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Acoustic rhinometry to evaluate plastic surgery results of the nasal septum

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Abstract. *Acoustic rhinometry to evaluate plastic surgery results of the nasal septum. Objective*: In this study, acoustic rhinometry was used in the preoperative and postoperative evaluation of 16 patients undergoing surgery for nasal obstruction.

Methodology: The parameters evaluated prior to and subsequent to the operation were the diameter of the nasal cavity at its narrowest point, and the total volume of the nasal cavity.

Results: This method accurately showed changes in the dimensions of the nasal cavity following surgery. As shown by acoustic rhinometry, the change in the mean minimal cross-sectional area of the nasal cavity was 67%. Similarly, the augmentation of the mean total volume of the nasal cavity was 24.15%. The change in the dimensions of the nasal cavity paralleled the improvement in clinical symptoms.

Conclusion: Acoustic rhinometry can accurately measure the dimensions of the nasal cavity, especially at the front part. It can also be used to assess the efficiency of treatment in cases of nasal obstruction, especially plastic surgery of the nasal septum.

Introduction

Acoustic rhinometry, which was developed in the late 1980s and early 1990s, enables us to examine and estimate the geometry of the nasal cavity. Hillberg was the first to describe acoustic rhinometry in 1989 as an easy, fast, and noninvasive examination of the dimensions of the nasal passage.[1-3] However, the most significant research and verification of this method and its application in rhinology, especially in rhinosurgery, is related to its use in assessing the results of septal surgery and surgery of the lower nasal turbinates[4] – the two most common surgical interventions of the nose.

Prior to surgery, acoustic rhinometry can show the patency of each nostril, as well as the narrowest points of the nasal cavity by means of its characteristic curve. The acoustic rhinometry device sends sound into the nasal cavity, through a nozzle fitted into the opening of each nostril. Sound sent by the acoustic rhinometer reflects off the walls of the nose, with part of it returning to the insert of the acoustic rhinometer where a microphone subsequently records it. The resonance characteristics change in relation to the dimensions of the nasal cavity. A computer analyses the reflected sound and the result takes the form of a curve that gives us the surface of the nasal cavity at every point in relation to the distance from the vestibulum of the nose.[4] Therefore, following surgery, we can evaluate the change in the geometry of the nasal cavity and assess the change realized in the anatomical deformities (septal deviations and hypertrophy of the lower turbinates[5-9]). The purpose of our clinical study was to assess the role of acoustic rhinometry in measuring nasal patency prior to and after plastic surgery of the septum, and to compare the measured results of the operation with a subjective evaluation by the patient.

Hence, from both a scientific and an ethical point of view, it is essential that the E.N.T. surgeon and the patient have access to an objective assessment and verification of the results of the surgical intervention in question.[7]

Material and method

Sixteen patients with a complaint of nasal obstruction were selected for the present study. The indication for plastic surgery of the nasal septum was based on the symptoms and on the findings of a clinical examination.

A Visual Analogue Scale (VAS) was used persistently. VAS is a measurement instrument that tries to measure a characteristic or attitude that is believed to range across a continuum of values and

Table 1

Minimal cross-sectional area of the narrowest nostril before and after surgery

Minimal cross-sectional area of the nasal cavity (cm^2)		
Patients	**Preoperative**	**Postoperative**
1	0.479	0.785
2	0.639	0.695
3	0.196	0.674
4	0.320	0.500
5	0.499	0.519
6	0.341	0.479
7	0.259	0.604
8	0.421	0.416
9	0.712	0.971
10	0.502	0.411
11	0.156	0.641
12	0.257	1.020
13	0.753	1.130
14	0.167	0.970
15	0.544	0.799
16	0.400	0.450

Table 2

Total volume of the nasal cavity before and after surgery

Total volume of nasal cavity (cm^3)		
Patients	**Preoperative**	**Postoperative**
1	17.042	26.100
2	24.800	31.000
3	16.310	29.400
4	12.050	16.000
5	19.240	15.610
6	17.490	10.480
7	18.340	44.300
8	10.530	11.710
9	23.130	30.900
10	26.500	15.800
11	11.390	37.100
12	19.970	16.000
13	20.100	22.000
14	31.700	27.900
15	14.720	13.900
16	20.810	39.300

cannot easily be directly measured, which in our study was blockage of the nose. Because such an assessment is highly subjective, these scales are of most value when looking at change within an individual.This scale makes use of five gradations where 0 corresponds to a completely free nasal passage and 4 corresponds to total blockage.

