EFFECTS OF CHEMICAL IRRITANTS ON VOICE AND SUBSYTEMS – AN ACOUSTIC ANALYSIS

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Abstract

Good voice quality is always vital for all individual at their occupation and in their environment to accomplish communication act. Many individuals due to their occupation are at greater risk of developing voice problems and other subsystem problems. The present study investigates the long term effect of irritants on voice quality and other subsystem function. Two groups of participants were participated in the present study. Experimental group had 43 participants (mean age- 43.56 years) who were working in a latex manufacturing factory and had a minimum experience of 10 years. Control group consisted of forty three individuals (mean age- 40.5years). Subjects performed monologue, s/z ratio, phonation duration of /a/, /i/, /u/ and reading meaningful words which included /a/, /i/, and /u/ in a VCV context. Praat software was used to analyze live voice acoustically with sampling frequency 44 kHz. A stop watch was also used to measure the phonation duration and s/z ratio. Paired sample t- test was carried out and it showed that participants in the experimental group showed significantly lower values for F0, SFF and jitter indicating an affected phonatory system. This was further confirmed by significantly short MPD values in experimental group. Result confirms that exposure to irritants for a longer time will result in vocal pathologies. Effects of irritants on voice can have significant impact on individual voice which in turn causes various pathologies in larynx and other sub system. This will have direct impact on occupation and social life. The present results will help speech language pathologist to provide good vocal hygiene measures and to reduce exposure time to irritants and also to monitor the effect of therapy for this kind of voice abnormalities.

***Key words**: Irritants, Ammonia, Jitter, Shimmer, F0*

Voice is the sound produced by the vibrating vocal folds (Aronson, 2009). This sound is shaped by the vocal tract into a unique acoustic form that allows the listener to recognize the speaker. It is the primary instrument through which most of them project their personalities. It is a combination and interaction of the mechanisms of respiration, phonation, resonance, and articulation (Schneider, 2007).Voice disorders result from faulty structure or function somewhere in the vocal tract in the process of respiration, phonation, or resonance. Voice disorder exists when one or more aspects of the voice such as loudness, pitch, quality, or resonance are outside the normal range for the age, gender or geographic background of the speaker. When the voice changes in any negative way it is said to be dysphonic. One of the ways to record and analyze the dysphonic is through acoustic analysis. Acoustic analysis helps us to understand normal voice production and deviations altering the normal voice state **(**Scalassara, 2007). Acoustic analysis gives account of frequency features, intensity features and perturbation features (Pribuisiene & Uloza, 2006).

Good voice quality is always essential for all individual at their work and in their environment to accomplish communication act. Many individuals by the very nature of their occupations are at a greater risk of developing voice problems and laryngeal pathologies (Vanhoudta & Thomas, 2008). The common vocal pathologies seen in an occupational setting includes laryngitis, vocal polyp, vocal nodule and contact ulcer (Vilkman, 2004). These disorders could be a result of bacterial or viral infections, by excessive use of voice or by chemical irritants.

There are numerous studies on the effect of chemical irritants on voice and its subsystems. National Institute of Occupational Safety and Health (1997) recognized exposure to sulphuric acid is not only a risk factor for the development of carcinoma of larynx but also disorder of laryngitis. Williamson (1995) reported 58% of people who inhaled steroids had some dysphonia or throat symptoms when compared to their control subjects. Perkner (1998) described vocal cord dysfunction due to general irritants in 11 individuals exposed in their working environments. Tanturri (1988) described a case of freon gas that resulted in oedematous pharyngolaryngitis. Exposure to irritants is associated with asthma symptoms (Ramon, 2005) and accompanied by lower respiratory tract dysfunction and other pulmonary diseases (Prezant, 2008). The Present study carried out to

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investigate the effect of chemicals like ammonia and sulphuric (H_2So_4) acid on latex manufacturing factory workers where these chemicals are used heavily. The association between exposure of these irritants and its effect on vocal quality and subsystems are investigated.

