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Original article

The Effect of Adenotonsillectomy on The Acoustic Aspects of Children's Voice

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Abstract:

Background: Adenotonsillectomy is the most common surgery in pediatric otorhinolaryngology. In most cases, low complications are associated with it. In pediatric adenotonsillectomy, parents often worry about voice patterns, which may be temporary or permanent. Computerized acoustic vocal analysis has been valued for its ability to quantify vocal parameters as well as provide qualitative data. This study aimed to analyze the changes in acoustic voice parameters after tonsillectomy, adenoidectomy, or adenotonsillectomy. **Methods:** The current study included 100 children, patients who underwent an adenotonsillectomy, tonsillectomy or adenoidectomy. The preoperative assessment included full history taking (demographic data and complaints), clinical examination and laboratory analysis. Tonsillectomy was done by cold steel dissection and Adenoidectomy by curettage. Acoustic analysis of voice included the fundamental frequency (F0), jitter percentage, shimmer percentage, and Harmonic/Noise ratio (HNR) measurements during preoperative preparation and at first day, one week and one month after the operation. **Results:** There was high statistically significant difference regarding the F0, jitter percentage, shimmer percentage, and HNR measurements between each duration during the follow and also as compared to the preoperative value. The Fundamental frequency was the most affected parameters and it showed changes in all types of operations **Conclusions:** Adenotonsillectomy is associated with significant changes at the different acoustic aspects in children and care should be taken during the follow up to provide the optimal care for the children. To avoid major voice disorders after adenotonsillectomy: Screen for predisposing conditions (e.g. VPI), use careful, tissue-sparing surgical techniques, avoid over-resection of adenoid pad near velopharyngeal valve and ensure proper postoperative follow-up and early speech intervention if needed. **Key words:** Adenotonsillectomy, Acoustic, Voice

Introduction

In the field of pediatric otorhinolaryngology, the adenotonsillectomy is without a doubt the most common surgical procedure. It is also one of the most common surgical procedures in their overall frequency. It is associated with a low rate of complications with the condition [(1)].

On the other hand, one of the most common concerns that parents have regarding pediatric adenotonsillectomy is the impact that the procedure will have on their child's voice patterns, which may be temporary or permanent [(2)].

Both the tonsils and the adenoids are found in the vocal tract. They have the ability to change the quality of the voice and reduce the amount of air space that is available, which can hinder the production of sound [(3)].

When it comes to subjective speech measurements, such as nasality and perceptual-auditory voice parameters, the primary focus is on the effect that adenotonsillectomy has. On the other hand, there have been observations of objective changes in the vocal cords and vibration patterns following the removal of a sizeable volume from the oropharyngeal and epipharyngeal space, which ultimately results in phonation instability [(4)].

A number of measurements, including the fundamental frequency (F0), jitter, shimmer, and harmonic-noise ratio (HNR), are used to reflect these different changes [(5)].

The F0 is the most crucial parameter when it comes to voice. Jitter refers to the variation in the fundamental frequency (F0), while shimmer indicates the variation in the amplitude of the sound wave of the F0 [(6)].

The harmonic distortion ratio (HNR) is a measure of the degree to which ambient noise detracts from the quality of speech [(7)].

Few studies have examined the objective changes in acoustic voice parameters following adenotonsillectomy. Some data show significant results, but most studies have a small sample size and draw broad conclusions. Consequently, the purpose of this study is to compare pre- and post-operative acoustic voice parameters in Egyptian patients who have undergone tonsillectomy, adenoidectomy, or adenotonsillectomy in order to definitively quantify and identify the duration of these changes. This study may help doctors give worried parents a meaningful statement backed by objective testing.

Methods:

This is a prospective interventional study that was conducted at the otorhinolaryngology Department, Benha University Hospitals, Benha city, Egypt, from April 2023 to December 2023.

The study included 100 patients (from both genders in the age between 5 and 10 years) who were scheduled for adenotonsillectomy, tonsillectomy or adenoidectomy.

The cases with the following criteria were excluded, patients younger than 5 years and more than 10 years, patients with systemic diseases, mentally retarded patients and patients who suffer from autism or Attention-deficit/hyperactivity disorder.

