoplasty. No patients underwent inferior turbinate procedures and all patients underwent medial osteotomies. Lateral osteotomies were the last surgical step that was performed internally or externally according to the study group; osteotomies were performed 5 minutes after 1:100,000 epinephrine administration in the path of the osteotomy. All osteotomies were done in a high to low to high technique. For the internal continuous osteotomy technique, a stab incision perpendicular to the piriform aperture was made just above the anterior end of the inferior turbinate. A curved 4-mm guarded osteotome was introduced along the interface between the cheek and the nose at the ascending process of the maxilla starting in the nasal vestibule just above the anterior end of the inferior turbinate. For external perforating lateral osteotomies, a 2-mm straight osteotome was held nearly parallel to the surface of the maxilla and introduced at the midportion of the bony nasal pyramid at the level of the inferior orbital rim and the nasofacial junction after an entry incision with No. 11 blade. The tip of the osteotome was pressed against the nasal bone and swept back in the entry site to reflect any terminal branches of the angular artery. The perforating osteotomy began at the midportion of the lateral osteotomy line and then followed the inferior portion of the osteotomy; the superior portion was done last. Regardless of either technique, after bilateral osteotomies, the thumb and index finger were used to induce a greenstick fracture to reposition the nasal bones in the desired location.

We reviewed 3-dimensional CT reconstructed images of each of the 3 groups of patients (see Figs. 4–10) to compare the characteristics of osteotomies in each group. Furthermore, we evaluated the endoscopic appearance of the nasal mucosa for each patient after osteotomy (see Figs. 11, 12).
RESULTS

There were 30 patients (60 nasal passageways). Tables 1 and 2 outline the mean pre- and postoperative values of total INV area, or MCA, of the nasal airway measured across all groups of patients in square centimeters using CT-derived images and AR. To isolate the effects of osteotomy on the INV area while accounting for the potential effect of correcting the septum during septrhaphy, we combined valve areas from both sides (total MCA); for each patient bilateral nasal valve areas (n = 60) were considered as a single unit and was termed total nasal valve area (total MCA).

According to CT-derived data, the mean preoperative total MCA (total MCA CT) for all patients was 1.28 cm² [standard deviation (SD) 0.41, min 0.67 cm², max 2.19 cm²]. The mean postoperative total nasal valve area (total MCA CT) was 1.11 cm² (SD 0.38, min 0.64 cm², max 2.05 cm², see Table 1).

Based on AR, the mean preoperative total nasal valve area (total MCA AR) was 1.15 cm² (SD 0.36, min 0.57 cm², max 1.82 cm²). The mean postoperative total nasal valve area (total MCA AR) was 0.99 cm² (SD 0.37, min 0.55 cm², max 1.74 cm², see Table 2).

The bar graph in Figure 13 depicts the decrease in INV area (MCA) as derived by CT from the pre- to postoperative state observed across all patient groups. Figure 14 depicts the decrease in INV area (MCA) as measured by AR comparing pre- and postoperative values. No patients reported postoperative nasal obstruction in follow-up at 6 months.

We evaluated the INV using imaging (CT) and physiologic (AR) testing. By both metrics, a decrease in INV area was observed postoperatively. The Kruskal-Wallis test was used to determine if a preoperative statistically significant difference existed among the 3 groups with respect to the INV areas measured bilaterally. For CT-image derived values, the \( P \) value was 0.083 (df = 2); for AR-derived values, the \( P \) value was 0.151 (df = 2). This statistical observation confirmed that the difference between preoperative INV areas was not statistically significant. Thus, any difference found in measured postoperative values could be attributed to the difference in the method of osteotomy.

FIGURE 5. Axial CT reconstruction of a group 1 patient, who underwent bilateral lateral osteotomies by the internal continuous technique. The arrow depicts the osteotomy site.
The Wilcoxon signed rank test was used to compare the pre- and postoperative total nasal valve area (square centimeters) for the combined 3 groups derived by CT scan and AR. For the CT-derived values, the $z$ value was $-4.784$ based on negative ranks and the $P$ value was 0.005 revealing a statistically significant difference, indicating that osteotomies decreased total nasal valve area. For AR, the $z$ value was $-4.784$ based on negative ranks testing ($P = 0.005$) revealing high statistically significant difference, indicating that osteotomies decreased total nasal valve area.

