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LONG TERM AVERAGE SPECTRUM

AND

ELECTROGLOTTOGRAPHY IN DYSPHONICS

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TO MY PARENTS

FOR WITHOUT THEM I AM NOT "

&

TO MY SISTERS

AMULU & RAJI

FOR THEIR LOVE & AFFECTION"

C E R T I F I C A T E

This is to certify that the dissertation entitled "LONG TERM AVERAGE SPECTRUM AND ELECTROGLOTTOGRAPHY IN DYSPHONICS " is the bonafide work in part fulfilment for the degree of Master of Science (Speech and Hearing), of the student with Register No. 8602.

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This is to certify that this dissertation entitled "LONG TERM AVERAGE SPECTRUM AND ELECTROGLOTTOGRAPHY IN DYSPHORICS" has been prepared under my supervision and guidance.

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DECLARATION

This dissertation is the result of my own study under the guidance of Mr. N.P. Nataraja,Reader and Head of the Department of Speech Sciences, All India Institute of Speech and. Hearing, Mysore, and has not been submitted earlier at any University for any other Diploma or Degree.

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INTRODUCTION

The treatment of patients suffering from dysphonia depends upon the ability to assess initially the bype and degree of voice improvement and also to monitor the patient's progress throughout the treatment" (Kelman,1981).

Many have suggested various means of analysing voice to note the factors that are responsible for creating an impression of a particular voice and to determine the underlying mechanism (Michel & Wendahl, 1971,; Jayaram, 1975, Fritzell, 1977,; Laver & Hanson, 1981, Hirano, 1981, Kelmen, 1981, Perkins, 1971; Emerick & Hatten, 1979).

According to Hirano (1975), there are several ways of direct or indirect assessment, observation, and/or measurements of the parameters in the process of the production and perception of voice. These can be classified as follows:-

(i)Parameters which regulate vibratory patterns of vocal folds

Eg. Physical examination, endoscopy, X rays, Electromyography etc.

(ii) Parameters which specify vibratory patterns

Eg. Stroboscopy, Electroglottography etc.&

(iii) Parameters which specify the sound generated

Eg. Acoustic Analysis.

Several of these methods have been used by different investigators, in different combinations. Sometimes only one or two of them have been used for evaluation of voice. However, as Hirano(1981) has pointed out there is no agreement regarding the findings and also the terms used. Moreover, only a few studies on analysis of voice parameters in voice disorders in Indian populations have been reported (Jayaram, 1975; Nataraja, 1986; Chandrashekar, 1987).

Therefore, in this study an attempt has been made to study the parameters which specify vibratory patterns namely Electroglottography(EGG), and which specify the sound generated namely the long term average spectrum(LTAS).

As suggested by Hanson, Gerratt, and Ward (1983) majority of the phonatory dysfunctions are associated with abnormal vibrations of the vocal folds. Hence, analysis of the vibrations of the vocal folds in terms of different parameters constitute an important aspect to be considered in the diagnosis and differential diagnosis of voice disorders.

Likewise, many investigators have also stressed the importance of long term average spectrum in diagnosis, differential diagnosis and follow-up of progress of therapy with voices disorders,(Lofqvist & Manderson, 1986; Frokjaer-Jensen & Prytz, 1976).

However, only a few studies on electroglottography and long term average spectrum have been carried out on dysphonics in India(Chandrashekar, 1987; Nataraja,1986).

Hence, the present study was proposed to observe the different parameters of EGG and LTAS in Indian clinical population, having different types of voice disorders.

Purpose of the Study

The study was designed to study the various parameters of EGG& LTAS in male and female dysphonics, and compare them with with normals.

The parameters considered for the study are:-

I Electroglottography

(a) Open quotient,

(b) Speed quotient, -

(c) Speed Index,

(d) Jitter, &

(e) Shimmer.

II Long term average spectrum

(a) Alpha-ratio,

(b) Energy above 1 KHz,

(c) Energy below 1 KHz,

(d) Energy in the frequency band 5-8 KHz, &

(e) The frequency of the highest peak.

Hypothesis

(1) There will be no significant difference between normals and dysphonics (as a group) in terms of these parameters.

(2) There will be no significant difference between normals and dysphonics males in terms of these parameters.

(3) There will be no significant difference between normals and dysphonics females in terms of these parameters.

(4) There will be no significant difference between dysphonics males and females in terms of these parameters.

(5) There will be no significant difference between normals males and females in terms of LTAS parameters.

In this study 18 dysphonic subjects (10 males and 8 females) in the age range 19-35 years were studied. For each subject, 5 parameters of EGG namely open quotient, speed quotient, speed index, shimmer, and jitter were measured for vowel /a/ using Electroglottography (Key Elemetrics) & High Resolution Signal Analyser(B&K 2033) instruments.

Further, five parameters of LTAS namely Alpha ratio, Energy above 1 KHz, energy below 1 KHz, energy in the frequency band 5-8 KHz, and the frequency of highest peak were studied using personal computer with necessary software.

Limitations:-

(i) Only 18 dysphonics were studied.

(ii) All types of dysphonics were not studied.

(iii) Only five parameters of EGG and LTAS were studied.

Implications :-

(i) It provides information regarding the vibratory and spectral patterns of vocal folds in dysphonics.

(ii) It helps in diagnosis and differential diagnosis of dysphonics.

(iii) The pre-therapy and post therapy EGG & LTAS recordings provides objective information about improvement in the voice of dysphonics.

Definitions:-

The following definitions have been used in the present study.

(i) Open Quotient (OQ)- $\dfrac{\text{Open phase}}{\text{Full period of one Vibration}}$

(ii) Speed Quotient(SQ)- $\dfrac{\text{Opening phase}}{\text{Closing phase}}$

(iii) Speed Index (SI)= $\dfrac{SQ-1}{SQ+1}$

(IV) Jitter (J) is cycle to cycle variation in period (in sustained phonation) in m.Sec.

(v) Shimmer (S) is cycle to cycle variations in amplitude(in sustained phonation) in dB (acoustical).

(vi) EGG - Electroglottography, same as Electrolaryngography.

(vii) LTAS = Long term average spectrum

(viii) Alpha Ratio = $\dfrac{\text{Energy above 1 KHz}}{\text{Energy below 1 KHz}}$

(iX) Energy above 1 KHz - Sum of energy in the frequency range 1-8 KHz divided by the number of points in this range.

(x) Energy below 1 KHz = Sum of energy in the frequency range 0-1 KHz divided by the number of points in this range.

(xi) Energy in the frequency band 5-8 KHz = sum of energy in this frequency band divided by the number of points in this frequency band.

(xii) The frequency of the highest peak = the frequency with maximum amplitude (Peak).

(xiii) NM = normal males (as a group)

(xiv) NF - normal females (as a group)

(xv) DM = dysphonic males (as a group)

(xvi) DF = dysphonic females (as a group)

(xvii) Ho = null hypothesis.

REVIEW OF LITERATURE

Communication has long been recognized as one of the most fundamental components of human behaviour. The ability of the human beings to use their vocal apparatus with other organs to express their feelings, to describe an event and to establish communication is unique to them. It took millions of years for human beings to develop this faculty. The onset of the human era is recognized to have started with the acquisition of the ability to communicate using the vocal apparatus for social interaction. No normal person has failed to develop this faculty and no other species is known to have developed this ability.)

" The act of speaking is a very specialised way of using the vocal mechanism. The act of singing is even more so. Speaking or singing demand a combination or interaction of the mechanism of respiration, phonation, resonance and speech articulation" (Boone,1983).

The underlying basis of speech is voice. The importance of voice in speech is very well depicted when one considers the cases of laryngectomy or even voice disorders., Voice plays the musical accompaniment to speech, rendering it tuneful, pleasing, audible and coherent, and is an essential feature of efficient communication by the spoken word" (Greene,1964).

Voice plays an important role in Speech and Language. The production of voice depends on the synchrony between the respiratory, the phonatory and the resonatory systems. Any anatomical, physiological or functional deviation in any of these systems would lead to a voice disorder. Such a disorder may cause social, economic and psychological problems to the individual with the voice disorder. Therefore voice problems must be treated i.e., help must be provided to the individuals with voice problems to overcome the problems or atleast to cope with the problem.

