EFFECT (IMMEDIATE AND PROLONGED) OF SEMI OCCLUDED VOCAL TRACT VOICE EXERCISE IN INDIVIDUALS WITH AND WITHOUT VOICE DISORDERS

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May, 2016

Certificate

This is to certify that this dissertation *entitled* ***"Effect (Immediate and Prolonged) of Semi Occluded Vocal Tract Voice Exercise in Individuals With and Without Voice Disorders"*** is a bonafide work in part fulfillment for the Degree of Master of Science (Speech-Language Pathology) of the student (Registration No.14SLP005). This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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Declaration

This dissertation entitled entitled ***"Effect (Immediate and Prolonged) of Semi Occluded Vocal Tract Voice Exercise in Individuals With and Without Voice Disorders"*** is the result of my own study under the guidance of Dr. T. Jayakumar, Reader in Speech Sciences, Department of Speech-Language Sciences, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier in any other University for the award of any Diploma or Degree.

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Chapter 1: Introduction

Human voice is produced when the vocal folds adduct slightly together, allowing air to pass between them, setting the vocal cords into vibration. This motion produces voice. The phonation is then resonated through various sites of the vocal tract and skull. Voice production can be viewed as a conversion of aerodynamic energy into acoustic energy at the level of the vocal folds, which control the glottal airflow. At this point, the acoustic energy travels away from the sound source up the vocal tract as a column of air, radiating outwards into vocal sound. The resonance of voice begins with this vibratory sound in the larynx, travelling up through the pharynx and the oral, nasal cavities above. The voice we hear then is produced by a combination of respiratory activation, phonation and amplifying resonance.

Normal voice may be characterised by five aspects. First, normal voice must be loud enough to be heard. Second, normal voice must be produced in a manner that does not produce vocal trauma thus laryngeal lesions. Third, the normal voice should be pleasant to listen to or in keeping with one – word descriptors pleasing in voice quality. Fourth, normal voice should be flexible enough to express emotions. Fifth, normal voice should represent the speaker well in terms of his age and gender (Boone, 2005).

Vanriper and Irwin (1958) reported that, speech is defective if it interferes with communication, draws undue attention to itself or causes the speaker to be somehow maladjusted. And the same holds good to voice also. In the five aspects of voice loudness, hygiene, pleasantness, flexibility and Speaker representation, one or more of these aspects are outside the normal range and when voice changes in negative way, it

is said to be disordered or dysphonic. Although traditional, the classical way of grouping voice disorders has been to three etiologic categories: functional neurological and organic. Functional voice disorders are usually caused by faulty use of normal voice mechanism (Hyperfunctional Voice Disorders). Organic voice problems are related to some physical abnormality in structure at various sites of the vocal fold and the vocal tract (Sulcus Vocalis, Contact Ulcer etc). Neurological voice disorder is caused by the disruption in the co ordination of underlying interactions mediated by the central nervous system (UMN, LMN lesions) (Boone, 2005). The management of these voice disorders can be medical and non medical. Medical management comprises the surgical procedures and pharmacological procedures. Non medical management comprises the behaviour modifications and the therapeutic techniques.

The therapeutic management of these voice disorders are accomplished by various set of voice therapy approaches. Voice therapy is a program designed to improve voice quality through guided change in vocal behaviours and lifestyle changes. Voice therapy consists of a variety of tasks designed to eliminate harmful vocal behaviour, shape healthy vocal behaviour, and assist in vocal fold wound healing after surgery or injury. The various philosophies of voice therapy management are hygienic voice therapy, symptomatic voice therapy, psychogenic voice therapy, physiologic voice therapy, eclectic voice therapy (Stemple, 2014). In short, hygienic voice therapy focuses on identifying unsuitable vocal hygiene behaviours, which then are made to order or eliminated. Symptomatic voice therapy focuses on modification of the deviant vocal symptoms identified by the speech-language pathologist, such as breathiness, low pitch, glottal attacks, and so on. The focus of psychogenic voice

therapy is on the emotional and psychosocial status of the patient that led to and maintains the voice disorder. The physiologic orientation of voice therapy focuses on directly modifying and improving the balance of laryngeal muscle effort to the supportive airflow, as well as the correct focus of the laryngeal tone. Finally, the eclectic approach of voice therapy is the combination of any and all of the previous voice therapy orientations.

Considering the overall causes of voice disturbances, the management approach is direct modification of the inappropriate physiologic activity through exercise and manipulations. These techniques aims to at once balance the three subsystems of voice production apart from the direct tap on the single component of voice like pitch loudness etc. Resonant voice therapy, vocal functioning exercises, accent method of voice therapy, semi occluded vocal tract exercises are example of this approach.

Semi occluded vocal tract (SOVT) exercises have been used widely in voice clinics as therapeutic approach to reduce the excessive tension on vocal tract and to facilitate voice therapy. As the name, these are voice therapy techniques facilitated by an occlusion which is partial, in the vocal tract. Semi-occluded vocal tract (SOVT) exercises involve narrowing the vocal tract, usually near the lips or tongue tip, while voicing. Because of the relative occlusion, the sound produced is not very loud force of collision of the vocal folds are reduced to the minimum. Thus it facilitates to use the breathing system fully and get a strong vibratory sensation of forward oral resonance without the inhibition associated with making loud sounds and without the concern of trauma to vocal fold. These exercises have been used for many years by singers and voice professionals as warm-ups and more recently have been incorporated into

therapeutic approaches by Speech-Language Pathologists (SLPs) for people with voice disorders (Dargin and Searl, 2015). They are characterized by a reduction in the cross-sectional area of the distal part of the vocal tract that alters the acoustic vocal tract impedance in relation to the glottis impedance (Story et. al, 2000). By using SOVT exercises, the vocal tract length or cross section is altered causing an impedance match between the vocal tract and vocal folds.

SOVT exercises vary in the resistance to airflow offered in the vocal tract and hence they are typed from high to low resistant. Increased resistance is created by narrowing or lengthening of the vocal tract; conversely, lower resistance is created by opening or shortening the vocal tract. Examples of SOVT exercises listed from higher to lower resistance are as follows: phonating while holding a straw between the lips, humming, sustaining a voiced labio-dentals fricative, voicing during lip or tongue trill, sustaining voiced alveolar or velar nasal consonants, and sustaining high tongue vowels (Titze & Laurkkanen, 2007).

The physiologic implications of semi occlusions are described based on the interaction between the sound source and the vocal tract with respect to impedance match between the two. Impedance is measured as the ratio between acoustic pressures in the vocal tract to the glottal airflow. Reactive impedance refers to the timing difference between the glottal air flow and the acceleration of the air column. It can be either advanced or delayed. Advanced implicates compliant reactance and the delayed timing is defined to be inertive reactance. The more inertive the tract is, more effective is the conversion of aerodynamic energy into acoustic energy and resonant voice is produced. The impedance match is done with a combination of glottal

adduction (or abduction) and epilaryngeal tube narrowing (or widening). This impedance matching requirement is achieved by certain internal sensations. In addition, the vocal folds may change shape from a convergent glottal shape where there is tight adduction of the vocal processes but loose adduction at the bottom of the folds, to a rectangular glottal shape where there is equal adduction top-to-bottom. This lowers the phonation threshold pressure (Titze, 2006), SOVT exercises may provide one means of helping re establish a more favourable Phonation threshold pressure (PTP) after excessive use or as a warm-up exercise. There is also heightened oral acoustic pressure which results in the tissue vibration all over the facial structures. Variations of SOVTs have been reported by different researchers. These include

Lip trills and Tongue trills: Make the lip or tongue vibrate with the airflow and pressure from the lungs with and without the support of larynx.

Hand over mouth: This exercise uses the closure of the mouth while producing a stable sound to free constrictions along the vocal tract (Behlau & Oliveira, 2013).

Wave in a cave: It is done by cupping both hands together, with one hand perpendicular to the other (Rosenberg, 2014).

Cup Phonation: In this exercise, a standard 10 oz. Styrofoam coffee cup is used. A hole approximately the diameter of a pencil or slightly bigger is punctures on the bottom. The larger open portion of the cup is completely sealed around the mouth and phonation is done (Rosenberg & LeBorgne, 2014).

Y – buzz: Y-Buzz creates an occlusion in the anterior oral cavity as the patient is cued to generate both /y/ as in “yellow” combined with the vowel /i/ as in “easy.” (Lessac, 1997)

Tongue Bubble glides: This exercise use a combination of tongue and lip trills. (Brian Petty, 2013)

Straw phonation: Straw phonation involves holding a straw between the lips while producing a sustained vowel. The length and diameter of the tube can be altered to result in more or less resistance to air flow. (Titze , 2006)

Lax Vox: It uses a wide diameter flexible straw in water and holding a straw between the lips while producing a sustained vowel. The length, diameter of the tube and water level can be altered to result in more or less resistance to air flow. (Shivo & Denizoglu, 2007)

The researches carried out in various SOVT exercises have brought into light the effect of practicing the same in various parameters of voice, perceptual, acoustic and aerodynamic. Using computational modelling, Titze and Laurkkanen (2007) reported that F1 is lowered from 300–150 Hz when a resonance tube was added to the vocal tract model. Schwartz and Ceilo (2009) also evaluated subjects stroboscopically, before and after performing SOVT Exercises and found a statistically significant change in the vibration amplitude of the vocal folds after SOVT Exercises. SOVT Exercises may also provide a means of achieving a more favourable PTP after excessive use. The aerodynamic changes that are derived from SOVTs are expected to lessen vocal fold loading (Titze and Finnegan, 2002). So, in executing the semi occlusives in maximum beneficial way, one could rationalize those to be used in the order ‘‘greatest effect, but most artificial’’ to ‘‘smallest effect, but closest to natural’’. In the hierarchy proposed by Titze (2006), he employs high resistance straw in the foremost position. In the present study we take up combined rigid and flexible straw phonation sequence recommended by Mara Behlau & Glaucya Madazio, (2013). It comprises combined sequence of using a flexible straw in water and a rigid straw phonation in air that offers more resistance. The flexible straw technique was proposed

by Marketta Shivo and is commonly known as Shivo lax Vox method (Shivo & Denizoglu, 2007). The use of rigid straw was proposed by Titze in, 2000 & 2006.

Need for the study

There is a rising graph on the research about the physiological impact of SOVTEs, and has an rapidly growing clinical opinion about the therapeutic benefits of the exercises among professionals. Laukkanen, Lindholm and Vilkman in 1995 reported phonation into the tube tended to lead to reduced vocal load in individuals with normal voice quality. Guzman et.al in 2013 reported immediate therapeutic effects in terms of Long Term Average Spectrum, in individuals with dysphonia. However empirical data are lacking on the same in describing expected laryngeal adjustments, acoustic changes in voice during and after the practice of these exercises. Also there have been limited studies on the candidacy for the exercises and dosing of it. In this context of less experimented dimensions of SOVTEs the efficacy of using it in clinical population needs evidence support. The current study attempts to provide an understanding towards the immediate and prolonged effect of using SOVT Exercises in individuals with hyperfunctional voice disorders and individuals with normal voice quality.

Aim of the study

To study the Effect of the SOVT Exercise – combined rigid and flexible straw phonation sequence on acoustic parameters of voice in population with normal voice quality and hyper functional voice disorders.

Objective of the study

- To estimate the immediate effect of SOVT Exercise- combined rigid and flexible straw phonation sequence on acoustic parameters of voice in individuals with normal voice quality and individuals with hyper functional voice disorders.

- To find out the prolonged effect of SOVT Exercise- combined flexible and rigid straw phonation sequence on acoustic parameters of voice in individuals with normal voice quality.

- To find out the prolonged effect of SOVT Exercises- combined rigid and flexible straw phonation sequence on acoustic parameters of voice individuals with hyper functional voice disorders.

Chapter 2: Review of literature

"The human voice is the most beautiful instrument of all, but it is the most difficult to play"

- Richard Strauss

Voice is the sound produced by vibration of vocal folds driven by air directed by lungs and resonated by the vocal tract. The human voice is a magical tool in our body which is superimposed with characteristics that set the uniqueness of each person and helps in accomplishing the act of verbal communication. Voice is constituted by multitude of features which makes it distinct like fingerprint of an individual and those set of characteristics include pitch intensity tone quality etc. These mentioned characteristics define the functions of voice (talking, singing, laughing, crying, screaming, gender discrimination, projection of emotions etc). The underlying physiology of voice comprises of myriads of muscle movements in and out the larynx which can loosen, tighten, or change their thickness of vocal folds, and over which breath can be transferred at varying pressures resulting in a change in pitch, volume, timbre, or tone of the sound produced. These parameters are dynamic and are achieved by the modulation of vibratory frequency of the vocal folds, degree of separation of the vocal folds, referred to as vocal fold adduction (coming together) or abduction (separating).

