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The effect of tonsillectomy on voice quality

Утицај тонзилектомије на квалитет гласа

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The effect of tonsillectomy on voice quality

Утицај тонзилектомије на квалитет гласа

SUMMARY

Introduction/Objective Tonsillitis is a very common condition found in the pediatric population but also in adult patients. One of the consequences of such conditions is poor voice quality. Hoarseness, poor voice impostation, interruption, and hypernazalization are just some of the differences in patient voice quality.

The objective of this paper was to examine the effects of tonsillectomy on the voice quality.

Methods The sample included 37 patients, 17 female and 20 males, ranging in age from 3 to 39 years. The method involved recording patients a month before and a month after tonsillectomy with a digital sound recorder and were analyzed in the Praat program. The variables monitored in the basic voice are: voice pitch, standard deviation of voice, degree of voice interruption, Jitter, Shimmer, and signal-to-noise ratio. In the statistical analysis, in addition to standard descriptive analyzes, t-test and ACNOVA were also used.

Results The results show that there are effects of tonsillectomy on SD of baseline voice (p = 0.002), Shimmer (p = 0.002) baseline voice interruption rate (p = 0.023), signal to noise ratio (p = 0.003). There were no differences in the effects of tonsillectomy with respect to the gender of the subjects.

Conclusion Based on the conducted research, there were some methodological conclusions that could be considered as a recommendation for future research: increase the number of persons in the sample, introduce a variable of chronological age, type of surgical intervention and gradation of size of the tonsil and adenoid tissue.

Keywords: tonsillectomy; voice quality; acoustic analysis

САЖЕТАК

Увод/циљ Обољења тонзила су веома често стање које се среће у педијатријској популацији, али и код одраслих пацијената. Једна од последица која се може евидентирати код оваквих стања је лош квалитет гласа. Промуклост, лоша импостација гласа, прекидност и хиперназализација су само нека од одступања у квалитету гласа пацијената. Циљ овог рада је био да се испитају ефекти тонзилектомије на квалитет гласа.

Методе У узорку је било 37 пацијената и то 17 женског и 20 мушког пола, старости од 3 до 39 година. Метод је подразумевао снимање пацијената пре и месец дана после тонзилектомије дигиталним снимачем звука и анализиран је у програму *Praat*. Варијабле које су праћене у основном гласу су: висина гласа, стандардна девијација гласа, степен прекидности гласа, *jitter*, *shimmer* и однос сигнал–шум. У статистичкој анализи поред стандардних дескриптивних анализа коришћен је још и *t*-тест и *ACNOVA*.

Резултати Резултати показују да постоје ефекти тонзилектомије на *SD* гласа (p = 0,002), степен прекидности гласа (p = 0,002), *shimmer* (p = 0,023) и однос сигнал–шум (p = 0,003). Нема разлика у ефектима тонзилектомије у односу на пол испитаника.

Закључак На основу спроведеног истраживања дошло се и до неких методолошких закључака који би се могли посматрати као препорука за будућа истраживања: повећати број особа у узорку, увести варијаблу хронолошког узраста, врсту хируршке интервенције и градацију величине тонзила и аденоидног ткива.

Кључне речи: тонзилектомија; квалитет гласа; акустичка анализа

INTRODUCTION

Voice, as a significant component of communication, has characteristics that provide some information about the speaker, such as age and gender, but also more subtle information, such as temperament, intention, emotion, or mood. The basic characteristics of voice are: height, intensity and color. Depending on the speed of vibration of the vocal cords, a stronger or quieter voice is produced, and higher or lower, depending on their tension and length. A quality, pleasant voice helps listeners focus on what they hear and listen to the

speaker with pleasure. An unpleasant voice interferes with communication and can frustrate both the speaker and the listener. Voice quality can be influenced by various factors such as health status, fatigue, hormonal status, stress, articulation disorders etc. [1].

One of the diseases that often lead to changes in voice quality is tonsillitis. This is due to the most common morphological and structural changes in the oral resonator that occurs in this condition. Morphological changes are associated with changes in the shape of the resonator, and structural changes are associated with changes in the structure of affected tonsil tissue.

Morphological changes most often occur with tonsil hypertrophy leading to a decrease in capacity and a change in the shape of the oral resonator. The phonation current under such conditions does not have a free and proper flow through the oral resonator. The particles of the phonation current encounter mechanical obstacles in the form of hypertrophic tonsils, leading to erroneous oscillations. This causes turbulence in the voice and therefore irregularities in the harmonics. The enlarged tonsils also misdirect the flow of the phonation current, so the phonation current often flows out through the nasal resonator, which leads to hypernasality [2]. In the Serbian language, there are only three voices that are inherently nasal (m, n, and nj) all other voices are oral, and any admixture of nasality in these voices is considered an articulatory deviation.

