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Influence of Hypertrophied Tonsil and Adenoid on the voice of children

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ABSTRACT

Changes in vocal patterns after adenotonsillectomy are questionable. Few articles had assessed acoustic changes in the voice of children pre and post adenotonsillectomy. The objective of the current study was to evaluate the effect of removal of hypertrophied tonsil and adenoid on the voice of children. prospective study tertiary care hospital (Minia university hospital) The study included fifty children ranging in age between 4 and 12 years, with adenotonsillar hypertrophy, indicated for adenotonsillectomy. Auditory perceptual assessment of speech included nasality, degree of hyponasality, degree of open nasality, and degree of dysphonia. Acoustic analysis of voice was done pre, one month and three months' post adenotonsillectomy, using multidimensional voice program software (MVDP). Acoustic parameters- fundamental frequency (Hz), shimmer (dB), jitter (%), and noise- harmony ratio (NHR; dB) were analyzed. Our results reveal that there is statistical significance in FO, Jitters, Shimmer between preoperative and postoperative results and improvement continues even after three months postoperatively there's no statistical significance regarding HNR preoperative and post-operative. There is weak statistical significant in correlation between HNR and APA of Voice and APA of speech after one month postoperatively as (P=0.047) Hypertrophied tonsil and Adenoid can lead to Hyponasal speech and/ or dysphonia this can be improved after their removal, so voice and speech changes that results from enlarged tonsil and Adenoid can be considered as indication of adenotosillectomy.

1. INTRODUCTION

The voice is actually a product of three physiological processes: a contentious expiratory airflow that mastered by chest muscles; production of glottal sound through adduction and vibration of the vocal folds, and modification of this glottic sound with amplification and muffling of frequencies happens when pharyngeal, oral and nasal resonant structures contract [1]. Palatine tonsils when enlarged, it not only compromises the oropharyngeal space but also protrude the tongue forward, causing mouth breathing, and muffled voice. It is also revealed that adenotonsillar hypertrophy causes narrowing of the nasopharynx

which imped the mobility of velopharyngeal muscles [1]. Adenotonsillectomy is one of the most common surgery performed in children, and the most frequently asked question is about changes of the voice after surgery and whether is it temporary or permanent [2]. Many studies using generally subjective voice analysis techniques; found significant changes in nasality and a decrease in nasal airway resistance [3], [4]. However, few studies had evaluated voice changes pre and post adenotonsillectomy, and most of these studies only used subjective measures (perceptual-auditory voice analysis). Therefore, the aim of this study was to evaluate the effect of adenotonsillectomy on the voice of children with hypertrophied tonsils and adenoid using objective voice analysis.

2. Patients and Methods

The current study was approved by the Research Ethics Committee of the Faculty of Medicine, Minia University. The parents/ guardian of children were informed about the study, and a signed informed consent was obtained. The current study is a prospective one that done on fifty children ranging in age between four and twelve years old, all cases were suffering from hypertrophied tonsils and adenoid, these children planned for adenotonsillectomy, they selected randomly from the outpatient clinic of otorhinolaryngology, Minia University hospital between March 2016 and December 2017. The children that excluded from the study those who suffer from other causes of chronic nasal obstruction, Cleft palate, Patients with history of misuse and abuse of voice and those who complain of dysphonia since birth, Children with sensorineural or family history of hearing loss and Patients below 4 years old. All patients were subjected to Full clinical history that taken from parents or guardian, Clinical evaluation was done with full otorhinolaryngological examination, all cases have multiple signs from the following, Mouth breathing, dry lower lip, hypo nasal speech, elevated upper lip, prominent central incisors, high arched palate, receding lower jaw and narrow pinched anterior nares. flexible endoscopes (Olympus model ENF-XP, Olympus America, Melville, NY, USA) connected to a Storz microcamera (Karl Storz, Tuttlingen, Germany), Was used to define Adenoid hypertrophy and examination of the tonsils, hypertrophied tonsils were Graded according to Brodsky 5 scale. the patients were subjected to Auditory perceptual assessment of speech, Gutzman test for nasality, and Auditory perceptual assessment of voice to assess dysphonia, all these subjective methods done by 2 experienced phoneticians. The cases after that subjected to objective analysis of voice using Acoustic analysis for measurement of fundamental frequency, jitter, shimmer and harmonic to noise ratio of the voice. We used the computerized speech lab (CSL, Kaypentax, USA) that covers multidimensional voice program (MDVP).