Voice disorder sets in when voice is hampered in any of aspects of production or function. A voice disorder is characterized by the abnormal production and/or absences of vocal quality, pitch, loudness, resonance, and/or duration, which is

inappropriate for an individual's age and/or sex. (ASHA, 1993). Voice disorders are a widespread and significant problem. The communicative problems associated with dysphonia can lead to social withdrawal, occupational handicaps, and depression (E. Smith et al., 1996). Hence the identification and treatment of dysphonia is very important and should be effective. Voice therapy is an integral part of treating dysphonia. (*Dysphonia* is defined as an impairment of the speaking or singing voice (ASHA, 2004). The overall goal of the voice therapy for the patient with dysphonia is optimal long-term voice quality and communication function with minimal recurrence. Voice therapy being the choice of intervention for different kind of dysphonias, voice therapy approaches used also varies accordingly and semi occluded vocal tract exercises are one among them. Semi-occluded vocal tract (SOVT) exercises have long been used in voice clinics throughout the world as a therapeutic approach to reduce excessive tension on the vocal tract and facilitate resonant voice quality.(Titze IR,2006). Exercises with semi-occluded vocal tract have been frequently used in the clinical practice aiming to improve vocal economy and efficiency. The partial occlusion during SOVT exercises produces backward resonance and the expansion of all the vocal tract area, from mouth to larynx, while the glottal activation is kept, tending to steadiness. (Sampaio, M., Oliveira, G., & Behlau, M. 2008). Studies suggest that individuals with normal voices present clearer, brighter, and more sonorous voices after performing semi-occluded exercises. (Guzman M, et.al, 2013, 1. Laukkanen AM, 1992 Laukkanen et.al,1995) . SOVT Exercises have been recommended for vocal pathologies like vocal fatigue, recurrent laryngeal nerve paresis, and vocal nodules. (Guzman M, et.al, 2013, 1. Laukkanen AM, 1992,). Great variety of SOVT exercises have been introduced along the years in literature (eg, lip and tongue-trills, hand-over-mouth, flow resistant straws, LaxVox

humming, raspberries, among others) aiming to improve voice quality and to promote easy phonation; however, within them, there are significant differences with regards to implementation and physiology. Some present a constant frontal obstruction of the vocal tract (humming and hand-over-mouth); others impart a secondary source of vibration into the vocal tract (lip and tongue-trills, LaxVox), and few characterized by lengthening of the vocal tract through means of a resonance tube coupling (LaxVox). The SOVT exercise considered in the present study follows by lengthening of the vocal tract through means of a resonance tube coupling.

Laukennen, lindholm and vilkman , 1995 has investigated the phonatory and voice quality during and after tube phonation using electromyography, electroglottography and inverse filtering of acoustic signal of vowel sample before and after the practice of the exercise in individuals with normal voice quality. Authors concluded that, tube phonation tended to produce a higher vertical laryngeal posture and a reduction vocal load in vowel phonation after tube phonation, especially in males. Guzman et.al, 2013 in an endoscopic investigation of the he effect on these variables of different semi occluded vocal tract postures in 20 subjects diagnosed with hyperfunctional dysphonia. The findings revealed All semi occluded techniques produced a lower Vertical Laryngeal Position, narrower aryepiglottic opening, and a wider pharynx than resting position. More prominent changes were obtained with a tube into the water and narrow tube into the air.

In a electroglottographic study by Andrade et. Al,2013 comparison was done between seven different SOVT exercises (LaxVox, Straw, Lip-Trill, Tongue-Trill, Humming, Hand-Over-Mouth, and Tongue-Trill Combined With Hand-Over-Mouth)

and results implicated that the SOVT exercises should be divided into two groups, as follows: (a)steady (single sourced) with lower contact quotient range and F1_ F0 difference (hand-over-mouth, humming, and straw) and (b) fluctuating (dual source) with larger contact quotient range and F1-F0difference (tongue-trill, lip-trill, and LaxVox). Because of these differences, different therapeutic effects can be expected.

Dargin and Searl (2015) described changes in aerodynamic and electroglottographic (EGG) measures immediately after completing three semi-occluded vocal tract (SOVT) exercises . Aerodynamic and EGG measurements were obtained before and immediately after performing three SOVTs (straw phonation, lip trill, and tongue trill) in four singers for pre-post comparisons to evaluate laryngeal changes persisting beyond the execution of SOVTs. The results showed changes in Mean air flow, sound pressure level, and EGG closed quotient after completing SOVTs.

A study which investigated the immediate effect of two semi occluded vocal tract exercises (finger kazoo and straw phonation) in 8 participants Each exercise, with one minute duration, was performed twice by the participants. The acoustic analysis showed a statistically significant reduction of F0 after the finger kazoo exercises and phonation with straw. The F0 reduction in both exercises may be related to the tension reduction to the vocal tract adjustments and to reactance. The reactance is part of the resistance to the vocal production that is called impedance and allows saving the acoustic energy. This energy changes the glottal flow and the oscillatory characteristics of the vocal folds. The self assessment of voice by participants after the exercise suggested more comfort during phonation, probably due to the changes in the

vibratory patterns of the vocal folds and to the reduction in the first formant and in the sub-glottal pressure necessary to phonation The resulting sensorial effects reported should be the reduction of the phonation pressure, of the glottal flow and, at the same time, a voice that is harmonically rich. (Sampaio, Oliveira and Behlau, M. 2008).

Paes et .al (2013) in a study investigated the immediate effects of the Finnish resonance tube method for teachers with behavioral dysphonia where in Twenty-five female teachers (m = 39.9 years of age) with at least a 5-year history of dysphonia subjected to three sets of 10 tokens of sustained phonation with a 1-minute rest interval between tokens into a 27-cm glass tube immersed in at least 2 cm of water. Voice samples were recorded before and after these sets. The effects of these exercises were evaluated by self-assessment, auditory perceptual analysis, and acoustic evaluation involving extraction of fundamental frequency and visual spectrographic analysis. The results showed increased phonatory comfort and Perceptual analysis indicated improved voice quality in the samples of counting numbers, confirmed by decreased instability, sub harmonics, noise in high frequencies, and the tendency for reduced low frequency noise on spectrographic evaluation. Additionally, mean fundamental frequency decreased.

In an investigation done by Costa et.al (2011) immediate effect of straw phonation in individuals with or without vocal fold lesion, 48 individuals, aged between 18 and 55 years participated was assessed . They were divided into two groups- with benign vocal fold lesion and without a lesion. voice self-analysis, [e] vowel auditory-perception analysis, selected parameters acoustics (jitter, Shimmer, Mean F0) and videolaryngoscopy were carried out before and after the straw phonation exercises. both groups reported benefits with phonation exercises into a straw, in the voice self

assessment more positive results were reported by individuals with vocal fold lesion than those without lesion. The acoustic analysis done did not show significant changes. Similar was the result in visualisation of larynx. Author states that the results could be possibly because execution time was insufficient. Also he posits about the possibility of using straw phonation as a therapeutic tool for individuals with vocal fold lesion.

Chapter 3: Method

Participants

A total of 40 participants were enrolled for the study. One group of participants included 30 individuals with normal voice quality (group I). Individuals included in group I got a score of zero in GRBAS scale .The other group included 10 individuals with mild – moderate dysphonia secondary to hyper functional voice disorder(group II). Age range of the subjects were 20-50 years**.**

Exclusion Criteria

- Participants, who have upper respiratory tract infection, asthma, or allergic diseases at the time of recording.
- Participants with the history of neurological, speech or language disorders.

Details of the participants

In the groups considered for the study, group I: individuals with normal voice quality comprised of 30 participants *(15- males and 15- females)* and group II: individuals with hyper functional voice disorder included 10 participants *(7- females and 3- males).*In group II, individuals with bilateral vocal nodules *(n=6)* hereafter referred to as group II.A and individuals with other hyper functional voice disorder*(n= 4)*named group II.B were enrolled.

Table 1: *Participant details of group II*

Subject Number	**Age/ gender**	**Diagnosis**
S1	50/F	Bilateral vocal nodules
SII	22/M	Other hyper functional voice disorder

SIII	36/F	Bilateral vocal nodules
SIV	39/F	Bilateral vocal nodules
SV	36/M	Bilateral vocal nodules
SVI	36/F	Bilateral vocal nodules
SVII	29/F	Other hyper functional voice disorder
SVIII	34/M	Other hyper functional voice disorder
SIX	20/F	Other hyper functional voice disorder
SX	50/F	Bilateral vocal nodules

Table 2: *Number of subjects enrolled in group I and group I for three different phases.*

Group	Individuals with normal voice quality (group I)			Individuals with hyperfunctional voice disorders (group II)		
Condition	Pretest (phaseI)	Immediate post test (phaseII)	Prolonged post test (phaseIII)	Pre test (phaseI)	Immediate post test (phase II)	Prolonged post test (phaseIII)
Number of subjects enrolled	30	30	10	10	10	3

Procedure

Present study was carried out in three phases to estimate the immediate and prolonged effect of SOVT exercises.

Phase I – Base line

First phase of the study baseline for both groups of participants were estimated. All the participants were seated comfortably in a sound treated room and the ask to phonate neutral vowel [a] in comfortable pitch and loudness for at least 5 sec. Three

trials of phonation was recorded using Computerised Speech Lab 4500 (Kay elemetrics, USA). F0, F1 ,F2 and F1-F0 was estimated from phonation sample of |a| using Praat Software. Similar phonation task of neutral vowel [a] was used in Real time EGG in Computerised Speech Lab 4500 (Kay elemetrics, USA) for measuring the contact area of vocal fold. Both the microphone recording of phonation and EGG recording were accomplished simultaneously. From the recorded microphone signal, intensity ,perturbation measures, noise measures and tremor measures were estimated using Multi dimensional voice profile (MDVP) (Kay elemeterics, NJ) and Dr. Speech (Tiger electronic, NJ).

Phase II - Immediate effect

In the second phase, the participants of both the group were made to practice one Semi occluded vocal tract exercise – combined rigid and flexible straw phonation sequence for duration of 15 minutes. Participants were provided with video demonstration of the exercise before the real trial of practice starts.

Procedure

Flexible straw into the water

Step 1

A small 250 ml bottle filled with room temperature water was used. A wide, flexible straw approximately 14 inches long and quarter of an inch (35 cm long and 9 mm diameter) was inserted to the water filled bottle. Approximately 1 inch (2 to 3 cm) length of straw was below the surface of water.

Step 2

The subject was instructed to sit in a good posture holding the bottle and straw with hands and to put the straw gently between pursed lips.

Step 3

The next instruction to the subject was to produce a neutral sustained vowel sound through the straw with bubbles occurring in the water and to feel a sensation of back pressure or reverberation in your mouth and throat. Care was taken to avoid puffing of cheeks while phonation through straw.

Step 4

Subject was asked to repeat step 3, progressing up to 3 minutes

Step 5

Once again repeat step 3 will be repeated with varying the depth of the straw as neutral vowel is phonated.

Step 6

Tune wordlessly, such as “happy birthday” shall be sung while phonating into straw.

Rigid Narrow Plastic Straw into the Air

Step 1

A rigid straw approximately 9 cm long and 2-3 cm long wide was used. Subject was asked to maintain a good posture. Holding the straw in one hand, he was made to place the straw firmly between pursed lips.

Step 2

Subject was instructed to produce a neutral sustained vowel through the straw, similar to Flexible straw into the water and continue for one minute with inhaling through nose as needed. Care was taken to avoid puffing of cheeks while phonation through straw and air leakage through lips and nose.

Step 3

Repeat step 2, progressing up to 3 times.

Step 4

Next, he/she was asked to produce a sustained "oo" sound by pursing lips. Repeat the step for 3 minutes.

Participants were evaluated for a comfortable phonation of neutral vowel and on the same acoustic and electroglottographic parameters as used for baseline measures.

Phase III- Prolonged effect

In the third phase of the study, 10 participants selected from the group 1 and 3 participants of group II were monitored to practice the semi occluded vocal tract exercise – combined rigid and flexible straw phonation sequence for a duration of 10 days regularly for 15 minutes daily. Researcher attempted to select homogenous participants from group II. The practices of the exercise was monitored using a self recording sheet. The individuals were subjected to the evaluation of the same acoustic and electroglottographic as used for baseline measures.

