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Research Article

CHANGES IN VOICE QUALITY OF NASAL RESONANCE BEFORE AND AFTER SEPTOPLASTY

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ABSTRACT

Introduction: Changes in the configuration of sinonasal cavity after surgery have been assumed to cause changes in the voice quality. The purpose of this study was to know when the hypernasality will be recovered after septoplasty by checking serially obtained nasalance scores using nasometer.
Methodology: The patients who underwent septoplasty, at FMMC, Mangalore from March 2015 to December 2016 were included in the study. The diagnosis was made based on patient history, clinical examination and nasal endoscopy. The assessment of nasalance was performed using the Nasometer module of VAGHMI, voice and speech system, Bangalore. The nasalance scores were recorded before surgery, 1, 2, 3, 4, 5, and 6 months after surgery.
Results: A total of 75 patients were enrolled, out of these 65 patients successfully completed follow-up visits. The mean nasalance scores of [m], [ma], [mi] were significant, before surgery and 4 months post-surgery. Consequently, nasalance values returned to its preoperative level at 5 months post operatively.
Conclusion: Septoplasty can alter the acoustic characteristics of the vocal tract and produce a significant hupernasality. Return to its preoperative value at 5 or 6 months postoperatively depending on the subtype of speech stimuli. Therefore, surgeon can reassure patients, especially voice professionals.

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INTRODUCTION

The acoustic characteristics of voice are determined by the vocal cords and vocal tract. The nasal cavity, paranasalsinuses, oral cavity, pharynx, and supraglottic larynx have been considered to act as a resonator to shape sound quality (Mora R *et al*, 2009 and Soneghet R *et al*, 2012).Therefore, various disorders in the nasal cavity and paranasal sinuses can negatively affect the resonance of the nasal passage and result in a perceptual change of the quality of nasal sound (Hong KH *et al*, 1997). Furthermore, alterations in the configuration of these structures after septoplasty surgery are assumed to cause changes in the voice quality, such as nasal and oral sounds (Hosemann W *et al*, 1988).

Nasal sounds are defined by nasality, the subjective perception of nasal components of speech (Hong KH *et al*, 1997). Nasality has traditionally been measured using auditory perceptual methods, due to the poor reliability of these methods, instrumental analysis of the speech signal has been developed to provide objective measurement of nasality. Recently, the nasometer (part of the VAGHMI software module) was developed to quantify nasalance, and has been found to be a valid and reliable measure for evaluating nasality objectively (Birkent H *et al*, 2009).

Nasalance is the ratio of nasal acoustic energy to nasal and oral acoustic energy (Birkent H *et al*, 2009). Previous studies have reported, septoplasty surgery to have significant effect on nasalance scores (Mora R *et al*, 2009, Soneghet R *et al*, 2012, Hong KH *et al*, 1997 and Birkent H *et al*, 2009). However, in the clinical practice, the voice quality of the patients recovers over time although they often complain of a nasal sound after septoplasty surgery. Therefore, the exact time for normalization of nasality after septoplasty surgery has an important meaning to otolaryngologists and patients.

AIM

The purpose of this study was to know when the hypernasality will be recovered after septoplasty in patients with nasal septal deviation by checking serially obtained nasalance scores using nasometer.

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MATERIALS AND METHODS

Subjects

We included patients who underwent septoplasty at Father Muller Medical College Hospital, Mangalore from March 2015 to December 2016. After approval from the Institutional Ethical clearance committee with obtained informed consent from all patients, the patients who underwent septoplasty were included in the study. Patients complaining of at least moderate to severe nasal obstruction lasting at least more than 6 months were recruited for the study. The diagnosis was always based on patient history, detailed clinical examination and nasal endoscopy. We enrolled patients with nasal obstruction due to gross septal deviation. Any patients who had a nasal polyp or history of immunodeficiency, palatal problems, or motor speech disorders, or have undergone a previous sinonasal surgery were excluded from this study. Only patients without allergies were enrolled to exclude any confounding influence of allergies.

The assessment of nasalance was performed using the Nasometer module of VAGHMI, voice and speech system, Bangalore. The nasalance scores were recorded before surgery to establish the pre-treatment baseline. Scoring was also taken at 1, 2, 3, 4, 5, and 6 months after surgery.

Speech stimuli

Patients were asked to sustain the emission of vowels [a], [i], [u], and nasal consonant [m] for at least 4 sec at a comfortable level. Repeated productions of nasal consonant– vowel combinations were also used.