After that, all patients were operated upon (Adenotonsillectomy) as planned.
All subjective and objective assessment of the studied sample were done one and three months postoperatively.

2.1 Statistical method

The collected data were statistically analyzed using SPSS program (Statistical Package for Social Sciences) software version 24.

Test of normality (Kolmogorov-Smirnov) was done to determine the distribution of the quantitative data. Descriptive statistics were done for parametric quantitative data by mean, standard deviation, and for non-parametric quantitative data by median, while they were done for categorical data by number and percentage. Analyses between different times were done using Wilcoxon signed rank test for qualitative and non- parametric quantitative data and using paired samples T test for parametric quantitative data. Correlation between two qualitative and quantitative variables was done by using Spearman's rho correlation coefficient. The level of significance was taken at (P value < 0.05).

3. Results

The current study was done to shed a spot of light on the effect of adenotonsillectomy on voice of children. The study sample composed of fifty children all of them had adenotonsillar hypertrophy 26 males (52%), 24females (48%) ranging in age (4-12) with Mean ± SD = 7.6±2.2, as shown in table 1. Our results reveal that there is statistical significance in FO, Jitters, Shimmer between preoperative and postoperative results and improvement continues even after three months postoperatively as values are higher preoperatively and decrease post operatively. there's no statistical significance regarding HNR preoperatively and postoperatively. (Table 2)

The current results showed a significant statistical difference between pre-operative, one month postoperative and three months postoperatively as regards of auditory perceptual assessment of voice (APA of voice) and auditory perceptual assessment of speech (APA of speech) as shown in table (3). As shown in table (4), There is no statistically significant difference between APA of Voice and APA of Speech with the acoustic parameters preoperatively. There is significant statistical difference between HNR and APA of Voice after one month postoperatively as (P=0.047). There is no statistical difference regarding FO, jitter, Shimmer and other voice parameters as shown in Table 5. There is fair negative correlation between HNR with APA of Voice, this may be due to improvement of dysphonia that accompanied with elevation of HNR (-0.282) and, also, negative weak correlation between HNR and APA of Speech.

There is no statistical difference between APA of Voice, APA of Speech, with other acoustic parameters three months post operatively. (Table 6)

4. DISCUSSION

The vocal tract, which begins from the lips and extend to the glottis, is a resonator for speech production, where the speech characteristics are changeable according to the shape of this tract [5]. Palatine tonsils are present at the vocal tract, between the palatoglossal and palatopharyngeal muscles, they are immunologically active lymphoid tissue that are part of the lymphoid system [6]. Hypertrophied tonsils, however, reduce oropharyngeal space and may protrude the tongue forward, and their interaction within the vocal tract may also affect consonants. Hypertrophied palatine tonsils may restrict the mobility of soft palate causing hypernasal speech, and muffled voice. When individuals produce certain sounds, the soft palate moves to touch the back of the throat which seals off the nasal cavity from the oral cavity, so Hypertrophied tonsils may impair this movement leading to escape of the air from the nasal cavity and causes hypernasal speech. It is reported in literature that tonsillectomy may resolve hypernasality in patients with a normal soft palate [5], [6]. Some studies using generally subjective voice analysis techniques found significant changes in the nasality and a decrease in nasal airway resistance [7], [8]. The computerized speech lab (CSL, Kaypentax, USA) covers multidimensional voice program (MDVP), Real-Time Pitch and Real-Time Spectrogram programs separately [9]. The computerized speech lab, which is used for acoustic analysis of voice, is a program including waveform, spectrogram and formant values, energy time graphic of voice signals. This software has been used for objective analysis of voice [10]. In the present study, MDVP was used to evaluate objective acoustic analysis parameters including fundamental frequency (F0), jitter, shimmer, and noise to harmonic ratio (NHR), we used it to evaluate changes of the voice before and after adenotonsillectomy, and patients preoperatively were considered as control and we evaluate these voice parameters postoperatively to see the changes that occurred after adenotonsillectomy in the same patient.