The data collected were acoustically analysed in four softwares, Multi dimensional voice profile (MDVP) (Kay elemeterics, NJ) , Real time EGG in Computerised Speech Lab 4500 (Kay elemetrics, USA), Praat, and Dr. Speech (Tiger electronic, NJ). The data was analysed for below mentioned parameters from the given software. The details of the parameter used in the study were listed in table 3.

Table 3: List of software and parameters derived from them for the study

Sl No	Software	Parameter
1	Multi dimensional voice profile (MDVP) (Kay elemeterics, NJ)	Average FundamentalFrequency(Mean F0)

		Standard Deviation of Fo (SDF0) Fo-Tremor Frequency (Fftr) Amplitude tremor Frequency (Fatr) Jitter Percent (jitter) Relative Average Perturbation (RAP) Fundamental Frequency Variation (vF0) Shimmer Percent (Shimmer) Amplitude Perturbation Quotient (APQ) Noise to Harmonic Ratio (NHR) Voice Turbulence Index(VTI) Fo-Tremor Intensity Index (Ftri) Amplitude tremor Intensity Index (Atri)
2	Real time EGG in Computerised Speech Lab 4500 (Kay elemetrics, USA),	Mean pitch Contact quotient (CQ) Open quotient (OQ) Speed quotient (SQ)
3	Praat (Boersma &Weenink, 2013)	F0 (hz), F1 (hz), F2 (hz), F1-F0(hz).
4	Dr. Speech (Tiger electronic, NJ).	Fo tremor Amplitude tremor (A-tremor) Signal to Noise ratio (SNR) Normalised Noise energy (NNE) Harmonics to noise ratio (HNR)

Analysis

The measured acoustic and electroglottographic parameters were tabulated for further statistical analysis. The data was subjected for suitable statistical analysis using SPSS, 20 version software. Kolmogorov-Smirnov test of normality was done to check the normality distribution in data .The mean and standard deviation was extracted. Mann Whitney U test was administered to check the difference between bilateral vocal nodule participants and those with other hyperfunctional voice disorder. Mann Whitney was also done for comparing the individuals with normal voice quality (group I) and individuals with hyperfunctional voice disorder. The results of pre test post test and prolonged post test within both the groups were done using Wilcoxon sign rank test

Chapter 4 : Results

The objective of the current study was to find the immediate and prolonged effect of SOVT (semi-occluded vocal tract) Exercise-combined rigid and flexible straw phonation sequence on acoustic parameters of voice in individuals with normal voice quality (group I) and individuals with hyper functional voice disorders (group II). The data was analysed using SPSS software (version 20.0) package. Given the number of subjects, variables and the preliminary nature of the study, group analysis was performed except for the prolonged post test condition (in group II) as the participants considered were less than five. The statistical measures carried out to understand the data includes

1. Kolmogorov-Smirnov test of normality
2. Descriptive statistics
3. Mann- Whitney U test
4. Wilcoxon sign rank test

The results are presented under following headings

3.1 Results of normality

3.2 The descriptive scores of acoustic analysis of normal group and Voice disorder group

3.3 Effect of SOVT exercise - By comparing pre test and immediate post test in normal group

3.4 Effect of SOVT exercise - By comparing pre test and immediate post test in Voice disorder group

3.5 Effect of SOVT exercise - By comparing pre test and

prolonged post test in normal group

3.6 Effect of SOVT exercise - By comparing pre test and prolonged post test in Voice disorder group

3.7 Comparison between Normal group and Voice Disorder group for pre test condition and immediate post test condition

3.8 Effect of gender in normal group

3.9 Effect of gender in Voice disorder group

3.1 Results of Normality

Kolmogorov-Smirnov Test of normality was done for the data of two groups. The distribution of data in both the group I and group II does not follow normality trend. The data was also analysed for normality across gender which also suggested non normal distribution. Thereby non-parametric test was used to analyze the data. Table 4. shows the results of Kolmogorov-Smirnov test of Normality in both normal and voice disorder groups.

Table 4: *Results of Kolmogorov-Smirnov test of Normality in both normal and voice disorder groups.*

Kolmogorov-Smirnov test of Normality								
Normals					Voice disorder			
	Pre test		Immediate Post test		Pre test		Immediate Post test	
	Statistic	Sig.	Statistic	Significance	Statistic	Sig.	Statistic	Sig.
meanF0	0.19	0.01	0.199	0.006	0.19	0.011	0.199	0.006
SD F0	0.44	0.00	0.319	0.000	0.442	0	0.319	0
Fftr	0.12	0.2	0.150	0.105	0.12	0.2	0.15	0.105
Fatr	0.08	0.2	0.192	0.010	0.084	0.2	0.192	0.01
Jitter	0.19	0.008	0.248	0.000	0.194	0.008	0.248	0
RAP	0.19	0.01	0.256	0.000	0.19	0.011	0.256	0
VF0	0.46	0.00	0.305	0.000	0.462	0	0.305	0
Shimmer	0.29	0.00	0.206	0.004	0.296	0	0.206	0.004
APQ	0.28	0.00	0.194	0.008	0.289	0	0.194	0.008
NHR	0.34	0.00	0.218	0.002	0.348	0	0.218	0.002

VTI	0.15	0.09	0.167	0.043	0.153	0.091	0.167	0.043
SPI	0.12	0.20	0.13	0.004	0.126	0.2	0.139	0.03
FTRI	0.14	0.12	0.257	0.000	0.148	0.12	0.257	0
ATRI	0.16	0.04	0.139	0.179	0.165	0.049	0.139	0.179
Pitch	0.19	0.07	0.190	0.011	0.196	0.007	0.19	0.011
CQ	0.12	0.20	0.112	0.200	0.124	0.2	0.112	0.200*
SQ	0.24	0	0.204	0.004	0.245	0	0.204	0.004
OQ	0.123	0.2	0.085	0.200	0.123	0.2	0.085	0.2
F0tremor	0.155	0.084	0.415	0.000	0.155	0.084	0.415	.000*
A-tremor	0.204	0.004	0.321	0.000	0.204	0.004	0.321	.000*
NNE	0.214	0.002	0.158	0.071	0.214	0.002	0.158	0.071
HNR	0.135	0.2	0.086	0.200	0.135	0.2	0.086	0.2
SNR	0.169	0.04	0.097	0.200	0.169	0.04	0.097	0.2
F0	0.190	0.01	0.199	0.006	0.19	0.011	0.199	0.006
F1	0.132	0.2	0.123	0.200	0.132	0.2	0.123	0.2
F2	0.196	0.007	0.105	0.200	0.196	0.007	0.105	0.2
F1-F0	0.105	0.2	0.140	0.170	0.105	0.2	0.14	0.17

3.2 The descriptive scores of acoustic analysis of normal group and voice disorder groups

The mean scores for pre test, immediate post test and prolonged post test for group I is depicted in table 5. The table comprises the mean, median and standard deviation for all parameters in the pre-test, immediate post-test and prolonged post test for normal group. CQ, F1 and A- tremor showed an consistent trend of increase from pre test to prolonged post test condition. SPI and OQ showed decrement throughout in the three conditions. Other parameters did not show any pattern of change in the three test conditions.

Table 5: *Mean, Standard Deviation and Median of all parameters in pre test, immediate post test and prolonged post test for Normal participants*

Parameters	Normal participants					
	Pre test		Immediate – post test		Prolonged - post test	
	Mean(SD)	Median	Mean(SD)	Median	Mean (SD)	Median
MeanF0	170 (49.79)	161	170 (49.33)	172	220 (18.82)	220
SDF0	6.08 (13.60)	3.14	4.30 (5.34)	3.05	18.35 (24.68)	5.58
Ftri	4.33(2.30)	4.30	4.33 (2.30)	4.30	4.80 (4.13)	4.07
Fatr	3.7(1.85)	3.88	2.73 (1.72)	3.06	3.66 (3.41)	3.75

Jitter	1.39(1.01)	1.24	1.27 (1.16)	0.916	1.93 (1.27)	1.76
RAP	0.836(.612)	0.74	.763 (.71)	0.547	1.15 (0.74)	1.06
VF0	3.44(7.14)	1.9	2.59 (3.05)	1.67	8.42 (11.49)	2.42
Shimmer	4.95(3.89)	4.34	4.36 (1.77)	3.62	5.6 (2.99)	5.23
APQ	3.56(2.45)	3.15	3.19 (1.33)	2.86	4.02 (2.25)	3.7
NHR	0.15(.09)	0.14	0.14 (0.04)	0.13	.15 (.0.05)	0.15
VTI	0.048(.009)	0.04	0.050(0.017)	0.04	.05 (.02)	.04
SPI	14.35(6.50)	12.80	13.47(7.36)	11.61	10.71 (4.1)	9.18
Ftri	0.288(.164)	0.246	.364(.409)	0.29	.78 (1.24)	.34
Atri	4.43(3.02)	3.52	3.66(2.91)	3.69	4.1 (3.73)	3.30
Pitch	170(47.73)	171.54	171(49)	0.172	215 (21.43)	210
CQ	43.0(3.42)	43.9	44.37(3.44)	43.7	44.72 (2.34)	45.01
SQ	346(179)	285.	388(154)	339	298 (64.08)	270
OQ	56.9(3.43)	56.08	55.99(3.73)	56.13	55.66 (2.19)	55.03
F0-tremor	1.70(.82)	1.49	3.09(3.8)	1.52	2.59 (3.79)	1.50
A-tremor	1.95(2.48)	1.31	2.02(2.03)	1.46	2.64 (2.99)	1.77
NNE	-9.43(5.86)	-9.51	-11.93(4.39)	-10.93	-8.56 (8.68)	-10.12
HNR	22.24(4.02)	21.07	22.58(4.53)	22.70	21.48 (3.71)	22.80
SNR	20.65(4.05)	19.35	21.28(4.46)	21.41	20.1 9 (3.74)	21.64
F0	170(49.78)	161	170(49)	172	220 (18)	220
F1	689(120)	672	700(160)	686	726 (117)	744
F2	1335(145)	1282	1334(163)	1309	1425 (195)	1475
F1-F0	518(104)	535	529 (143)	537	506 (119)	528

Table 6 represents the mean, median and standard deviation values of the group II for Pre test and immediate post test. Mean F0, Fftr, Fatr, Atri, F0- tremor, A- tremor, HNR, SNR, F1, F2, F1-F0 showed increment in post test condition. Decrease was seen in Jitter, Shimmer, VF0, APQ, RAP, NHR, VTI, SPI, Ftri, CQ, SQ, OQ and NNE.

Table 6: *Mean , standard deviation and median of all parameters in pre test and immediate post test condition for individuals with voice disorders.*

Parameters	Voice disorder			
	Pre test		Immediate post test	
	Mean (S D)	Median	Mean (S D)	Median
MeanF0	158 (44)	161	171 (43)	177

SDF0	7.60 (6.69)	4.55	8.15 (7.73)	3.15
Fftr	4.18 (3.46)	3.40	4.39 (1.84)	3.69
Fatr	1.41 (1.95)	0.0	1.62 (1.44)	2.23
Jitter	3.53 (5.48)	1.64	1.83 (1.08)	1.76
RAP	1.88 (2.60)	.96	1.16 (0.63)	1.12
VF0	5.38 (6.13)	2.63	4.71 (4.68)	1.99
Shimmer	7.10 (9.72)	4.00	3.47 (1.88)	2.89
APQ	5.73 (8.45)	2.86	2.84 (1.36)	2.21
NHR	0.17 (0.089)	0.155	0.132 (0.043)	0.134
VTI	0.039(0.025)	0.032	0.035 (0.021)	0.027
SPI	28.57 (21.82)	25.48	29.51 (13.95)	31.97
Ftri	0.426 (0.316)	0.345	0.642 (0.630)	0.393
Atri	1.66 (2.40)	0.124	3.62 (3.71)	3.027
Pitch	168 (40)	166	169 (42.11)	166
CQ	46.8 (2.1)	47.1850	45.46 (4.48)	45.4
SQ	235 (81.24)	224.9000	213 (72.36)	222
OQ	53.47 (2.17)	53.0400	53.66 (5.61)	54.9
F0-tremor	1.63 (1.05)	1.14	1.77 (1.01)	1.26
A-tremor	1.35 (0.861)	1.07	1.69 (1.23)	1.11
NNE	-8.66 (6.82)	-6.87	-3.86 (12.78)	-6.67
HNR	21.73(8.93)	25.37	27.01 (5.21)	28.25
SNR	20.40 (8.48)	23.65	25.94 (5.02)	27.44
F0	159 (50)	160	170 (43)	171
F1	590 (158)	623	678 (195)	645
F2	1272 (288)	1313	1279 (246)	1298
F1-F0	431 (127)	432	507 (162)	465

Comparison of Vocal Nodule and Other Hyperfunctional Voice disorder

The data from group II.A and group II.B were compared using Mann- Whitney U Test. The groups did not show significant difference except in standard deviation of F0($Z=2.34, p=0.19$), Variation of F0($|Z|=2.34, p=0.19$) and A- tremor ($Z=2.05, p=0.04$). Hence in the study, group II.A and group II.B were collectively considered as hyper functional voice disorders. Mean values for the groups are summarised in the Table 7.