The instrument which was used for objective measurements was an acoustic rhinometer (A1 Executive Acoustic Rhinometer, G.M. Instruments Ltd., UK). We measured the minimal cross-sectional area (MCA) prior to surgery (Table 1, Figure 1 as well as the total nasal volume (TNV), both before and after surgery (Table 2, Figure 1).

All measurements were performed according to the instructions established by the "Standardization Committee of Acoustic Rhinometry".[1,10] which was set up by the European Rhinological Society, i.e.: "1) careful monitoring of the adjustments of the device,[11] 2) monitoring of the surrounding space,[11-13] 3) monitoring of the of the patient's respiration during the measurements,[2,11] 4) adjustment of the insert inside the nostril,[14] 5) reproduction of the alignment of the pipe with the nasal axis,[11] and most importantly 6) the experience of the examiner.[14]"

The statistical analysis of the results (paired Student's t-test) was performed using the Statistical Package for the Social Sciences (SPSS version 16.0). The results indicate that increasing the MCA is highly statistically significant (value of two-tailed p = 0.0007) (Table 3).

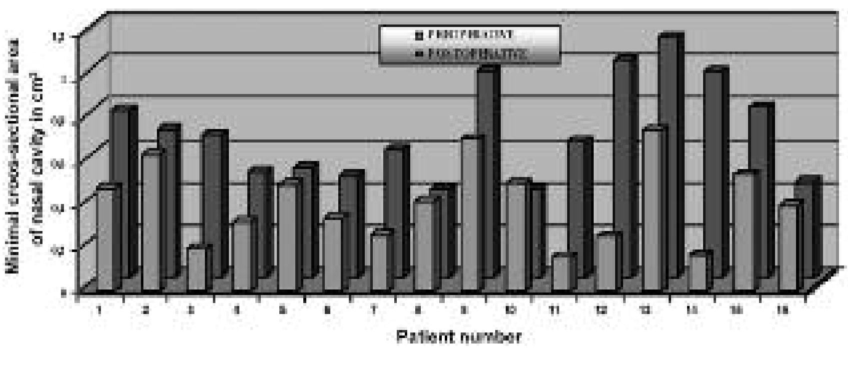

Figure 1

Change in total volume of the nasal cavity before and after surgery

Results

After surgery, all 16 patients exhibited subjective improvement with regard to the sensation of nasal patency, as expected. Indeed, the most significant indication of improvement is the way the patient feels about his or her breathing, which can be evaluated

Table 3

Statistical analysis

Paired Student's *t* test of MCA		
	Preoperative	**Postoperative**
Mean (cm^2)	0.41531	0.69150
SD	0.18772	0.23255
SEM	0.04693	0.05814
N = 16 , **t** = 4.2305, **df** = 15, **standard error of difference** = 0.065		
Confidence interval: The mean of postoperative minus preoperative MCA equals **0.27619 cm^2** 95% confidence interval of this difference: 0.13704 to 0.41534		
p = 0.0007		

Df: degrees of freedom; MCA: minimal cross-sectional area.

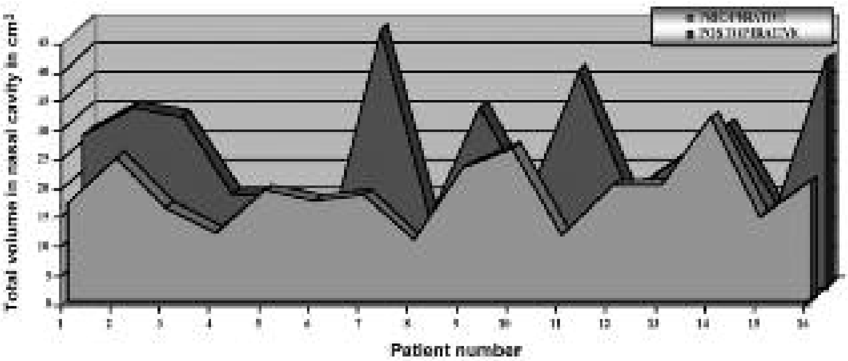

Figure 2

Change in the minimal cross-sectional area of the narrowest nostril before and after surgery.

using a VAS.[15,16] In our clinical study, all patients in question had an improvement of 2-3 grades (Table 1).