All procedures adhere to the 2013 Helsinki Declaration [(8)]. The study was approved by the Benha university faculty of medicine's local ethics committee (Code number: 53-5-2023).

The included cases underwent full and detailed history taking (with concentration on the analysis of the complaint related to adenoids hypertrophy with degree of adenoids75% and degree of tonsillectomy hypertrophy 3 and 4). Full clinical examination was performed and local examination of the

pharynx was done by the aid of a tongue depressor. Full assessment of oral mucosa, dentition, and salivary ducts was then be performed by gently "walking" a tongue depressor about the lateral oral cavity. chronic tonsillitis was identified when enlarged inflamed tonsils with exudates were detected. Palpation of cervical lymph nodes was also done. The routine laboratory investigation was performed during the preoperative preparation including Complete blood count (CBC) and bleeding profile.

The surgical technique

-All procedures were performed by the same surgeon in the same setting.

-Adenotonsillectomy: Tonsillectomy was done by cold steel dissection and adenoidectomy by curettage

-All procedures were performed under general anesthesia and endotracheal intubation, when the patient was in the Rose position.

-Boyle–Davis mouth gag was introduced and opened. We held it in place by Draffin's bipods or a string over a pulley.

-The patient's tonsil was grasped with tonsil-holding forceps and pulled in a medial direction.

-Incision was made in the mucous membrane where at the region of reflection from the tonsil to anterior pillar. Extension along the upper pole to mucous membrane between the tonsil and posterior pillar was done when needed.

-A blunt curved scissor was used to dissect the tonsil from the peritonsillar tissue and separate its upper pole.

-Then, the tonsil was held at its upper pole with downward and medial traction. Dissection was continued with tonsillar dissector or scissors until lower pole was reached.

-A wire loop of tonsillar snare was threaded over the tonsil on to its pedicle, tightened, and the pedicle cut and the tonsil removed.

-A gauze sponge was placed in the fossa and pressure was applied for a few minutes. Bleeding points were tied with silk. Procedure was repeated on the other side.

Postoperative care

Patients were transferred to the internal ward then to the internal ward, where close monitoring and frequent assessments were done. The mouth and the nose were checked for bleeding. Oral fluid intake was allowed when the patient achieved complete recovery (cold milk or ice cream). The parents were recommended to gradually advance diet from soft to solid ingredients. Most patients were discharged on the same operative day unless complications were encountered. All patients were commenced on oral brad-spectrum antibiotic (amoxicillin clavulanic) and analgesic (acetaminophen) for seven days. Oral hygiene was also recommended. An antiseptic mouth was prescribed for all cases.

Acoustic analysis of voice

The analysis included fundamental frequency (F0-Hz), jitter percentage (%), shimmer percentage (%), and HNR (Harmonic/Noise ratio). Measurements were conducted during preoperative preparation and at first day, one week and one month after the operation [(9)].

Two experienced phoneticians performed all the measurements in a double-blind manner using the PRAAT software. The findings are approved if they are agreed by the two observers.

The AKG 190HS microphone was set 30 cm away from the patient to record his or her voice. Vocal analysis was performed using a professional microphone (Shure) positioned at a 90° angle in the mouth, with a distance of 5 cm for vowel/a and 10 cm for counting from 1 to 10 and spontaneous speech.

The child was instructed to take a big breath in before continuing with the pronunciation of the extended vowel

/a/. Additionally, they were told to do phonation at a pitch that stayed constant while variations in strength and loudness were made to accommodate the specific needs of each individual. The sustained/a/vowel was used in the analysis to remove any abnormalities at the start and finish of the utterance.

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Statistical analysis

SPSS v26 was used to do the statistical analysis (IBM Inc., Armonk, NY, USA). Histograms and the Shapiro-Wilks test were used to assess the data distribution's normality. The unpaired student t-test was used to assess quantitative parametric data, which were shown as mean and standard deviation (SD). The Mann Whitney test was used to evaluate quantitative non-parametric data, which were shown as the median and interquartile range (IQR). When applicable, the Chi-square test or Fisher's exact test were used to assess the qualitative data, which were shown as frequency and percentage (%). Statistical significance was defined as a two-tailed P value < 0.05.

