Voice analysis following turbinectomy in patients with hypertrophied inferior turbinate secondary to allergic and vasomotor rhinitis refractory to conservative treatment

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ABSTRACT

Introduction: Alterations in the configuration of the nasal cavity made surgicallyvia procedures such as turbinectomy have been assumed to cause changes in the perceived nasal resonance of the patients post surgery which tends to manifest changes in the overall voice perception. These changes though perceivable are reported to be transient in nature and eventually fall in place as the post surgical duration increases.

The purpose of this study was to probe the changes in nasal resonance that affect perceived voice quality following turbinectomy in patients with hypertrophied inferior turbinates secondary to allergic and vasomotor rhinitis, by checking serially obtained nasalance scores.

Aim of the study: The aim of the study is to assess the pre and postoperative nasal resonance and thereby voice quality in patients with hypertrophied inferior turbinates following turbinectomy.

Materials & Methods: The patients who underwent Turbinectomy, at FMMCH, Mangalore from March 2015 to October 2016 were included in the study. The diagnosis was made based on patient history, clinical examination and nasal endoscopy. The Nasalance was assessed using the Nasometer module of VAGHMI, voice and speech system, Bangalore.The nasalance scores were recorded before surgery and at intervals of 1st , 3rd and 5th month post surgery.

Results: A total of 90 patients were enrolled, out of these 60 patients successfully completed follow up visits on a regular basis. The mean nasalance scores for nasal sounds [m] [ma] and [mi] showed significance before surgery and at the 1st and 3rd month post-surgery. Consequently, nasalance values returned within normal range at the 3rd month post operatively. While the mean nasalance scores for non nasal sounds [a] [i] and [u] returned to normal range at the 5th month post operatively.

Conclusion: The presence of a hypertrophied inferior turbinate and the excision of the same can alter the overall perceived nasal resonance of an individual. Though transient, these changes cause significant change in the nasalence scores. A significant amount of hyponasality is perceived and recorded in the pre operative nasalence scores while hypernasality is perceived and recorded for a period of 3 months post surgery which eventually diminishes and normalizes by the 5th month post surgery. Therefore, surgeons can conveniently reassure patients of the transient nature of the pre and post voice and nasal alterations associated in these conditions. This information will be highly beneficial to patients who are professional voice users.

Keywords: Turbinectomy, nasal resonance, nasometry, nasalance, voice quality.

INTRODUCTION

The voice is modulated at different resonator organs like vocal tract, oropharynx, paranasal sinuses, nose and the articulatory organs (tongue, palate and lips). [1]Resonator organs enhance the voice, while articulatory organs are related to speech functions. Formants (F) are the resonance peaks in vocal tract. Each formant is defined by a number. [2]Changes in the structure of these organs either due to disease or because of surgery may cause voice alterations. [3]Although nasal obstruction can be caused by number of diseases, hypertrophied inferior turbinate is the most common etiology after deviated nasal septum, and surgical interventions for this are commonly performed.[4,5]

For patients with inferior turbinate hypertrophy, a number of surgical procedures are performed (partial turbinectomy, total turbinectomy, anterior turbinectomy, cauterization of turbinates, turbinectomy with microdebrider, cryo turbinectomy, and vidian neurectomy).

Turbinate surgery can alter the structure of resonator organs, voice alterations can occur. nasal passage enlarges at

the end of surgery, and the surface area increases. These changes can result in enlarged resonator volume, which enhances nasal components. [6]Mora et al [7]concluded that one month after surgery, the data showed improvement in all acoustic parameters and a normalization of nasalance in severe septal deviation patients. Kim et al [8]stated that hypernasality was detected at first month after surgery, and it returned to preoperative levels after 5–6 months.

Hence the purpose of this study was to know the perceived nasal resonance that affects the voice quality following turbinectomy in patients with hypertrophied inferior turbinate secondary to allergic and vasomotor rhinitis, refractory to conservative treatment, by checking serially obtained nasalance scores using nasometer.