Table 7:*Mean, Median and Standard deviation of pre test and immediate post test condition for other hyper functional voice disorder group (group II.B) and vocal nodule group (group II.A)*

	Vocal nodules				Other hyperfunctional Voice disorder			
	Pre test		Immediate post test		Pre test		Immediate post test	
	Mean(SD)	Median	Mean	Median	Mean(SD)	Median	Mean	Median
meanF0	142(33)	157	173(13)	182.06	177(59)	161	169.56(73)	150
SD F0	10.71(7.68)	6.51	11.72(8.91)	13.29	2.71(1.39)	2.78	2.46(0.92)	2.18
Fftr	4.09(4.02)	3.03	3.62(1.17)	3.31	5.34(2.62)	5.50	4.87(2.42)	4.72
Fatr	0.58(1.31)	0.00	1.37(1.25)	2.15	2.81(2.19)	3.21	1.61(1.86)	1.55
Jitter	5.20(7.6)	2.23	1.91(0.72)	1.89	1.17(0.54)	1.12	1.14(0.60)	1.14
RAP	2.66(3.57)	1.33	1.22(0.34)	1.13	0.69(0.33)	0.67	0.77(0.49)	0.69
VF0	8.09(7.74)	3.70	6.66(5.72)	7.27	1.57 (0.44)	1.54	1.58(0.61)	1.80
Shimmer	9.98(13.61)	4.58	3.17(1.66)	2.88	3.18 (1.23)	2.96	2.98(1.52)	2.58
APQ	8.20(11.93)	3.30	2.79(1.01)	2.09	2.55 (0.94)	2.24	2.25(1.20)	1.93
NHR	0.204(0.12)	0.15	0.12(0.05)	0.13	0.14 (0.03)	0.14	0.13(0.02)	0.13
VTI	0.038(0.01)	0.031	0.03(0.01)	0.03	0.03 (0.01)	0.03	0.04(0.03)	0.03
SPI	25.04(7.9)	25.48	29.8(7.79)	27.67	37.13 (33.69)	29.96	32.4(20.6)	41.23
Ftri	.61(0.352)	0.64	0.79(0.78)	0.43	0.34 (0.16)	0.30	0.29(0.14)	0.27
Atri	.98(2.06)	0.00	1.90(2.87)	0.00	2.93 (2.80)	2.54	4.32(3.67)	4.37
Pitch	170(9.24)	169	165(11.70)	164	166(69)	150.16	173 (71)	155.40
CQ	46.79(2.08)	47.05	44.4(2.98)	46.25	47.80(1.13)	47.46	47.84(5.7)	45.51
SQ	204(63.9)	222	236(57.73)	227.20	294(77.19)	312.20	196.(96.2)	228.10
OQ	53.53(2.13)	52.95	54.93(3.8)	53.80	52.45(1.35)	52.77	51.35(7.9)	54.99
F0-tremor	1.24(1.15)	1	1.22(0.27)	1.13	1.77(0.78)	1.62	2.14(1.31)	1.78
A-tremor	0.81(0.453)	1	1.05(0.07)	1.01	1.94(0.97)	1.67	1.72(0.71)	1.59
NNE	-8.20(5.76)	-8.00	-11.5(4.65)	-13.58	-10.82(8.68)	-9.52	5.36(15.7)	3.97
HNR	19.20(11.4)	25.04	29.28(2.6)	28.97	26.38(3.60)	26.34	27.37(3.1)	27.26
SNR	18.07(10.7)	23.57	27.81(2.43)	27.54	24.9 (3.40)	24.69	26.79(2.7)	27.50
F0	152(43)	164.17	168(16)	174	168 (70)	152	173(72)	153
F1	605(145)	696	701(175)	631	526(174)	473	635(263)	608
F2	1241(177)	1289	1365(147)	1300	1180 (319)	1177	1176(356)	1119
F1-F0	453(117)	501	533(161)	456	358 (105)	325	461(197)	458

3.3 Effect of SOVT exercise - By comparing Pre test and immediate post test in Normal group

Pre test and immediate post test scores for all parameters of group I was compared using Wilcoxon Sign Rank test. Figure 1. Depicts the parameters with significant difference By comparing Pre test and immediate post test in normal group. The parameters that showed significance were Fatr (Z= 2.6,p0.008), CQ(Z=2.3,p=0,018), SQ(Z=2.86,p=0.004), OQ (Z=1.87,p=0.068) and NNE (Z=2.21, p=0.02). Fatr, NNE and OQ was found to be decreased in the immediate post test . SQ and CQ showed increased values in immediate post test condition.

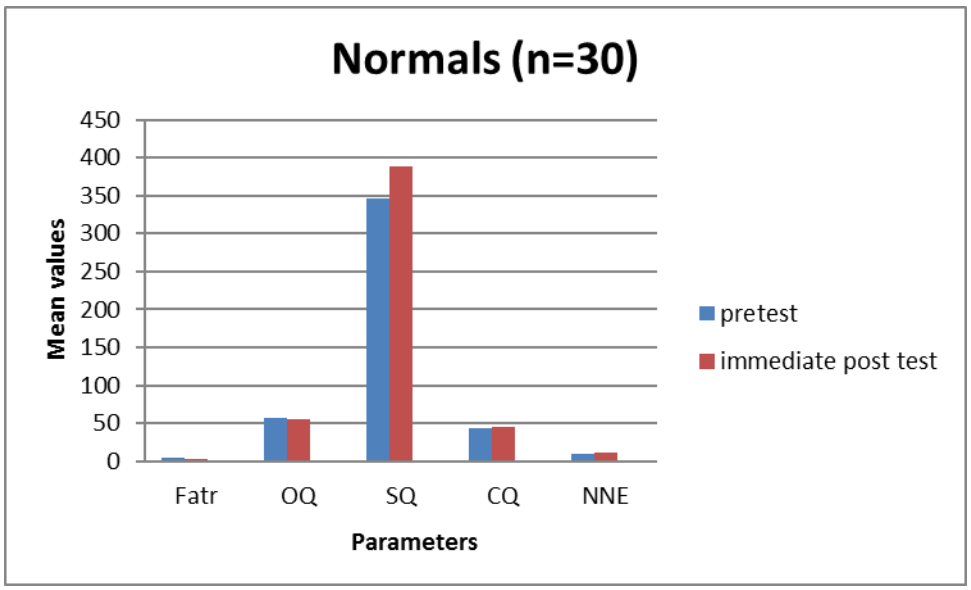


Figure 1*: The parameters with significant difference by comparing pre test and immediate post test in normal group (n=30)*

3.4 Effect of SOVT exercise - By comparing pre test and immediate post test in Voice disorder

Pre test and immediate post test scores for all parameters of group II was compared using Wilcoxon Sign Rank Test. Only SNR (Z= 2.5,p=0.009) showed significance

difference between both the conditions. SNR has improved in the immediate post test condition. Jitter, RAP,VF0, Shimmer, APQ, NHR, VTI, SQ and NNE had decreased in the immediate post test though the reduction was not statistically significant. Similarly SPI, HNR, SNR and formants showed increment. Additionally Tremor parameters (F0-tremor and A- tremor) also showed slight increase.

Effect of SOVT exercise - By comparing pre test and immediate post test within normal and voice disorder group across gender

The comparison was carried out using Wilcoxon sign rank test. The comparison of pre test and immediate post test of group I across the male subjects revealed significance only in CQ (Z= 1.9,p=0.053) and females differed significantly SQ (Z= 3.8,p=0.001). In group II male subjects showed no significance in any of the parameters where as females showed change in HNR (Z=2.20, p=0.028).

Table 8: *Z and p value for comparison of pre test and immediate post test of normal and voice disorder group across gender*

	Normals				Voice disorder			
	Male		Female		Male		Female	
	|Z|	p	|Z|	p	|Z|	P	Z	p
MeanF0	0.00	1.000	0.057	0.955	0	1.000	1.352	0.176
SDF0	0.45	0.650	0.568	0.570	0.134	0.655	0.338	0.735
Fftr	0.39	0.695	1.817	0.069	0	1.000	0.676	0.499
Fatr	2.27	0.023	1.433	0.152	0	1.000	0.105	0.917
Jitter	0.28	0.977	1.363	0.173	1.604	0.109	0.338	0.735
RAP	0.03	0.977	1.363	0.173	0.535	0.593	0.338	0.735
VF0	0.51	0.609	0.568	0.570	0.447	0.655	0.507	0.612
Shimmer	0.51	0.609	0.454	0.650	0	1.000	1.183	0.237
APQ	0.40	0.691	0.511	0.609	0.535	0.593	1.521	0.128
NHR	0.09	0.925	0.284	0.776	1.069	0.285	1.192	0.233
VTI	0.63	0.530	0.189	0.850	0.535	0.593	0.507	0.612
SPI	0.40	0.691	1.533	0.125	0	1.000	1.183	0.237
Ftri	0.06	0.955	0.284	0.776	1.604	0.109	0.314	0.753
Atri	1.19	0.233	0.454	0.650	1.069	0.285	0.734	0.463
Pitch	0.40	0.691	0.454	0.650	1.604	0.109	0.338	0.735
CQ	1.93	.053*	1.363	0.173	1.604	0.109	1.183	0.237
SQ	1.42	0.156	3.181	.001**	0	1.000	0	1.000
OQ	1.76	0.078	0.722	0.470	1.069	0.285	0.507	0.612

F0tremor	0.97	0.331	0.512	0.609	0	1.000	0.676	0.499
A-tremor	0.53	0.593	0.795	0.426	0.535	0.593	2.201	0.028
NNE	1.76	0.078	1.363	0.173	0	1.000	0.676	0.499
HNR	1.08	0.281	0.199	0.842	0	1.000	2.197	0.028
SNR	1.53	0.125	0.085	0.932	1.069	0.285	2.366	0.018
F0	0.00	1.000	0.057	0.955	1.069	0.285	0.507	0.612
F1	0.00	1.000	0.795	0.427	1.069	0.285	0.845	0.398
F2	0.97	0.334	1.136	0.256	1.069	0.285	0.676	0.499
F1-F0	0.17	0.865	0.625	0.532	1.069	0.285	0.845	0.398

**p<0.05, **p<0.01*

3.4 Effect of SOVT exercise - By comparing pre test and prolonged post test in Normal group

Wilcoxon signed rank test performed showed a change in pre test and prolonged post test condition in group I for SQ(Z=1.9,p=0.047), CQ(Z=2.09,p=0.037) and HNR (Z=1.89, 9= 0.057) CQ has increased where as SQ and HNR reduced after the prolonged post test condition. Figure 2 depicts the pre test and prolonged post test comparison in group I