Results

The current study included 100 children, patients who underwent an adenotonsillectomy, tonsillectomy or adenoidectomy in Benha university hospitals, during the period from April 2023 to December 2023.

As shown in (**Table 1)**, the mean age of the cases was 6.78 ± 1.77 years with age range between 5 and 10 years. There were 50% and 50% females. Regarding the type of operations performed, adenotonsillectomy was performed in 64%, tonsillectomy in 18% or adenoidectomy in 18%.

(Table 2) shows that preoperative fundamental frequency was 287.36 ± 42.87. The value of fundamental frequency increased during the postoperative follow up with values of 309.26 ± 52.52, 317.71 ± 46.98 and 323.63 ± 53.03 at 1 day, one week and one month postoperative. There was high statistically significant difference between each duration during the follow and also as compared to the preoperative value. preoperative shimmer test was 1.36 ± 0.21. The value of shimmer test during the postoperative follow up were of 1.36 ± 0.24, 1.40 ± 0.20 and 1.41 ± 0.19at 1 day, one week and one month postoperative, respectively. There was a statistically significant difference between the shimmer test at one month postoperative as compared to preoperative and 1 day postoperative. The preoperative jitter (local percent) was 2.62 ± 0.99. The value of jitter (local percent) decreased to 2.48 ± 0.93 at the first day postoperative and then increased again to 2.63 ± 0.98 and 2.63 ± 1.27 at one week and one month postoperative, respectively. There was a significant decrease at 1 day postoperative as compared to preoperative value. Also, there was a significant increase at 1 week and 1 month postoperative as compared to 1 day postoperative.

The preoperative harmony to noise ratio (HNR) was 7.43 ± 2.25. The value of harmony to noise ratio (HNR) decreased during the postoperative follow up with values of 7.21 ± 2.83, 6.16 ± 2.10 and 6.04 ± 2.13 at 1 day, one week and one month postoperative. There was high statistically significant decrease at the one week and one month postoperative as compared to the preoperative value and value at 1 day postoperative.

(Table 3) showed that the preoperative fundamental frequency was statistically significantly higher in the cases underwent adenoidectomy (301.32 ± 31.94) followed by the cases underwent adeno-tonsillectomy (289.84 ± 43.31) and then in the cases underwent tonsillectomy (264.59 ± 44.20). There was no statistically

significant difference between the cases who underwent different operations regarding the fundamental frequency at one day at one week postoperative. The fundamental frequency at 1 month postoperative was statistically significantly higher in the cases underwent adenoidectomy (349.63 ± 54.90) followed by the cases underwent adeno-tonsillectomy (323.31 ± 53.85) and then in the cases underwent tonsillectomy (298.77 ± 35.30). There was a statistically significant increase in the Fundamental frequency in all groups during the follow up starting from the first day postoperative. (**Table 2)**

(Table 4) shows that there was no statistically significant difference between the cases who underwent different operations regarding the shimmer test at preoperative value, one day, one week and one month postoperative. There was a statistically significant decrease in the shimmer test in the cases underwent adenoidectomy at one week and one month postoperative compared to the preoperative value. On the other hand, there was a statistically significant increase in the shimmer test in the cases underwent Adeno-tonsillectomy at one week and one month postoperative compared to the preoperative value.

(Table 5) shows that the preoperative jitter (local percent) and jitter (local percent) at one month postoperative were statistically significantly higher in the cases underwent adenoidectomy followed by the cases underwent tonsillectomy and then in the cases underwent adeno-tonsillectomy. There was no statistically significant difference between the cases who underwent different operations regarding the jitter (local percent) at one week and one month postoperative. There was a statistically significant decrease in the jitter (local percent) in the cases underwent adenoidectomy during the follow up at one week and one month postoperative.

(Table 6) shows that there was no statistically significant difference between the cases who underwent different operations regarding the Harmony to noise ratio (HNR) at preoperative value, one day, one week and one month postoperative. There was a statistically significant decrease in the Harmony to noise ratio (HNR) in the cases underwent adenoidectomy and, in the cases, underwent Adeno-tonsillectomy at one week and one month postoperative compared to the preoperative value.

