Impact of Tonsillectomy With or Without Adenoidectomy on the Acoustic Parameters of the Voice

A Comparative Study

Vijayalakshmi Subramaniam, MBBS, DLO, Dip NB; Padmanabhan Kumar, MBBS, MS, Dip NB

Objective: To assess the effects of chronic tonsillitis with or without adenoiditis and the effects of tonsillectomy with or without adenoidectomy on the voice by means of acoustic analysis.

Design: Prospective case-control study.

Setting: Yenepoya Medical College Hospital, a tertiary referral hospital.

Patients: Patients 5 to 26 years old with chronic tonsillitis with or without adenoiditis.

Interventions: Tonsillectomies were performed under general anesthesia by surgeons using cold steel instruments via a standard capsular dissection technique, and adenoids were removed by curettage.

Main Outcome Measures: Acoustic analysis of 6 parameters (fundamental frequency, jitter, shimmer, harmonics: noise ratio, long-term average spectrum, and nasalance) 4 weeks after surgery compared with 1 day before surgery.

Results: Postoperatively, shimmer altered in males, and hypernasality was eliminated in almost all cases. None of the other associations were significant statistically.

Conclusions: Chronic tonsillitis and tonsillar hypertrophy cause alterations in some acoustic measurements, which make the voice dysharmonic and harsh. Tonsillectomy eliminates nasalance and lowers shimmer. Overall, it does not significantly alter dysphonia owing to disease.


METHODS

This prospective case-control study comprised 20 patients aged 5 to 26 years who underwent tonsillectomy with or without adenoidectomy in the Department of Otorhinolaryngology at Yenepoya Medical College, Mangalore, India. Patients with chronic tonsillitis with or without adenoiditis and obstructive sleep apnea symptoms were included in the study. Those with craniofacial anomalies, neurologic problems, previous attacks of quinsy, sensorineural hearing loss, patients who undergo tonsillectomy before excision of elongated styloid processes, and children who undergo speech or language therapy before surgery were excluded from the study. The patients selected for the study were subjected to a detailed ear, nose, and throat examination. Tonsil size was estimated on a scale of 1 to 4, where grade 1 indicates normal size; grade 2, tonsils that reach the level of the posterior pillar; grade 3, tonsils that project beyond the posterior pillar; and grade 4, tonsils that meet at the midline.

Acoustic analysis of the voice was done 1 day before surgery by means of a standardized commercial voice analysis system (Vaghmi; Voice and Speech Systems, Bangalore, India) that provides normative data for analyzed measures. The device comes with a nasal/oral microphone used to record voice for measuring nasalance. The subjects sat comfortably in front of the microphone. To obtain a sample for voice analysis, they were instructed to phonate the vowel /a/ for a duration of at least 5 seconds after taking a deep breath. Nasalance was recorded by means of the oral-nasal micro-
hypertrophy than in controls. The difference was not statistically significant (Table).

Jitter values varied widely between different age groups among case and control individuals; these differences did not reach levels of statistical significance. Jitter, or amplitude jitter, refers to the cycle-to-cycle variation in amplitude of successive glottal cycles. The HNR, widely accepted to quantify the irregular or noise component of the voice, is the ratio between the sound pressure level of harmonics and noise in a glottal signal. The LTAS is a display of the overall spectral characteristics of the voice, which demonstrates the amount of energy present at each frequency pooled across time. Nasalance is the ratio of the nasal acoustic energy to the nasal plus oral acoustic energy, expressed as a percentage.

Male patients were subgrouped into 2 age categories of 5 to 10 years and 11 to 16 years, while females were subgrouped into 3 age categories: 5 to 10 years, 11 to 16 years, and 17 years or more. This division served to differentiate between prepubertal and postpubertal patients. Females 17 years or older were placed in a separate group, as there were no corresponding male patients for comparison.

Control individuals were selected from children and adolescents who studied at a school in the neighboring locality. These children and adolescents underwent a screening questionnaire followed by clinical examination. Only children and adolescents without tonsillitis and those without the exclusion criteria used for cases were selected. Forty-six controls, age- and sex-matched with the study group, were selected. The same technique of voice recording, nasalance recording, and voice analysis was performed with the selected control individuals. Results were analyzed and compared.