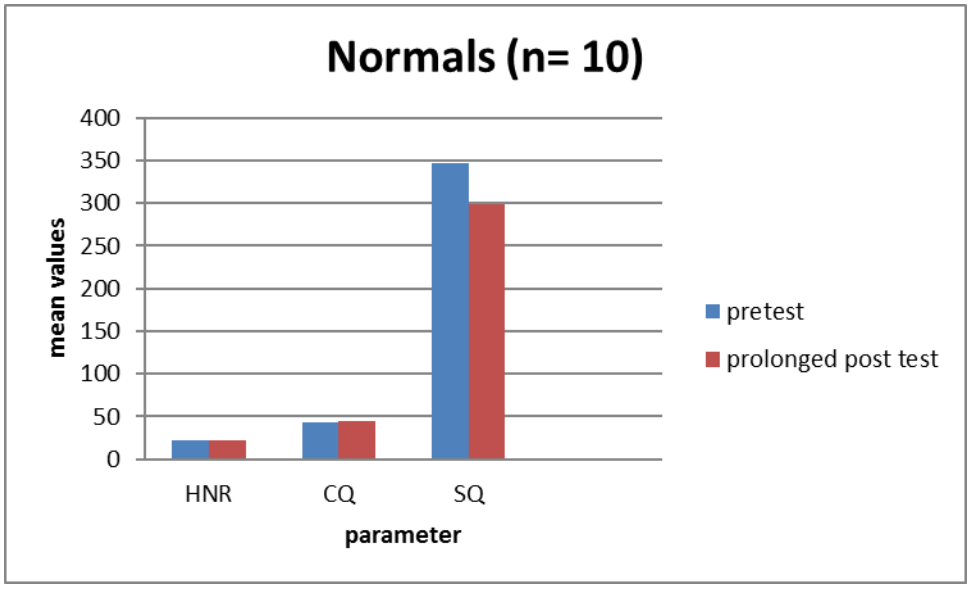
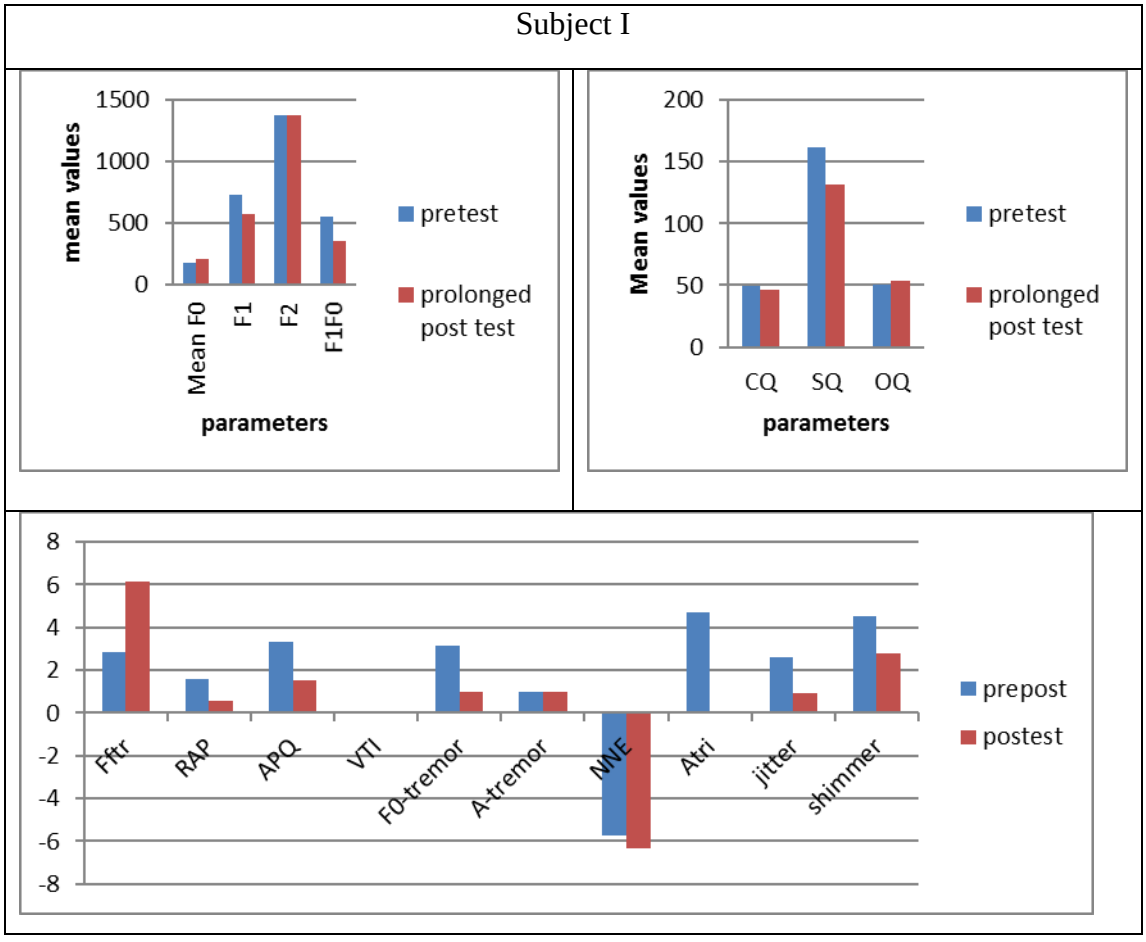


Figure 2: *The parameters with significant difference by comparing pre test and prolonged post test in normal group.*

3.6 Effect of SOVT exercise - By comparing pre test and prolonged post test in group II

From group II the subjects SI, SII and SIII were considered for long term

(10 sessions) administration of SOVT exercises. Considering SI, a female subject of age 50 years showed increase in Mean F0,Fftr, OQ, A-tremor, HNR and SNR in prolonged post test condition. jitter, Shimmer, RAP,APQ, VTI, Ftri, Atri,SQ, F1, F2, F1-F0 ,SPI, CQ, NNE and F0-tremor showed reduction in the prolonged post test condition. Figure 3 depicts the comparison of pre test and prolonged test of Subject I. Majority of the parameters showed towards improvement of voice quality.



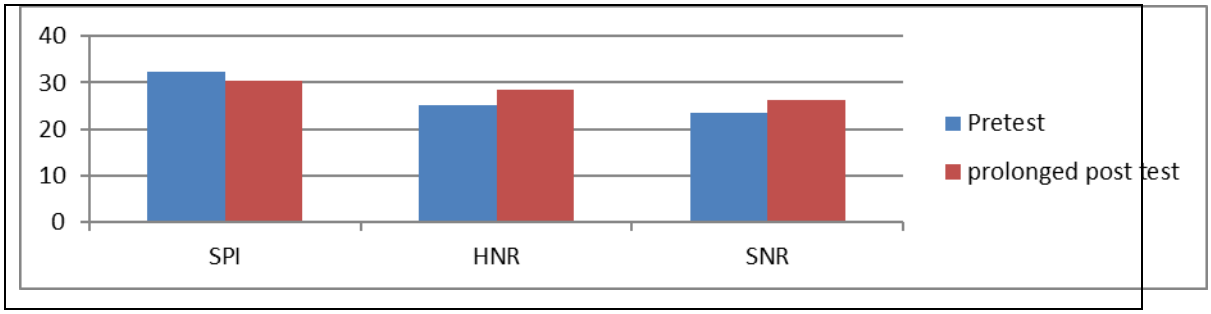
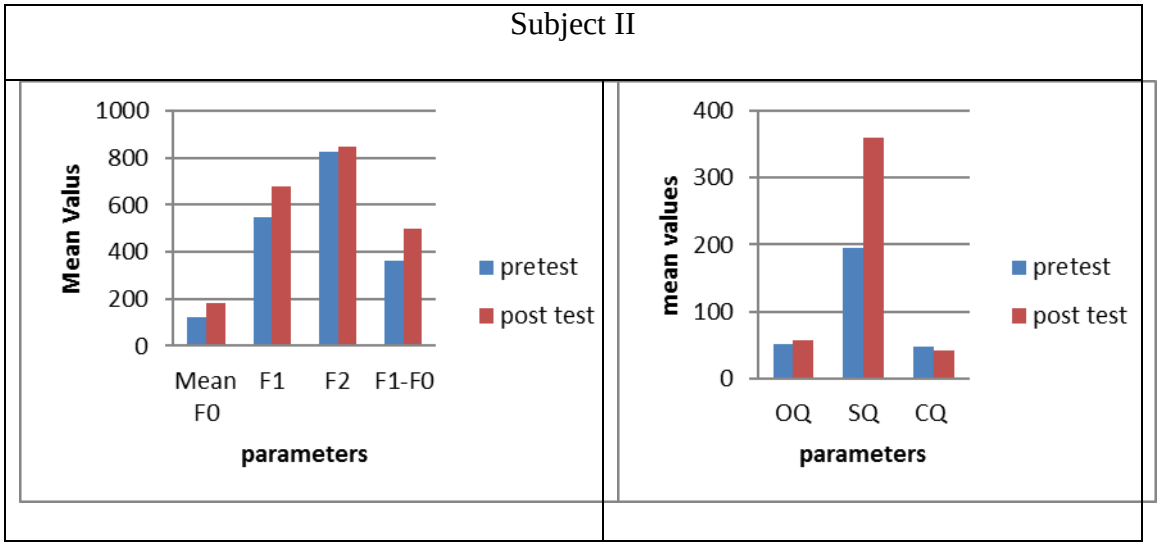


Figure 3. *Comparison of pre test and prolonged post test scores of subject I in voice disorder group.*

The subject SII, 22years, male in the comparison of pre test and prolonged test showed decrement in SPI,SNR, HNR, NNE, OQ, Fftr, than pre test condition and F0-tremor, SQ,CQ, Atri, Ftri, NHR, APQ, Shimmer,VF0, Jitter Mean F0, F1-F0, F1, showed increment compared to pre test condition. CQ, OQ, F2, A-tremor and VTI did not show considerable change in prolonged post test condition. Fig.4 shows the comparison of pre test and prolonged post test scores of subject II. This shows there is no signs of improvement in the voice quality.



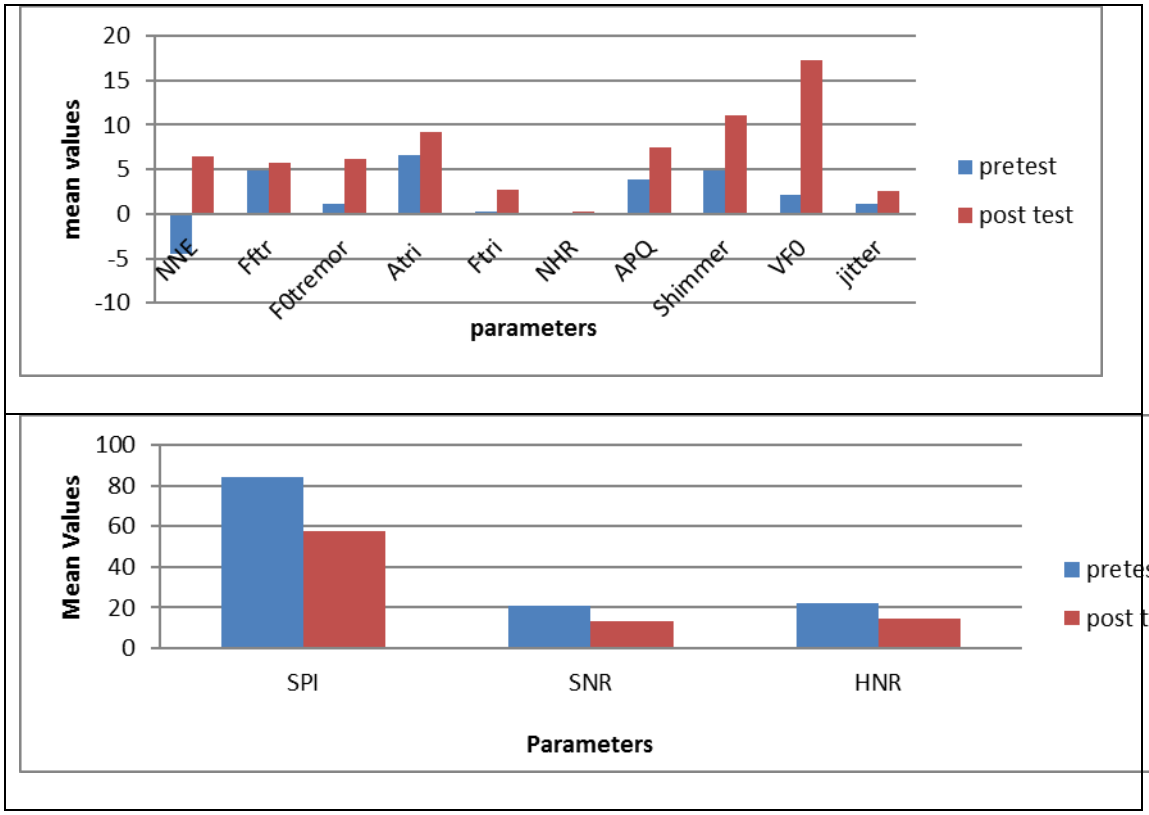


Figure 4. *The comparison of pre test and prolonged post test scores of subject II in voice disorder group.*