" The treatment of patients suffering from dysphonia depends upon the ability to assess initially the type and degree of voice impairment and also to monitor the patient's subsequent progress throughout treatment" (Kelmen, 1981). "Diagnosis is intended to define the parameters of the problem, determine etiology and outline a logical course of action" (Emerick and Hatten, 1979).

Many have shown their concern regarding the need for defining and describing normal voice which forms the basis for defining or describing variations from normal i.e., supra or subnormal voice (Perkins, 1971; Laver and Hanson, 1981; Michel and Wendahl, 1971).

Inspite of the fact that there is a great need to understand the voice, its production, factors affecting it, basic issues like definition of voice, normalcy in voice have not been resolved. They are vague and ambiguous. Michel and Wendahl (1971) give a good account of problems in defining voice.

Many have suggested various means of analyzing voice to note the factors which are responsible for creating an impression of a particular'voice" (Michel and Wendahl, 1971, Perkins, 1971; Jayaram, 1975; Nataraja and Jayaram, 1979; Hirano, 1981; Laver and Hanson, 1981).

According to Hirano (1981), "with regard to phonation various methods have been proposed and used by many clinicians and researchers all over the world. Unfortunately, none of these methods appear to have been standardized on an international basis. With respect to some of these techniques, a majority of investigators seem to be in agreement in terms of the significance of these tests and the interpretations of the data thereby obtained".

Hirano(1981) while hoping for standardization of clinical examination of voice suggests several methods like E.M.G of Laryngeal muscles, acoustic analysis of voice signal, aerodynamic tests, study of vocal fold vibrations, psychoacoustic evaluations of voice to examine phonatory ability, which would reflect different aspects of respiratory, phonatory and resonatory systems. These methods have been used by different investigators, some in combinations, and some in isolation to evaluate voice. However, as Hirano (1981) has pointed out, there is no agreement regarding the findings and terms used.

According to Hanson, Gerratt and Ward (1983), "Majority of the phonatory dysfunctions are associated with abnormal vibrations of the vocal cords. Hence, Analysis of the vocal fold vibrations in terms of different parameters constitutes an important aspect to be considered in the diagnosis of voice disorders".

The study of vibratory movements of the vocal folds has therefore drawing a lot of interest among reseachers recently.

The vocal folds vibrate around 100-300Hz, during normal conversation, and even at a higher level during singing, observation of such vibrations requires several methods, some of these methods are invasive and others non invasive. Each of these methods have their own limitations.

As Fritzell (1986) points out, "In clinical management of patients with voice disorders, the examination of the patients relies upon the ear and eye of the examiner. It is highly desirable to supplement this subjective evaluation with recording procedures and qualitative measurements for diagnostic purposes as well as for assessment of the result of treatment.

In the examination situation, the patient's vocal behaviour is influenced by a number of factors. The situation as such may make the patient tense. Indirect laryngoscopy with a mirror in the throat is an extremely unnatural situation, and one should be very careful to draw conclusions about vocal behaviour from the findings during mirror laryngoscopy. All optic recordings of the vocal folds and their vibrations are invasive and consequently more or less irritating and disturbing for the patient. Acoustic recordings have the advantage that they can be made with the patient relaxed with a fairly normal behaviour."

The following are some of the direct and indirect methods used to study vocal fold vibration.

(1) Electro glottography.(E.G.G.)

(2) Stroboscopy

(3) Ultra high speed photography

(4) Inverse filtering method

(5) Photo glottography

(6) Ultra sound / Echo glottography

Stroboscopy permits the clinician to view the vibrations of the vocal cords. However, providing the description of the condition and movements of the vocal cords depends on the ability of the clinician. Further, the use of stroboscopy many interfere with normal phonation and thus it may not provide information regarding the abnormalities of the vocal cords (Hirano, 1981).

Though ultra high speed photography technique provides an objective information about vocal cords, movements, it's clinical applications are limited.

As it is an invasive technique, it requires a greater cooperation from the patients", (Holmer, Kitzing, Lindstrom, 1973).

These method is limited to the study of vibratory patterns of vocal folds in sustained phonation of vowels and non speech vocalization" (Harden,1975). .

This technique is expensive and also consumes a lot of time and space" (Hanson et. al., 1983)

Photo glottography method is better than stroboscopy as it provides graphical display and better than high speed photography as it is economical " (Hanson et.al., 1983).

Several investigations have pointed out the limitations of P.G.G. technique. They are:-

(1) P.G.G yields sufficient information about only certain points of the vibratory cycle (Dejonckere and Lebacq, 1985).

(2) In P.G.G, the point at which the glottal opening starts can often be difficult to locate(Kitzing and Lofqvist, 1979).

(3) According to Hanson et.al., (1983), P.G.G wave forms may not represent accurately the glottal area of patients who adduct the ventricular folds during phonation and with patients who have significant assymetry of vocal cords closure, P.G.G signal may not reflect the glottal opening.

According to Hanson et.al., (1983), " Ultrasound or electrography is not frequently used clinicially, as it requires a special ultrasound transducer".

Electro glottography (E.G.G) is a technique for the indirect examination of vocal fold contact during vibration through measurements of electrical impedence change(Fourcin, 1974). Whatever details it represents, E.G.G certainly reflects the vibratory cycle of the vocal folds with fairly high fidelity. Irregularaties of E.G.G. thus corresponds to irregularities in the vibratory pattern of the vocal cords (Haji, Horiguchi, Baer and Gould, 1986). Moreover, the E.G.G does not interfere with phonation (Fourcin, 1981, Kelman, 1981, Pederson, 1971).

Some of the other observations reported about E.G.G. are:-

(i) According to Dejonckere and Lebacq (1985), " E.G.G. reflects the glottal conditions more during the closed phase, as against P.G.G. which reflects more about the openphase of the glottal cycle. As majority of laryngeal pathologies manifests abnormalities more during the closed phase,. E.G.G has been considered as a better technique for the studying vocal fold movement in disphonics.

(ii) The presence or absence of glottal vibrations can be readily determined using E.G.G. technique.

(iii) Dejonckere and Lebacq (1985) have suggested that, "The fundamental period of the glottal vibrations is easily determined using E.G.G. as the beginning of each closed phase is marked by a sharp rise in graphic display of Lx wave forms".

Inverse filtering method is an acoustic procedure in which the inverse of the lip radiations and the vocal tract spectral contributions are used to remove acoustic effects of the supraglottal vocal tract leaving the glottal volume flow.

Reviewing the literature thus far, the E.G.G. seems to be the most appropriate method for studying the vibration of vocal cords.

Electroglottography

This technique makes use of motion induced variations in the electrical impedence between the two electrodes placed on the skin covering the thyroid laminae. A weak, high frequency voltage signal of 0.5-10MHz is applied to one electrode, and the other electrode picks up the electrical current passing through the larynx. The transverse electrical impendence varies with the opening and closing of the glottis, and reflects in a variation of the electrical current in phase with the vibratory phase of the vocal folds.

The technique was first developed by Fabre (1957). Improvements in the apparatus and applications of the technique to clinicial investigations have been extensively performed by several investigators mostly in Europe (Fourcin & Abberton, 1971 Fourcin, 1981).

The detailed relationship between the impedence curve of the electroglottograms and the underlying physiology of the vocal folds have been well documented by several authors (Gilbert, Lecluse, Brocaer and Verschuve, 1975, Pederson, 1977; Childres, Smith and Moore, 1984).

Moore and Thompson (1975) reports that glottal wave forms by normal phonation consists of;

(i)All the three phases of the vibratory cycle viz., opening phase, closing phase and closed phase.

(ii) The motion of the two cords tend to be relatively synchronous and equal in amplitude.

Fourcin (1981) made simultaneous recordings of EGG's and airflow velocity curves for different modes of phonation and described the method to interpret the laryngeal wave forms. He also emphasised that the fundamental period of the vocal fold vibrations could be determined quite accurately using E.G.G.