Method

Participants

Two groups of forty three male participants in the age range of 35 to 48 years (mean age 43.56 years) took part in the study. Experimental group (EG) consisted participants who were working in a latex manufacturing factory and had a minimum experience of 10 years. All the participants were exposed to these irritants for at least 8 hrs a day. All were native speakers of Malayalam with no history of speech and language impairment or neurological or psychiatric disease. Control group (CG) consisted of forty three individuals with age range of 30 to 50 years (mean age 40.5 years). The Inclusion criteria consisted of Individuals with no history of speech, language and hearing disorders, individuals with no history of allergy and frequent rhinitis and individuals with any exposure to any such previous experiments.

Equipments

The study was conducted in a sound treated room. Voice samples were recorded using Sony vaio laptop with frontech external microphone. Praat software version 5.1.22 (Weenink & Boersma, 2009) was used to analyze live voice acoustically. The sampling frequency used was 44 kHz. A stop watch was also used to measure the phonation duration and s/z ratio.

Procedure

A brief history was taken for the purpose of obtaining demographic data, the duration of exposure to irritants per day and subjects experience of their voice quality in daily communication. Participants were seated comfortably. The microphone was placed 3 inches away from the subject's mouth. Subjects were asked to perform four tasks which included monologue, s/z ratio, maximum phonation duration of /a/, /i/, /u/ and reading meaningful words which include /a/, /i/, and /u/ in VCV context.

Acoustic Analysis

Acoustic parameters such as fundamental frequency (FO), speaking fundamental frequency (SFF), jitter percent, shimmer dB and harmonic to noise ratio (HNR) were determined from the recorded sample. Further statistical analysis was done using SPSS software.

Results

The acoustic analysis of voice included measurement of fundamental frequency, speaking fundamental frequency, jitter, shimmer, harmonics to noise ratio, phonation duration and s/z ratio.

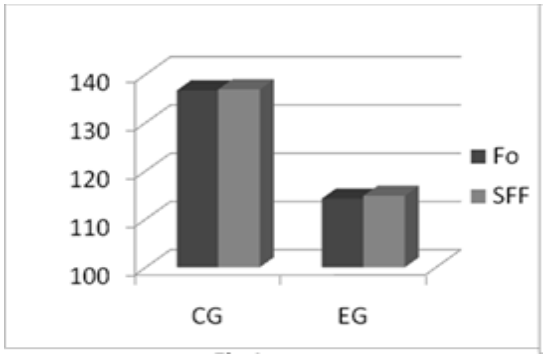

Figure 1. *Mean values of control group (CG) and experimental group (EG) for fundamental frequency (F0) on phonation task, and speaking Fundamental Frequency (SFF) on monolog task.*

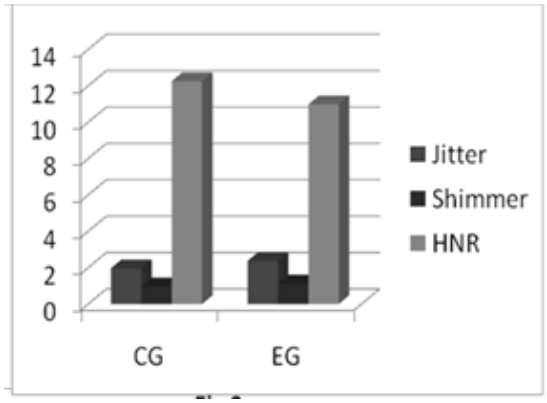

Figure 2. *Mean perturbation values in terms of jitter and shimmer and also shows mean values of Harmonic to Noise ratio (HNR).*