Nasometric analysis

Nasalance scores were obtained using the Nasometer module of VAGHMI Voice and Speech Systems. An input device consisting of a directional microphone was mounted on either side of a sound separator plate, which rested against the upper lip of the subject. Each microphone measured the nasal and oral sound intensities separately and then computed the nasalance. The ratio of acoustic energy output detected from the nasal cavity for a particular word, phrase, or speech passage is expressed as percentage of the total acoustic energy produced by the nasal and oral cavities together. This percentage is referred to as a nasalance score. The value for nasalance can theoretically vary from 0 % (no sound form the nose) to 100 % (all sound from the nose). With a normal nasal airway patency, the nasalance score is very dependent on the phonetic content of speech. Each participant practiced production of the speech samples before recordings were obtained. Only productions that were accurate for both articulation and voicing were included for analysis.

Statistical Analysis

Data were presented as mean ± standard error of mean. Statistical significance was assessed by a Wilcoxon signed-rank test using the SPSS software package version 20.0 (SPSS Inc., Chicago, IL, http://www.spss.com). A p value >0.05 was considered significant

RESULTS

A total of 75 patients were enrolled in the study, including 42 male and 33 female from 17 to 75 years of age, with mean age of 47.8 years. Out of these patients, 65 patients successfully completed all follow-up visits according to the clinical protocol, whereas 10 patients were not evaluated in all follow-up visits because of protocol violations and patient's early discontinuation of the study. The mean preoperative nasalance scores were different among speech stimuli.

Recovery of nasalance according to speech stimuli

From 1-month post-surgery, nasalance scores continued to decrease by postoperative 6 months. However, postoperative nasalance scores remained significantly higher than preoperative scores by postoperative 4 months for all speech stimuli.

Statistical significance of the difference between pre-operative and 5-month postoperative values of [a], [i], [u] was noted in septoplasty. However, these 6-month postoperative values showed no statistical difference from the preoperative values.

The mean nasalance scores of [m], [ma], [mi] were significantly different in septoplasty between before surgery and 4 months post-surgery. However, these 5-month postoperative values showed no statistical difference from the preoperative values.

Table 1 Nasalance change after septoplasty

		Postoperative months					
	Preoperative	1 M	2 M	3 M	4 M	5 M	6 M
[a]	9.6 ± 8.2	18.1 ± 8.0	15.6 ± 7.6	13.4 ± 8.1	12.5 ± 6.9	11.5 ± 7.3	9.7 ± 7.0
p value		(0.001)	(0.003)	(0.005)	(0.022)	(0.041)	(0.059)
[i]	18.5 ± 10.4	37.0 ± 16.1	32.9 ± 15.0	29.0 ± 14.1	26.4 ± 13.8	22.1 ± 12.9	19.6 ± 10.4
p value		(0.001)	(0.002)	(0.003)	(0.012)	(0.024)	(0.052)
[u]	6.9 ± 3.9	13.5 ± 7.5	11.5 ± 7.1	11.0 ± 8.0	10.7 ± 6.7	9.1 ± 7.0	7.4 ± 4.1
p value		(0.001)	(0.002)	(0.009)	(0.012)	(0.030)	(0.062)
[m]	91.1 ± 3.6	95.4 ± 4.2	94.2 ± 4.5	93.6 ± 5.4	92.9 ± 5.6	91.4 ± 5.4	91.3 ± 3.7
p value		(0.001)	(0.028)	(0.032)	(0.048)	(0.226)	(0.315)
[mama]	62.0 ± 9.5	70.4 ± 8.1	68.4 ± 7.2	67.2 ± 6.8	64.4 ± 6.8	62.7 ± 7.4	62.3 ± 6.2
p value		(0.004)	(0.019)	(0.029)	(0.006)	(0.072)	(0.208)
[mimi]	77.5 ± 7.4	82.3 ± 9.6	81.1 ± 7.8	80.4 ± 6.9	79.5 ± 6.8	78.0 ± 7.4	77.5 ± 6.4
p value		(0.022)	(0.028)	(0.032)	(0.009)	(0.051)	(0.129)

Data are expressed as the mean ± standard error of the mean (p value)

Consequently, nasalance scores returned to its preoperative level at 5 months in the speech stimuli for nasal sound such as [m], [ma], [mi], but at 6 months in the speech stimuli for non-nasal sound such as [a], [i], [u].