Table 1: Age, sex and operation type in the cases of the study.

Variables		**Study cases N = 100**	
Age (Years)	**Mean ± SD**	6,78 ± 1.77	
	Median (Range)	6 (5 – 10)	
		Number	**Percent**
Sex			
Males		**50**	**50**
Females		**50**	**50**
Operation type			
Adenoidectomy		18	18
Tonsillectomy		18	18
Adenotonsillectomy		64	64

Data is presented as Mean ± SD. SD: standard deviation.

Table 2: Follow up of acoustic parameters in the cases of the study

Time point	Preoperative (N=100)	At 1st day postoperative (N=100)	At one week postoperative (N=100)	At one month postoperative (N=100)	*P* value
Fundamental frequency (F0)	287.36 ± 42.87	309.26 ± 52.52 a	317.71 ± 46.98 a, b	323.63 ± 53.03 a, b, c	F= 62.213 P < 0.001 *
Shimmer test	1.36 ± 0.21	1.36 ± 0.24	1.40 ± 0.20	1.41 ± 0.19 a, b	F= 76.610 P < 0.001 *
jitter (local percent)	2.62 ± 0.99	2.48 ± 0.93 a	2.63 ± 0.98 b	2.63 ± 1.27 b	Fr= 116.674 P < 0.001 *
Harmony to noise ratio(HNR)	7.43 ± 2.25	7.21 ± 2.83	6.16 ± 2.10 a, b	6.04 ± 2.13 a, b	Fr= 62.198 P < 0.001 *

Data is presented as Mean ± SD. F: Repeated measures ANOVA, Fr: Friedman's test, F0: fundamental frequency, *: Statistically significant (p<0.05), HNR: Harmony to noise ratio, a: Significance in relation to preoperative data, b: Significance in relation to 1st day, c: Significance in relation to 1st week.

Table 3: Comparison of Fundamental frequency (F0) in the studied cases according to the type of surgery

Time of follow up	Adenoidectomy (N=18)	Tonsillectomy (N=18)	Adeno-tonsillectomy (N=64)	Test of significance
Preoperative	301.32 ± 31.94	264.59 ± 44.20	289.84 ± 43.31	**F = 3.804 *p* = 0.026***
At 1st day postoperative	331.62 ± 45.52	295.40 ± 44.24	306.86 ± 55.18	F = 2.389 *p* = 0.097
Paired samples t-test (With baseline)	**0.003***	**< 0.001 ***	**< 0.001 ***	
At one week postoperative	333.95 ± 42.53	297.16 ± 36.10	318.93 ± 49.31	F = 2.929 *p* = 0.058
Paired samples t-test (With baseline)	**0.001***	**< 0.001 ***	**< 0.001 ***	
At one month postoperative	349.63 ± 54.90	298.77 ± 35.30	323.31 ± 53.85	**F = 4.249 *p* = 0.014***
Paired samples t-test (With baseline)	**0.001***	**< 0.001 ***	**< 0.001 ***	

Data is presented as Mean ± SD, F: One-Way ANOVA test, F0: Fundamental frequency, *: statistically significant (p< 0.05).

Table 4: Comparison of shimmer test in the studied cases according to the type of surgery

Time of follow up	Adenoidectomy (N=18)	Tonsillectomy (N=18)	Adeno-tonsillectomy (N=64)	Test of significance
Preoperative	1.38 ± **0**.18	1.40 ± **0**.25	1.35 ± **0**.21	F = 0.511 *p* = 0.602
At 1st day postoperative	1.31 ± **0**.13	1.41 ± **0**.26	1.37 ± **0**.26	F = 0.775 *p* = 0.463
Paired samples t-test (With baseline)	0.054	0.896	0.429	
At one week postoperative	1.34 ± **0**.14	1.43 ± **0**.16	1.40 ± **0**.22	F = 0.928 *p* = 0.399
Paired samples t-test (With baseline)	**0.011 ***	0.506	**0.038 ***	
At one month postoperative	1.36 ± **0**.17	1.44 ± **0**.16	1.40 ± **0**.21	F = 0.927 *p* = 0.399
Paired samples t-test (With baseline)	**0.007 ***	0.384	**0.037 ***	

Data is presented as Mean ± SD, F: One-Way ANOVA test, *: statistically significant (p< 0.05).