Structural changes need not only be associated with hypertrophic tonsils but also with all other diseases that lead to structural changes in the tissue of the tonsil. Unlike morphological changes, these changes affect the tone, that is, the tension and firmness of the resonator walls, which cause oscillation of the phonation particles and thus affect the voice quality. If the tonus is low or too high or the tissue relief is altered than the voice will surely suffer certain consequences.

Tonsillectomy is one way of treating tonsillitis and is the most common surgery in otolaryngology, especially in the pediatric population [3, 4]. One of the indications for tonsillectomy is obstruction, while changes in the voice, although present, do not represent a reason for a surgery.

Several studies have shown that tonsillectomy and adenoidectomy have influence on voice quality [5, 6, 7, 8]. After tonsillectomy, a modification of the morphology and structure of the oral resonator occurs, which results in changes in the acoustic characteristics of the

voice [9]. Part of the studies suggest that hypertrophic tonsils have hypernasality as a concomitant symptom that decreases postoperatively and thus leads to improvement of voice quality [10]. However, some studies show that after tonsillectomy, only a subjective experience of voice improvement occurs but this is not confirmed by objective measurement [11, 12].

To date, not many researches were measuring voice quality by physical acoustic measures, but mainly using scales for subjective voice assessment. This was one of the reasons for the use of spectral voice analysis in this study. The aim of this study was to investigate the effect of tonsillectomy on voice quality by monitoring basic acoustic parameters before and after surgery.

METHODS

This study was approved by the Ethics Committee of the Faculty of Special Education and Rehabilitation, at the Belgrade University and the University Hospital in Foca. All respondents gave their consent to participate in this research. The study was conducted from August 2014 to September 2015 at Foca University Hospital, Department of Otolaryngology. The study involved cohort of participants, 17 female and 20 males, ranging in age from 3 to 39 years (mean age 11.04 years). All individuals in the sample had clear indications for the operative treatment of adenoid vegetation and palatal tonsils and all operations were performed by the same operating team using the same operating techniques (cold adenotonsillectomy, haemostasis by electrocautery).

All patients were examined by otolaryngologists. The examination consisted of: taking a detailed medical history, physical examination and, if necessary, audiological diagnostics. The criteria for inclusion in the study sample were: indications for tonsillectomy, adenoidectomy and tonsilladenoidectomy.

The criteria for exclusion from the sample were: patients with second-degree voice disorders, neurological diseases, upper and lower respiratory tract infections, and craniofacial malformations affecting speech.

All patients were recorded with an Olympus VN-7000 digital voice recorder one day before surgery and one month after surgery. The recorded material was then transferred to a PS computer and processed using a PRAAT program, created by Powell Boersma and David Weenink of the Institute of Phonetics, University of Amsterdam [13]. First, voice segmentation was made that allowed the vocal to be clearly separated from the words and to analyze the basic voice when pronouncing the vocals. The standard Praat bands were used in the analysis, namely the frequency ranges from 0 to 5000Hz with voice sampling every 0.005 seconds and dynamic range up to 50 dB.

Voice quality was monitored through the following variables: base voice pitch (Hz), standard deviation of base voice, voice interruption rate, vocal frequency oscillations (%) - Jitter, vocal volume oscillations (dB) - Shimmer, and signal to noise ratio.

Data were analyzed using IBM SPSS Statistics for Windows, Version 24.0 (IBM Corp., Armonk, NY, USA). In the statistical analysis, t-test and ANCOVA were used in addition to standard descriptive analyzes.

RESULTS

Table 1 shows the results of the observed variables of voice quality before and after tonsillectomy. It is evident that some changes in voice quality were identified, in some of the analyzed variables. Statistically significant differences were observed in the SD of baseline voice at the level of $t = 3.330$ and $p = 0.002$ and it was found that the SD was significantly smaller after the tonsillectomy, which was also seen in Mean which, before the operation, was 66 and afterwards 31Hz.

Statistically significant differences were also found in the voice interruption rate ($t = 3.408$; $p = 0.002$), in the intensity fluctuations of the vocal cords - Shimmer ($t = 2.369$; $p = 0.023$) and in the signal-to-noise ratio ($t = -3.212$; $p = 0.003$). All analyzed voice parameters showed better values after tonsillectomy. The baseline interruption rate after surgery decreased from 23.39% to 10.82%, the Shimmer from 1.38dB to 1.23dB, and the signal-to-noise ratio increased from 7.5 to 9.4dB (Table 1).