DISCUSSION

The nasal cavity and paranasal sinuses play an important role in shaping the resonant characteristics of the vocal tract (Jiang RS *et al*, 2006). Resonance relates to vocal amplification in the oral and nasal cavities and is classified into hypernasality, hyponasality, and mixed resonance. Nasalance was highest at 1-month post-surgery and returned to preoperative level at 6 months in the stimuli for non- nasal sound, but at 5 months for nasal sound. Nasalance was highest at 1-month post-surgery for all acoustic parameters. Nasalance returned to preoperative level at 6 months in the stimuli for non-nasal sound.

On the other hand, hyponasal speech may be present in patients with nasal obstruction because of compromised nasal airways. The nasalance that is an objective parameter of nasality measured by the nasometer has been reported to change with conditions affecting the whole nasal cavity such as anatomic abnormalities, nasal polyps, nasal septal deviation, and CRS (Gerek M *et al*, 2012). Several studies reported that the nasalance scores were increased after sinonasal surgery such as septopalsty.

Although a few studies evaluated when nasality is normalized after sinonasal surgery, these studies have had various limitations, including small sample size, limited follow-up period, and non-validated nasality measures (Jiang RS *et al*, 2006 and Kim CS *et al*, 2000). This study examined when the hypernasality is recovered after sinonasal surgery according to the subtype of speech stimuli. Furthermore, we obtained serial nasa-lance scores until postoperative 6 months.

In this study, the mean nasalance scores for vowels, nasal consonant, nasal consonant–vowel combinations increased significantly after septoplasty. One month after surgery, nasalance scores were highest in all groups for all acoustic parameters. Although nasal valve region enlargement by theapplication of nasal strips reported to have no effect on nasalance (Kim CS *et al*, 2000), changes in nasalance may develop due to an increase in nasal cavity and paranasal sinus volume or a decrease in nasal airway resistance as a result of septal correction and enlargement of sinus ostium (Mora R *et al*, 2009, Soneghet R *et al*, 2012, Hong KH *et al*, 1997, Birkent H *et al* 2009 and Gerek M *et al* 2012). Therefore, we hypothesize that septoplasty may cause a decrease in nasal airway resistance which results in an increase of nasalance by increasing nasal acoustic energy although we did not measure the nasal cavity volume and airway resistance in this study. Furthermore, the decreased mucosal surface of sinonasal cavity and widened nasal passages after surgery would be expected to result in a general decrease in acoustic damping and increase in acoustic coupling with paranasal sinuses, thereby increasing the nasal acoustic energy and nasalance. Consequently, these results indicate that septoplasty without affecting the larynx change the structure of the vocal tract and the resonance of voice production which is capable of changing the voice quality.

However, from 1 month after surgery, nasalance scores continued to decrease by 6 months although they remained significantly higher than preoperative scores by 4 months in all groups for all speech stimuli. Interestingly, nasalance scores returned to its preoperative level differently depending on the subtype of speech stimuli. Nasalance scores returned to its preoperative level irrespective of septoplasty at 5 months in the speech stimuli for nasal sounds such as [m], [ma], [mi], and hypernasality sentence, but at 6 months in the speech stimuli for non-nasal sounds such as [a], [i], [u], [p^ha], [p^hi], and hyponasality sentence. The recovery of postoperative hypernasality may be explained that as the sinonasal mucosa healing after surgery, mucosal vibration and dampening function may subsequently normalize, resulting in recovery of nasality. Compensatory control of velopharyngeal port as well as the resonant volume of the nasal tract may be important factors to the normalization of nasalance.[9] It is difficult to explain the differing recovery time of hyper-nasality after septoplasty according to subtype of speech stimuli, but it may be related to higher nasalance scores inherent in the speech stimuli for nasal sounds.

Limitation of our study is that patients were not classified according to the degree of disease, despite the extension of nasal septal deviation could have influence on the results. Future studies for combination of nasal airway resistance and nasal cavity volume measures would be helpful to determine their relative contribution to the changes in nasalance.

CONCLUSION

In conclusion, septoplasty can change the acoustic characteristics of the vocal tract and produce a significant increase in nasality. After nasality showed the highest scores at 1-month post-surgery, it returned to its preoperative level at 5 or 6 months after surgery depending on the subtype of speech stimuli.

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