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Evaluation of Voice Parameters in People with Head and Neck Cancers: An Investigational Study

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Abstract

Background: Head and neck cancer severely affects the voice and compromises a patient's vocal independence. In the present study we have investigated the difference in three vital components of the voice - pitch, jitter, and shimmer in head and neck cancer patients and compared the findings with age matched healthy volunteers.

Methods: Voice parameters were ascertained in newly diagnosed head and neck cancer patients and controls using voice analysis software (PRAAT) and a Dynamic Unidirectional AUD-59 XLR microphone in a sound proof voice recording laboratory.

Results: We observed considerable changes in the three voice indices of pitch, jitter and shimmer. According to gender, there were significant changes in all three indices for men (P<0.015 to 0.0001), whereas only pitch significantly changed in women (P=0.0001).

Conclusion: The results have suggested that individuals with any form of head and neck cancer will have a degree of voice problems even before the initiation of cancer treatments. Voice assessment is a vital aspect to be considered before initiation of treatment.

Keywords: Voice quality, Head and neck cancer, Pitch, Jitter, Shimmer

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Introduction

Recent reports indicate that at the global level cancers of the head and neck (H&N) region are increasing.[1] On a functional basis, when compared to most other cancers, the H&N cancers (HNC) have a disproportionate impact on a patient's quality of life. Patients with HNC report significant and persistent physical and psychosocial problems. The voice is a multidimensional series of measurable events defined as the "laryngeal modulation of

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pulmonary air streams which is further modified by the configuration of the vocal tract".[2]

On a functional note, the mobility of the vocal folds is regulated by the biomechanical properties of the fold itself, magnitude of the subglottis air pressure, and neural control.[3] The human voice has several parameters which determine voice quality such as measures of F0, amplitude or intensity, frequency perturbation (jitter), amplitude perturbation (shimmer), tremor related, and noise related. Fundamental frequency refers to the rate of oscillation of the vocal folds and is the primary measure in pitch perception. The pitch of an individual can be low or high. It is one of the most useful, measurable voice parameters. Pitch is measured in cycles per second or hertz.[4] Vocal frequencies are determined by factors such as elasticity, mass, and length of the vocal folds. Fundamental frequency changes with age.

Jitter or frequency perturbations are F0 variability's of the fundamental period from one cycle to the next. Jitter percent measures the very short term cycle-cycle irregularity of the pitch period of the voice, which has a normal value of 3%.[5] Measurements of amplitude perturbations (shimmer) are analogous to those of F0 perturbations. It is the measurement of the short term instability of the vocal signal. Shimmer values serve to quantify short term amplitude instability that does not alter the qualitative features of the vocal wave form.

Speech and voice, considered the most important daily communication tools, are part of a person's identity and personality. Both contribute to the person's wellbeing and overall quality of life. Head and neck cancer tumor sites are either non laryngeal (oral cavity, oropharynx, hypopharynx, and nasopharynx) or laryngeal. It is expected that the effects of the tumor and its treatment on voice and speech outcomes differ. In non-laryngeal tumors, the tumor itself will not affect voice quality. However, depending on its location, these tumors can impede speech.

Existing reports indicate that laryngeal tumor scan have a negative effect on the patient's voice and speech. Voice quality is distorted primarily due to obstruction in the airflow through the glottis, impairment of normal cord movement, and

