



RESEARCH

EFFECTS OF TONSILLECTOMY ON ACOUSTIC PARAMETERS

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SUMMARY

The vocal tractus from the glottis to the lips is considered to be a resonator and any change in its shape may cause voice changes. Since tonsillectomy causes a shape and volume difference in supraglottic area, it is assumed that acoustic characteristics may change postoperatively. In this study, the effects of tonsillectomy over voice parameters is examined. 20 patients (13 males, 7 females), aged between 21 and 39 were included to the study. They all went tonsillectomy for recurrent episodes of tonsillitis under regional anesthesia. Voice samples to measure F0 (fundamental frequency) and F1, F2, F3 formants were recorded 1 week before and 3 months after the surgery. These parameters were analyzed on a sustained [a:] using the CSL main program with the Computerized Speech Lab CSL 4300B (Kay Elemetrics Ltd., Lincoln Park, NJ, USA). The patients were also asked, whether they perceived any change in their voices postoperatively. None of the patient perceived any change in his/her voice postoperatively. Fundamental frequency (F0), F1, F2 and F3 formants showed statistically insignificant changes in females postoperatively. In males, F1 and F2 formants showed statistically significant changes postoperatively. As a conclusion, in cases for vocal performing artists, they should be warned for any possible changes in voice colors after surgery.

Keywords: Tonsillectomy, acoustic analysis, formant

TONSİLLEKTOMİNİN AKUSTİK PARAMETRELER ÜZERİNE ETKİLERİ

ÖZET

Glottisten dudaklara kadar olan vokal traktus rezonator olarak kabul edilir ve şeklindeki her hangi bir değişiklik ses değişikliklerine sebep olabilir. Tonsillektominin supraglottik alanda neden olduğu şekil ve hacim değişikliğinin post operatif akustik karakteristikleri değiştirebileceği düşünülmektedir. Bu çalışmada tonsillektominin ses parametreleri üzerine etkileri incelenmiştir. Yaşları 21 ve 39 arası 20 hasta (13 erkek 7 kadın) çalışmaya dahil edilmiştir. Hepsine tekrarlayan tonsillit atakları nedeniyle lokal anestezi altında tonsillektomi yapıldı. Ses örnekleri FO (Fundamental frekans) ve F1, F2, F3, formantları ameliyattan bir hafta önce ve üç ay sonra ölçülerek kaydedildi. Bu parametreler CSL ana programı kullanılan bilgisayarlı konuşma laboratuvarı CSL 4300B modeli (Kay Elemetrics Ltd., Lincoln Park, NJ, USA) üzerinde analiz edildi. Hastalar ayrıca post operatif seslerindeki algılanan değişiklikler açısından sorgulandı. Hastaların hiç biri post operatif fark edilmiş ses değişikliği tariflemedi. Fundamental frekans (F0), F1, F2 ve F3 formantları kadın hastalarda ameliyat sonrası dönemde istatistiksel olarak anlamlı bir değişim göstermedi. Erkek hastalarda ise F1 ve F2 formantları ameliyat sonrası dönemde istatistiksel olarak anlamlı bir değişim göstermiştir. Sonuç olarak seslerini profesyonel olarak kullanan kişiler cerrahi sonrası olası ses rengi değişiklikleri açısından uyarılmalıdır.

Anahtar Sözcükler: Tonsillektomi, ses analizi, formant

INTRODUCTION

Tonsillectomy is a common surgical procedure performed to treat upper respiratory tract infections and/or obstructive diseases caused by recurrent and/or hypertrophic tonsillitis. This procedure is one of the most performed surgical procedures worldwide.

The vocal tractus is a resonator and any change in its shape may cause voice changes. Since tonsillectomy causes a shape and volume difference in the supraglottic area, it is assumed that acoustic characteristics may change after tonsillectomy. But the question is whether these changes are minimal or they have a crucial effect over voice parameters? The answer to this question is important for the vocal

performing artists, since any change in vocal quality may interfere performing their jobs. In this study, the effects of tonsillectomy over voice parameters is examined.