MATERIALS & METHODS

After Institutional Ethical clearance from the committee, informed consent from patients willing to be a part of study was taken and these patients underwent turbinectomy at Father Muller Medical College Hospital, Mangalore. The study was conducted between March 2015 and October 2016. Patients with history of moderate to severe nasal obstruction with positive history of allergy, lasting for atleast more than 6 months were included in the study. The diagnosis was based on history, clinical examination and diagnostic nasal endoscopy and those with hypertrophied inferior turbinates were included in the study. Patients diagnosed with nasal polyps, palatal problems, motor speech disorders, history of previous sinonasal surgery were excluded from this study.

The nasalance assessment was done using the Nasometer module of VAGHMI, voice and speech system, Bangalore. Nasometric analysis Nasalance scores were recorded 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 then rested against the upper lip of the subject. Each microphone measured the nasal and oral sound intensities separately and computed the nasalance scores. The ratio of acoustic energy output detected from the nasal cavity for a particular word, or speech phrase, passage is expressed as percentage of the total acoustic energy produced by the nasal and oral cavities together.

This percentage is referred as nasalance scores. This value can theoretically vary from 0 % (no sound form the nose) to 100 % (all sound from the nose) considering normal nasal airway patency, nasalance score is very dependent on the phonetic content of speech. Each participant practiced the speech samples before the recordings. Only those samples 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 signedrank 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 90 patients were enrolled in the study, including 44 male and 46 female from 17 to 50 years of age, with mean age of 27.8 years. Out of these patients, 70 patients successfully completed all follow-up visits according to the clinical protocol, whereas 20 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 5 months. However, postoperative nasalance scores remained significantly higher than preoperative scores by postoperative for all speech stimuli. Statistical significance of the difference between pre-operative and 5-month postoperative values of [a], [i], [u] was noted in turbinectomy. However, these 5-month postoperative values showed no statistical difference from the preoperative values. The mean nasalance scores of [m], [ma], [mi] were significantly different in turbinectomy before surgery and 3 and 5 months post-surgery. However, these 5-month postoperative values showed no statistical difference from the preoperative values.

Consequently, nasalance scores returned close to its preoperative level at 3 months in the speech stimuli for nasal sound such as [m], [ma], [mi], but at 5 months in the speech stimuli for nonnasal sound such as [a], [i], [u].

Table 1: Nasalance change after turbinectomy

	Preoperative	1 M	3 M	5 M
[a]	9.6 ± 8.2	18.1 ± 8.0	16.4 ± 8.1	13.5 ± 7.3
	P value	(0.001)	(0.005)	(0.041)
[i]	18.5 ± 10.4	37.0 ± 16.1	29.0 ± 14.1	19.1 ± 12.9
	P value	(0.001)	(0.003)	(0.024)
[u]	6.9 ± 3.9	19.5 ± 7.5	16.0 ± 8.0	12.1 ± 7.0
	P value	(0.001)	(0.009)	(0.030)
[m]	11.1 ± 3.6	38.4 ± 4.2	13.6 ± 5.4	12.4 ± 5.4
	P value	(0.001)	(0.032)	(0.226)
[ma]	13.0 ± 9.5	31.4 ± 8.1	18.2 ± 6.8	15.7 ± 7.4
	P value	(0.004)	(0.029)	(0.072)
[mi]	13.5 ± 7.4	22.3 ± 9.6	18.4 ± 6.9	14.0 ± 7.4
	P value	(0.022)	(0.032)	(0.051)

DISCUSSION

Nasal and paranasal surgeries causes changes in the intranasal currency and pressure,[9,10,11] but it has been reported that nasal surgery does not alter voice quality.[12, 13,14,15] However, more recent studies revealed that nasal and pharyngeal surgeries may alter voice quality. Behrman et al[6] reported that surgical intervention of upper respiratory tract causes changes in voice quality, which was perceived by the patients themselves[16,17].