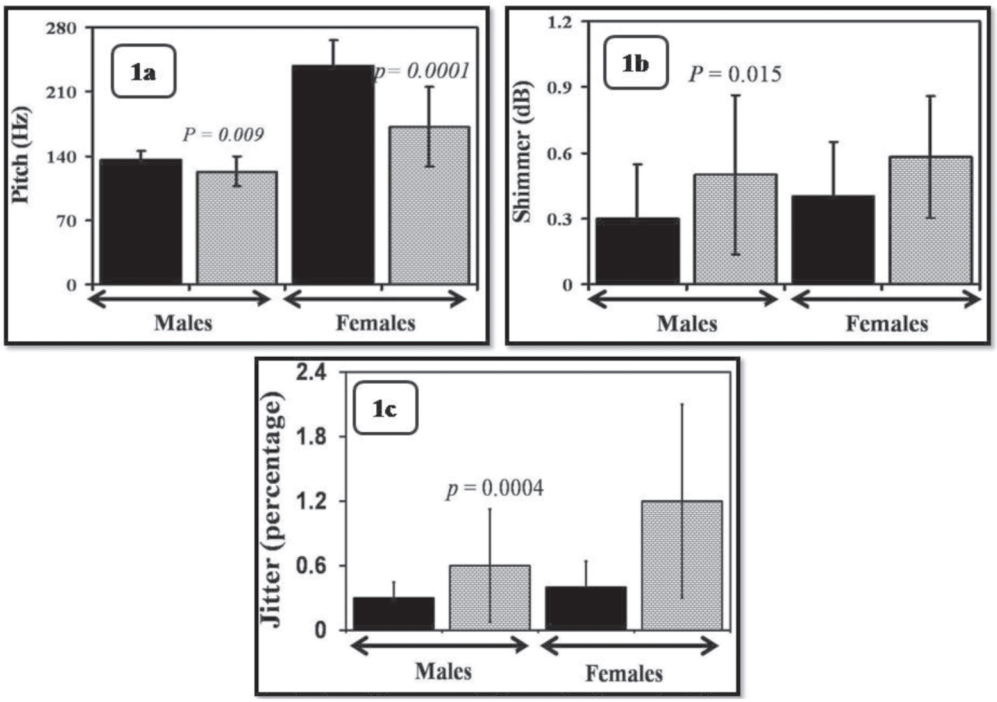

Figure 1. (a) Changes in pitch, (b) shimmer, and (c) jitter in head and neck cancer (HNC) patients. Solid black bars: Normal healthy individuals; Shaded bars: Cancer patients.

ensuing edema.[6] Reports also suggest that that vocal fold neuromuscular weakness and paresis due to tumor also contribute to these changes.[7] In lieu of these observations it is imperative to study how HNC alters voice quality. This study ascertains the difference by comparing the results with age matched normal healthy volunteers.

Materials and Methods

This single center study consisted of two groups, control and experimental. The inclusion criteria for the controls included healthy volunteers above the age of 18 years that had no evidence of any illness. The exclusion criteria for the controls were that the volunteers should not be involved in any profession that had regular use of their voices (e.g., teacher, singer, and musician). The inclusion criteria for the study group consisted of patients recently diagnosed with HNC, they had not received any type of cancer treatment, and above the age of 18 years. Exclusion criteria included cancer patients who had a secondary recurrence after treatment, surgery, prior chemotherapy or radiation, teachers, singers, or musicians.

The study was initiated after obtaining permission from the Institute's Ethics Committee and carried out in agreement with the tenets of the Helsinki Declaration. Before the start of the study, all participants were counseled regarding the purpose and aim of the study and a written consent was taken from all the subjects in their respective native language. The investigators developed a detailed HNC questionnaire to document information about the subjects and included demographic data, cancer type, and other associated problems. The acoustical voice analysis was carried out for all subjects in both the control and experimental groups (prior to cancer treatment) using the voice analysis software PRAAT and Dynamic Unidirectional AUD-59 XLR microphone in a sound proof voice recording laboratory. Parameters of voice such as F0, jitter (%), and shimmer (dB) were assessed.

The data accrued were entered into a Microsoft Excel program and subjected to statistical analysis using the SPSS statistics version 23 (IBM). Cancer specific data, age, and gender of HNC patients were expressed as frequency. The difference in quality of voice between the controls and patients with HNC were subjected to the student's t-test. A statistical value of $P<0.05$ was considered significant.

Table 1. Patient and tumor characteristics.

	Male (n=45)	Female (n=14)
Age (years)	**57.93±11.17**	**56.50±11.24**
Site		
Nasopharynx	1	1
Floor of the mouth	0	1
Base of the tongue	3	0
Alveolus	2	2
Buccal mucosa	2	0
Cheek	1	0
Maxilla`	3	0
Tongue	7	6
Soft palate	2	0
Retro molar trigone	0	1
Parotid	2	0
Oropharynx	8	1
Tonsil	1	0
Epiglottis	1	0
Transglottis	1	0
Thyroid	0	1
Parathyroid	1	0
Posterior cricoid	1	2
Vocal cord	4	1
Pyriform sinus	4	0
TNM stage		
Primary		
T1	4	2
T2	19	6
T3	11	4
T4	8	2
TX	1	0
Regional nodes		
N0	19	5
N1	12	4
N2	6	2
N2a	1	1
N2b	5	1
N2c	2	1
Metastasis		
M0	41	11
MX	5	2

Results

A total of 59 clinically diagnosed HNC patients

aged between 32-70 years (mean: 44 years) enrolled as the experimental group. Among 59 subjects, there were 45 males and 14 females. Both males and females were divided into two different groups as the fundamental frequency varies between both genders. The control group consisted of 75 age matched (47 females, 28 males) individuals without cancer.

Table 1 lists the patients and tumor characteristics. We observed a statistically significant difference in the three evaluated parameters of pitch, shimmer, and jitter in both males and females (Figure 1a-c).

Figure 1a shows that a significant decrease existed for changes in pitch among the age matched cancer free male volunteers (135.96Hz±3.83) compared to those with cancer (125.91Hz±6.54; *P*=0.009) and for healthy control females (237.31Hz±8.26) versus those with cancer (171.78Hz±26.10; *P*=0.0001).