Tonsillectomies were performed under general anesthesia by means of cold steel instruments via a standard capsular dissection technique. Bleeding from the tonsillar fossa was controlled by gauze packs and finger pressure. Bleeding that could not be controlled by these means was stopped by bipolar cautery. Ligatures were avoided. Adenoids were removed by curettage.

The empiric values obtained from the presurgical and postsurgical voice analysis samples were statistically analyzed by means of the Windows SPSS software program (SPSS Inc, Cary, North Carolina). Statistical analysis was performed by analysis of variance. Correlation between the grade of tonsillar hypertrophy and voice parameters was determined by Pearson correlation coefficient.

RESULTS

The F0 values were consistently lower in all cases of tonsillar hypertrophy than in controls. The difference between patient preoperative and control values was significant only in the males in the 5- to 11-year age group (P = .01). The F0 showed a variable trend after surgery. Reduction in F0 was significant in males aged 11 to 16 years postoperatively (P = .02) (Table).

Jitter values varied widely between different age groups among case and control individuals; these differences did not reach levels of statistical significance. Jitter generally decreased after surgery, although the difference was not statistically significant (Table).

Shimmer values were higher for all cases of tonsillar hypertrophy than in controls. The difference was statistically significant in all male patients (P = .01 [5-10 years], P = .02 [11-16 years]) and in females aged 5 to 10 years (P < .001). After surgery, shimmer showed a variable trend, generally lower. The difference was significant in the same groups that showed statistical significance preoperatively (P = .001, .002, and .001 respectively) (Table).

The HNR was lower in all patients with tonsillar hypertrophy than in control individuals. Postoperative HNR values were higher than the preoperative values in all age groups studied irrespective of sex. However, none of the differences in the preoperative or postoperative groups was statistically significant (Table).

The LTAS values were higher in all patient subgroups preoperatively than in controls (Table). The difference was statistically significant in all male patients (P = .02 [5-10 years], P = .01 [11-16 years]) and females aged 11 to 16 years (P = .009). There was minimal increase in the values postoperatively; however, the difference was not statistically significant (Table).

Mean nasalance scores were higher among all patients with tonsillar hypertrophy. This finding was statistically significant among all males (P = .001 [5-10 years], P = .02 [11-16 years]). Mean nasalance scores decreased after surgery among all groups. The difference was statistically significant among male groups (P = .02 [5-10 years], P = .02 [11-16 years]) (Table). The improvement in mean nasalance scores after surgery was compared separately among patients who underwent tonsillectomy alone vs patients who underwent tonsillectomy with adenoidectomy. Mean nasalance scores showed a downward trend after surgery in both groups, although this finding was not statistically significant.

When the correlation between grade of tonsillar hypertrophy and voice parameters was tested, only nasalance showed a significant correlation. A decrease in nasalance scores after surgery was observed in patients with larger tonsils, while an increase was noted in patients with smaller tonsils (P = .02 [5-10 years], P = .02 [11-16 years]).

COMMENT

Tonsillar hypertrophy definitely lowers vocal pitch, although the change was significant only in males aged 5 to 10 years. Mean F0 values varied in the different age groups. Postoperatively, only the reduction in values of F0 in the 11- to 16-year male group was statistically significant. These changes reflect the variable behavior of F0 after surgery. Von Leden et al1 reported that the most common observation in pathological conditions is a strong tendency for frequent and rapid changes in the regularity of the vibratory pattern, which are reflected acoustically as disturbances of F0.

Previous studies that have evaluated changes in F0, F1, and F2 formant frequencies after tonsillectomy with or without adenoidectomy have not detected any significant changes.2-5 Chuma et al7 believed that this observation is not surprising because tonsillectomy and adenoidectomy do not directly affect the larynx and therefore should not influence the rate at which vocal folds open.
and close during sustained phonation. Contrary to this, Lin et al. observed a postoperative increase in F0. Parsa and Jamieson and Yu et al. observed that jitter was the least capable measure in the discrimination between healthy and disordered voices. Ilk et al. observed that, although jitter variation is random, jitter values obtained from the same speaker before and after surgery were consistent and within a certain range. In this study, the differential behavior of this parameter, which is dependent on F0, was too varied to derive a conclusion. This differential behavior needs to be investigated in a larger sample.

Deal and Emanuel and Parsa and Jamieson have stated that shimmer is a better predictor of dysphonic severity.