MATERIAL and METHODS

20 patients (13 males, 7 females), aged between 21 and 39, mean age 29, were included to the study. They all went tonsillectomy for recurrent episodes of tonsillitis under regional anesthesia. Voice samples to measure F0 (fundamental frequency) and F1, F2, F3 formants were recorded 1 week before and 3 months after the surgery. These parameters were analyzed on a sustained [a:] using the CSL main program with the Computerized Speech Lab CSL 4300B (Kay Elemetrics Ltd., Lincoln Park, NJ, USA). The patients were also asked, whether they perceived any change, negative or positive, in their voices postoperatively. Statistical analysis was carried out using Paired Sample T-Test procedure.

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Received: 8 March 2006, revised for: 5 April 2006, accepted for publication: 28 July 2006



Patient No	sex	pre-Fo(Hz)	pre-F1(Hz)	pre-F2(Hz)	pre-F3(Hz)	post-F0(Hz)	post-F1(Hz)	post-F2(Hz)	post-F3(Hz)	perceived voice change
1	f	244	612	1042	2432	238	664	1055	2543	N
2	f	218	778	1432	2890	214	772	1344	2816	N
3	f	196	445	1523	3012	201	442	1218	3218	N
4	f	255	812	1094	3217	248	801	1112	3432	N
5	f	231	566	987	2766	236	559	1002	3961	N
6	f	218	398	1271	3211	218	398	1284	2817	N
7	f	190	412	1439	3490	188	427	1440	2923	N
8	m	140	531	1528	3765	134	525	1551	3012	N
9	m	93	651	1374	2801	102	644	1411	3217	N
10	m	144	801	1639	2310	140	814	1699	3455	N
11	m	135	450	1138	2695	136	442	1143	2988	N
12	m	102	569	1217	2519	112	561	1299	3112	N
13	m	116	367	1410	3097	120	365	1501	3451	N
14	m	91	327	1032	3484	97	322	1030	2967	N
15	m	87	481	975	3401	92	489	992	3522	N
16	m	112	339	902	3248	114	336	1001	2918	N
17	m	105	617	1455	3917	107	611	1462	3331	N
18	m	81	429	1290	2912	92	417	1301	2310	N
19	m	124	311	703	3269	126	299	714	3379	N
20	m	132	723	943	3317	130	711	951	3412	N

Table 1: The vocal analysis results of the patients. Any perceived voice change by the patients themselves is also marked. (N= No), f=female; m=male

RESULTS

Results for males and females patients were shown in table 1. The means and the standard deviations of the male and female study groups were shown in table 2. Fundamental frequency (F0), F1, F2 and F3 formants showed statistically insignificant changes in females postoperatively (p values are 0.513, 0.518, 0.333 and 0.662 respectively). In males, F1 and F2 formants showed statistically significant changes postoperatively (p values are 0.047 and 0.005 respectively). None of the patients perceived any change in his/her voice postoperatively.

DISCUSSION

The effects of tonsillectomy over voice have not been studied extensively from the perspective of acoustic changes, other than its effect on nasalance¹. A few studies have examined potential changes in vocal quality after tonsillectomy. In general, minimal changes were found^{2,3,4,5}. Tonsillectomy can affect the voice by enlarging the resonating chamber and altering the formant frequencies or by altering the conformation of the tonsillar fossae^{1,3}. Potentially, part of the soft palate musculature can be removed or disturbed. This could theoretically lead to scarring and subsequent limitation of fine motor control or even velopharyngeal closure⁶.

Formants are the resonant frequencies of the vocal tract when vowels are pronounced. While vowels are attributed to this periodic resonance, consonants are not periodic. They are produced by restriction of air flow with the mouth, tongue, and jaw⁷. Formant refers to peaks in the harmonic spectrum of a complex sound which arise from some sort of resonance of the source. Because of their resonant origin, they tend to stay essentially the same when the frequency of the fundamental is changed⁸.

	Mean ± Std. Deviation (Hz) (Females)	Mean ± Std. Deviation (Hz) (Males)
Pre-op FO	221,71	112,46
	23,75	21,27
Post-op FO	220,43	115,54
	21,56	16,88
Pre-op F1	574,71	507,38
	170,11	157,85
Post-op F1	580,43	502,77
	167,72	160,21
Pre-op F2	1255,43	1200,46
	216,17	278,78
Post-op F2	1207,86	1235,00
	159,82	287,70
Pre-op F3	3002,57	3133,46
	346,72	472,69
Post-op F3	3101,43	3159,54
	477,45	331,51

Table 2: The means and standard deviations of the female and male study groups.



