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Acoustic Analysis of Voice Quality in Inhaled Cortico Steroid Users

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Abstract

Inhaled corticosteroids are efficient and safe medicines used to treat people with asthma and chronic obstructive pulmonary disease. It reduces and can help to avoid redness, swelling, and mucus build-up in airways and lungs and this will help the patient to breathe easier. Inhaled corticosteroids (ICS) are recommended first line therapy for persistent asthma, but unfortunately they frequently provoke laryngeal adverse effects.

The aim of the study is to analyze the voice quality of inhaled cortico steroid users by means of subjective and objective methods. The present study analysed the voice quality of inhaled cortico steroid users by comparing the voice parameters jitter (pitch-period perturbation-ppq) (difference of periods-ddp), shimmer (amplitude perturbation-apq) (difference of amplitude- dda), Pitch (mean pitch, minimum pitch, maximum pitch, range,) Voicing (degree of voice breaks, number of voice breaks,) and Noise to harmonic ratio across the group, within the group and gender wise. 90 inhaled cortico steroid users in the age range of 22 to 70 years were selected from chest clinic for asthma and allergic centre at Thiruvalla, Kerala.

These findings would suggest a trade-off between controlling the symptoms of asthma and maintaining normal vocal functioning. However, individuals with asthma present with a wide range of co-morbidity factors such as smoking, chronic cough and co-existing allergic rhinitis, which may confound the effects of ICS on voice production. Laryngeal complications of asthma are poorly understood. The administration of ICS for a long duration will affect the vocal fold function. Because of ICS main cause for voice difficulty is steroid deposition on the superficial layer of the larynx. This will be the primary cause of dysphonia.

Key words: Acoustic Analysis of Voice Quality, Inhaled Cortico Steroid Users, gender distinction in voice quality

Introduction

Voice is an integral part of unique human attribute known as speech. Voice is a powerful tool that not only delivers message but adds meaning to it (Colton and Casper, 1996). According to Boone (1991), A normal voice should have adequate loudness, should be clear, appropriate pitch for age, and gender, constant inflections, and should implicate the meaning of what is spoken. An abnormal voice can be described as a sign of illness, or a symptom of illness or a disorder of communication.

Effect of Corticosteroids

There are different factors which affect the normal voice such as, air quality, humidity, noise, speaker-listener distance, fatigue, aging, allergies and infection, hydration, recreational drugs and medication. Among over the counter drugs, the primary enemies of the vocal tract are aspirin and anti-inflammatory drugs. One of the most common anti-inflammatory drugs used by asthma patients are corticosteroids. (Derendorf and clin, 2007)

Inhaled corticosteroids are efficient and safe medicines used to treat people with asthma and chronic obstructive pulmonary disease. It reduces and can help to avoid redness, swelling, and mucus build-up in airways and lungs and this will help the patient to breathe easier. Inhaled corticosteroids (ICS) are recommended first line therapy for persistent asthma, but unfortunately they frequently provoke laryngeal adverse effects. It's an irritant of the pharyngeal and laryngeal mucosal layers. The inhaled corticosteroids have side effects like Mouth or throat irritation, Cough, sore throat, Headache, Nausea and laryngeal complications such as dysphonia, hoarseness and these local complications may rise up to 80% of the inhaled dose is deposited on the mucosal surfaces of the pharynx and larynx before being swallowed.

Bhalla. Watson, Taylor and Roland, (2009) did a cross-sectional and investigator blinded study. In which 46 subjects were recruited and further divided into three groups 1) non-asthmatics 2) occasional ICS users or seasonal asthmatics and 3) regular ICS users. Laryngeal effects were measured by correlating the results of a vocal performance questionnaire, a respiratory symptoms questionnaire, and acoustic measurement of voice. The researchers concluded that regular ICS users demonstrated significantly more pharyngeal inflammation and throat discomfort than the other two groups. Laryngeal function and vocal performances were also worse in this group than the other two groups and were more likely to have hoarseness,

weakness of voice, aphonia and cough. Results of acoustic analysis showed that the cycle-to-cycle variation in vocal F0 (i.e., jitter) was a good objective measure of hoarseness. Regular ICS users were also more likely to have abnormal amplitude variations in their F0 (i.e., shimmer).

Dogan, Eryuksel, Kocak and Sehitoglu, (2007) performed a comparative, controlled, cross sectional study to evaluate the voice quality in patients with asthma. The researchers found that maximum phonation time values were significantly shorter both in male and female patients with asthma. Also the average shimmer values were higher for both sexes in the asthma group compared to the controls. Female patients with asthma had higher average jitter values. The VHI score was outside the normative limits.

Lavy, Wood, Rubin and Harries, (2000) performed a study on 22 patients receiving ICS for asthma, They concluded that there is a significant variation in mean fundamental frequency (F0), maximum phonation time and jitter. Hoarseness, dryness, supraglottic hyper function and side effects were reported. A primary cause of these findings was attributed to use of ICS.