### Table. Comparison of Acoustic Parameters Between Groups

<table>
<thead>
<tr>
<th>Sex and Age Group, y</th>
<th>Controls</th>
<th>Preoperative</th>
<th>Controls vs Preoperative</th>
<th>Postoperative, Mean (SD)</th>
<th>Postoperative vs Controls</th>
<th>Mean Fundamental Frequency, Hz</th>
<th>Mean Jitter, Hz</th>
<th>Mean Shimmer</th>
<th>Mean HNR</th>
<th>Mean LTAS</th>
<th>Mean Nasalance, %</th>
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<td><strong>Male</strong></td>
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<tr>
<td>5-10</td>
<td>252.00 (6.54)</td>
<td>206.37 (37.06)</td>
<td>.01&lt;sup&gt;a&lt;/sup&gt;</td>
<td>217.61 (57.87)</td>
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<td>11-16</td>
<td>239.14 (1.15)</td>
<td>207.68 (24.29)</td>
<td>.13</td>
<td>192.63 (25.41)</td>
<td>.02&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>5-10</td>
<td>258.88 (28.22)</td>
<td>237.58 (19.47)</td>
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<td>216.80 (33.50)</td>
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<td>11-16</td>
<td>176.33 (100.00)</td>
<td>173.92 (65.51)</td>
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<td>200.30 (56.58)</td>
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<td>≥17</td>
<td>240.30 (27.66)</td>
<td>232.01 (9.17)</td>
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<td>199.27 (29.33)</td>
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<td><strong>Mean Jitter, Hz</strong></td>
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<td><strong>Mean LTAS</strong></td>
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<td><strong>Mean Nasalance, %</strong></td>
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Abbreviations: HNR, harmonic:noise ratio; LTAS, long-term average spectrum.

<sup>a</sup>P < .01.
<sup>b</sup>P < .05.
<sup>c</sup>P < .001.
Tonsillar hypertrophy causes changes in the dimensions of the vocal tract that are evident as increased shimmer values. Change in shimmer in turn is reflected in the roughness of the voice. In this study, the higher values of shimmer in cases than controls indicate that chronic tonsillitis alters the voice. This may be owing to a difference in acoustic parameters in people with disease. Shimmer was significantly altered in males.

The HNR values were lower in patients with chronic tonsillitis with or without adenoiditis; however, the association was not statistically significant. Most authors have found low HNR values to correlate with particular aspects of dysphonia, such as hoarseness, roughness, and breathiness. The alteration that tonsillar and adenoid hypertrophy cause in the voice resonators is reflected as low HNR. Observations in this study, where voice parameters were studied 4 weeks postoperatively, suggest that the change in voice consequent to disease was not significantly altered by surgery.

The LTAS values in patients were higher than in controls. The overall preoperative and postoperative spectral differences were minimal and statistically insignificant. Adenotonsillectomy does not significantly alter the voice or sound energy distribution.

Previous studies have found that tonsillar hypertrophy contributes to hypernasal speech. Subtelny and Koepp-Baker reported that hypertrophic tonsils could alter oropharyngeal resonance characteristics. Shprintzen et al. opined that hypertrophic tonsils may intrude into the pharyngeal airway and alter the pharyngeal resonance of speech, which would result in a muffled voice or sound energy distribution.

Tonsillectomy has been found to be curative in the elimination of hypernasal speech. The HNR values were lower in patients with chronic tonsillitis, while the LTAS values remained within the range of intraindividual fluctuations. The proportion of cases that showed a decrease in frequency was almost the same for grade 1 and grade 2 hypertrophy. The proportion of cases that showed an increase in frequency was minimal and statistically insignificant. Adenotonsillectomy does not significantly alter the voice or sound energy distribution.

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Correspondence: Vijayalakshmi Subramaniam, MBBS, DLO, Dip NB, Department of Otorhinolaryngology, Yenepoya Medical College, Deralakatte, Mangalore-575018, Karnataka, India (vijisubbu@gmail.com).

Author Contributions: Drs Subramaniam and Kumar had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Subramaniam and Kumar.

Acquisition of data: Subramaniam and Kumar.

Analysis and interpretation of data: Subramaniam and Kumar.

Drafting of the manuscript: Subramaniam.

Critical revision of the manuscript for important intellectual content: Subramaniam and Kumar.

Study supervision: Kumar.

Financial Disclosure: None reported.

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References