Acoustic analysis correlated well with other methods (such as perceptual analysis, indirect laryngoscopy, laryngostroboscopy) in the examination of voice disorders and considerd by as a complementary method

[11]. The parameters of /a/ vowel were examined in laryngeal voice assessment. It is known that /a/ vowel is formed phonetically without complete obstruction or extreme contraction in the vocal tract unlike other vocals [12]. In the present study, measurement of F0 normalized significantly at 1st month after surgery, while the significant changes in Jitter and Shimmer delayed to the 3rd month with non-significant changes in HNR. In literature, there is a controversy about the results of acoustic analysis after adenotonsillectomy in children. The results of the study done by [13] revealed that adenotonsillectomy had only minimal effect on quantitative and/or qualitative (perceptual) aspects of vocal function, when measurements performed at 15 weeks post adenotonsillectomy. No significant postoperative changes were detected in the majority of acoustic speech measurements (vocal F0, formant bandwidths, measures of vowel space or diadochokinetic rates), these results contradict the finding of the present study and this may have attributed to methodology they used. The data by [2] showed that after adenotonsillectomy there was an improvement in all the parameters of F0, Jitter, and shimmer, in addition to supralayngeal parameters including NHR, voice turbulence index, soft phonation index, degree of voiceless and degree of voice breaks, these parameters showed a postoperative decrease in comparison to healthy children, and these results agree with our results except in HNR. The data by [14] showed significant improvement of the acoustic and other parameters in the children after adenotonsillectomy: F0, Jitter, Shimmer, which agree also with the current study. In the study by [15] the F0 showed a variable trend after adenotonsillectomy, reduction in F0 was significant in boys aged eleven to sixteen years postoperatively. Jitter and Shimmer generally reduced after surgery, but the difference was not statistically significant. They also reported that HNR were higher postoperatively than the preoperative values in all age groups irrespective of gender. However, none of the differences in the preoperative and postoperative groups was statistically significant. The study by [12] stated that adenoidectomy may influence voice resonance and nasalance, by changing the shape and size of nasopharyngeal airspace without any significant changes in the voice quality. Also, they found no significant changes in F0, shimmer, amplitude perturbation quotient, jitter, relative average perturbation, NHR, F1 and F2 formant values which contradicts our results. The current results only agree with Subramaniam and Kumar in the HNR.

[1] reported a significant change between NHR and shimmer during vowel /u/ production between the preoperative and one-month postoperative time and irrelevant differences were reported for other acoustic parameters between preoperative analysis and the 3rd month after adenotonsillectomy [1], which differs from our observation of normalization of jitter and shimmer at 3rd month. The current results revealed a significant normalization in F0 one month postoperatively, and F0 represent the vocal fold vibratory rate and reflects resonance characteristics of the supralaryngeal vocal tract in relation to tongue articulation. Early normalization of F0 after adenotonsillectomy, although this procedure does not affect the larynx, but it changes the structure of the vocal tract which influence the resonance of speech production, so surgery capable of improving speech quality [16], [2]. Although the studies by observed postoperative increase in F0, [17], [2], [11] the study by Subramaniam and Kumar showed that the change in F0 was significant only in children aged 5 to 10 years and the mean F0 values varied in the different age groups Postoperatively, only the reduction in values of F0 occurred in boys aged 11- to 16-year group, was statistically significant [11]. Other studies have evaluated changes in F0, F1, and F2 formant frequencies after tonsillectomy with or without adenoidectomy have not detected any significant changes. [13], [5] 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 [13]. In the present study jitter and shimmer were normalized at 3rd month after adenotonsillectomy. This delay in normalization may be partly attributed to our use of electro-cautery during adenotonsillectomy which results in residual tissue edema.

Observed that jitter was the least capable measure in the differentiation between healthy and disordered voices [18], [19]. 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 [5]. In the study by Subramaniam and Kumar, the differential behavior of jitter, which is dependent on F0, was too varied to derive a conclusion. This differential behavior needs to be investigated in a larger sample [15]. Deal and Emanuel (1978) and Parsa and Jamieson (2000) have stated that shimmer is a good predictor of the severity of dysphonia. Adenotonsillar hypertrophy lead to changes in the dimensions of the vocal tract which is evident in increased shimmer values and change in shimmer in turn is reflected in the roughness of the voice [20], [18] In the current study, the higher values of preoperative Shimmer indicate that chronic hypertrophy of the tonsil and adenoid alters the voice, which is corrected postoperatively. In the present study, NHR has a negative fair correlation with APA of voice, this may be due to improvement of dysphonia that accompanied with elevation of NHR. Other authors pointed out that low NHR values correlate with some aspects of dysphonia, such as hoarseness, roughness, and breathiness [21], [22] The effect of adenotonsillar hypertrophy on the voice resonators is reflected as low NHR. [15] The short comings of our study are small sample number, one center study and not a case control study. The present study conclude that removal of hypertrophied tonsil and adenoid can improve acoustic parameters, nasality, and dysphonia within 3 months after surgery in children, and the voice change that attributed to Adenotonsillar hypertrophy can be considered as an indication of adenotonsillectomy.