In order to study glottal wave forms, various quotients and indices have been used. These quotients and indices are based on the measurement of duration of different phases of vibration cycles. They are:-

(i) Open quotient (O.Q)

$$O.Q = \frac{\text{Duration of open phase}}{\text{Duration of full phase}}$$

(ii) Speed Quotient (S.Q)

$$S.Q = \frac{\text{Duration of the opening phase}}{\text{Duration of the closing phase.}}$$

S.Q is also called as velocity quotient(V.Q).

(iii) Speed Index (S.I)

According to Hirano (1980), ". . . . .Speed Index is an another useful measure of larynx wave form derived from speed quotient.

$$\text{Speed Index} = \frac{\text{Speed guotient-1}}{\text{Speed quotient+1}}$$

The SI values may range from -1.00 to +1.00. It is an relative ratio, where positive values indicate more opening time and the negative values indicate more closing time of the vibratory cycle and zero indicates the equality of timing (Hirano,1981).

Hirano (1981) summarised the advantages of SI over S.Q. They are:-

(i) SI ranges from -1.00 to + 1.00, where as S.Q ranges over larger values.

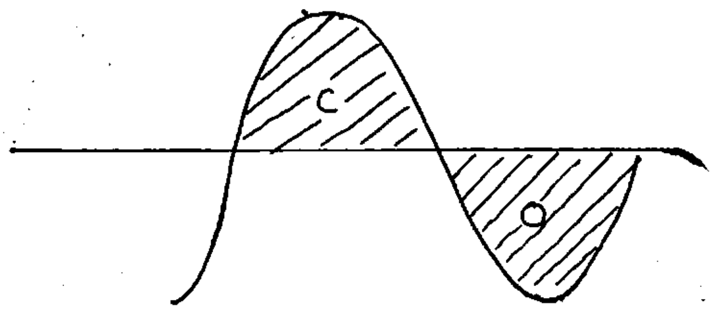
(ii) When two wave forms have the same triangular shape and one is reverse of the other (with respect to time), the S.I. takes equal absolute values with reverse signs. On the other hand, the S.Q. takes two different values whose product is one.

(iii) S.I. has a simpler relationship with spectral characterstics of the wave form than S.Q.

(iv) One can visualise the wave forms from S.I values more easily than S.Q values.

(4) "S" Quotient or "S" ratio (S.R)

Dejonckere and Lebacq (1985) in an attempt to qualify the shape of the glottal wave form introduced the "S" quotient or "S" ratio.



It is given by the formula,

$$\text{"S" ratio} = \frac{\text{area of the contact phase}}{\text{area of the open phase.}}$$

Dejonckere and lebacq (1985) have pointed out that "S" quotient can be used as an indicator of the behaviour of the vocal folds in different vocal pathological conditions.

Sridhara (1986) studied Laryngeal wave forms in young normal females and males using /a/, /i/ and /u/ vowels. He reported the following values for different parameters of laryngeal wave forms.

l.Open Quotient

Mean values of O.Q.

	/a/	/i/	/u/
Males	0.69	0.71	0.72
Females	0.74	0.72	0.71

2.Speed quotient

Mean values of S.I.

	/a/	/i/	/u/
Males	1.98	1.74	1.79
Females	2.25	2.28	2.30

3. Speed Index

Mean values of S.I.

	/a/	/i/	/u/
Males	0.378	0.247	0.266
Females	0.377	0.361	0.362

4. "S" Ratio

Mean values of S.R.

	/a/	/i/	/u/
Males	1.13	1.12	1.16
Females	1.13	1.10	1.09

5. Jitter (J)

Mean values of J.(in msecs)

	/a/	/i/	/u/
Males	0.065	0.11	0.067
Females	0.058	0.03	0.048

6. Shimmer (S)

Mean values of S (in dB)

	/a/	/i/	/u/
Males	0.033	0.066	0.15
Females	0.7	0.37	0.44

Some of the investigators have suggested the applications of E.G.G. in clinical assesment and treatment of vocal disorders.

Fourcin and Abberton(1972) reported that the laryngeal wave forms in different laryngeal pathologies such as vocal polyps, vocal nodules, unilateral vocal and paralysis varies from normal laryngeal forms. They also observed that laryngeal wave forms in different laryngeal pathologies need not be necessarily be uniformly impaired and that one part of utterance may be normal with the others being disturbed.

Fourcin (1981) reports that normals and individuals with laryngitis can be differentiated using laryngeal histograms methods.

Hanson et.al., (1983) studies laryngeal wave form patterns in individuals having normal larynges, with distinct phonatary abnormalities like adductor spastic dysphonia, parkinsonism and Arsenic poisoning.

They reported that in individuals with spastic dysphonia, there was a relatively longer closure period, resulting in decreased open quotient. Moreover they also reported larger S.Q. values than normal indicating abnormally short closing time. They attributed this finding to the increased tension of the vocal cords then normal in spastic dysphonia.

In parkinsonism, they reported longer open phase then normals and incomplete glottal closure which may explain the breathiness. They also reported larger values of jitter and shimmer in parkinsonism.

Hanson et.al., (1983) have also observed similar larger values of shimmer and jitter in individuals who suffered from acute arsenic poisoning. They also report very short or incomplete periods of glottal opening in these individuals.

They further state that, " Glottographic techniques appear to offer some insight into more subtle vibratory and tension abnormalities that are associated with pathalogical phonation in otherwise normal appearing larynx. For example, glottography in our experience, relatively documents the presence of incomplete vocal cord closure. In some cases, this may be visible laryngoscopically, but often is not detected without the analysis of ultra high speed films. Similarly valuable diagnostic information, such as indications of abnormally increased vocal folds tension or cycle to cycles variability in the vibration of vocal cords, may be identified and measured from laryngeal wave forms.

According to Dejonckere and Lebacq (1985) abnormal E.G.G. findings can be considered in five differrent ways:-

(i) Pitch characteristics (too high or low)

(ii) Vibration irregularities (jitter and shimmer) demonstrated by Fo histograms (Kitzing, 1979; Fourcin, 1981).

(iii) Special features of signal in the case of dyplophonics (Dejonckere and Lebacq, 1983).

(iv) Qualitative description of the modified wave forms (Wechsler, 1977; Fourcin, 1981), and

(v) Spectral analysis of the wave forms. (Kelman, 1981).

In an attempt to quantify the shape of E.G.G. signal, Dejonckere and lebacq (1985) studied 25 normal females and 25 females with vocal nodules. They measured the values of "S" quotient for /a/ vowels phonated at 70 dB SPL. They concluded that "S" quotient provides information combining the relative surface and duration of vocal fold contact during the one vibrating cycle. They reported the mean "S" quotient of 0.66 for normal females and 0.4 for females with vocal nodules. They attributed this reduction in the value of "S" quotient as an etiological factor for vocal nodules

Childers et.al., (1984) reported unusual change in the rising slope of the laryngeal wave forms in individuals with vocal nodules on extensive laryngeal cancer. They observed double periodicty of laryngeal wave forms in a patient with unilateral paralysis of vocal cords. However, they report that the E.G.G. wave forms of certain individuals with vocal cord paralysis appear normal and laryngeal wave forms of some normals appear abnormal.

According to Fourcin (1981), ". . . . . for vigorous breathy voice, the contact phase of laryngeal wave form is distinguished by the presence of small, well defined, positive closure peak. In the case of creaky voice the laryngeal wave forms typically show pairs of vocal fold contact- seperation sequence in which a small peak precedes a larger peak, both occuring with considerable temporal irregularities. The smaller peak has a relatively slower onset than the larger peak and the width of the larger peak indicates a very long closure duration".

Jitter and Shimmer:-

Variations in fundamental frequency and amplitude of successive glottal cycles are referred to as " Jitter and shimmer" respectively (Heiberger and Horii, 1982).

Several investigators have reported the presence of small variations in fundamental frequency and /or amplitude of glottal vibrations in normal voice (Horii, 1979, 1982,1985; Hollien et.al., 1977; Sridhara, 1986).