With regards to shimmer, we observed a significant increase in male patients (0.44 dB±0.10) compared to their controls (0.27dB±0.09) and in female patients (0.58dB±0.37) compared to their controls (0.38dB±0.07). This finding was statistically significant only in males (*P*=0.015; Figure1b). Jitter showed a similar tend to shimmer where there was a statistically significant difference only in male cancer patients (0.56%±0.13) compared to male controls (0.34%±0.05; *P*=0.0004; Figure 1c).

Discussion

The main focus of the current study was to compare and understand how voice quality differed between the experimental group that consisted of individuals clinically diagnosed with HNC prior to initiation of any cancer treatments and a control group which consisted of individuals without cancer. We have conducted this study due to our observations that the majority of patients treated by radiation for HNC develop voice changes which are very mild at the beginning of treatment and worsen as treatment progresses. In order to understand how the progress in treatment affects voice quality, one should know the voice quality prior to initiation of treatment such that baseline information is available to understand progression of the problem.

The results of the current study indicated that the pitch of both males and females significantly altered compared to healthy individuals. When we took into consideration the proportion of laryngeal and non-laryngeal cancers, the majority of subjects had non-laryngeal cancer irrespective of gender. The statistical difference in pitch has provided new information that cancers located at a distance from the voice box (larynx) could have a direct influence on the voice even before the initiation of treatment. Even though the voice is defined as the laryngeal, modulation of pulmonary airstream, it is not just the larynx which determines the quality of the voice. Rather, there are resonators which begin at the level of the glottis and end at the entrance to the oral cavity. These resonators modulate the voice which makes it more pleasant and unique to an individual. It has been reported that changing the default length of the vocal tract can induce major shifts in the frequencies which lead to differences in pitch.[8] In the current study, the length of the vocal tract or the resonator might have become altered in cases with non-laryngeal cancer because of the presence of this cancer which indirectly affected the pitch compared to those without cancer.

We have observed significant differences in males but not females for jitter and shimmer. Jitter and shimmer values are directly altered when there is a change in vocal cord vibration. The significant difference observed in males and no difference observed in females could be explained in two ways. First, the total number of males with laryngeal cancer (n=14) was more than females (n=4). Because of the reduced sample size, it would be difficult to infer anything significant in females. Secondly, in males, there were subjects with cancer of the vocal folds which would significantly influence jitter and shimmer. No female subjects had cancer of the vocal folds.

From the current study, it can be understood

that even non-laryngeal tumors can have a significant impact on pitch, which is one of the most important parameters in voice assessment. A detailed voice analysis should be mandatory before the initiation of any type of cancer treatments (chemotherapy, radiation therapy, surgery) even for individuals with non-laryngeal cancer. It is important to inform patients with HNC about the importance of the voice and the chance that their voice may be affected as cancer treatment progresses. Previous researchers have focused on studying effects on the voice with cancer treatment progression. This is the only study which has focused on determining whether the voice was already affected before the initiation of treatment. The main limitation of the current study was the smaller number of female participants.

Conclusion

The results from the present study have indicated that all individuals with any form of HNC will have some amount of voice problems even before the initiation of cancer treatments. It should not be assumed that only patients with laryngeal cancer will have voice problems. Rather, voice assessments before treatment should not solely focus on laryngeal cancer patients, but include all patients with HNC.

Conflict of Interest

No conflict of interest is declared.

Reference

1. Chaturvedi AK, Anderson WF, Lortet-Tieulent J, Curado MP, Ferlay J, Franceschi S, et al. Worldwide trends in incidence rates for oral cavity and oropharyngeal cancers. *J Clin Oncol.* 2013;31(36):4550-9.
2. Michael, JF; Wendhal, R. Correlates of voice production. In: Travis, LE, editor. Handbook of speech pathology & audiology. NJ Prentice-Hall Inc, USA;1971.p.465-80.
3. Chan RW, Titze IR, Titze MR. Further studies of phonation threshold pressure in a physical model of the vocal fold mucosa. *J Acoust Soc Am.* 1997;101(6):3722-7.
4. Lieberman P. Some acoustic measures of the fundamental periodicity of normal and pathologic larynges. *J Acoust Soc Am.*1963;35(3):344-53.
5. Lieberman P. Perturbations in vocal pitch. *J Acoust Soc Am*. 1961;33(5):597-603.
6. Kazi R, Venkitaraman R, Johnson C, Prasad V, Clarke P, Newbold K, et al. Prospective, longitudinal electroglottographic study of voice recovery following accelerated hypofractionated radiotherapy for T1/T2 larynx cancer. *Radiother Oncol.* 2008;87(2):230-6.
7. Meleca RJ, Dworkin JP, Kewson DT, Stachler RJ, Hill SL. Functional outcomes following nonsurgical treatment for advanced-stage laryngeal carcinoma. *Laryngoscope.* 2003;113(4):720-8.
8. Tokuda IT, Zemke M, Kob M, Herzel H. Biomechanical modeling of register transitions and the role of vocal tract resonators. *J Acoust Soc Am*. 2010;127(3):1528-36.