To compare pre- and postoperative total nasal valve areas for each of the 3 groups, the Wilcoxon signed rank test was used. For group 1, the $z$ value of the CT-derived values was $-2.805$ based on negative ranks and the $P$ value was 0.005 revealing a statistically significant difference. This finding indicated that osteotomies decreased the total nasal valve area for patients in group 1. For the AR-derived values, the $z$ value was $-2.810$ based on negative ranks and the $P$ value was 0.005 revealing a statistically significant difference. This finding indicated that osteotomies decreased the total nasal valve area for patients in group 1. For group 2, the $z$ value of the CT-derived values was $-2.810$ based on negative ranks and the $P$ value was 0.005 revealing a statistically significant difference. This finding indicated that osteotomies decreased the total nasal valve area for patients in group 2. For the AR-derived values, the $z$ value was $-2.809$ based on negative ranks and the $P$ value was 0.005 revealing a statistically significant difference. This finding indicated that osteotomies decreased the total nasal valve area for patients in group 2. For group 3, the $z$ value of the CT-derived values was $-2.807$ based on negative ranks and the $P$ value was 0.005 revealing a statistically significant difference. Finally, for group 3 AR-derived values, the $z$ value was $-2.805$ based on negative ranks and the $P$ value was 0.005 revealing a statistically significant difference. These values indicated that osteotomies decreased the total nasal valve area for patients in group 3.

The next set of statistical analyses centered on determining whether either method, internal continuous or external perforat-
ing osteotomy, was more effective in decreasing nasal valve area as measured by CT imaging and AR. The Mann-Whitney U test was used to compare the change in nasal valve area made by osteotomy in group 1 (internal continuous technique) and in group 2 (external perforating technique). As studied by CT imaging, the $z$ value was $-1.175$ and the $P$ value was $0.240$ indicating that the difference between the 2 groups was not statistically significant. For AR-derived values, the $z$ value was $-0.531$ and the $P$ value was $0.596$ indicating that the difference between the 2 groups was not statistically significant. Across both groups, the decrease in nasal valve area did not correlate among groups 1 and 2, which had patients with identical bilateral osteotomy techniques; neither method of osteotomy correlated with a greater degree of decreasing relative nasal valve areas as measured by CT image data and AR.

Furthermore, we studied the null hypothesis that there was no difference with either osteotomy technique in decreasing nasal valve area in patients (group 3) with internal continuous osteotomy on 1 side and external perforating osteotomy on the other side in the same patient. Applying the Mann-Whitney U test to compare the change in nasal valve area, made by osteotomy in the right side of patients of group 3 (internal continuous technique) and in the left side of patients of group 3 (external perforating technique), as measured by the CT scan, the $z$ value was $-1.175$ and the $P$ value was $0.240$ indicating that the difference between the 2 sides was not statistically significant. By AR-derived values, the $z$ value was $-0.531$ and the $P$ value was $0.596$ indicating that the difference between the 2 sides was not statistically significant. Thus, the relative decrease in nasal valve area from the pre- to postoperative state was not greater for 1 osteotomy technique compared with the other in the same patient.

In studying baseline values of the INV, overall mean measurements were obtained. In summary, there were 120 numeric INV...
areas using AR- and CT-derived image data. There was a mean of 0.60 cm² (SD 0.24 cm²) for CT scan measurements and a mean of 0.53 cm² (SD 0.22 cm²) for AR measurements.