Presence of excessive jitter and / or shimmer is associated with abnormal voice quality and which is often identified as hoarse or harsh voice(Koike, 1969; Michel and Wendahl, 1971; Iwata, 1972; Deal and Emanuel, 1978; Haji et.al., 1986).

Jitter values of 0.3 msec(4.9%) for severely hoarse voice and 0.06msec(1.14%) for moderately hoarse voice was reported by Moore and Thompson(1965).

According to Sonesson (1967), patients with laryngeal hemiparalysis, show a large amount of shimmer values but normal jitter values.

Kitajima and Gould(1976) reported that Shimmer values vary from 0.08 to 3.23 dB in subjects with vocal polyps.

Deal and Emanuel(1978) suggested that, the cycle to cycle variations in amplitude may provide a better index of perceived roughness of voice than cycle to cycle variations in period.

Zemilin(1981) reported jitter values for a group of subjects with multiplesclerosis to vary from 0.2 to 0.9msecs.

According to Heiberger and Horii(1982), " the workdone by Liberman and his collegues (Liberman,1961,1963; Liberman and Michel, 1962; Smith and Liberman, 1969) probably represents the pioneering studies of laryngeal pathalogy detections by the analysis of jitter and shimmer values".

Kane and Wellen(1985) reported a very high positive correlation between jitter and shimmer values and rating of roughness in ten children with vocal nodules. They reported jitter values in children to vary from 0.0023 to 0.0472 msecs and shimmer values from 0.0151 to 0.0911 dB.

Till early 1980's majority of the studies on jitter and shimmer were done through the analysis of voice signal. Recently, Haji et.al.,(1986) suggested that E.G.G. can be considered as a most suitably technique than voice signal methods for perturbation analysis, as E.G.G. wave forms are less complex than voice signal and is unaffected by the acoustic resonance of the vocal tract.

Chandrashekar(1987) studied laryngeal wave form parameters in 17 male disphonics and 17 female disphonics in the age ranges of 15 to 50 years and concluded that :-

(i) Male disphonics as a group and also in different sub-groups(vocal nodules, vocal fold paralysis, glottal chink, functional high pitch voice) differed from normals on different parameters of E.G.G.

(ii) Female disphonics as a group and also in different sub-groups(vocal nodules, vocal cord paralysis, glottal chink, functional hoarse voice) differed from normals on different parameters of E.G.G.

(iii) Males and females with the same pathalogical conditions did not show significant difference on the same parameters of E.G.G. For example, males with vocal cord paralysis showed significant difference from normals in terms of O.Q., J, and S values only. Where as, females with vocal fold paralysis showed significant difference from normals in terms of S.Q., S.I, and J values only.

Thus from this review of literature it can be stated that the E.G.G. seems to be the most appropriate method of studying the vibrations of vocal cords during phonation. Further more evidence is present regarding the usefulness of E.G.G. in diagnosis and in follow up of therapy of various voice disorders.

However, many dysphonic characteristics also occur between vowels and during consonant- vowel-consonant transitions. Hence studying these characteristics will also be useful in the diagnosis and treatment of voice disorders.

One such method is Long Term Average Spectrum which gives us the source spectrum.

LONG TERM AVERAGE SPECTRUM (LTAS)

There are a number of methods by which speech can be analysed spectrally. One such analysis procedure takes a time average of the sound-pressure level per cycle accross frequency. This measurement is commonly referred to as the Long Term Average Spectrum of speech (LTAS) (Formby and Monsen, 1982)

The measurement of the longterm average speech spectrum is made by passing the speech energy through a series of contigenous band pass filters and interpreting the energy at the output of each filter. These average values are then plotted to arrive at the visual representation, a smoothed plot by the envelope of the power spectrum of the speech sample (Formby and Monsen, 1982).

LTAS has been used for studies of the human voice source. The speech signal represents the product of the sound source and the vocal tract transfer functions. The vocal tract transfer function differs for different sound segments, but in the averaging process, the short term variations due to phonetic structure will be averaged out and the resulting spectrum can be used to obtain information on the sound source(Lofqvist and Manderson, 1987).

If the analysis is restricted to voice sounds, the sound source is the vibrating glottis. The analysis can be made of readings of a standard text in order to further minimise variations due to phonetic structures (Lofqvist and Manderson, 1987).

The earliest measurements of Long Term Average Spectrums was reported by Bell telephone laboratories about 60 years ago(Crandall and Mackenzie, 1922). Ever since then, speech spectra have been obtained by different investigators for different purposes.

The earliest investigators were interested in the spectra of continous speech from communication engineering point of view(Dunn and Farnsworth, 1939; Dunn and White, 1940).

Recently LTAS has been obtained to study the disorders of speech production(Frokjaer- Jensen and Prytz, 1976; Wendler et.al., 1980; Weinberg et.al.,-1980; Hammerberg et. al., 1984.; Hartman and von cramon,1984;Dejonckere, 1986).

Acoustic voice sampling has practical advantages in clinical applications as it is non-invasive, does not require close co-operation from the patient, and can be made off-line from tape recordings. Such applications include the screaning of large populations for early detection of voice pathalogy and, in particular, the followup of the effects of voice therapy(Lofqvist and Manderson, 1987).

Although the study of long term average spectra is potentially useful in the clinics, their possibilities and limitations are yet to be fully understood in relation to other acoustic measures of voice functions(Lofqvist and Manderson, 1987).

The speech power is greatest between 100 to 600 Hz, where the energy of the fundamental frequency of the voice and the first formant overlaps. It drops off with increasing frequency above about 600 Hz such that at 10,000 Hz, the level is approximately 50 dB below the peak levels measured at lower frequencies(Denes and Pinson, 1963).

In normal voices, the amplitude of source spectrum partially decreases with 12dB/octave approximately, provided, that the vocal folds can close the rima glottidis efficiently(Frietzell, Hallen, and Sundberg, 1974).

The spectra for group speech are generally comparable both with in and across languages (Fant, 1973). However the general shape of the spetra can be altered depending upon the experimental variables used in given studies.

Among the most salient variables are age(Niemoeller et.al., 1974), sex of the talker(Benson and Hirsh, 1953; Niemoller et.al., 1974), the analysis band widths(Stevens et.al., 1947; Frokjaer- Jensen and Prytz, 1976) and vocal effort (Brandt et.al., 1969).

Byrne(1977) studied the spectral differences between males and females speech samples. According to him, the main difference is that the region of 0.1 KHz and 0.125KHz. Where as female level is much lower, although it could ot be measured preciesely in this study. This is explicable by the fact that this frequency region corresponds to the fundamental frequency of male voices.

Long Term Average Spectra measured for individual talkers are highly dependent upon the personal characteristics of talker such as vocal effort, pitch, timbre, articulation and speech of ultrances(Tarnoczy, 1956).

Different investigators have employed different methodologies for obtaining long-term average spectrum.

Weinberg et.al., (1980) obtained Long Term Average Spectra using an FFT computing spectrum analyzer. The analyser was set in cumulative mode for 64 frames with a frequency range of 0 to 10,000 Hz and a time window of 40 ms. The quantized speech signal was weighted by a hanning function, Fourier transformed, and stored for cummulation of 64 frames. Each frame represented FFT results for a 40-ms speech segment. An amplitude spectrum with A-weighting was plotted at the end of cummulation. Thus, the amplitude spectrum represented an average long time spectrum derived from a total of 64 "sections" made from an oral reading by each subject.

Kitzing(1986) obtained long time averrage spectograms by means of a B&K signal analyzer 2033, analysing 400 frequency lines in the choosen range,using linear average over 128 triggered spectra by flat weightings. The analysis werre accomplished in two series with different base band frequency ranges, viz. 0-5 KHz and 0-2 KHz, respectively. In order to avoid noise from consonant articulation, unvoiced parts of the signal were elimilated by a gate, controlled either by E.G.G. signal or by a low pass filter devise.

Hammerberg et.al., (1986) fed recorded speech material of 40 seconds duration through 51 band pass filters, each 250 Hz wide. The pre-emphasized level of each channel was averaged by a computer and was plotted on a frequency-intensity diagram. All voiceless speech sounds were automatically eliminated as only segments above a certain amplitude threshold in the low frequency region were considered as voiced. This was done in order to eliminate the influence of voiceless fricatives on the higher frequency part of LTAS registration.