Table 5: Comparison of jitter (local percent) in the studied cases according to the type of surgery

Time of follow up	Adenoidectomy (N=18)	Tonsillectomy (N=18)	Adeno-tonsillectomy (N=64)	Test of significance
Preoperative	3.10 ± 1.16	2.88 ± 1.32	2.41 ± **0**.77	**F = 4.412 p = 0.015***
At 1st day postoperative	2.85 ± 1.08	2.80 ± 1.02	2.29 ± **0**.81	**F = 4.180 p = 0.018***
Paired samples t-test (With baseline)	0.056	0.675	0.105	
At one week postoperative	2.82 ± 1.08	2.96 ± 1.17	2.49 ± **0**.87	F = 2.083 p = 0.180
Paired samples t-test (With baseline)	**0.003 ***	0.542	0.363	
At one month postoperative	2.74 ± 1.07	2.89 ± 1.18	2.53 ± 1.34	F = 0.650 p = 0.524
Paired samples t-test (With baseline)	**0.001 ***	0.966	0.440	

Data is presented as Mean ± SD, F: One-Way ANOVA test, *: statistically significant (p< 0.05).

Table 6: Comparison of Harmony to noise ratio (HNR) in the studied cases according to the type of surgery

Time of follow up	Adenoidectomy (N=18)	Tonsillectomy (N=18)	Adeno-tonsillectomy (N=64)	Test of significance
Preoperative	6.37 ± 1.55	7.35 ± 2.73	7.74 ± 2.21	F = 2.697 p = 0.072
At 1st day postoperative	7.42 ± 2.25	6.86 ± 2.27	7.25 ± 3.12	F = 0.193 p = 0.825
Paired samples t-test (With baseline)	0.059	0.362	0.109	
At one week postoperative	5.44 ± 1.03	6.45 ± 1.98	6.28 ± 2.33	F = 1.331 p = 0.269
Paired samples t-test (With baseline)	**0.018***	0.127	**< 0.001 ***	
At one month postoperative	5.16 ± **0**.77	6.38 ± 2.05	6.18 ± 2.36	F = 1.946 p = 0.148
Paired samples t-test (With baseline)	**0.001***	0.106	**< 0.001 ***	

Data is presented as Mean ± SD, HNR: Harmony to noise ratio, F: One-Way ANOVA test, *: statistically significant (p< 0.05).

Discussion

The current study was conducted to analyze the changes in acoustic voice parameters after tonsillectomy, adenoidectomy, or adenotonsillectomy. The current study included 100 children, patients who underwent an adenotonsillectomy, tonsillectomy or adenoidectomy in Benha university hospitals, during the period from April 2023 to December 2023.

The vocal cord vibratory pattern changes often and quickly in the majority of clinical disorders; these variations are reflected acoustically as F0 disruptions [(10)]. F0 indicates vocal fold vibratory rate and supralaryngeal vocal tract resonance related to tongue articulation and placement [(11, 12)].

In this study, the preoperative fundamental frequency was 287.36 ±

42.87. The value of fundamental frequency increased during the postoperative follow up with values of 309.26 ± 52.52, 317.71 ± 46.98 and 323.63 ± 53.03 at 1 day, one week and one month postoperative. There was high statistically significant difference between each duration during the follow and also as compared to the preoperative value.

This was supported by Brkic et al., [4] who examined 1258 adenotonsillectomy patients and found that F0 values differed statistically between preoperative measurements and measurements taken on the first and seventh postoperative days, but not 1 month after surgery.

This was also consistent with the findings of Atan et al., [13] who observed noteworthy alterations in F0 one month following surgery in their investigation of 26 people having tonsillectomy surgery.

This contradicted Shetti et al., [14] who included 60 adenotonsillectomy patients. They found no statistical significance between pre-operative and post-operative (after four weeks) fundamental frequencies.