All patients experienced an increase in the surface of the MCA. The mean MCA prior to the operation was 0.43 cm^2, while after surgery it was 0.70 cm^2. In other words, a significant increase ($p = 0.0007$, mean of postoperative minus preoperative MCA equals 0.27619 cm^2) (Table 3) was noted upon measuring the parameters.

There was a 67% increase in the diameter of the narrowest point of the nasal cavity (Figure 2). A corresponding increase was also observed in the dimensions of TNV as shown in Table 2.

It is evident that the TNV increased on average from 19 cm^3 to 23.59 cm^3 after surgical treatment, an increase of 24.15% (Figure 1) although not statistically significant: $p = 0.078$ (Table 2).

Discussion

Acoustic rhinometry as a means of measuring the nasal passage in relation with the distance from the nostril constitutes a modern method for assessing nasal patency and, hence, the entire nasal function.[17-19] In order to carry out the examination, we need to appropriately prepare the patient, ensure ideal conditions of the surrounding area where the examination is carried out, and above all, perform the correct operation and have knowledge of the device which must strictly comply with the guidelines from the International Committee on Acoustic Rhinometry.[1,10] The accuracy of the examination is greater in the area of the nasal valve, which is the narrowest point in the anatomy of the nose. Consequently, the results of surgical treatment of this area can be better evaluated and studied.[17] The nasal valve is considered the most anatomically suitable area for the application of this method, since it has been noted that in other areas, such as the nasopharynx, the results were unreliable. This is probably due to diffusion of the sound wave at larger distances from the nostrils.[20]

Therefore, the clinical value of acoustic rhinometry is in its use in the nasal valve area. It estimates the degree of nasal obstruction by producing a characteristic curve according to measurements before and after surgical decongestion. It also assesses the causes of the obstruction due to nasal muciferous factors, as in allergic rhinitis,[2,21,22] or due to the anatomy of the nasal bone structure as in septal deviation, nasal valve rigidity, etc.[3,23] The examination of our patients, who received plastic surgery of the nasal diaphragm, accurately showed the resulting changes in the nasal cavity in general, and more specifically, in the nasal valve area. An increase of 67% was observed in the average

MCA (Figure 2) simultaneously with an increase of 24.15% in the TNV (Figure 1). Notably, in patients assessed prior to surgery, measurements of the minimal cross-sectional area less than 0.5 cm^2 were classified as indicative of pathology, provided that they were accompanied by symptoms of nasal obstruction.

Corresponding studies have been carried out in the past by Reber *et al.*[4] and by Shemen[24] whose findings were in line with our study. The feeling of clear nasal patency (ease of breathing) evaluated by the patient after surgery, although potentially subjective, constitutes a very important criterion. As all surgeons know, this sensation strongly dictates surgical treatment of the obstruction and after the operation indicates the result of nasal diaphragm plastic surgery. In our study, this was successfully accomplished in all our patients.[4,25] The objective examination and postoperative assessment after surgery (which corresponded with the postoperative acoustic rhinometry measurements) was carried out both in the clinical examination and by endoscopic examination with a non-flexible nasopharyngoscope, a method also adopted by researchers.

Conclusion

Acoustic rhinometry constitutes a modern method to assess nasal patency and the overall function of the nose. The most significant information it provides is the minimal cross-sectional area of the nostril, and the total nasal capacity. The accuracy of this examination is greater in the nasal valve area, which is where the narrowest point of the nose is. Yet, vital prerequisites for the reliable implementation of the method are the appropriate preparation of the patient, clear knowledge of the device, and ideal conditions of the surroundings where the examination is being held.

In the patients in our study with nasal obstruction due to diaphragm deviation, acoustic rhinometry proved useful in indicating surgical intervention for the restoration of nasal patency prior to surgery, in the postoperative evaluation, and to verify the success of the operation, which was paralleled by the patient's feeling of improved nasal patency.

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