Wendler et.al., (1986) analysed the type recordings of on going speech by means of a real time analyser, using 25 1/3 octave filters in the area of 63 Hz to 12.5 KHz in combination. With an averager NTA 512, one analysis was carried out with the unmanipulated continous signal, another with the voice less consonants eliminated. As there were no significant differences with regard to these two variants, they generally based all further explanations on the data from the continous signals.

Lofqvist and Manderson (1987) digitalized the speech signal at a rate of 20 Hz and analyzed in frames of 12 ms duration using FFT analysis. Pauses Voiceless segments were excluded from the analysis.

Several different measurements have been may by different investigators on long term spectrum, although, there are no generally agreed upon principles for making these measurements.(Lofqvist and Manderson,1987).

Frokjaer-Jensen and Prtytz(1976) used the ratio of energy below and above 1 KHz and named it as parameter. According to them since the amplitude above 1000 Hz is nomalized relative the amplitude below 1000Hz, is independent of the microphone distance, amplitude level, etc.

Hammarberg et.al.,(1984) measured the level of the fundamental, the peak amplitude in frequency band 400-600 Hz, the spectral level at 1.5 and 5 KHz, respetively, and the peak amplitude in the frequency band 5-10 KHz. They then used the difference between the peak level in the 400-600 Hz and other levels as a measure of spectra tilt.

Nataraja(1986) studied three spectral parameters in the voice of dysphonics, they are:-

(1) The ratio of intensities between 0-1 KHz and above 1-5 KHz and named AA.

(2) Ratio of intensities of harmonics and noise in 2-3 KHz and named it as AC

(3) Frequency of first formant(AD) which is defined as the frequency with maximum intensity in the range of 300-1000 Hz.

Kitzing(1986) discusses several different measures that correlate with perceptual judgements of sonarity and strain. The study indicates that

(i) The ratio of energy below and above 1000Hz.

(ii) The spectral slope in the first formant region

(iii) The ratio between the level of the fundamental and the spectral level in the region of the first formant as useful measures.

Lofqvist and Manderson(1987) made two measurements on the calculated long term spectrum they are:-

(l)<u>The ratio of energy between 0-1 KHz to l-5 KHz.</u>

According to them," This ratio provides a measure of the overall tilt of the sound spectrum. A high value of this ratio indicates that the fundamental and the lower harmonics dominates the spectrum which thus falls off rapidly. A low value of this ratio shows, on the other hand, that the sound spectrum has a lower spectal tilt.

(2) Measurement of the energy between 5-8 KHz.

A high level of energy at these frequencies can be associated with noise components of the source in a hypofuncional voice(Yanagihara,1967).

Hartman and Cramon(1984) studies the amount of spectral energy in 1 to 5 KHz range and above 5 KHz.

Since the aim of the analysis is to study the voice source, it is most reasonable to restrict the analysis to voiced portions of the speech signal. In order to find out the affects of inclusion of invoiced sounds in the speech sample, Lofqvist and Manderson(1987) found that the inclusion of voiceless segments mostly affects the spectal level above 5KHz for normal voices. However Wendler et.al.,(11986) found significant difference between the spectras of unmanipulated speech signal and the speech equal signal voiced sounds eliminated.

The amount of speech that can be analysed is most often restricted by the memory limitations of the available computer or spectrum analyser. In order to assess the effects of varying analysis time, readings of a standard text were analysed in successively smaller and smaller portions by Lofqvist and Manderson(1987).The original analysis time was 12 msecs

They found that "...there is virtually no effect of halfing the analysis time. However when the time is reduced to 1/3, 1/4 or 1/5 of the original analysis, variations occur between the measurements. These measurements are most likely due to differences in the segmental structure between the analysed parts. Other sources of variations are onsets and offsets of voicing segments, as well as stress and pitch patterns.

An interesting question about the LTAS analysis concerns the resolution of the measurement. Lofqvist and Manderson(1987) addressed this question by analysing recordings of the same voice recorded twice on the same day. They found that in all cases, there is a clear difference between the two recordings. They further added that when the voice has been in constant use during the day, the source spectrum has a lower spectral tilt.

Another interesting aspect of LTAS is the amount of speech signal that is to be analyzed to get a stabilized pattern. Li et.al., (1969) suggests that after 30 seconds of continous speech, the effect of individual speech sounds on the LTAS will not change significantly regardless of how much more speech is analyzed.

Inspite of these variations and the methodology yet to settle, several attempts have been made to use LTAS for the diagnosis of voice disorders.

Rashmi(1985) has made an attempt to study the ratio of intensities below and above 1 KHz, in the spectra of vowel /i/. She has concluded that:-

(i) The energy level above 1 KHz is less than the energy level below 1 KHz.

(ii) The alpha parameter shows no significant difference till the age of 9 years in both males and females. The female group in the age range 9 to 14 and the male group age ranging from 9 to 15 years had shown some changes, and

(iii) No significant difference between males and females has been found. The age group above 9years at age showed a change in the voice quality both in the case of males and females as reflected by the changes in ratio. The mean value ranged from 0.78 to 0.92.

Gopal(1986) reports of no significant difference between males and females upto the age of 55 years. A significant difference was observed between males and females in the age range of 56 to 65 years group i.e., males showing a higher score (0.73) than females (0.70). The value has ranged from 0.71 to 0.76 in the age range 16 to 55 years both in the case of males and females. Similar to the results of Rashmi's (1985) study, the average intensity above lKHz has been less than below 1 KHz.

Wendler, Doherty and Hollien(1980) met with encouraing results when they used long term speech spectra to objectively differentiate between four classes of voices according to auditive judgements(normal, mild, moderate or severe degree) of hoarseness. In addition, they attempted to differentiated between certain degrees of roughness and breathiness as well as to carry out differential diagnosis based on acoustic analysis

Hartman and Cramon(1984) studied the amount of spectral energy in the 1 to 5 KHz range and above 5 KHz in two subgroups of patients. The first subgroup showed a voice quality compound of breathiness and tense, which gradually normalized in the follow-up period. The other subgroup initially exhibited a normal or lax, breathy voice, which sub sequently became more tense. They found that the variations of spectral energy and the duration of aspiration preceding voice onset indicates signs of tense and breathy voice production. Thus they concluded that this measure is sufficient to differentiate these two subgroups.

Dejonckere(1986) investigated the differences in long-time-average spectra between the voices of 30 carriers of vocal nodules before treatment and 30 normal subjects of the same sex and age. All subjects read a standardized french text of about 45 seconds. The text was phonetically selected in order to avoide any fricative consonants with articulatory turbulence, and to assume a continous laryngeal vibrations. Computerised analysis of the spectra (0 to 10,000 KHz) revealed that the voices of nodules carriers have less acoustic energy in the field of fundamental speaking frequency and more acoustic energy in the band of 6 to 10 KHz than normals.

Nataraja(1986) found the following results.

(i) The males and females of the dysphonic group show no significant difference in terms of AA ratio. The males and females of the normal groups also showed no significant difference. A statistically significant difference was found between the dysphonic and the normal groups. The dysphonic groups showed lower AA values than the normal groups i.e., the dyshonics had higher intensities in the frequencies above 1 KHz than normals.

(ii) The AC ratio values shown by the males and females of the dysphonic groups was found to be not significant. The normals also showed similar results. However, a significant difference between the males of the two groups was found.

(iii) The first formant frequency of the males and females wthin the dysphonic group showed a significant difference. This was similar to the results seen with in the normal groups. The dysphonic group and the normal groups of males and females did not differ from each other from both males and females.

Thus he concluded that of all the three parameters, only AA parameter significantly differentiated normal and dysphonics in both genders.

Fritzell, Hallen and Sundberg(1974) studied the pre-operative and post-operative long term average spectra of one case(left recurrent nerve palsy) who underwent teflon injection procedure. The pre-operative LTAS exhibited one single peak which was found in the frequency region covered by the fundamental. After the treatment, the fundamental increased by about 6 dB on the average, the partials underlying the I formant by 20 dB and the partials underlying the II formant by 15 dB.