Studies cited above have shown effects of ICS on the laryngeal and other complications. Most studies involve usage of symptoms questionnaire. Only few studies have recorded acoustic measures of voice of ICS users. The data in this direction is yet to be fully understood. The present study is probably the first of its kind in India to involve acoustic analysis of voice in ICS users. Such comprehensive objective and subjective evaluation of vocal performance provides useful information about comparison of normal subjects and ICS users and enhances the clinical knowledge in assessing and treating client with voice problems due to ICS usage.

Review of Literature

The larynx houses the major source of sound during speaking. Voice is the laryngeal modification of the pulmonary air stream which is further modified by the configuration of the vocal tract (Johnson, Friederic, and Spriesterrbach, 1963). In addition to its role as a carrier of words, the voice can also produce music and express emotions - it acts as a mirror of the inner self. Hence voice is a powerful tool that not only delivers message but also adds meaning to it (Colton and Casper, 1996). The use of the voice and the demands placed on it vary among individuals.

Steroids can be divided into two categories, (1) anabolic steroids and (2) corticosteroids. Anabolic steroids are a class of steroid hormones related to the hormone testosterone. The steroid serves to increase protein synthesis within cells, which results in the build-up of cellular tissue in muscle called anabolism (de Bolster, 1997). Anabolic steroids also have androgenic properties, such as the development of masculine characteristics (e.g., body hair).

A corticosteroid is a steroid hormone that is produced naturally in the adrenal cortex. Corticosteroids are used by physicians to treat inflammatory conditions, such as asthma, allergic rhinitis, atopic dermatitis, rheumatoid arthritis, chronic low back pain, shoulder injuries, polymyalgia, and preventing rejections in transplants (Barnes, 2001; Gaffo, Saag, and Curtis, 2006).

Inhaled corticosteroids (ICS), also known as inhaled steroids, are the most potent anti-inflammatory controller medications available for the treatment of asthma to reduce airway inflammation and mucus production. The use of inhaled steroids leads to:

- Better asthma control
- Fewer symptoms and flare-ups
- Reduced need for hospitalization

Corticosteroids can be administered into different route like oral, intravenous (injection), inhalers and topical (lotions, gels, creams). The route of administration usually depends on the severity of the symptoms. Inhaled steroids come in three forms: the metered dose inhaler (MDI), dry powder inhaler (DPI), and nebulizer solutions.

Common inhaled corticosteroids include:

- Flovent (Fluticasone)
- Pulmicort (Budesonide)
- Azmacort (Triamcinolone)
- Aerobid (Flunisolide)
- Qvar(Beclomethasone)
- Vanceril (Beclomethasone dipropionate)
- Beclovent (Beclomethasone dipropionate)

The impact of ICS on voice production has received considerable research attention (Gallivan, Gallivan and Gallivan, 2007). A majority of this research has focused on individuals with asthma. The bulk of these studies suggest that ICS has a negative impact on voice production (Bhalla, Watson, Taylor, Jones and Roland, 2009). However, there are studies showing no adverse affects of ICS on voice production (Shaw and Edmunds, 1986) as well as an improvement in voice following ICS (Meyer, Scott and Chapman, 2001). A chronological review of the salient literature follows:

Kosztyla-Honja, Rogowski, Rutkowski, Pepinski and Rycko, 2006 examined the influence of ICS on the phonatory function of the larynx in patients suffering from asthma. The effect of ICS was measured in 15 patients after 30 minutes of ICS administration. Evaluation of voice function was done subjectively and objectively by using videostroboscopy. The researchers found that administration of ICS resulted in incidents of cough, mouth and throat dryness, sensation of polydipsia and skin inflammation around the mouth. On long-term administration, dysphonia, hoarseness and voice fatigue were noted due to dysfunction of the innermost laryngeal muscles, particularly the vocal fold adductors. They concluded that long-term treatment with ICS resulted in myopathy of proper muscles of the larynx.

Dogan, Eryuksel, Kocak and Sehitoglu, 2007 performed a comparative, controlled, cross sectional study to evaluate the voice quality in patients with mild to moderate asthma using subjective and objective methods. Patients with mild to moderate asthma (n=40) age of 19 and sex-matched with a group of healthy controls (n=40). Acoustic analysis of jitter and shimmer was performed and the movements of the vocal cords were examined by videostroboscopy. In addition, the duration of asthma, maximum phonation time and vital (respiratory) capacity were evaluated. The Voice Handicap Index (VHI) scale was used for subjective evaluation of voice quality. The researchers found that maximum phonation time values were significantly shorter both in male and female patients with asthma compared to controls. The average shimmer values were higher for both sexes in the asthma group compared to the ontrols. Female patients with asthma had higher average jitter values compared to their healthy counterparts. The VHI score was outside the normative limits for patients with asthma (40%), and vital capacity findings were abnormal in 39 (97.5%) asthmatics. The researchers concluded that asthmatic patients demonstrated a generalized voice disorder compared to non-asthmatics. The outcome of the disorder was attributed to a laryngeal movement disorder and use of ICS. However, the authors could not exclude that some of the voice problems may have been caused by asthma.