Frequency fluctuations of the vocal cords - Jitter also showed a tendency to decrease after tonsillectomy from 1.29 to 1.03%, but this decrease was not statistically significant one month after tonsillectomy. It can be stated that the smallest change was in the pitch. There was a discrete decrease in voice value from 249 to 244Hz, with no statistical significance (Table 1).

Analyzing the changes in voice quality between men and women through the parameters listed in Table 2, we can see that there is no statistically significant difference that would indicate a different effect of tonsillectomy on male and female gender, respectively. The only statistically significant difference was observed in the frequency oscillation of the vocal cords - Jitter, before surgery, which was statistically significantly more pronounced ($t = 5.088$; $p = 0.031$) in men (1.42%) compared to women (1.13%). This difference is lost after tonsillectomy.

DISCUSSION

Dysphonias resulting from diseased tonsils and adenoids can impair person's quality of life in his or her professional, educational, or daily functioning. Therefore, it is important that the principle of monitoring the effects, not only of tonsillectomy, but also of other surgical interventions on the day-to-day functioning of operated patients, be established and become part of the therapeutic routine. To our knowledge, no research has been conducted to examine changes in the voice quality of patients after tonsillectomy.

The obtained and analyzed results of our study indicate that there are some changes after tonsillectomy in most of the analyzed acoustic parameters of the voice. Removal of enlarged adenoid tissue and tonsils results in changes in the resonator cavities, especially in the nasopharynx. As a result, the resonator cavities widen, and the soft palate becomes more mobile[9]. These anatomical-morphological changes of the vocal tract resonators that occur after surgery, lead to certain changes in the quality of voice, and therefore in the speech of patients [14, 15].

The impact of tonsillectomy on voice pitch has not been determined in this study which confirms the findings of some similar studies [16, 17]. There are also other conclusions that emerged from the research by Mora and colleagues [7] regarding the changes in pitch.

Namely, they found these changes to be statistically highly significant. The results of our research support the fact that no changes in this acoustic parameter of the voice are expected after tonsillectomy [18], because it is an operation that does not directly touch the larynx, and therefore does not affect the rate of vocal cord adduction during phonation. Patients may have subjective observations about changes in their voice after tonsillectomy, as evidenced by research by Behrman et al. [19] who found that one-fifth of patients in their own observation had improvement, while none had a deterioration of voice after surgery. Similar results have been reported in other studies indicating that there were no changes in the acoustic parameters of the voice and that patients reported a subjective sense of improvement in voice quality [20, 21, 22]. In any case, the subjective experience of improving voice quality is very important, especially in patients whose general quality of life has been compromised by this disease [23].

One of the variables registered with statistical significance is standard deviation of the voice, indicating that tonsillectomy stabilizes the voice at values predicted for a gender and age. Even though statistical significance was not recorded in the voice peaks, as expected, indirectly, that is, through the standard deviation, the effect of tonsillectomy on this acoustic parameter was observed. This means that tonsillectomy does not affect the abduction of the vocal cords but does affect the stabilization and safer impostation of the voice. This surgical intervention reduces the differences between the minimum and maximum peaks in speech production, which affects the homogeneous grouping of individual voices around assumed standard norms.

Voice interruption is a variable in which a statistically significant difference in form of percentage reduction after surgery is also found. The presence of intermittent voice in the studied patients is probably due to altered surrounding tissue caused by inflammation, increased secretion, or fatigue. Their attempts to speak with the usual tension of the vocal cords caused the vocal cords not to vibrate at that frequency, which causes spasm. This spasm is perceived in the voice as interruption in phonation. Removal of altered diseased tissue as well as minimization of post-operative talking leads to functional recovery, as confirmed by the results of our study.

Statistically significant differences were observed in the decrease in the intensity fluctuations of the vocal cords - Shimmer, which occurs after surgery. Similar results have been reported in other studies [24, 8], which show that during the postoperative period, this

acoustic parameter normalizes. Decibel decrease Shimmer indicates improvement in voice quality because of function of transfer in supraglottic cavities, which in the preoperative status was impaired by hypertrophic adenoids and tonsils [24]. Tarnopolsky et al. [25] point out that there is a difference in Shimmer improvements depending on the type of surgical intervention, that is, a greater improvement in this acoustic parameter occurs after adenotonsillectomy than after tonsillectomy. Unlike Shimmer, no statistically significant difference was observed in the frequency oscillations of the vocal cords - Jitter. However, it should be emphasized that the deviations of voice in Jitter prior to surgery were minimal compared to the reference values, the value before surgery was 1.23%, after surgery 1.03, and the reference value is 1%.