5. References

[1] Dimatos SC, Neves LR, Beltrame JM, Azevedo RR, Pignatari SS. Impact of adenotonsillectomy on vocal emission in children. Braz J Otorhinolaryngol. 2016;82(2):151-8.

[2] Mora R, Crippa B, Dellepiane M, Jankowska B. Effects of ade- notonsillectomy on speech spectrum in children. Int J PediatrOtorhinolaryngol. 2007; 71:1299-304.

[3] Wallner LJ, Hill BJ, Waldrop W, Monroe C. Voice changes following adenotonsillectomy. A study of velar function by cinefluorography and video tape. Laryngoscope 1968; 78:1410-8.

[4] Andreassen ML, Leeper HA, MacRae DL, Nicholson IR. Aerodynamic, acoustic, and perceptual changes following adenoidectomy. Cleft Palate Craniofac J 1994; 31:263-70.

[5] İlk HG, Erogul O, Satar B, and Ozkaptn Y. Effects of Tonsillectomy on the speech Spectrum. J Voice, 2002; 4:580- 6

[6] Finkelstein Y, Nachmani A, and Ophir D.The functional role of the tonsils in the speech. Arch Otolaryngol Head Neck Surg. 1994, 120:846-51

[7] Wallner LJ, Hill BJ, Waldrop W, Monroe C. Voice changes following adenotonsillectomy. A study of velar function by cinefluorography and video tape. Laryngoscope 1968; 78:1410-8.

[8] Andreassen ML, Leeper HA, MacRae DL, Nicholson IR. Aerodynamic, acoustic, and perceptual changes following adenoidectomy. Cleft Palate Craniofac J 1994; 31:263-70.

[9] Uloza V. Effect on voice by endolaryngeal microsurgery. Eur Arch otorhinolaryngol, 199; 256, 312-5

[10] Carson C, Ingrisano D, Eggleston K. The effect of noise on computer-aided measures of voice: a comparison of CS speech SP and the multi-dimensional voice Program software using the CSL 4300B module and multi-speech for windows. J of voice 2003; 17:12-20

[11] Nemr K, Amar A, Abrahão M, Leite GC, Köhle J, Santos Ade O, et al. Comparative analysis of perceptual evaluation, acoustic analysis and indirect laryngoscopy for vocal assessment of a population with vocal complaint. Braz J Otorhinolaryngol 2005; 71:13-7.

[12] Kara M, Öztürk K, Özer B. An evaluation of the effects of adenoidectomy on voice and speech function in children. Kulak Burun Bogaz Ihtis Derg; 23(4):225-31.

[13] Chuma AV, Cacace AT, Rosen R, Feustel P, Koltaii PJ. Effects of tonsillectomy and/or adenoidectomy on speech and voice.Int J PediatrOtorhinolaryngol. 2008; 9:1377-84.

[14] Salami A, Jankowska B, Dellepiane M, Crippa B, Mora R. The impact of tonsillectomy with or without adenoidectomy on speech and voice.Int J PediatrOtorhinolaryngol. 2008, 9:1377-84.

[15] Subramaniam V, Kumar P. Impact of tonsillectomy with or without adenoidectomy on the acoustic parameters of the voice: a comparative study. Arch Otolaryngol Head Neck Surg. 2009; 135(10):966-9.

[16] Van Lierde KM, Wuyts FL, De Bodt M, Van Cauwenberge P. Age-related patterns of nasal resonance in normal Flemish children and young adults. Scand. J. Plast. Reconstr. Surg. Hand Surg. 2003; 37:344-350.

[17] Lin P, Gould W, Fukazawa T, and El-assuooty A. Acoustic analysis of voice in tonsillectomy. J voice, 1989, 3:81- 6

[18] Parsa V and Jameson D. Velopharyngeal incompetence: the need for speech measures. J Speech Lang Hear Res.2000; 43:469-85

[19] Yu P, Ouaknine M, and Giovanni A. Objective voice analysis for dysphonia patients: a multi-parametric protocol including acoustic and aerodynamic measurements. J Voice, 2001; 15:529-42

[20] Deal R, and Emanuel F. Some wave form and spectral features of vowel roughness. J Speech Hear Res. 1978; 21, 250-64

[21] Feijoo S, and Hernández C. Short-term stability measures for the evaluation of vocal quality. J Speech Hear Res. 1990; 33:324-34

[22] Klatt DH, Klatt LC. Analysis, synthesis, and perception of voice quality variation among female and male talkers. J Acoust Soc Am. 1990;87(2):820-857.