Meyer, Scott, and Chapman, 2001 recruited 77 patients who took 1000 µg/day of inhaled ICS (BDP) and 10 patients who received occasional ICS treatment. At 2, 4, 8, 12 and 16 weeks, each patient's voice was audio recorded for later acoustic analysis. The results of the acoustic analysis indicated that mean jitter values did not differ significantly between the two groups. However, mean shimmer (i.e., cycle-to-cycle variation in vocal loudness) scores fell significantly ($p<0.05$) in the active treatment group. The researchers concluded that individuals with asthma who take 1000 µg/day of inhaled BDP could actually show an improvement in their voice, suggesting that the dosage regime used in ICS is an important factor in regard to vocal function.

Lavy, Wood, Rubin and Harries, 2000 performed a study on 22 patients receiving ICS for asthma, who had developed persistent troublesome hoarseness subsequent to the commencement of aerosol steroid treatment. Each patient was formally assessed in a voice clinic with VSL and stroboscopy. After this, a sample of speech and other vocal parameters were recorded using the "aerophone" and analysed using a visi-speech vocal analysis program. Using laryngoscopy, the vocal fold position, supraglottic hyperfunction, and mucosal changes were evaluated. For objective acoustic measures, mean fundamental frequency (F0), maximum phonation time and jitter (i.e., cycle-to-cycle variation in F0) were performed. The researchers found that 17 (77%) patients complained of hoarseness on a daily bases. Eight (36%) patients complained of other side effects, in most cases this was dryness and soreness of the throat. In nine (41%) patients there was some evidence of poor vocal fold positioning detected by laryngologists. Marked supraglottic hyperfunction and arytenoids over-ride was found in five (23%) patients. In 58% of the patients, opposition abnormalities were noted, supraglottic hyper function was noted in 40% patients. The acoustic analyses were revealing of cycle-to-cycle irregularity in 39% patients. Maximum phonation time was also reduced in 73% of the patients. A primary cause of these findings was attributed to use of ICS.

Acoustic Analysis of Voice

Computer software based acoustic analysis has become an integral component of the clinical process rather than a supplement to assessment and treatment (Behram and Orlikoff, 1997). Acoustic parameters most commonly measured are fundamental frequency (f_0),

perturbation (jitter and shimmer), harmonic to noise ratio (HNR) (Felippe, Grillo and Grechi, 2006).

The **fundamental frequency (F_0)** is determined by the number of cycles produced by the vocal folds per second. It is the result of the iterations among vocal fold length, mass and tension during speech (Morris and Brown, 1996). Among acoustic parameters, F_0 is the most uniform and less sensitive to voice recording characteristics (Carson, Ingrisano and Eggleston, 2003).

During sustained vibration, the vocal folds exhibits slight variation of frequency and amplitude from cycle to cycle; these phenomena are called frequency perturbation **(Jitter)** and amplitude perturbation **(Shimmer)** (Wang and Huang, 2004). These changes reflect the slight difference in mass, tension, and biochemical characteristics of the vocal folds as well as slight variations in their neural control and these correlate with the perceived roughness and hoarseness in voice (Colton and Casper, 2006).

Harmonic to Noise Ratio (HNR) characterises the relationship between the two components of the acoustic wave of a sustained vowel: the periodic component, vocal fold regular sign and the additional noise coming from the vocal fold and vocal tract (Ferrand, 2002). It correlates with the perception of vocal roughness (Woodson and Cannito, 1998).

Need of the Study

Studies cited above have shown effects of ICS on the laryngeal and other complications. Most studies involve usage of symptoms questionnaire. Only few studies have recorded acoustic measures of voice of ICS users. The data in this direction is yet to be fully understood. The present study is probably the first of its kind in India to involve acoustic analysis of voice in ICS users. Such comprehensive objective and subjective evaluation of vocal performance provides useful information about comparison of normal subjects and ICS users and enhances the clinical knowledge in assessing and treating client with voice problems due to ICS usage.

Aim of the Study

The aim of the study is to analyze the voice quality of inhaled cortico steroid users by means of subjective and objective methods.

Methodology

The aim of the present study is to analyze the voice quality of inhaled cortico steroid users by comparing the voice parameters jitter (pitch-period perturbation-ppq) (difference of periods-ddp), shimmer (amplitude perturbation-apq) (difference of amplitude- dda), Pitch (mean pitch, minimum pitch, maximum pitch, range,) Voicing (degree of voice breaks, number of voice breaks,) and Noise to harmonic ratio across the group, within the group and gender wise.