The third subject S III, considered for the prolonged post test of the SOVT technique was 36 year old female. In the MDVP analysis the results showed that Mean F0, Fftr, OQ had marked increase where as SPI , SDF0 , VF0,APQ ,CQ, SQ has reduced considerably. Slight decrement were observed for jitter, Shimmer, RAP, APQ, NHR and VTI in prolonged post test condition. F0-tremor, HNR and SNR showed increase and NNE decreased in prolonged post test condition. A- tremor showed no change from pre test condition. The formant analysis showed that the F1, F2 and F1-F0 has reduced. Overall the results suggested notable improvement in the voice quality by the objective measures

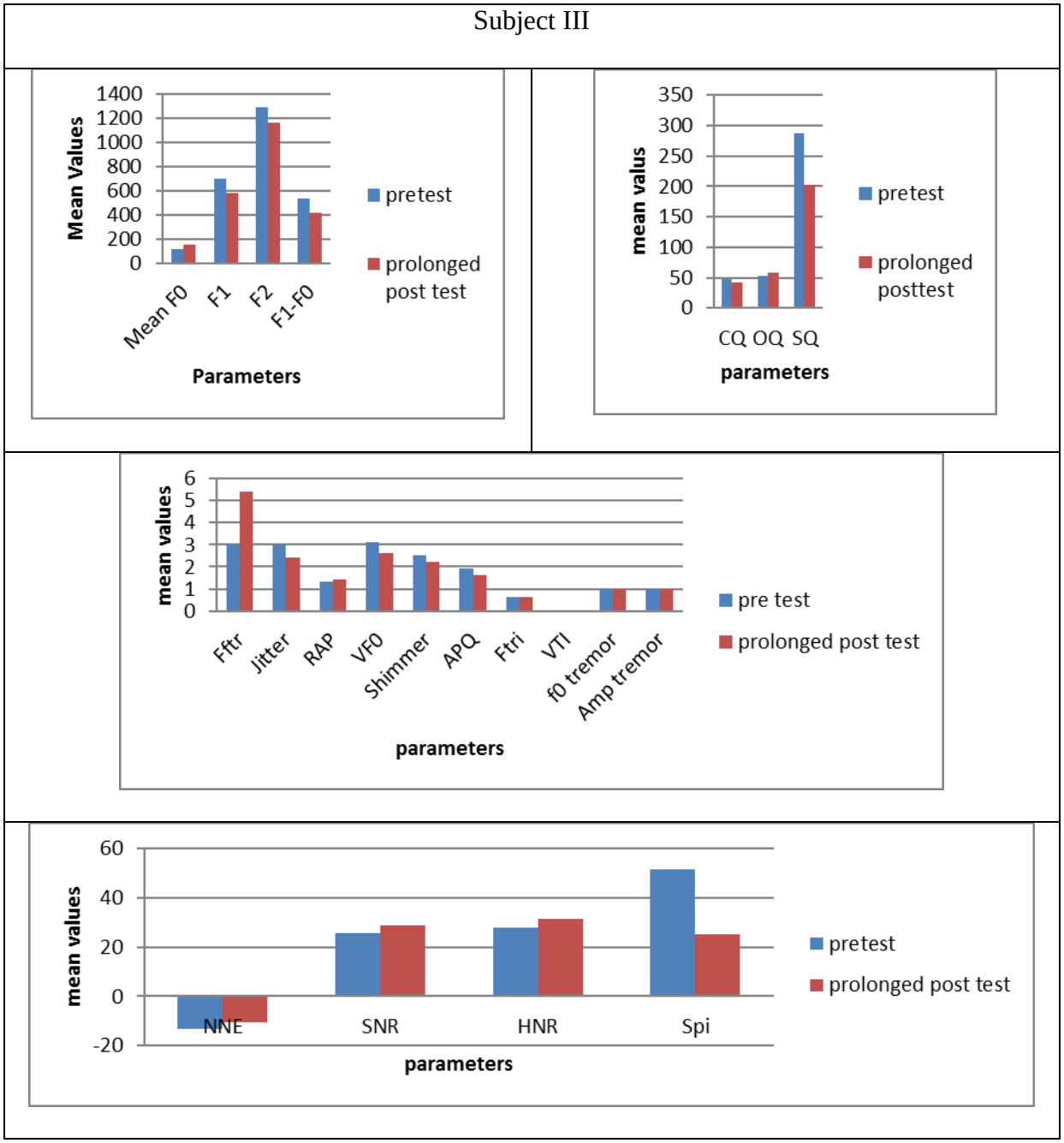


Figure 5.*Comparison of pre test and prolonged post test scores of subject III in voice disorder group.*

3.7. Comparison between Normal group and Voice Disorder group for pre test condition and immediate post test condition

Group I and group II were compared between for all parameters in pre test and immediate post test condition. In pre test condition, VTI(Z=2.53,p0.01),

SPI(Z=2.5,p=0.011), Atri(Z=2.53,p=0.011), CQ(Z=2.9,p=0.003), SQ(Z=2.2,p=0.025), OQ(Z=2.7, p=0.007),

F1 - F0(Z=1.9,0.04) showed significant difference across group I and group II. Among the significantly different parameters, only SPI values were higher for voice disorder group .

In immediate post test condition, Fatr (Z=2.1, p0.05), Jitter(Z=2.09,p=0.036), RAP(Z=2.3,p=0.018), VTI (Z=2.45,p=0.014), SPI(Z=3.2,p=0.01), SQ(Z=2.2,p<0.01), NNE (Z=1.96,p=0.04), HNR(Z=2.59,p=0.01) SNR(Z=2.62,p=0.009), F1-F0(Z=1.9, p=0.049) showed significance and VTI, SQ, Fatr were higher in normal individuals than voice disorders.

3.8 Effect of gender in Normal group

Mann- whitney U test was done to find the effect of gender in the two groups .In group I, Pre test condition showed significant difference in Mean F0 (Z=4.6, p<0.01), SDF0(Z=4.6,p=0.02),jitter (Z=2.7,p=0.006), RAP (Z=2.8,p=0.004), NHR (Z=3.19,p=0.01),VTI(Z=1.9,p=0.65), SQ(Z=4.1,p=0.00), NNE (Z=1.8,p=0.05), HNR(Z= 3.17,p=0.02), SNR (Z=3.29,p=0.001), F1 (Z=2.4,p=0.014), F2 (Z=2.55, p=0.011) and immediate post test condition, differed significantly in Jitter (Z=2.7,p= 0.006),RAP (Z=1.8, p=0.004), Shimmer (Z=1.9, p=0.054), APQ(Z=2.7,p= 0.07), NHR (Z=3.15,p=0.002),SQ(Z=4.4,p=0.00), F1(Z=3.007,p=0.01), F2(Z=3.2,p=0.003), F1-F0 (Z=2.13,p=0.033). In prolonged post test only females were considered hence gender effect could not be estimated. In pre

test condition, Females showed higher values than males in RAP, HNR, F1, F2 .Post test condition showed higher scores for males in SQ , NHR and Shimmer where as females had higher values in RAP,APQ , Jitter, F1, F2, F1-F0. The results are tabulated in Table 9.

Table 9: *The gender comparison in pre test and immediate post test condition for normal group.*

Parameters	Normals							
	Pre test				Immediate Post test			
	Males	Females	/Z/	p	Males	Females	/Z/	P
	Mean (SD)	Mean (SD)			Mean (SD)	Mean (SD)		
meanF0	124 (16)	216.53 (18)	4.67	0.0**	125.26 (18)	216.27 (16)	4.67	0.00**
SD F0	3.27(4.13)	8.88 (18.69)	3.13	0.00**	3.12 (2.89)	5.48 (6.91)	2.18	0.03*
Fftr	3.31(1.59)	3.98 (1.99)	1.18	0.24	3.62 (2.49)	4.99 (1.96)	1.51	0.13
Fatr	4.27(1.60)	3.29 (2.01)	1.62	0.11	3.12 (1.43)	2.34 (1.95)	1.34	0.18
Jitter	0.93(0.49)	1.86 (1.19)	2.76	0.01*	0.95 (0.76)	1.61 (1.41)	1.68	0.09
RAP	0.56(0.31)	1.12 (.72)	2.84	0.00	0.55 (0.44)	0.98 (0.87)	1.80	0.07
VF0	2.51(2.77)	4.39 (9.80)	0.39	0.69	2.55 (2.63)	2.63 (3.52)	0.10	0.92
Shimmer	4.71(1.77)	5.20 (5.31)	0.93	0.35	4.95 (1.81)	3.77 (1.59)	1.93	0.05*
APQ	3.56(1.06)	3.56 (3.36)	1.43	0**	3.79 (1.33)	2.61 (1.07)	2.72	0.01*
NHR	0.16(0.02)	0.16 (0.13)	3.20	0.00	0.16 (0.02)	0.14 (0.06)	3.15	0.00*
VTI	0.05(0.01)	0.04 (0.01)	1.97	0.05	0.05 (0.02)	0.05 (0.01)	1.14	0.25
SPI	14.9(7.84)	13.81 (5.06)	0.02	0.98	14.98 (7.46)	11.96(7.19)	1.35	0.18
Ftri	0.30(0.17)	0.27 (0.16)	0.56	0.58	0.31 (0.25)	0.41 (0.53)	0.52	0.60
Atri	5.39(3.22)	3.46 (2.55)	1.85	0.00**	4.50 (2.76)	2.82 (2.91)	1.52	0.13
Pitch	125.55(14)	215.48 (12)	4.67	0.00**	125.68 (17)	217.06 (17)	4.67	0.00**
CQ	42.36(3.7)	43.79 (3.09)	1.35	0.00**	43.94 (4.31)	44.81(2.35)	1.20	0.23*
SQ	446(210)	246.97 (28)	4.17	0.00**	490.15(160)	287.73 (39)	4.42	0.00**
OQ	57.66(3.6)	56.19 (3.12)	1.35	0.18	56.26 (4.47)	55.72(2.96)	0.66	0.51
F0tremor	1.74 (1.02)	1.68 (0.59)	0.66	0.51	2.37 (2.85)	3.82 (4.54)	0.12	0.90
A-tremor	2.47 (3.45)	1.43 (0.56)	1.11	0.27	1.87 (1.46)	2.17 (2.53)	0.08	0.93
NNE	-8.86(2.97)	-10.02 (7.85)	1.89	0.06	-10.63(3.51)	-13.2(4.89)	1.41	0.16
HNR	19.99(3.4)	24.49 (3.26)	3.17	0.0**	20.93 (4.56)	24.23(3.99)	1.97	0.05*
SNR	18.39(3.5)	22.92 (3.29)	3.30	0.00**	19.62 (4.36)	22.95(4.04)	2.01	0.04*
F0	124 (16)	216.53 (18)	4.67	0**	125.35 (18)	216 (16)	4.67	0.00**
F1	628 (73)	750.32 (128)	2.47	0.01*	622.51 (91)	778 (178)	3.01	0.00**
F2	1261 (43)	1410.83(173)	2.55	0.01*	1233.29(83)	1435(162)	3.30	0.00**
F1-F0	503 (82)	533.73 (124)	0.89	0.37	497.15 (97)	562 (174)	2.14	0.03*

3.9 Effect of gender in Voice Disorder group

In group II, In pre test condition, significant effect of gender was not obtained except for A- tremor (Z=2.08,p=0.037) and post test condition showed F2 (Z=

2.16,p=0.030), SNR (Z=1.93,p=0.053), HNR (Z=2.3,p=0.017), Shimmer (Z= 1.93,p=0.053) significantly different. Prolonged post therapy showed no effect of gender in it. Table 10 shows the tabulated data of the same.