The results contradict Liu et al., [15] who found no significant changes in F0 at 1 month after tonsillectomy in 98 pediatric patients.

Even though adenotonsillectomy does not affect the larynx, it changes the vocal tract structure, which affects speech resonance, so surgery can improve speech quality [11, 12].

Subramaniam and Kumar found that F0 changed significantly only in children aged 5 to 10 years, and the mean F0 values varied by age. The only statistically significant reduction in F0 values postoperatively was in boys aged 11–16 [16].

Tonsillectomy and adenoidectomy do not directly affect the larynx, so they should not affect vocal fold opening and closing during sustained phonation [15, 17]

In the current study, preoperative shimmer test was 1.36 ± 0.21. The value of shimmer test during the postoperative follow up were of 1.36 ± 0.24, 1.40 ± 0.20 and 1.41 ± 0.19at 1 day, one week and one month postoperative, respectively. There was a statistically significant difference between the shimmer test at one month postoperative as compared to preoperative and 1 day postoperative.

In agreement with Brkic et al., [4] shimmer measures showed no statistically significant variations between preoperative and first or seventh postoperative days. After one month of surgery, the shimmer values were significantly lower than what they had been one month prior.

This agreed with the results of recent meta-analysis by Wang et al. that included twenty-three studies with 2154 children were analyzed. The computerized acoustic analysis revealed significant changes in shimmer at 1 month after surgery. With follow up at 3 months postoperative, the change was statistically insignificant [18].

Shetti et al., [14] also found comparable findings, with a drop in the mean shimmer value from 5.75 before surgery to 2.57 after (p=0.000).

In their study of 26 adults after tonsillectomy, Atan et al., [13] found significant shimmer changes one month after surgery. This copes with the current findings.

In contrast, Liu et al., [15] found no significant shimmer alterations at 1 month after tonsillectomy in 98 pediatric patients.

In a study by Dimatos et al., [2] shimmer during vowel production changed significantly between preoperative and one-month postoperative time, but other acoustic characteristics did not alter.

In this study, preoperative jitter (local percent) was 2.62 ± 0.99. The value of jitter (local percent) decreased to 2.48 ± 0.93 at the first day postoperative and then increased again to 2.63 ± 0.98 and 2.63 ± 1.27 at one week and one month postoperative, respectively. There was a significant decrease at 1 day postoperative as compared to preoperative value. Also, there was a significant increase at 1 week and 1 month postoperative as compared to 1 day postoperative.

The findings of the current study were in agreement with those of Liu et al., [15] who included 98 pediatric patients who had undergone tonsillectomy and found that there were no significant changes in jitter at one month after surgery.

On the other hand, the majority of the research that evaluated the variations in jitter test values revealed significant shifts at later durations. Brkic et al., [4] for example, found no statistically significant variations between preoperative jitter values and the first two postoperative assessments. The investigation found statistically significant reduced values one month after surgery when compared to the preoperative jitter test.

This was consistent with the findings of Wang et al., [18] recent meta-analysis, which examined twenty-three trials involving 2154 children. Computerized acoustic analysis showed considerable changes in jitter one month after surgery. At three months postoperatively, the difference was statistically negligible.

This was consistent with Shetti et al, [14] findings, which indicated that the mean jitter percentage after adenotonsillectomy decreased from 3.62 to 0.64. These results were found to be statistically highly significant (p=0.000).

Like our study, Lundeborg et al., [19] found a drop in jitter percent post-surgery, but the 65 measurements were still greater than the control group of normal youngsters.

Additionally, Atan et al, [13] showed significant alterations in jitter one month post-surgery in their study involving 26 adults having tonsillectomy.

Gomaa et al., [20] found that preoperative Jitter readings considerably decreased at the 3rd month ($P < 0.001$), with a significant difference between 1st and 3rd month readings ($P = 0.004$). Due to persistent tissue edema from electro-cautery during adenotonsillectomy, jitter and shimmer did not normalize until the third month after surgery in their study.

When tissue hypertrophy dampens the vocal transfer function, vocal sound quality and precision decline. Noise harmonics ratio measures aperiodic noise in voice signals [21].