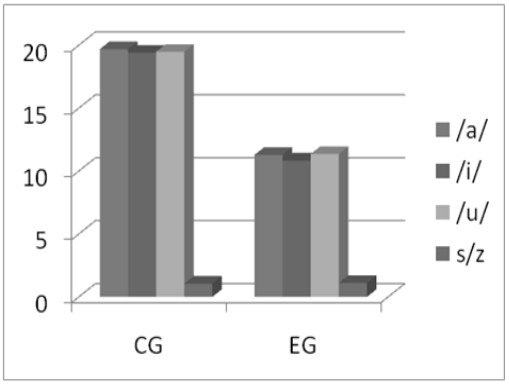

Figure 3. *Mean values of phonation duration (PD) of /a/, /i/ and /u/ and also the mean s/z ratio.*

Paired sample t- test was carried out between two groups, results revealed significant difference for

parameters like F0 (figure 1), SFF (figure 1) and Jitter (figure 2). Subjects in the experimental group showed significantly lower values for F0 (mean= 114.26 Hz, SD=12.82, $p<0.001$), SFF (mean=114.83 Hz, SD= 12.63, $p<0.001$) and jitter (mean=2.37, SD=0.7276, $p<0.01$), than the control group, indicating an affected phonatory system. This was further confirmed by significantly short maximum phonation duration (/a/=11.28sec, /i/=10.83sec and /u/=11.35sec) values in experimental group. However measures such as shimmer (figure 2) and HNR (figure 2) didn't not significant value across two groups Values obtained on s/z ratio testing although not statistically significant (p=0.387), were lower in the experimental group (mean /s/= 9.14 sec and mean /z/= 7.85 sec) when compared to control group (mean /s/=20.84 sec and mean /z/=19.03sec).

Discussion

Present study attempted to highlight the effect of chemical irritants on vocal quality and respiratory subsystem. It was reported in earlier studies that pulmonary diseases caused by irritants inhalation have effect on acoustic measures of voice including maximum phonation time, frequency, and amplitude perturbation parameters (Dogan, 2007). The differences in acoustic parameters may be due to abnormal mucosal wave symmetry/periodicity, glottic closure, mucosal quality and mucosal wave amplitude/magnitude resulting from irritants inhalation (Gallivan, 2007). Exposure to irritants along with other factors such as prolonged shouting reduced fluid intake and dehydrating agents results in vocal fold pathologies (Bradley, 2010). Laryngitis may also cause huskiness, reduced pitch, loss of part of the range of the voice These abnormalities could result in vocal perturbations which are evident in terms of pitch and amplitude. The possible causes will include inhalation of H_2So_4 and ammonia acid for a considerable duration. Long term inhalation of these irritants will results in hoarseness, tightness of throat, cough and pain (Agency for Toxic Substances and Disease Registry, 1999). But the physical characteristics of the phonatory system was not visually studied which is one of the limitation of this study.

Inhalations of irritants convey variety of effects to the airway ranging from mucous membrane irritation to respiratory diseases (Allan, 2006). The complications may include nasal symptoms, wheezing and breathlessness, and reduced spirometric lung function (Sripaiboonkij, Phanprasit & Jaakkola, 2007). And the extent of disease depends on the exposure time and amount of irritants in the environment which in turn reduce lung capacities (forced expiratory volume and vital capacity) which are important for sustained phonation activities and other respiratory measures. Present study showed a significant reduction in respiratory and phonatory aspects with reduced phonation duration, /s/ and /z/. One possible factor that could have influenced results of the present study was the exposure time to these irritants which was more than 10 years in each of the participants. And the adverse effect of such irritants can lead to different vocal pathologies. Study confirms previous research showing affected phonatory and respiratory system due to long term exposure to irritants.

Conclusions

The study results clearly states that exposure to irritants for a longer time will have a significant impact on individual voice which in turn causes various pathologies in larynx and other sub system. The results of the study has direct impact on occupation and social life and will help SLP to provide good vocal hygiene measures and to reduce exposure time to irritants. Further the results highlight the importance for careful evaluation of those exposed to potentially harmful chemical irritants irrespective of preventive measures. And these measures can used to monitor the effect of therapy for this kind of voice abnormalities. Future research can be focused on correlating acoustic changes with anatomical status of the individual using direct visualization techniques such as endoscope or stroboscope.

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