Tables

Table (1): Distribution of children regarding age, sex

Variables	Descriptive statistics

	N=50
Age Range Mean ± SD	 (4-12) 7.6±2.2
Sex Male Female	 26(52%) 24(48%)

Table (2): Statistical comparisons between pre-operative, post-operative 1month, post-operative 3 month as regards fundamental frequency (FO), jitter 1st, shimmer db, harmonic noise ratio (HNR).

	Pre	Post 1	Post2	P value		
				Pre vs Post 1	Pre vs Post 2	Post 1 vs Post 2
FO Range Mean ± SD Median	(219.4-431.8) 293±47.1 281.8	(226.5-365.6) 284.2±40.7 278.8	(220.8-377.7) 279.9±39.7 274.6	0.025*	<0.001*	0.018*
Jitter 1st Range Mean ± SD Median	(0.5-76.7) 5.7±11.2 2.7	(0.3-21.4) 4±4.6 2.4	(0.5-10.3) 2.3±2.4 1.4	0.137	<0.001*	0.004*
Shimmer Range Mean ± SD Median	(0.3-4.5) 1.5±0.8 1.4	(0.3-3.6) 1.3±0.8 1.1	(0.3-3.2) 1.1±0.5 1	0.193	0.003*	0.142
($)HNR Range Mean ± SD Median	(6-21.2) 14.1±3.2 14.2	(5.8-20.3) 13.8±3.2 14	(7.1-19.3) 13.8±3.1 14.3	0.513	0.557	0.965

- Wilcoxon signed rank test for non-parametric quantitative data
- ($) Paired sample t test for parametric quantitative data
- *: Significant level at p value < 0.05

Table (3): Comparison between pre-operative, postoperative 1month and postoperative month 3 as regards audiotary perceptual assessment of voice (APA of voice) and audiotary perceptual assessment of speech (APA of speech).

	Pre	Post 1	Post 2	P value		
				Pre vs Post 1	Pre vs Post 2	Post 1 vs Post 2
APA of Voice						

No dysphonia Mild dysphonia Moderate dysphonia	30(60%) 16(32%) 4(8%)	38(76%) 12(24%) 0(0%)	45(90%) 5(10%) 0(0%)	0.001*	<0.001*	0.008*
APA of Speech No hypo-nasality Mild hypo-nasality Moderate hypo-nasality	19(38%) 24(48%) 7(14%)	36(72%) 13(26%) 1(2%)	45(90%) 5(10%) 0(0%)	<0.001*	<0.001*	0.002*

- Wilcoxon signed rank test qualitative data

- *: Significant level at p value < 0.05

Table (4): Correlation between APA of Voice, APA of Speech with the acoustic parameters pre operatively.

	APA of Voice pre		APA of speech pre	
	R	P value	R	P value
FO pre	-0.177	0.218	-0.053	0.712
Jitter pre	-0.009	0.949	0.193	0.179
Shimmer pre	0.037	0.799	-0.117	0.417
HNR pre	-0.145	0.315	-0.074	0.608

- Non-parametric Spearman's rho correlation

- *: Significant level at p value < 0.05

Table (5): Correlation between APA of voice, APA of Speech with the acoustic parameters post operatively 1month.

	APA of voice post 1		APA of Speech post 1	
	R	P value	R	P value
FO post 1	-0.159	0.270	0.055	0.704
Jitter post 1	-0.029	0.840	0.211	0.142
Shimmer post 1	0.177	0.219	0.016	0.914
HNR post 1	-0.282	0.047*	-0.010	0.946

- Non-parametric Spearman's rho correlation

*: Significant level at p value < 0.05

Table (6): Correlation between APA of Voice, APA of Speech with the acoustic parameters post operatively 3month.

	APA of Voice post 2		APA of Speech post 2	
	R	P value	R	P value

FO post 2	0.058	0.690	0.159	0.269
Jitter post 2	-0.049	0.738	0.030	0.836
Shimmer post 2	-0.146	0.313	-0.136	0.345
HNR post 2	0.081	0.577	0.062	0.667

- 2Non-parametric Spearman's rho correlation

- *: Significant level at p value < 0.05