Thus this review of literature indicates that LTAS and E.G.G. are potential measures for diagnosis and follow-up of treatment of various voice disorders.

However there are very few studies of LTAS and E.G.G. in dysphonics particularly in our country. Thus an attempt is made here to study the E.G.G. and LTAS in both normals and dysphonics of both genders.

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METHODOLOGY

The present study employed the technique of EGG and LTAS to study the vibratory patterns of the vocal cords and the source spectrum respectively in dysphonic subjects.

The aim of the study was to investigate EGG and LTAS parameters in normals and dysphonics, and possibilities of using these parameters to differentiate dysphonics from normals.

Subjects :-

The individuals who reported with complaints of voice problem to AIISH were examined by qualified speech pathologists, audiologist and ENT specialists and who were diagnosised as having voice problems were considered as the subjects for the present study(experimental group).

Table-1 highlights the details of the subjects in terms of age, sex, number and different pathological conditions.

TABLE I: Distribution of experimental group.

Pathology condition	Males Age Range	Males Number of subjects	Females Age Range	Females Number of subjects
1. Unilateral RLN Palsy	28-29	2	*	*
2. Vocal Polyp	30-34	3	26-28	2
3. Laryngitis	24-31	2	23-31	2
4. Glottic chink	19-35	3	20	1
5. Vocal nodule,	*	*	19-35	3

Table- II gives the details regarding the control group. The subjects of this group had no different speech, hearing or ENT problem. They had no complaint regarding their speech, hearing or voice.

Case histories from subjects of both the groups were obtained and then other evaluations/measurements were carried out.

Table II: Age Range & No. of subjects of control group.

GROUP	Age Range	No. of subjects
Normal Males	20-34	10
Normal Females	20-33	10

The Experimental setup for EGG:-

The following instruments were used for the study:-

(i) Electroglottograph (kay elemetrics corporation)

(ii) High resolution signal analyser (HRSA) B&K type 2033

The instruments were arranged as shown in the diagram I

```
:-----------------:      :-----------------:  :----------------:
: ELECTRODES      :-----:     E.G.G         :--:  H.R.S.A        :
:-----------------:      :-----------------:  :----------------:
```

Diagram-1

The signal from the laryngograph was fed to the HRSA to obtain the display of the glottal wave forms which were used to measure different parameters of glottal wave forms.

The HRSA displays the glottal wave signals in terms of time (in msec) on X- axis and amplitude (in mv) of the signal on X-axis. The time at any given point can be measured by moving the cursor horizontally.

All instruments were calibrated prior to the experiment and then periodically as per the instructions given in the mannual of these foresaid instruments.

Additional care was taken to avoid 50 Hz hum in the instruments by using proper grounding.

Procedure

The subjects were seated comfortably infront of the instruments. The electrodes of the Laryngograph were placed on the thyroid alae. The position of the electrodes were adjusted to obtain clear laryngeal wave forms on the HRSA screen. The subjects were instructed to phonate vowel /a/ as long as possible at comfortable pitch and loudness.

Once stable laryngeal wave forms were observed on the HRSA screen, five successive cycles of each of glottal wave form were selected for further analysis. Each cycle was analysed at different points (as shown in diagram II) to obtain the duration of different phases of vocal fold vibrations.

After measuring the durations between different points on each cycle of glottograms, the following different parameters of the laryngeal wave forms were calculated as follows:-

(i) Open Quotient (OQ) $= \dfrac{\text{Open period}}{\text{Vibratory period}} = \dfrac{P7 - P4}{P7 - P2}$

(ii) Speed Quotient (SQ) $= \dfrac{\text{Opening period}}{\text{Closing period}} = \dfrac{P5 - P3b}{P3a - P_1}$

(iii) Speed Index (SI) $= \dfrac{SQ - 1}{SQ + 1}$

(iv) Jitter (J) $= \dfrac{(t1 - t2) + (t2 - t3) + (t3 - t4) + (t4 - t5)}{4}$ (m sec

Where tl,t2,t3,t4,& t5 represent the periods of five successive glottal waves.

(v) Shimmer (S) $= \dfrac{(a1 - a2) + (a2 - a3) + (a3 - a4) + (a4 - a5)}{4}$ (dB)

Where A1,A2,A3, A4 & A5 represent the amplitudes of the five consecutive laryngeal cycles.

Thus,

(a) Open Quotient,

(b) Speed Quotient,

(c) Speed Index,

(d) Jitter, &

(e) Shimmer

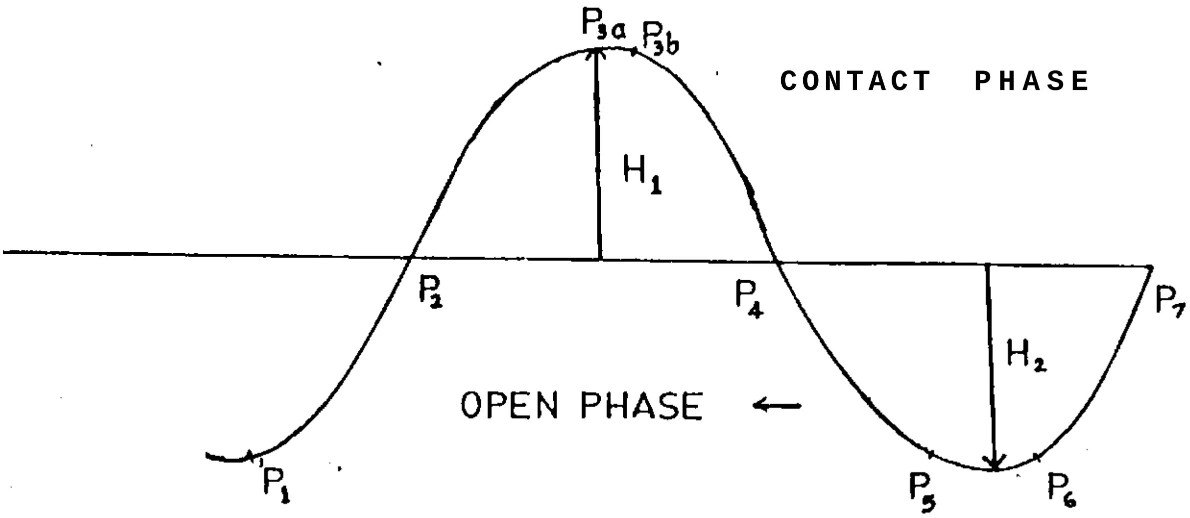

Fig.3: Showing different phases of vibratory cycle in m.sec,

$P_{3a}-P_1$ = Closing period.

$P_{3b}-P_{3a}$ = closed period (in normals $P_{3a} \approx P_{3b}$)

P_5-P_{3b} = Opening period.

P_6-P_5 = open period.

P_7-P_2 = Period of the vibratory cycle.

$P_4-P_2 = B_1$ = Base of contact phase.

$P_7-P_4 = B_2$ = Base of open phase.

H_1 = Height of contact phase.

H_2 = Height of open phase.

Values were obtained for vowel /a/, for each subject. Thus, for all dysphonic subjects, all the five parameters of EGG were measured for vowel /a/.

Experimental setup for LTAS measurement :-

For the purpose of measuring the spectral parameters namely the alpha-ratio, energy above 1 KHz, energy below 1 KHz, energy in the frequency band 5-8, and the frequency of the highest peak, it was decided to use the " Kannada voiced passage" which is being routinely used at the Department of Speech Science, ALL INDIA INSTITUTE OF SPEECH AND HEARING, Mysore for speech and voice analysis.

The " Kannada voiced passage" contained only two fricative sounds. Thus care was taken to avoid them during spectral analysis by choosing only those parts of the speech sample which did not contain these fricatives.

The speech samples were recorded using the type recorder of the spectrograph (voice identification Inc). The tape speed was 7 1/2" per second. A directional microphone was kept at a distance of approximately 6-8" from the subject's mouth.