Table. 10: *Gender comparison in pre test and immediate post test condition for voice disorder group.*

Parameters	Voice disorders							
	Pre test				Immediate Post test			
	Males	Females	/Z/	P	Males	Females	/Z/	P
	Mean (SD)	Mean (SD)			Mean (SD)	Mean (SD)		
meanF0	154.35 (26)	216.531 (18)	0.11	0.91	154.59 (40)	179.25 (45)	1.02	0.31
SD fFo	5.80 (5.21)	8.88 (18.69)	0.34	0.73	6.20 (6.07)	8.99 (8.64)	0.57	0.57
Fftr	4.42 (4.19)	3.98 (1.99)	0.23	0.82	5.25 (2.15)	4.02 (1.75)	0.57	0.57
Fatr	2.14 (2.13)	3.29 (2.00)	0.77	0.44	2.01 (1.75)	1.45 (1.41)	0.71	0.48
Jitter	2.58 (1.85)	1.86 (1.19)	0.57	0.57	2.16 (1.83)	1.69 (0.76)	0.11	0.91
RAP	1.52 (1.07)	1.12 (0.72)	0.57	0.57	1.41 (1.08)	1.06 (0.42)	0.51	0.57
VF0	3.60 (3.00)	4.39 (9.80)	0.11	0.91	3.71 (3.29)	5.14 (5.36)	0.11	0.91
Shimmer	5.36 (2.78)	5.20 (5.31)	0.57	0.57	5.05 (2.01)	2.81 (1.49)	1.94	0.05
APQ	4.03 (1.97)	3.56 (3.37)	0.79	0.43	3.91 (1.56)	2.39 (1.08)	1.71	0.09
NHR	0.16 (0.04)	0.16 (0.13)	0.34	0.73	0.15 (0.03)	0.12 (0.05)	0.80	0.42
TI	0.04 (0.05)	0.04 (0.01)	0.00	1.00	0.04 (0.02)	0.03 (0.02)	0.11	0.91
SPI	43.48 (36.87)	13.81 (5.06)	1.02	0.31	34.06 (16.0)	27.57 (13.8)	0.79	0.42
Ftri	0.15 (0.14)	0.27 (0.16)	1.81	0.07	0.62 (0.62)	0.65 (0.69)	0.11	0.91
Atri	3.28 (3.32)	3.47 (2.55)	1.09	0.27	6.99 (3.50)	2.18 (2.91)	1.76	0.08
Pitch	149.69 (37)	215.48 (12)	1.03	0.31	156.77 (37)	174.67 (45)	0.11	0.91
CQ	45.94 (2.64)	43.78 (3.09)	0.57	0.57	43.99 (2.74)	46.09 (5.11)	0.57	0.57
SQ	208.43 (58)	246.96 (28)	0.79	0.42	207.57 (45)	215.98 (84)	0.34	0.73
OQ	54.46 (2.54)	56.18 (3.12)	0.79	0.42	55.53 (0.97)	52.86 (6.67)	0.57	0.57
F0tremor	2.32 (1.00)	1.68 (0.59)	1.49	0.14	2.22 (0.95)	1.58 (1.05)	1.25	0.21
A-tremor	2.22 (.97)	1.43 (0.56)	2.08	0.04	2.56 (2.05)	1.33 (0.61)	1.26	0.21
NNE	-3.24 (1.10)	-10.02 (7.85)	1.71	0.09	-5.32 (5.26)	-3.24 (15.31)	0.57	0.57
HNR	21.62 (5.58)	24.49 (3.26)	0.57	0.57	21.32 (6.16)	29.45 (2.24)	2.39	0.02
SNR	20.27 (5.81)	22.91 (3.29)	0.57	0.57	21.16 (7.20)	27.99 (2.06)	1.94	.053
F0	150.04 (39)	216.53 (18)	0.34	0.73	155.94 (36)	176.71 (47)	0.34	0.73
F1	571.52 (189)	750.31 (128)	0.11	0.91	650.05 (87)	690.32 (233)	0.11	0.91
F2	1214.04 (516)	1410.83 (173)	0.57	0.57	1009 (218)	1395 (152)	2.16	0.03
F1-F0	421.43 (170)	533.72 (124)	0.11	0.91	494.10 (63)	513.59 (194)	0.11	0.91

Summary of Results

- **Effect of exercise within the normal group**
    - **Pre test – immediate post test difference:** SQ and CQ increased where as NNE, Fatr and OQ reduced in immediate post test condition. Males differed significantly in CQ where as females differed in SQ.
    - **Pre test- prolonged post test difference:** CQ, SQ, HNR showed statistical significance. CQ has increased while SQ and HNR decreased

- **Effect of exercise within the voice disorder group**
    - **Pre test – immediate post test difference:** statistical significance was obtained only for SNR values. Apart from that Mean F0 and formants have showed increase. CQ, SQ, jitter and Shimmer reduced. Males did not show any significant difference but females differed in HNR.
    - **Pre test- prolonged post test difference:** three participants were considered. Each subject is described separately.

      Table. 11: *Summary of individual results of prolonged post test condition in voice disorder group*

Subjects	Parameters increased	Parameters decreased
SI	Mean F0, VTI, Fftr, OQ, F0-tremor, HNR and SNR	F1, F2, F1-F0,SPI, CQ, NNE, SQ, RAP, APQ, F0-tremor, A-tremor, Atri, Jitter, Shimmer,
SII	NNE, OQ, Fftr, Mean F0, F1, F2, F1-F0, F0-tremor, FTRI, NHR, APQ, Shimmer, Jitter, VF0	SQ, CQ, Atri, Ftri, SPI, SNR, HNR,
SIII	SDF0, Fftr, OQ, RAP, HNR, SNR, Mean F0, F0-tremor	SPI, , CQ, SQ, NNE, , F1, F2, F1-F0, jitter, Shimmer,VF0, APQ,

- **Comparison of the effect of exercise between normal and voice disorders**

- **Pre test condition:** Normals and Voice disorder group differed significantly in VTI, Atri, CQ, SQ, OQ, F1 and F2.
- **Post test condition:** Fatr, Jitter, RAP, VTI, SPI, SQ, NNE , HNR, SNR, F1-F0 differed signficantly between both the groups. VTI, SQ, Fatr were higher in normal individuals than voice disorders.

Chapter 5 : Discussion

The current study aimed to investigate the effect of the SOVT Exercise – combined rigid and flexible straw phonation sequence on acoustic parameters of voice in population with normal voice quality and hyper functional voice disorders. The objective was to find the immediate and prolonged effect of the SOVT exercise - combined rigid and flexible straw phonation sequence was accomplished in three phases. First phase, i.e, the pretest condition contained estimation of baseline values of acoustic parameters. In second phase, the immediate post test condition the same parameters were estimated after the practice of the SOVT Exercise – combined rigid and flexible straw phonation sequence for 10 minutes. The third phase, prolonged post test condition was carried out after the practice of the exercise for 10 sessions of 10-20 minutes duration. The first and second phase was accomplished for 30 individuals with normal voice quality and 10 individuals with hyperfunctional voice disorders. From enrolled subjects, ten of individual with voice quality, and two of individuals with hyperfunctional voice disorders were considered for third phase of study. The results obtained from the study is discussed under following topics

- Effect of SOVT exercise within the normal group
- Effect of SOVT exercise within the voice disorder group
- Comparison of the SOVT effect of exercise between normal group and voice disorder group

Effect of SOVT exercise within the normal group

The comparison of the pre test and immediate post test condition showed difference in Fatr, CQ, SQ, OQ, NNE. The Fatr, which is the measure of rate of change of amplitude, showed a decrease in the immediate post test condition implying that the subjects could maintain a steady amplitude in the phonation. Further, CQ has showed increment in the immediate post test condition. Gaskill and Erickson (2010), described that no correct pattern of change in CQ was observed in participants after practicing phonation through straw and has explained the possible mechanism of increase in CQ. According to them during tube phonation, participants could have made subtle adjustments in vocal process adduction, and a need to push against the perceived acoustic back pressure, resulting in a general increase in muscular activation and an accompanying increase in CQ. Similar explanations were reported in a study done by Story et. al in 2000. Random individual variations in laryngeal height may also have played a part in the observed CQ changes during tube phonation. This increase in CQ correspondingly reduces the OQ hence showing a reduced air escape and more vocal fold contact. Also, in a recent study on the effects of tube phonation in two groups of male subjects, 10 with no vocal training and 10 with classical vocal training, Gaskill and Quinney (2012) also noted an increase of CQ during tube phonation in all the subjects of the study.The next electroglottographic parameter, Speed Quotient (SQ) is the ratio of duration of the opening phase to duration of the closing phase (Timcke, von Leden, and Moore 1958) has reduced and goes well with the findings of CQ. Normalised Noise Energy (NNE) is an acoustic measure of the voice that assesses the relative level of vocal noise to that of harmonics. In the present study the mean value of NNE has been found to

decrease in the immediate post test condition implying less noise share in the voice and better signal is obtained from production.

The changes in the CQ were maintained in the prolonged post test condition similar to immediate post test condition. This change could be due to an aerodynamic acoustic interaction , where in the increased impedance in supraglottal region hold back the air flow, also allowing for an acoustically rich harmonic spectrum. it is also assumed that the typical lag between maximal glottal opening and maximal glottal flow would be enhanced. Thereby restraining air flow, and at the same time assisting the closing phase, without the need to increase muscular adduction. Thought in this way, CQ might be expected to slightly increase, indicating an aerodynamically assisted closure.(Titze, 2000,2006.). Hence it can be assumed that the prolonged practice of the exercise might promote an aerodynamically assisted vocal fold adduction than a mechano acoustic closure. The restrain that happens to the glottal airflow tend to bring down the breathy component in voice thereby improving the voice quality. Whereas the reduction in the HNR in prolonged post test condition shows an increase in noise energy of the signal. This can be ascribed to the factor that HNR can vary according to different levels of acoustic noise in the environment (Deliyski, 2005).

Gender effects were observed in the outcome, where in the males varied significantly in CQ. Males have shown an increase in CQ values. A finding by Ma and Love, 2010 which showed adult males have increased vocal fold contact than younger adult females, Recent study by Paul et al (2011), reported a significantly longer contact phase in Indian young adult males versus females. Correlating the result of this study by Paul et. al (2011) females are expected to have higher SQ .But the findings in the current study states females had significant difference in SQ

values and it is tend to be reduced, hence contradicting the finding of previous researches.

Effect of SOVT exercise within the voice disorder group

The pre test and immediate post test comparison had statistically significant changes only in SNR values. The value has increased indicating the reduction in noise component of the signal which can be an indicative of better approximation of vocal folds. Considering the mean scores, SNR and HNR also showed improvement indicating a reduction in noise energy and a clearer signal after the practice of the SOVT exercise. Paes et .al, (2013) reported reduction of noise in high frequencies in an spectrographic analysis of phonation after the practice of straw phonation in individuals with dysphonia. The increased Mean F0 values observed in the immediate pre test could be attributed to the crichothyroid muscle activity during exercise, which is important for controlling frequency; its contraction raises the F0 (Laukkenenn et.al, 1995). In the continuant part of the study where 10 sessions of SOVT exercise was carried in individuals with hyperfunctional disorder can reveal the better picture of the consistency of the immediate effect derived from it.

The prolonged administration of the SOVT exercise was carried out in three subjects (SI, SII,S III) of which SI and SIII were diagnosed with bilateral vocal nodules. Both were female subjects. SII was male subject with muscle tension dysphonia. The direction of changes of the parameters in SI, SII and SIII share commonalities as well as differences. Mean F0 was found to be increased in all the three subjects. Except SII, all the subjects showed reduced F1 and F1-F0 difference in prolonged post test. In all the three subjects F0 was lesser than F1. The reduction in formants signifies an

inertive vocal tract with higher supraglottal impedance especially when the F1-F0 difference is less and it reduces the vocal load, assisting the vocal fold vibration. (Titze,1988)

The measurements SNR, HNR, increased and NNE and showed decrease for SI and S III and the subject SII showed a opposing trend on the same. SPI was found to be reduced in all the three subjects. Which implies reduced breathiness in the voice quality of the subjects after the practice of the SOVT exercise. SI and SIII showed reduced noise measures correlating to reduction in SPI. SII had increased jitter and Shimmer value while SI and SIII showed reduction in respective parameters. Taking in account the amplitude and Frequency tremor indices, SI had increment SII had decrement and SIII did not show considerable change between pre and prolonged post test condition. slight changes were observed in RAP and APQ in all the three subjects. SI showed increment in both, APQ decreased in SII and RAP had no change in SII, SIII had increased APQ and decreased RAP. This variations presented in these acoustic parameters could not support the underlying physiology of the laryngeal pathology. Additionally, the age gender and the variation in the extent of practice could also account the magnitude of change derived.

Electroglottographic measurements also revealed varied results in the three subjects. SQ, OQ and CQ showed similar trend of change in all the three subjects. OQ increased from pre test to prolonged post test and CQ and SQ showed a reduction in prolonged post test. Titze 2006, explains that the vocal folds may change shape from a convergent glottal shape where there is tight adduction of the vocal processes but loose adduction at the bottom of the folds, to a rectangular glottal shape where there is equal adduction top-to-bottom. This lowers the phonation threshold pressure. Contraction of the thyroarytenoid muscle facilitates this ‘‘squaring up’’ of the vocal

folds. Thus, hyper adduction at the vocal processes is traded for less adduction throughout the glottis and hence the contact quotient reduces. Titze, in the same study also posits that this help in the more efficient voice production.