Participants

90 inhaled cortico steroid users in the age range of 22 to 70 years were selected from chest clinic for asthma and allergic centre at Thiruvalla, Kerala. The criteria for selection of participants included, no history of speech, language, hearing problem and Upper Respiratory Tract Infection. All the subjects where further divided in to seasonal ICS users and regular ICS users, 20 normal non ICS users. All the subjects were Malayalam speakers and were using ICS for at least 3 years.

Equipment

Patient history were assessed with respect to the family history, medical history, developmental history, speech language and hearing problems and the problems which affect the daily routine life especially voice problems by using inhaled cortico steroids

Perceptual analysis of voice quality was assessed by using voice handicapped index (Jacobson, Johnson, and Grywalski, 1997).

PRAAT software (version 5.1.37, Boersma and Weenick, 2009) was used to extract the acoustic parameters of live voice. Acoustic parameters considered for the present study were jitter (pitch-period perturbation- ppq) (difference of periods- ddp), shimmer (amplitude perturbation- apq) (difference of amplitude- dda), Pitch (mean pitch, minimum pitch, maximum pitch, range,) Voicing (degree of voice breaks, number of voice breaks,) and harmonic to noise ratio.

Procedure

The examiner completed the case history of the patient with respect to medical, family, developmental history, speech language problems, and Voice problems. It was explained to the subjects so they would provide appropriate responses to the questions addressed.

The Voice Handicap Index (Jacobson, Johnson, and Grywalski, 1997) scale was used for subjective evaluation of voice quality. It is used to describe the subject's voices and the effects of their voices on their lives with respect to physical, emotional and functional condition. The participants had to complete the questionnaire in voice handicap index. The examiner has to evaluate and interpret the voice handicap index scale.

The subjects were asked to phonate vowel /a/ /i/ and /u/ at comfortable loudness and pitch and was recorded using PRAAT software (version 5.1.37) keeping the microphone at a standard distance of 3cm away from mouth. The initial and final portion of the vowel phonation was truncated and the middle steady portion was considered for acoustic analysis. The advantage of using a sustained vowel is that it can usually be sustained in a steady manner and for an adequate period of time. Perturbation must be measured from sustained vowel phonation in which participant is instructed to produce a steady pitch level. Connected speech confounds the measure because linguistically produced frequency variations cannot be separated from frequency variations produced by the bio mechanical characteristics of the vocal folds (Colton and Casper, 1996). Hence, sustained phonation of /a/ was used.

The selected voice parameters included jitter (pitch-period perturbation) (difference of periods), shimmer (amplitude perturbation) (DDP), Pitch (mean pitch, minimum pitch, maximum pitch, range,) Voicing (degree of voice breaks, number of voice breaks,) and Noise to harmonic ratio. All these measures were analyzed using PRAAT (version 5.1.37) and were compared with the group, gender and were statistically analyzed using the two way ANOVA.

Results

The aim of the present study was to analyze the voice quality of inhaled cortico steroid users by means of subjective and objective methods. Subjective evaluation of case history and voice handicap index tool was assessed. The voice parameters analysed in this study was (jitter (pitch-period perturbation-ppq) (difference of periods -dda), shimmer (amplitude perturbation) (difference of amplitude- dda), Pitch (mean pitch, minimum pitch, maximum pitch, range,) Voicing (degree of voice breaks, number of voice breaks,) and Noise to harmonic ratio and compared each parameters with across the group, within the group and gender wise and the results are shown below.

Subjective Evaluation

Inhaled corticosteroids (ICS) are the most effective anti-inflammatory agents and are recommended in national and international guidelines as first line therapy for persistent asthma. If used properly they seldom induce serious systemic side effects, but unfortunately frequently provoke some local problems.

Information obtained through case history (medical, family, developmental, speech and language and voice problems) shows that oropharyngeal adverse effects are mainly associated with upper airways mucositis and include dry cough, wheeze. The incidence of local side effects can be high and variable, and depends on the type and dose of ICS, The voice problems noted was dysphonia (hoarseness) or chronic pharyngitis (sore throat) weakness of voice, aphonia, sore throat, throat irritation, and cough. The regular ICS users were more likely to experience hoarseness, weakness of voice, aphonia, sore throat, throat irritation, and cough than either of the other groups.

Voice Handicap Index

VHI describes the subject's voices and the effect of their voices on their lives. It was administered in all normals, Seasonal ICS users and Regular ICS users, and the Scores shows '0' in non ICS users indicates that no voice problems, In seasonal users VHI scores was between normal and moderate level. Some subjects had normal range and some subjects come under mild to moderate range. In regular users most of the subject's scores shows was out of the normal limits. So this report indicates voice handicap index tool is a good quality measure of finding out the voice problems in inhaled cortico steroid users and it describes how their voice problems are affected in their daily routine life.