Each subject was instructed to read the passage at a comfortable pitch and loudness. The VU meter of the spectrograph (voice identification Inc) was further adjusted to see that the speech levels were reasonably steady and were at a suitable level to ensure good recordings.

These tape recordings were then fed to an computer (WIPROW PC\ XT) through an A to D converter (voice and speech system) developed by Anantha padmanabha.

The arrangement of instruments were as illustrated in diagram-III.

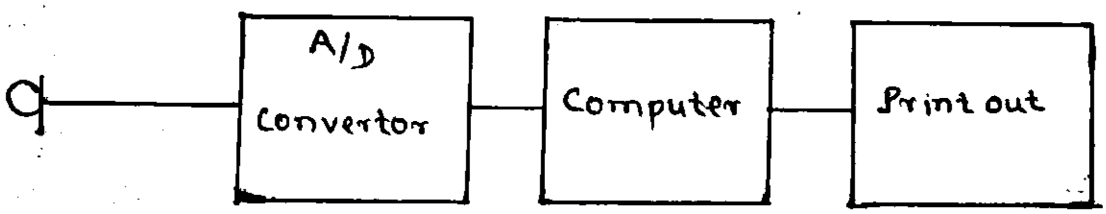

Diagram-III

Thus " Kannada voiced passage" of duration 10 seconds contain any fricative sounds was submitted to spectral analysis.

For carrying out spectral analysis the programme "LTAS" with autocorrelation was used. This programme was developed by voice and speech system, Bangalore.

The spectral analysis were carried out for the frequency range 0-8 KHz with a resolution of 10 and block duration of 20.

The spectral analysis data thus obtained contained the following:- (sample enclosed in appendix-1).

(i) A graphical display of the spectral pattern in the frequency range of 0-8 KHz,

(ii) A data of the energies of all the different points which were analysed by the computer,

(iii) Alpha ratio,

(iv) Energy above 1 KHz (1 KHz-8KHz)

(v) Energy below 1 KHz (0-1 KHz).

Further information regarding the energy concentration in the frequency band 5-8 KHz was obtained through the computer programme by summing up the energies of all the different points in that frequency band and dividing it by the number of all the points in that frequency band.

Thus the following parameters were studied from the long-term average spectra of each individual.

(i) Alpha ratio,

(ii) Energy above 1 KHz,

(iii) Energy below 1 KHz,

(iv) Energy in the frequency band 5-8 KHz, &

(v) The frequency of the highest peak.

These data were then subjected to appropriate statistical analysis to find out if we can differentiate normals and dysphonics through LTAS and EGG parameters.

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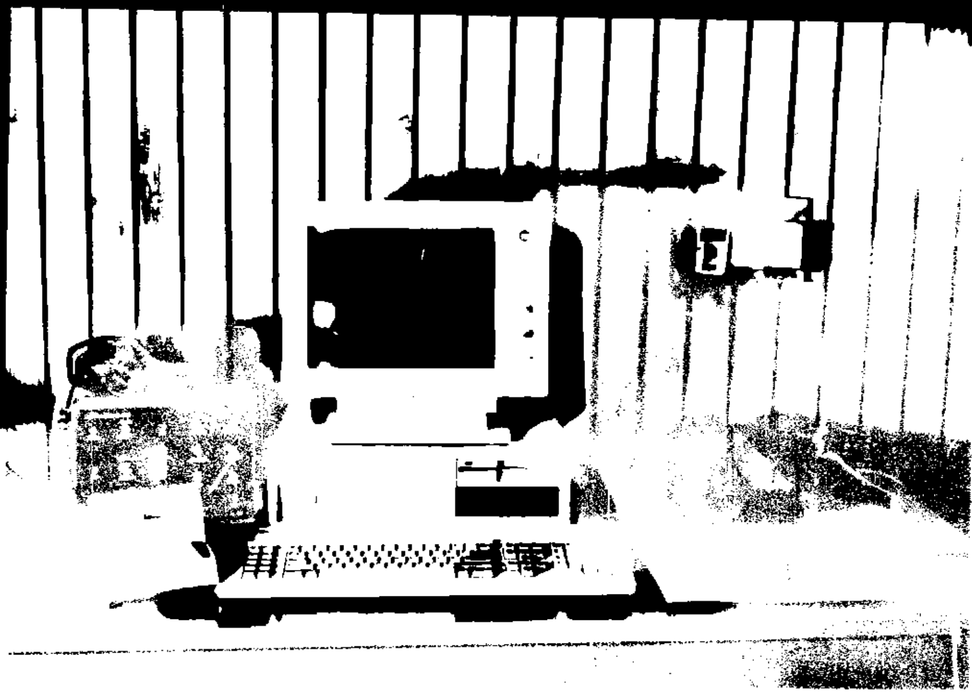
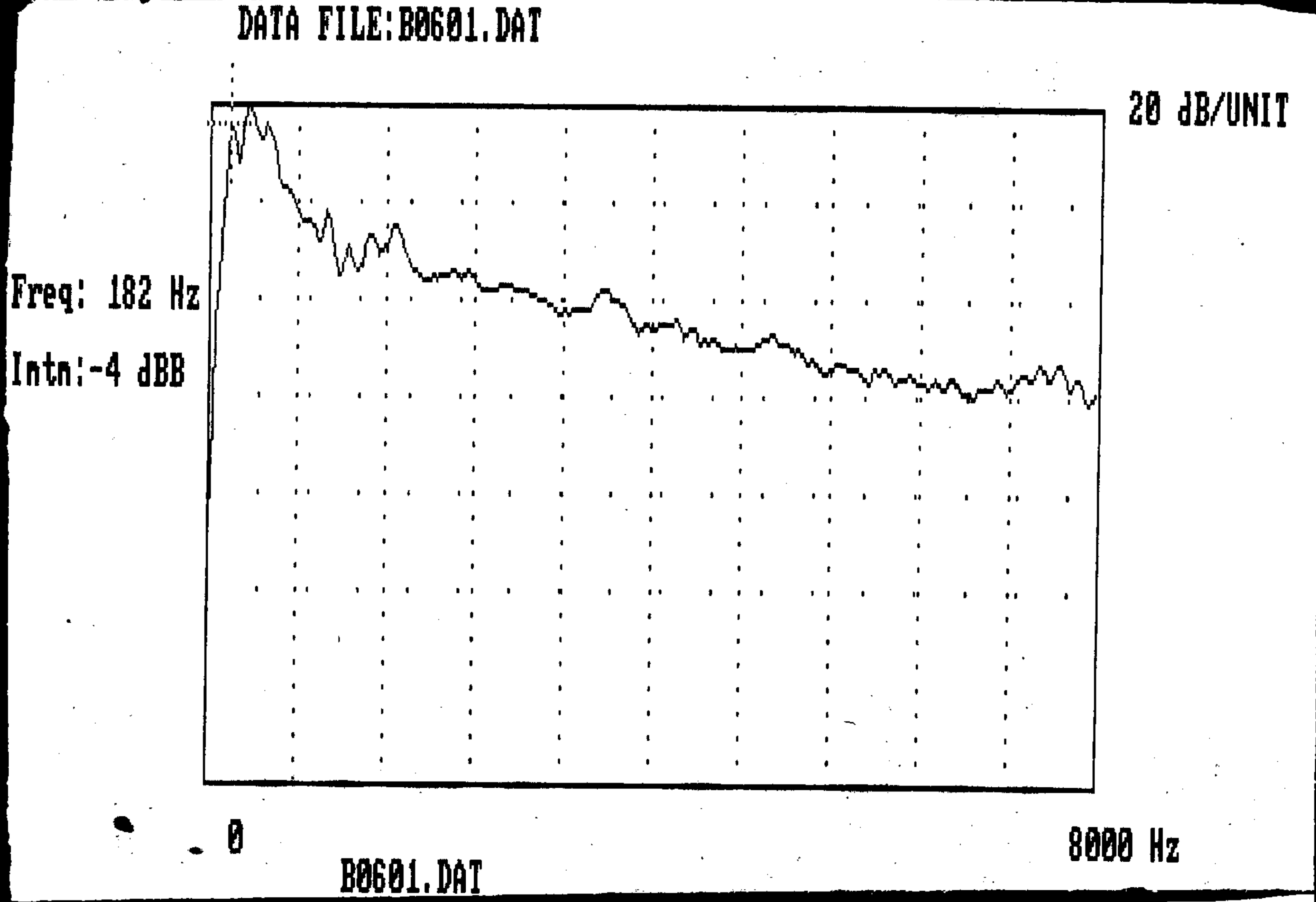


APPENDIX I(a): showing the A/D converter, personal computer & print out used for spectral Analysis



APPENDIX I(b): showing the spectral pattern of continuous speech

RESULTS AND DISCUSSIONS

The purpose of the study was to find out the parameters of Long-term average spectrum and Electroglottography which can differentiate between normal and abnormal voice. Further an attempt is made here to find out the difference between different types of voice disorders and normal voices(both sexes) on these parameters.