**DISCUSSION**

In the literature, there have been efforts in comparing differences between the 2 most widely used osteotomy techniques, internal and external, in rhinoplasty by observing postoperative edema, ecchymosis, and mucosal tears. Yucel found that the external and internal continuous techniques of osteotomy yielded similar results regarding edema and ecchymosis on the seventh postoperative day; however, the internal continuous technique resulted in less ecchymosis on the second postoperative day.¹⁹

In a similar study design with the current study, Gryskiewicz and Gryskiewicz compared the external perforating method and the internal continuous technique of osteotomy by studying differing osteotomy techniques on both sides of the nose in the same patients. The authors found that a perforating lateral osteotomy with a 2-mm straight osteotome reduced postoperative ecchymosis and edema in rhinoplasty when compared with an internal continuous osteotomy with a 4-mm curved guarded osteotome.¹⁰ Rohrich et al noted nasal mucosal trauma to be less common with the external perforating technique.⁷

Prevention of postoperative airway sequelae in rhinoplasty is of the utmost importance; aesthetic rhinoplasty should not compromise the nasal airway. Several authors have reported mechanisms of nasal obstruction after rhinoplasty.¹,²,¹¹ In the current study, we sought to quantify changes in the INV area after osteotomies. We evaluated the INV using imaging (CT) and physiologic (AR) testing.

In the current study, using an internal continuous osteotomy or an external perforating technique resulted in a statistically significant decrease in INV cross-sectional area as measured by CT-derived image data and AR. However, neither method of osteotomy was more narrowing. Particular attention is needed to determine whether intraoperative maneuvers may potentially reduce the nasal airway and, if so, to incorporate other techniques, such as spreader grafting, that may widen the nasal valve and the nasal airway in a preventative manner.

Lateral nasal osteotomies are indicated for narrowing the lateral sidewalls of the nose, closing an open-roof deformity after dorsal hump removal, and straightening a deviated nasal bony framework.¹² The ideal lateral osteotomy technique should be safe, precise, reproducible, maximizing aesthetic and functional results with minimal postoperative sequelae.¹⁰

Ford et al performed anatomic studies correlated with CT scans in 4 cadaver specimens and demonstrated that variations in osteotomy technique may have an impact on the nasal airway.⁴ The authors concluded that the interrupted transperiosteal approach resulted in a more stable bony framework with less compromise of the airway.⁴

Adamson et al stated that aesthetic open septorhinoplasty, in general, and osteotomies, in particular, did not result in significant difference in nasal resistance before and after surgery as detected by rhinomanometry.¹¹ However, the authors performed adjunctive functional airway maneuvers in this series such as outfracturing of the inferior turbinates.¹¹

**FIGURE 10.** Three-dimensional CT reconstruction of a group 3 patient, who underwent bilateral lateral osteotomies by the internal continuous technique (right side) and external perforating technique (left side).
Constantinides et al studied the long-term effects of open aesthetic septorhinoplasty on nasal airflow by comparing pre- and postoperative nasal resistance values (measured by head-out body displacement plethysmography). The authors found that aesthetic septorhinoplasty has the potential for altering nasal patency. Patients with normal preoperative nasal resistance values had asymptomatic increases in nasal resistance values, which is consistent with the current study results. They recommended continuous attention in monitoring airway patency during manipulating the nasal framework for cosmetic purposes, as slight changes in the nasal valve area may result in significant alterations of the nasal airflow resistance.

The nasal valve area is the narrowest segment of the nose and is of the utmost importance for functional rhinoplasty. AR is an accurate measure of the nasal valve area in the anterior segment of the nasal passageway; the limitations of AR are in the posterior portion of the nasal cavity.

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<th>TABLE 1. Pre- and Postoperative Total Internal Nasal Valve Areas by CT-Derived Image Data</th>
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<th>TABLE 2. Pre- and Postoperative Total Internal Nasal Valve Areas Measured by Acoustic Rhinometry</th>
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Measuring the INV area was found to be more accurate when measured in a plane perpendicular to the acoustic axis of the nose. The current study results demonstrate statistical correlation between the nasal valve areas as measured by AR and CT scan in the plane perpendicular to the acoustic axis of the nose.

CONCLUSIONS

The authors noted that total INV, or MCA, of the nose, whether measured by AR or CT scan, decreased statistically significantly when performing lateral osteotomies during rhinoplasty. Neither lateral osteotomy technique caused more statistically significant narrowing of the airway. Preventative intraoperative maneuvers such as spreader graft placement, septoplasty, or turbinate reduction may correct asymptomatic deviations or anatomic conditions that may become symptomatic after rhinoplasty.

REFERENCES