Acoustic Analysis

The acoustic data measures included jitter (pitch-period perturbation-ppq) (difference of periods-ddp), shimmer (amplitude perturbation- apq) (difference of amplitude- dda), Pitch (mean pitch, minimum pitch, maximum pitch, range,) Voicing (degree of voice breaks, number of voice breaks,) and Noise to harmonic ratio. Obtained through acoustic analysis of phonation of /a/ /i/ and /u/ using PRAAT software was compared with the group, with in group, gender and were statistically analyzed by using the two way ANOVA.

The mean values of Jitter (pitch-period perturbation- ppq) (difference of periods- ddp), shimmer (amplitude perturbation- apq) (difference of amplitude- dda) Pitch (mean pitch, minimum pitch, maximum pitch, range,) Voicing (degree of voice breaks, number of voice breaks,) and Noise to harmonic ratio were compared across the group, within the group, and gender wise and are summarized in the table and graph below.

Vowel Sound	Source	ANOVA F value	Degree of freedom	p value	
/a/	Group	4.822	2.54	.012	SIG
	Gender	.009	1.54	.926	-
	Group * Gender	.061	2.54	.941	-
/u/	Group	3.870	2.54	.027	SIG
	Gender	3.054	1.54	.086	-
	Group * Gender	1.143	2.54	.326	-
/i/	Group	5.340	2.54	.008	HS
	Gender	.083	1.54	.774	-
	Group * Gender	3.008	2.54	.058	-

Table 1: Jitter ppq, (Pitch perturbation period) of all the subjects across group, with in group, and gender

From the above table it is evident that there is a significant difference in jitter Ppq, for /a/ and /u/ vowels and vowel sound /i/ was highly significant across the group and there is no significant differences seen in within group and gender.

Vowel Sound	Source	ANOVA F value	Degree of freedom	p value	
/a/	Group	3.528	2.54	.036	SIG
	Gender	.413	1.54	.523	NS
	Group * Gender	.904	2.54	.411	NS
/u/	Group	3.417	2.54	.040	SIG
	Gender	3.608	1.54	.063	NS
	Group * Gender	.416	2.54	.661	NS
/i/	Group	4.884	2.54	.011	SIG

	Gender	.005	1.54	.941	NS
	Group * Gender	.110	2.54	.896	NS

Table 2: Jitter ddp (difference of period), of all the subjects across group, with in group, and gender

From the above table it is clear that there is a significant difference in jitter ddp, in across the group for all the vowels and there is no significant differences seen in within group and gender.

Vowel Sound	Source	ANOVA F value	Degree of freedom	p value	
/a/	Group	24.718	2.54	.000	HS
	Gender	.902	1.54	.346	-
	Group * Gender	.547	2.54	.582	-
/u/	Group	20.821	2.54	.000	HS
	Gender	.222	1.54	.640	-
	Group * Gender	3.874	2.54	.027	SIG
/i/	Group	22.280	2.54	.000	HS
	Gender	.486	1.54	.489	-
	Group * Gender	3.914	2.54	.026	SIG

Table 3: shimmer apq, (amplitude perturbation), of all the subjects in the present study across group, with in group, and gender

From the above table the result shows that there is a highly significant difference in shimmer apq, across the group for all the vowels and within group /e/ /u/ vowels shows significant differences. There is no significant differences were seen in gender.

Vowel sound	Source	ANOVA F value	Degree of freedom	p value	

/a/	Group	25.128	2.54	.000	HS
	Gender	.830	1.54	.366	-
	Group * Gender	1.098	2.54	.341	-
/u/	Group	21.143	2.54	.000	HS
	Gender	.642	1.54	.426	-
	Group * Gender	2.754	2.54	.073	-
/i/	Group	21.688	2.54	.000	HS
	Gender	2.563	1.54	.115	-
	Group * Gender	8.073	2.54	.001	HS

Table 4: shimmer, (difference of amplitude), of all the subjects in the present study across group, with in group, and gender

From the above table we can conclude that there is a significant difference in shimmer dda, across the group and within group /i/ sound shows a highly significant difference. There is no significant difference seen in other comparisons.

Vowel Sound	Source	ANOVA F value	Degree of freedom	p value	
/a/	Group	.245	2.54	.784	-
	Gender	15.903	1.54	.000	HS
	Group * Gender	2.882	2.54	.065	-
/u/	Group	1.752	2.54	.183	-
	Gender	85.339	1.54	.000	HS
	Group * Gender	7.792	2.54	.001	HS
/i/	Group	.762	2.54	.472	-
	Gender	68.689	1.54	.000	HS
	Group * Gender	4.297	2.54	.019	SIG

Table 5: Pitch (mean pitch), of all the subjects in the present study across group, with in group, and gender

From the above table it reveals that there is a significant difference in mean pitch across the group for all the vowels and gender wise there is a highly significant difference in /i/ and /u/ vowels and significant differences were seen in within the group for /u/ sound. There is no significant differences were seen in other comparisons.