Formants can be found where there are large concentrations or peaks of energy in the spectrogram reading of a voiced sample. In other words, a formant is a frequency range in which a phoneme has its most distinctive and characteristic pitch. Although all phonemes have their own formants, vowel sound formants are usually the easiest to identify. Almost all formants have the trait of waxing and waning in energy in all frequencies, which is caused by the repeated closing and opening of the human vocal tract. On average, this repeated closing and opening occurs at a rate of 125 times per second in an adult male and 250 times per second in an adult female. This rate gives the sensation of pitch (higher frequencies result in higher pitches). Formant values can vary widely from person to person, but the spectrogram reader learns to recognize patterns which are independent of particular frequencies and which identify the various phonemes with a high degree of reliability⁷.

Sundberg has identified portions of the vocal anatomy which he associates with the formant frequencies. The jaw opening, which constricts the vocal tract toward the glottal end and expands it toward the lip end, is the deciding factor for the first formant. This formant frequency rises as the jaw is opened wider. The second formant is most sensitive to the shape of the body of the tongue, and the third formant is most sensitive to the tip of the tongue⁸.

It is not expected that fundamental frequency (F0) change after tonsillectomy. Because it is an operation that did not directly affect larynx and not influence the rate at which vocal folds open and close during phonation. With respect to supralaryngeal factors, if extirpation of soft tissue from the oropharynx altered the anatomy of the supralaryngeal acoustic transmission pathway and possibly the dynamics of physiologic function, the acoustic measures related to vocal tract resonances could be changed¹.

Ilk et al. reported that after tonsillectomy certain speech parameters changed. These changes were mainly F3 (formant center frequency) and B3 (formant bandwidth) for the vowel /o/ and a slight decrease in B1 and B2 for the vowel /a/. The larger the tonsil had been, the more changes were seen in the speech spectrum. The changes in the speech characteristics (except F3 and B3 for the vowel /o/) tended to recover, suggesting an involvement of auditory feedback and/or replacement of a new soft tissue with the tonsils⁹.

Chuma et al. reported that tonsillectomy had only minor quantitative and qualitative effects on

various acoustic parameters¹. Saida et al. and Hori et al. also reported similar observations in their studies^{2,3}. In general, it was reported that after tonsillectomy, fundamental frequency and F1 and F2 formant frequencies remained unchanged whereas F3 decreases and F4 increases postoperatively⁵. Like in our report, some other reports doesn't support this findings^{1,10}.

Patients may ask about the possibility of voice changes after tonsillectomy. Patients perception of voice is an important treatment outcome measure, especially in the case of benign disease where the greatest impact is on the quality of life¹¹. They should be advised of potential voice changes, especially professional voice users who may be particularly sensitive to changes in resonant characteristics. However, according to Behrman et al., one fifth of the patients perceived their voices to be improved after surgery and none thought that the voice to be worse¹¹. Therefore, it is concluded that patients are unlikely to perceive a change in voice as a result of surgery, but in those cases where a difference is perceived, it is likely to be a positive change.

For children, anecdotal accounts of some parents suggest that tonsillectomy changes sometimes voice production within the first few weeks after surgery. These parental concerns may in part reflect short-term acoustic changes associated with hyponasal speech improving to normal, normal speech becoming more hypernasal¹¹. In our study, the subjects were not asked to come just after surgery, since it was expected that during the healing process some voice parameters be changed and limitation in singing or performing be noted⁶. The focus of our study was to research any permanent voice change after surgery.

In a retrospective study among the performing artists done by Jarboe et al. it was stated that patients voices were not impaired after tonsillectomy⁶. The majority of the patients also reported that they perceived an improvement in their singing, but this should not be discussed as an indication for surgery, simply a possible coincidental outcome. The expression of improvement in voices after surgery could be related to the reduction of discomfort in throat and to the enlarged resonating chamber.

The gathered information in his study suggests that tonsillectomy may cause any voice change and vocal performing artists should be warned about it although it was not perceived subjectively.



CONCLUSION

Based on our study, tonsillectomy does not have any effect over fundamental frequency. Though changes in some formant frequencies after surgery is statistically significant, it was not recognized by the patients.

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