In the current study, the preoperative harmony to noise ratio (HNR) was 7.43 ± 2.25. The value of harmony to noise ratio (HNR) decreased during the postoperative follow up with values of 7.21 ± 2.83, 6.16 ± 2.10 and 6.04 ± 2.13 at 1 day, one week and one month postoperative. There was high statistically significant decrease at the one week and one month postoperative as compared to the preoperative value and value at 1 day postoperative.

Consistent with what Shetti et al., [14] found, the average NHR dropped from 36.20 to 13.98 in the group that underwent adenotonsillectomy.

Also, Comparison of HNR in the study by Brkic et al., [4] revealed statistically significant differences between preoperative values and measurements on the 1st and 30th postoperative days. No statistical significance was observed when comparing the preoperative measurement with values 1-week postoperatively.

On the other hand, the results contradicts those of Liu et al., [15] who

analyzed 98 pediatric patients undergoing a tonsillectomy revealing no significant changes in HNR at 1 month after surgery.

Additionally, Subramaniam and Kumar found the exact opposite—that HNR were greater after surgery than they had been before—across all age categories and both sexes. On the other hand, there were no statistically significant changes between the groups before and after surgery [16].

The variance in results after adenotonsillectomy may be due to transient alterations in vocal output, causing phonation instability that dissipates after surgery [20].

These modifications may have been transient, and it's unclear if normalization would have followed. This idea is corroborated by two study groups, which found alterations in all four acoustic voice characteristics after 30 days and normalization after 3 months [2, 13].

Low NHR readings have been associated with specific dysphonic features, including breathiness, roughness, and hoarseness, according to some researchers. Reduced NHR is a manifestation of the effects of enlarged tonsils and adenoids on the voice resonators [16, 22]

In the current study, there was no statistically significant difference between the cases who underwent different operations regarding the fundamental frequency, shimmer test, jitter (local percent) and harmony to noise ratio (HNR) at one day, at one week postoperative and at one month postoperative. However, the fundamental frequency at 1 month postoperative was statistically significantly higher in the cases underwent adenoidectomy (349.63 ± 54.90) followed by the cases underwent adeno-tonsillectomy (323.31 ± 53.85) and then in the cases underwent tonsillectomy (298.77 ± 35.30).

This was in agreement with the findings of Brkic et al., [4] who demonstrated that all acoustic voice parameters exhibited the same statistically significant changes when cases were categorized according to surgical type (tonsillectomy vs. adenoidectomy vs. adenotonsillectomy).

Acoustic speech parameters may evaluate vocal tract effects from tonsil or adenoids removal, which does not directly influence the larynx. In some cases, supralaryngeal vocal tract architecture can impact tongue positioning and articulation, which can affect vocal cord vibration and resonance [17].

Massive tonsil hypertrophy may allow this, according to another opinion. The excision of this much adenotonsillar tissue may affect voice quality after surgery. One may argue that shifts in F0, shimmer, jitter, and HNR would reflect these modifications [4].

It has been shown that the removal of tonsils or adenoids from the supralaryngeal vocal tract might change the pattern of vibration of the vocal cords, which can cause phonation instability [17].

The current study has a few limitations that could reduce the power of the obtained results, such as a small included sample size and being a single center study. However, the results are still promising. The power to assess the long-term effects of follow-up on vocal-related parameters may be limited due to the relatively short duration of the study and it is preferable to select one operation adenoidectomy, tonsillectomy or adenotonsillectomy.

Conclusions

Because adenotonsillectomy is linked to significant changes in the various

acoustic aspects of children, it is important to exercise caution during the follow-up period in order to ensure that the children receive the best possible care. To avoid major voice disorders after adenotonsillectomy: Screen for predisposing conditions (e.g. VPI), use careful, tissue-sparing surgical techniques, avoid over-resection of adenoid pad near velopharyngeal valve and ensure proper postoperative follow-up and early speech intervention if needed.

List of abbreviations

F0: fundamental frequency, HNR: Harmonic/Noise ratio, HNR: harmonic distortion ratio, CBC: Complete blood count, F test: ANOVA test, Fr test: Friedman's test.

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