Vowel Sound	Source	ANOVA F value	Degree of freedom	p value	
/a/	Group	33.718	2.54	.000	HS
	Gender	23.223	1.54	.000	HS
	Group * Gender	14.084	2.54	.000	HS
/u/	Group	11.830	2.54	.000	HS
	Gender	41.837	1.54	.000	HS
	Group * Gender	5.043	2.54	.010	SIG
/i/	Group	10.605	2.54	.000	HS
	Gender	27.002	1.54	.000	HS
	Group * Gender	2.854	2.54	.066	-

Table 6: Pitch (minimum pitch), of the entire subject in the present study across group, with in group, and gender.

From the above table it is clear that there is a highly significant difference in minimum pitch across the group for all the vowels, within the group and gender wise except vowel /i/ of within group.

Vowel Sound	Source	ANOVA F value	Degree of freedom	p value	
/a/	Group	8.785	2.54	.000	HS
	Gender	1.224	1.54	.053	-
	Group * Gender	1.224	2.54	.302	-
/u/	Group	8.443	2.54	.001	HS.
	Gender	5.753	1.54	.020	SIG
	Group * Gender	1.203	2.54	.308	-
/i/	Group	6.969	2.54	.002	HS.
	Gender	1.652	1.54	.204	-
	Group * Gender	1.994	1.54	.146	-

Table 7: Pitch (maximum pitch), of all the subject in the present study across group, with in group, and gender

From the above table it is evident that there is a highly significant difference in maximum pitch across the group for all the vowels, and significant differences are seen in vowel sound /u/ when comparing gender wise. No significant differences in other comparisons.

Vowel Sound	Source	ANOVA F value	Degree of freedom	p value	
/a/	Group	19.710	2.54	.000	HS
	Gender	.280	1.54	.599	-
	Group * Gender	.823	2.54	.445	-
/u/	Group	14.861	2.54	.000	HS
	Gender	.014	1.54	.907	-
	Group * Gender	.085	2.54	.918	-
/i/	Group	13.156	2.54	.000	HS
	Gender	.555	1.54	.460	-
	Group * Gender	.720	2.54	.491	-

Table 8: Pitch (range), of the entire subject in the present study across group, with in group, and gender.

From the above table the result shows that a highly significant difference in pitch range across the group for all the vowels, and there is no significant difference in other comparisons.

Vowel Sound	Source	ANOVA F value	Degree of freedom	p value	
/a/	Group	3.643	2.54	.033	SIG
	Gender	.184	1.54	.669	-
	Group * Gender	.600	2.54	.553	-
/u/	Group	14.837	2.54	.000	HS
	Gender	.665	1.54	.418	-
	Group * Gender	.258	2.54	.774	-

/i/	Group	9.684	2.54	.000	HS
	Gender	2.018	1.54	.161	-
	Group * Gender	.552	2.54	.579	-

Table 9: Pitch (number of voice breaks), of all the subject in the present study across group, with in group, and gender

From the above table it is clear that there is a significant difference in number of voice breaks across the group for all the vowels, and there are no significant differences in other comparisons.

Vowel Sound	Source	ANOVA value	Degree of freedom	p value	
/a/	Group	1.184	2.54	.314	-
	Gender	1.000	1.54	.322	-
	Group * Gender	.944	2.54	.395	-
/u/	Group	5.653	2.54	.006	HS
	Gender	3.530	1.54	.066	-
	Group * Gender	1.134	2.54	.329	-
/i/	Group	4.234	2.54	.020	SIG
	Gender	.557	1.54	.451	-
	Group * Gender	.002	2.54	.998	-

Table 10: Pitch (Mean H-N ratio), of all the subject in the present study across group, with in group, and gender

From the above table it is evident that there is a significant difference in harmonic to noise ratio across the group for /a/ and /i/ sound and there is no significant differences in other comparisons.

In summary the results showed significant difference across the group, within the group and gender. Group wise comparison showed significant difference in jitter- Ppq, (p value = 0.012/) and vowel sound /i/ was highly significant (p value = .008). Jitter- ddp, was significant for all the vowels (p value = .036). Shimmer (Apq, dda) minimum pitch, maximum pitch, range,

number of voice breaks was highly significant (p value = .000) across the group. No significant difference was seen for mean pitch, degree of voice breaks and noise to harmonic ratio. When comparing with male and female highly significant difference was found for the entire vowel sounds in mean pitch and minimum pitch (p value = 0.000) maximum pitch showed a significant difference in /u/ sound (p value = .020). No significant differences were found in other measures. Within group there was a significant difference seen for /u/ and /i/ vowels in shimmer- apq (p value = .027) highly significant differences found for /u/ sound in dda, /i/ vowel in mean pitch (p value = .001) and highly significant difference was found for /a/ vowel phonation in minimum pitch (p value = 0.000) and /u/ (p value = 0.010) sig). No significant differences were found in other measures