Comparison of the effect of exercise between normal group and voice disorder group

The pre test comparison of Normals and voice disorders showed that the two groups differed significantly in SPI VTI, Atri, OQ, SQ, CQ. The mean scores of pre test condition clearly depicts the perceptual correlates for the normal and dysphonic voices.In the immediate post test condition. Fatr, Jitter, RAP, VTI, SPI, SQ, NNE, HNR, SNR, F1-F0 showed statistical significance. It could assumed that the change can occur easily in voice disorder group because of the high room the system exhibits to the voice use introduced during the practice of exercise. The threshold of succeptiblity to change is high in normal physiology than in pathologic physiology.

Although no Self perceptual assessment of voice was not used with the participants in the study, participants expressed a relaxation effect, a reduction in the tension and an openness in the vocal tract, directing to a smooth and easy voice production after the practice of exercise. One of the subject in the voice disorder group reported the observation of reduction in the need to clear throat after the practice of the SOVT exercise. An improvement in comfortable phonation duration and a clearer morphology of EGG waveform was also observed after the practice. Though only few acoustic and glottographic parameter showed significant changes in the post test conditions, the perceptual and subjective observations support the findings and

implicate the usefulness of the exercise. It can also be noted that the parameters that showed a trend of change (SPI, SNR, HNR, CQ, OQ, SQ etc) is significant in the judgement of voice quality and vocal fold vibratory pattern, therefore throws light to the effectiveness of the exercise.

Chapter 6: Summary and conclusion

Voice is produced by the vibration of vocal folds, which are driven by the rushes of air from lungs. The voice has an array of characteristics (pitch, intensity, quality) which make it the most unique to an individual. These characteristics of voice are utilised to accomplish a set of functions such as talking, crying, laughing, singing etc. When the voice characteristics find deterioration in accomplishing the functions of it, the term voice disorder is attributed to the condition. Voice disorders can be of varied type, nature and severity. Based on which medical or non medical approach of treatment is introduced to bring down the condition proximal to normality. Voice therapy is one such non medical tool and semi occluded vocal tract exercises (SOVT exercise) are one among the various kind of voice therapy technique. It makes use of a semi occlusion brought in the vocal tract and associated impedance and pressure change that happens in the cavity to accomplish economical voice production. Combined flexible and rigid straw phonation sequence is one method of SOVT exercise.

In the context of less experimented aspects of SOVT exercises, the present study aimed to study the effect of the SOVT exercise – combined rigid and flexible straw phonation sequence on acoustic parameters of voice in population with normal voice quality and hyper functional voice disorders. The objective of the study was to obtain the immediate and prolonged therapeutic effect of the exercise voice in population with normal voice quality and hyper functional voice disorders. The study was done in in three phases. First phase, i.e., the pre test condition contained estimation of baseline values of acoustic and electro glottograhic parameters were done. In second phase, the immediate post test condition the same parameters were estimated after the practice of the SOVT Exercise – combined rigid and flexible straw

phonation sequence for 10 minutes. The third phase, prolonged post test condition was carried out after the practice of the exercise for 10 sessions of 10- 20 minutes duration. The first and second phase was accomplished for 30 normals and 10 individuals with hyperfunctional voice disorders. From enrolled subjects ten of normal and two of individuals with hyperfunctional voice disorder group subjects were considered for third phase of study. The software used for acoustic analysis and electroglottographic study are Multi Dimensional Voice Program, Praat, Dr. Speech and CSL Real time EGG respectively.

The results of the study revealed changes in the acoustic and electroglottographic parameters in immediate and prolonged practices in both groups considered for study. The EGG quotients exhibited consistent change in all the condition of both the groups. Considering the acoustic parameters, noise measurements, frequency and amplitude parameters showed notable changes. Out of three subjects considered for the prolonged post test condition in voice disorder group two of them showed objective changes implying a better voice quality. The findings of the study strengthens the assumption that SOVT exercise practiced alters the supraglottal impedence thereby reducing vocal load and assisting in vocal fold vibration. SOVT exercise is ascribed to bring about vocal economy implying a efficient voice production with less effort. However more number of homogenous subject and more time duration of SOVT exercise might result in promising result than the present study.

Implications of the study

The study gives an understanding regarding the SOVT exercise – combined rigid and flexible straw phonation sequence. It promotes the administration of SOVT exercise for hyperfunctional laryngeal pathology like vocal nodule and muscle tension dysphonia. it also emphasize the need of long term practice on a regular basis reflected a marked improvement on the acoustic and electroglottographic dimensions in individual with hyperfunctional voice disorders.

Limitation of the study

- The type and magnitude of changes in the voice varied substantially after the SOVT exercise-– combined rigid and flexible straw phonation sequence, indicating that a very large group of participants will be needed to better define what changes should be anticipated. The sample size considered in laryngeal pathology was low, hence the results cannot be generalised within the group. The variety of laryngeal pathology considered are only two. Also, the study did not include any perceptual assessment to rate the effect of the exercise on the voice quality and self assessment by participant to rate his / her voice before and after performing the exercise.

References

Andrade, P. A., Wood, G., Ratcliffe, P., Epstein, R., Pijper, A., & Svec, J. G. (2014). Electroglottographic study of seven semi-occluded exercises: LaxVox, straw, lip-trill, tongue-trill, humming, hand-over-mouth, and tongue-trill combined with hand-over-mouth. *Journal of Voice*, *28*(5), 589-595.

American Speech-Language-Hearing Association. (1993). Definitions of communication disorders and variations.

American Speech-Language-Hearing Association. (2004). *Knowledge and Skills needed by Speech Language Pathologist and Audiologist to Provide Culturally and Linguistically appropriate services* [Knowledge and Skills].

Behlau, M. (1994). Tecnicas de reabiliticao vocal.Sao Paulo,Brazil.

Behrman, A., & Haskell, J.,(2013). *Exercises for Voice therapy.* Plural publishing, San Diego.

Behlau & Oliveira, 2013, cited in Behrman, A., & Haskell, J.,(2013). *Exercises for Voice therapy.* Plural publishing, San Diego.

Boersma, P., & Weenink, D. (2013). Praat software. *Amsterdam: University of Amsterdam*.

Boone, D. R., McFarlane, S. C., Von Berg, S. L., & Zraick, R. I. (2005). The voice and voice therapy.

Brian Petty, 2013 cited in Behrman, A., & Haskell, J.,(2013). *Exercises for Voice therapy.* Plural publishing, San Diego.

Cordeiro, G. F., Montagnoli, A. N., Nemr, N. K., Menezes, M. H. M., & Tsuji, D. H. (2012). Comparative analysis of the closed quotient for lip and tongue trills in relation to the sustained vowel/ɛ. *Journal of Voice*, *26*(1), e17-e22.

Costa, C. B., Costa, L. H. C., Oliveira, G., & Behlau, M. (2011). Immediate effects of the phonation into a straw exercise. *Brazilian journal of otorhinolaryngology*, *77*(4), 461-465.

Dargin, T.C. & Searl, J. (2015).Semi-Occluded Vocal Tract Exercises: Aerodynamic and Electroglottographic Measurements in Singers. *Journal of Voice, 29*(2), 155-164.

Gaskill, C. S., & Erickson, M. L. (2010). The effect of an artificially lengthened vocal tract on estimated glottal contact quotient in untrained male voices. *Journal of Voice*, *24*(1), 57-71.

Gaskill, C. S., & Quinney, D. M. (2012). The effect of resonance tubes on glottal contact quotient with and without task instruction: a comparison of trained and untrained voices. *Journal of Voice*, *26*(3), e79-e93.

Guzman, M., Higueras, D., Fincheira, C., Muñoz, D., Guajardo, C., & Dowdall, J. (2013). Immediate acoustic effects of straw phonation exercises in subjects with dysphonic voices. *Logopedics Phoniatrics Vocology*, *38*(1), 35-45.

Kay, C. S. L. (2007). PENTAX. *Computerized Speech Lab (Version 4500)[Computer Software]*. *Lincoln Park, NJ: A Division of Pentax Medical Company*.

Laukkanen, A. M. (1992). About the so called "resonance tubes" used in Finnish voice training practice: An electroglottographic and acoustic investigation on the effects of this method on the voice quality of subjects with normal voice. *Scandinavian Journal of Logopedics and Phoniatrics*, *17*(3-4), 151-161.

Laukkanen, A. M., Lindholm, P., & Vilkman, E. (1995). On the effects of various vocal training methods on glottal resistance and efficiency. *Folia phoniatrica et*

Lessac, A. (1997). The Use and Training of the Human Voice: A Practical Approach to Speech and Voice Dynamics.). Santa Monica.

Ma, E. P. M., & Love, A. L. (2010). Electroglottographic evaluation of age and gender effects during sustained phonation and connected speech. *Journal of voice*, *24*(2), 146-152 *logopaedica*, *47*(6), 324-330.

Mara Behlau & Glaucya Madazio, (2013), cited in Behrman, A., & Haskell, J.,(2013). *Exercises for Voice therapy.* Plural publishing, San Diego.

Paes, S. M., Zambon, F., Yamasaki, R., Simberg, S., & Behlau, M. (2013). Immediate effects of the Finnish resonance tube method on behavioral dysphonia. *Journal of Voice*, *27*(6), 717-722

Paul, N., Kumar, S., Chatterjee, I., & Mukherjee, B. (2011). Electroglottographic parameterization of the effects of gender, vowel and phonatory registers on vocal fold vibratory patterns: an Indian perspective. *Indian Journal of Otolaryngology and Head & Neck Surgery*, *63*(1), 27-31

Rosenberg, M., & Le Borgne, W. (2014). The vocal athlete: Application and technique for the hybrid singer.

Rosenberg, M. D. (2014). Using Semi-Occluded Vocal Tract Exercises in Voice Therapy: The Clinician's Primer. *SIG 3 Perspectives on Voice and Voice Disorders*, *24*(2), 71-79.

Sampaio, M., Oliveira, G., & Behlau, M. (2008). Investigation of the immediate effects of two semi-ocluded vocal tract exercises. *Pró-Fono Revista de Atualização Científica*, *20*(4), 261-266.

Shivo, M., & Denizoglu, I. (2007). Lax VoxR: Voice therapy technique. Izmir, Turkey.

Smith, E., Verdolini, K., Gray, S., Nichols, S., Lemke, J., Barkmeier-Kraemer, J. M., & Hoffman, H. (1996). Effect of voice disorders on quality of life. *Journal of Medical Speech-Language Pathology*, *4*(4), 223-244.

Schwarz, K., & Cielo, C. A. (2009). Modificações laríngeas e vocais produzidas pela técnica de vibração sonorizada de língua. *Pró-Fono*, *21*(2), 161-6.

Story, B. H., Laukkanen., & Titze, I. R.(2000). Acoustic impedance of an artificiallylengthened and constricted vocal tract. *Journal of Voice,14,* 455–469.

Stemple, J. C., (2014). *Clinical voice pathology: Theory and management*. San Diego, Calif: Singular Pub. Group.

Timke, R., Von Leden, H., & Moore, P. (1958). Laryngeal vibrations: measurements of the glotticwave; part I. The normal vibratory cycle. *Arch. Otolaryngol, 68,* 1-19.

Titze, I. R. (1988). The physics of small-amplitude oscillation of the vocal folds. *The Journal of the Acoustical Society of America, 83*(4), 1536-1552.

Titze, I. R., Finnegan, E., Laukkanen, A. M., & Jaiswal, S. (2002). Raising lung pressure and pitch in vocal warm-ups: the use of flow-resistant straws. *Journal of Singing, 58*(4), 329-38.

Titze an, I. R.(2006). Voice training and therapy with a semi-occluded vocal tract: rationale scientific underpinnings. *Journal of Speech, Language, and Hearing Research, 49*(2), 448-459.

Titze, I. R., & Laukkanen. (2007). Can vocal economy in phonation be increased with an artificially lengthened vocal tract? A computer modeling study *Logopedics Phoniatrica Vocology, 32*,147–156.

Van Riper, C. & Irwin, J. V. (1958). Voice and articulation (2nd Edition.). London, Pitman Medical.