The nasal cavity and paranasal sinuses play important role in shaping resonant characteristics of the vocal tract (Jiang RS et al, 2006). Resonance relates to vocal amplification in oral and nasal cavities and is classified into hyponasality, hypernasality, and mixed resonance. Nasalance was highest 1-month post-surgery and returned close to preoperative level at 6 months in the stimuli for non- nasal sound, but at 3 months for nasal sounds.

Hyponasal speech can be present in patients with nasal obstruction because of compromised nasal airways. Nasalance is an objective parameter of nasality measured by the nasometer and has been reported to change with the conditions affecting the whole nasal cavity such as anatomic abnormalities, nasal polyps, nasal septal deviation, turbinate hypertrophy and CRS (Gerek M et al, 2012). Several studies have shown that nasalance scores were increased after sinonasal surgery such as septopalsty and turbinectomy. A few studies have shown that nasality is normalized after sinonasal surgery, these studies have had various limitations, which includes small sample size, limited follow-up , and non-validated nasality measures (Jiang RS et al, 2006 and Kim CS et al, 2000).

In this study hypernasality was recorded when it was recovered after turbinectomy surgery according to the subtype of speech stimuli. Later, serial nasalance scores till 5 months postoperatively was recorded. In this study, the mean nasalance scores for nasal consonants, vowels, nasal consonant–vowel combinations were increased significantly after turbinectomy procedure. One month later surgery, nasalance scores were the highest. Changes in nasalance can develop because of an increased nasal cavity and paranasal sinus space or due to decreased nasal airway resistance due to septoplasty, turbinectomy and enlargement of the 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 turbinectomy can cause decrease in nasal airway resistance which in turn results in increased nasalance by increasing the nasal acoustic energy, although we did not measure the nasal cavity volume and airway resistance [18,19,20].

Furthermore, decreased mucosal surface of the sinonasal cavity and the widened nasal passages after surgery will be expected to cause decrease in the acoustic damping and increase in the acoustic coupling with paranasal sinuses, thereby increasing the nasal acoustic energy and nasalance. Therefore, these results indicate that turbinectomy without affecting the larynx, can change the structure of the vocal tract and vocal resonance which is capable of changing the quality of voice[21,22,23].

However, 1 month after surgery, nasalance scores continued to decrease.By 5 months although they remained significantly higher than the preoperative scores for all the speech stimuli. Interestingly ,the nasalance scores returned to its preoperative levels depending on the subtype of speech stimuli. Nasalance scores returned to its preoperative levels irrespective of the status post turbinectomy at 3 months in the speech stimuli for nasal sounds such as [m], [ma], [mi], but at 5 months in speech stimuli for non-nasal sounds like [a], [i].

The recovery of the postoperative hypernasality can be cause of the sinonasal mucosal healing after surgery, mucosal vibration and dampening function can subsequently normalize, resulting in the recovery of nasality. Compensatory control of the velopharyngeal port along with the resonant volume of the nasal tract may be the important factors for the normalization of the nasalance.[9] It is difficult to explain the changing recovery time of the hyper-nasality after turbinectomy, according to the subtype of the speech stimuli, but it may be related to the higher nasalance scores inherent in the speech stimuli for different nasal sounds. Studies in the future for the combination of nasal airway resistance and nasal cavity volume measures would be helpful in determining their relative contribution to the change in the nasalance and thereby voice quality[24,25].

CONCLUSION

In patients with hypertrophied inferior turbinate secondary to allergic and vasomotor rhinitis refractory to conservative treatment, surgical procedure turbinectomy can alter the overall perceived nasal resonance of an individual. Though transient, these changes causes significant change in the nasalence scoresand thereby alter the acoustic characteristics of the vocal tract and produce a significant increase in the nasality. Therefore, surgeons can conveniently reassure patients of the transient nature of the pre and post voice and nasal alterations associated in these conditions which will be mainly useful to professional voice users.

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