Discussion

The purpose of this study was to evaluate the negative effect of ICS on voice production using acoustic analysis and voice handicap index. The results obtained from the present study reveal a considerable change in the acoustic parameters of voice such as jitter, shimmer, pitch, and voice breaks. These changes are more evident in regular ICS users. (Bhalla. Watson, Taylor and Roland, 2009) concluded the change in voice characteristics of ICS users is because of steroid induced myopathy and subsequent phonatory gap, or because of increased time of apposition as consequence of chronic laryngitis.

Studies have shown that the occurrence of vocal and pharyngeal side effects is deemed to be multifactorial. (Kosztyla-Honja, Rogowski, Rutkowski, Pepinski and Rycko, 2006) found the wide range of pitch is due to increased vocal cords mass in laryngeal oedema in which in accordance with the present study.

The subjective evaluation and acoustic analysis of sustained vowel sounds results shows that regular ICS users are more possible to have abnormal pharyngeal and laryngeal complications compared with either normal subjects or seasonal asthmatics. (Bhalla. Watson, Taylor and Roland, 2009) stated the laryngeal complications of ICS users are hoarseness, weak voice, aphonia and troublesome chronic cough, and the pharyngeal problems of sore throat and irritation. We noticed that regular ICS users were also found to have more severe dysphonia compared to seasonal ICS users and control groups as represented by the highly significant jitter, shimmer, pitch variation and voice breaks.

VHI describes the subject's voices and the effect of their voices on their lives. It was administered in all subjects in this study and the Scores In seasonal users were between normal and moderate level. In regular ICS users most of the subject's scores was out of the normal limits means the patient is more concern about their problems. (Dogan, Kocak and Sehitoglu, 2007) administered voice handicap index in asthma patients and found that the voice handicap index score was outside the normal limits. So this report indicates voice handicap index tool is a good quality measure of finding out the voice problems in inhaled cortico steroid users and it describes how their voice problems are affected in their daily routine life.

Acoustic analysis is an objective and sensitive assessment tool of voice pathology. Most important index in voice analysis include: fundamental frequency Fo, Jitter, Shimmer, NHR, voice breaks, maximum pitch and minimum pitch. Fundamental frequency (Fo) is the number of vibratory cycles completed per second depends on vocal cords tension and their length. Increased vocal cords mass in laryngeal oedema is associated with decreased Fo value (Kosztyla-Honja, Rogowski, Rutkowski, Pepinski and Rycko, 2006).

The present study noted statistically considerable decrease in Fo, jitter shimmer pitch in regular and seasonal ICS users and number of voice breaks was higher in regular users compared to other 2 groups. We found the pitch range was out of the normal limits both in male and female in regular and some seasonal ICS users. ICS administration which confirms causes laryngeal oedema as well as glottal paralysis.

Summary and Conclusion

Corticosteroids are the most potent and reliable of the available agents among the anti-inflammatory drugs, and have assumed a major role in the management of asthma (Szelfler, 1991). This has subsequently resulted in the widespread use of ICS. The impact of ICS on voice production has received considerable research attention. Most research indicates that the long-term use of ICS has a negative effect on voice production (Williams, Bhagat, Stableforth, Clayton, Shenoi, and Skinner,. 1983; Lavy et al., 2000 & Bhalla et al., 2009).

These findings would suggest a trade-off between controlling the symptoms of asthma and maintaining normal vocal functioning. However, individuals with asthma present with a wide range of co-morbidity factors such as smoking, chronic cough and co-existing allergic rhinitis, which may confound the effects of ICS on voice production. Laryngeal complications

of asthma are poorly understood. The administration of ICS for a long duration will affect the vocal fold function. Because of ICS main cause for voice difficulty is steroid deposition on the superficial layer of the larynx. This will be the primary cause of dysphonia.

Hence the present studies focus on hypothesizing the effect of ICS on Vocal behaviours and acoustic characteristics of voice by using subjective and objective methods.90 inhaled cortico steroid users in the age range of 22 to 70 years with no history of speech, language, hearing problem and upper respiratory tract infection (URTI), were further divided in to seasonal ICS users and regular ICS users, 20 normal non ICS users were participated in present study..

The different analyses are deemed complementary and collectively provide information regarding vocal quality and laryngeal function. The information's obtained through subjects, shows that oropharyngeal adverse effects are mainly associated with upper airways mucositis and include dry cough, wheeze. The incidence of local side effects can be high and variable, and depends on the type and dose of ICS, The voice problems noted was dysphonia (hoarseness) or chronic pharyngitis (sore throat) weakness of voice, aphonia. The regular ICS users were more likely to experience hoarseness, weakness of voice, aphonia, sore throat, throat irritation, and cough than either of the other groups

Voice handicap index result in regular ICS users were out of the normal limits shows that the patient is more concern about their voice problems.