The signal-to-noise ratio in the results of this study showed that most patients had poor voice quality before surgery, that is, their voice had a lot of noise. After surgery, there was an increase in the difference between signal and noise, indicating a statistically significant improvement in voice quality. The average value of the signal-to-noise ratio did not reach the reference value of 10dB, but the deviation from this value is minimal and is 9.38. In the research carried by Mora at al. [7] NHR reached the value of orderly voice, which is explained by the changed dynamics of the vocal tract structure.

Analyzing the results of the acoustic parameters of the basal voice before and after tonsillectomy with respect to gender, it was found in our study that there were minimal statistically significant differences. A statistically significant difference appeared between men and women in Jitter before surgery, whereas after surgery, the difference was present but not statistically significant. This means that the intervention led to a significant improvement in this parameter in men, so this difference among them and the women disappeared. There were no statistically significant differences in all other acoustic parameters. Other studies have found statistically significant differences in pitch in relation to gender, since it has been found that there is no change in baseline frequency for women, unlike men, where statistically significant change was found [18].

Based on the conducted research, there were some methodological conclusions that could be considered as limitations of our work. First, to be able to make conclusions with high reliability, the number of persons in the sample should be increased; the sample of children and adults should be grouped separately. It would be very important to deepen these studies in the direction of testing with relation to the type of surgical intervention being

performed (tonsillectomy, adenoideoctomy or tonsilladenoideoctomy). Also, for hypertrophic tonsils, a new variable should be introduced relating to the categorization or gradation of the size of the tonsils and adenoid tissue.

CONCLUSION

The results of our study showed that tonsillectomy affects most of the acoustic parameters of the voice, such as standard deviation of voice peaks, interruption rate of voice, Shimmer, and signal-to-noise ratio. The effects of this surgical intervention are not recorded in Jitter and the pitch of the baseline voice. Based on this, the general conclusion would be that tonsillectomy has a positive effect on improving voice quality.

Also, the recommendations arising from our research would relate to extending the indications for performing tonsil and adenoid surgery, especially in those practicing professions where voice quality is important. The voice is an essential mean of work for the singers, presenters or lecturers and it is certainly important for them that their voice is clean, clear, with the right strength and pleasant. In addition, it would be good to introduce phonopedic therapy and short training on informal exercise programs to be carried out at home in those individuals who do not experience improvement in voice quality even one month after surgery.

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Table 1. Differences in voice quality before and after tonsillectomy

Variable	Before		After		t	p
	Mean	SD	Mean	SD		
Peak of baseline voice in Hz	248.64	43.76	243.84	59.1	0.596	0.555
SD of baseline voice	66.1	50.08	31.23	27.01	3.330	0.002
Baseline voice interruption rate	23.39	17.31	10.82	13.57	3.408	0.002
Frequency oscillations of vocal cords in % – jitter	1.29	0.61	1.03	0.56	1.902	0.065
Intensity fluctuations of vocal cords in dB – shimmer	1.38	0.25	1.23	0.27	2.369	0.023
Signal to noise ratio	7.5	2.46	9.38	2.85	-3.212	0.003

*statistical significance ($p < 0.05$)

Table 2. Differences in voice quality with respect to sex before and after tonsillectomy

Variable		Men		Women		t	p
		Mean	SD	Mean	SD		
Peak of baseline voice in Hz	Before	254.14	49.39	242.16	36.48	1.480	0.232
	After	241.31	69.27	246.81	46.30	0.878	0.355
SD of baseline voice	Before	74.60	45.06	56.11	55.09	1.806	0.188
	After	33.4	28.05	28.68	26.36	0.832	0.368
Baseline voice interruption rate	Before	19.36	15.83	28.13	18.24	2.326	0.136
	After	13.23	14.29	8	12.48	1.289	0.264
Frequency oscillations of vocal cords in % – jitter	Before	1.42	0.63	1.13	0.56	0.156	0.031
	After	1.22	0.66	0.81	0.31	2.104	0.088
Intensity fluctuations of vocal cords in dB – shimmer	Before	1.44	0.178	1.31	0.3	2.373	0.133
	After	1.23	0.25	1.24	0.3	0.000	0.985
Signal to noise ratio	Before	7.06	1.87	8.03	2.98	1.180	0.285
	After	8.93	3.16	9.91	2.42	0.840	0366

*statistical significance ($p < 0.05$)