The results of the acoustic analysis showed significant difference across the group, within the group and gender. Group wise comparison showed significant difference in jitter and Shimmer, minimum pitch, maximum pitch, range, number of voice breaks. When comparing with male and female highly significant difference was found for the entire vowel sounds in mean pitch and minimum pitch and maximum pitch. Within group there was a significant difference seen in shimmer, mean pitch and minimum pitch. Regular ICS users were also found to have more severe dysphonia compared to either of the other groups, as represented by the highly significant jitter, shimmer, pitch and voice brakes.

It is widely accepted that the risk of adverse effects during long-term ICS administration depends on the dose, method of administration, biological dose and absorption. For this reason,

the most appropriate drug and delivery device are essential considerations when prescribing for asthma control. ICS users need to know more about the factors that may affect the voice resulting in changes such as decreased vocal efficiency, Dysphonia, hoarseness, and other vocal pathologies. Awareness of these changes may help them to use their voice more effectively.

This study gives an understanding to speech language pathologist regarding the various voice parameters that are expected to undergo significant changes following long term use of ICS and direction for enhancing the clinical knowledge.

In summary the purpose of the present study was to analyses the effects of ICS on voice production by using subjective and objective method. The general question was to determine whether ICS has an effect on acoustic features of voice following exposure to ICS. The results of this study indicate that ICS does have an effect on acoustic properties of voice. These effects were more evident in regular ICS users compared to seasonal ICS users and control groups. Local side effects are more common in asthmatics that use ICS regularly and the acoustic voice assessment method can be used to accelerate early diagnosis of voice abnormalities in ICS users.

Limitations

This study measures few parameters of the voice that are available in PRAAT soft ware it's very important that to measure all the parameters of voice. Future studies will incorporate this factor.

One of the other limitations of this study was the acoustic analysis of voice done in vowels only it is important that the analysis should be done in connected speech.
Relatively small sample size and grouping of all type of ICS medicine in one group can be a limitation of this study

Directions for Future Research

Future studies may focus their intentions on the effect of different steroids and, perhaps, different propellants.

Secondary area of research could be to determine the effects of various doses of ICS on voice production.

A closer correlation between voice changes and measures of lung function would also be useful, as would voice studies and airflow measures after a bronchodilator.

Conservative measures to avert the risk of complications of ICS therapy, such as gargling or spacer devices have an unpredictable response

A logical next step in this line of research would be to determine the changes of acoustic properties of voice in connected speech and to compare whether this effect are same as vowels.

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Appendix

Voice Handicap Index (VHI)

(Jacobson, Johnson, Grywalski, *et al*.)

Instructions: These are statements that many people have used to describe their voices and the effects of their voices on their lives. Check the response that indicates how frequently you have the same experience.

(Never = 0 points; Almost Never = 1 point; Sometimes = 2 points; Almost Always = 3 points; Always = 4 points)

	Never	Almost Never	Sometimes	Almost Always	Always
F1. My voice makes it difficult for people to hear.					
P2. I run out of air when I talk					
F3. People have difficulty under- standing me in a noisy room					
P4. The sound of my voice varies throughout the day.					
F5. My family has difficulty hearing me when I call them throughout the house.					
F6. I use the phone less often					
E7. I'm tense when talking with others because of my voice.					
F8. I tend to avoid groups of people because of my voice.					
E9. People seem irritated with my voice.					
P10. People ask, "What's wrong with your voice?"					
F11. I speak with friends, neighbors, or relatives less often because of my voice.					

F12. People ask me to repeat myself when speaking face-to- face.					
P13. My voice sounds creaky and dry.					

	Never	Almost Never	Sometimes	Almost Always	Always
P 14. I feel as though I have to strain to produce voice					
E15. I find other people don't understand my voice problem.					
F16. My voice difficulties restrict my personal and social life.					
P17. The clarity of my voice is unpredictable.					
P18. I try to change my voice to sound different.					
F19. I feel left out of conversations because of my voice.					
P20. I use a great deal of effort to speak.					
P21. My voice is worse in the evening.					
F22. My voice problem causes me to lose income.					
E23. My voice problem upsets me.					
E24. I am less out-going because of my voice problem.					
E25. My voice makes me feel handicapped.					
P26. My voice "gives out" on me in the middle					
E27. I feel annoyed when people ask me to repeat.					
E28. I feel embarrassed when people ask me to repeat.					
E29. My voice makes me feel incompetent.					
E30. I'm ashamed of my voice problem.					

Please circle the word that matches your voice today

P..... F.....E..... TOTAL.....

Normal Mild Moderate Severe

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