Therefore to meet the purpose of the present study, the following parameters were considered.

i

Long term average spectrum parameters:-

(1) Alpha-ratio,

(2) Energy in the frequency band 5-8 KHz,

(3) Energy above 1 KHz,

(4) Energy below 1 KHz, &

(5) Frequency of the first formant.

Electroglottography parameters :-

(1) Open Quotient (OQ),

(2) Speed Quotient (SQ),

(3) Speed Index (SI),

(4) Jitter (J), &

(5) Shimmer.

10 male dysphonics and 8 female dysphonics with various types of voice disorders were studied. A matched group of 10 males and 10 females were also studied to compare the LTAS parameters. The norms given by Sridhara (1986) were used to compare the EGG parameters.

The results of these different parameters have been discussed, after analysing them using appropriate non parametric statistical tests.

LTAS Parameter :-

Alpha Ratio :-

Table III reads the mean and S.D of Alpha ratio as shown in various groups.

Table III :-

Group	Mean	Standard deviation	Range
Normal Males	0.764	5.319	0.692 - 0.866
Normal females	0.869	4.22	0.808 - 0.938
Dysphonic males	0.820	7.267	0.706 - 0.952
Dysphonic females	0.789	0.126	0.63 - 0.982

The comparison between normal males and normal females on this parameter reveals that they are significantly different (T=8) at 0.05 level.

The inspection of the scores also reveals that the mean alpha-ratio for normal females is greater than that for normal males. Further the normal males shows a greater variability than normal females.

Rashmi (1985) found no sex difference for this parameter till the age of 9 years. However, after 9 years of age, the normal males and normal females alpha values differed in her study which she attributed to change in quality of voice.

However, Gopal (1986) and Nataraja (1986) found no difference between normal males and normal females on this parameter. Gopal (1986) found no significant difference between normal males and normal females upto the age of 5 years. Nataraja (1986) also reports of similar finding for the age range 16-45 years.

The comparison of normal males and dysphonic males on this parameter show that they are not significantly different (T=27) at 0.05 level.

The inspection of the scores however show that dysphonic male group has a slightly higher alpha-ratio when compared to normal male group. Moreover, the variability of alpha-ratio is greater in dysphonic males than in normal males.

However, Nataraja(1986) found a significant difference between normal males and dysphonic males with dysphonic males tending to exhibit lower than normal males.

Frokjaer-Jensen & Prytz(1976) found this parameter to be useful in differentiating vocal cord paralysis from normals.

A comparison of alpha-ratio of normal females and dysphonic females also reveals that they are not significantly different (T= 54.5) at 0.05 level. However, dysphonic females exhibits a slightly lower alpha-ratio than normal females and is found to be in the vicinity of alpha-ratio of normal males.

This finding is in agreement with that of Nataraja (1986) who also found no significant difference between normal female and dysphonic females.

A further comparison of alpha-ratio of dysphonic female and dysphonic male groups shows that they are not significantly different (T=46). This is in agreement with the findings of Nataraja(1986).

Dejonckere (1986) found a significant difference between normal females and dysphonic females (vocal nodules) with dysphonic females exhibiting higher energy concentration above 1 KHz.

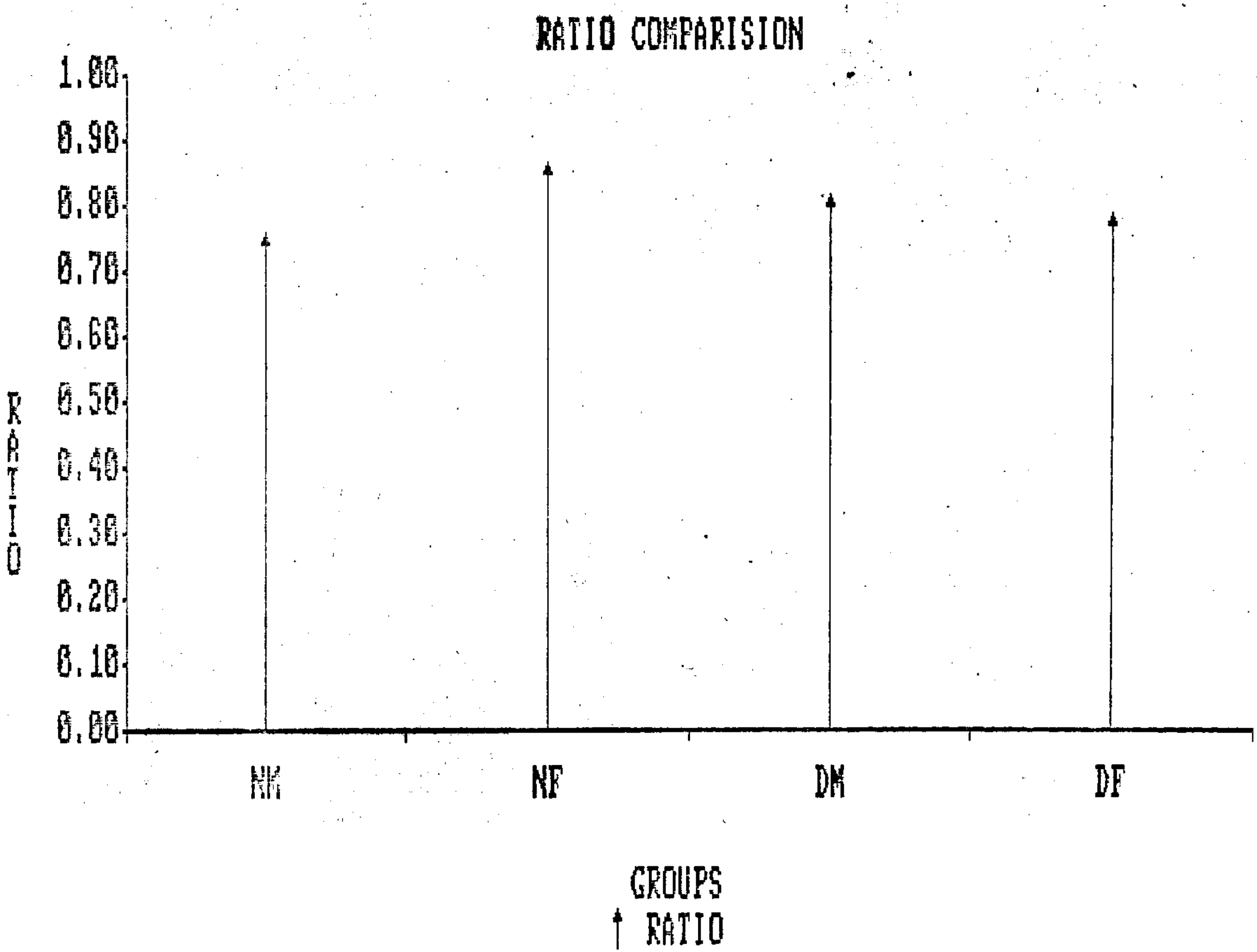

RATIO COMPARISION
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
RATIO
NM
NF
DM
DF
GROUPS
RATIO

Table IV gives the alpha-ratio values (mean, S.D and range) of different types of voice disorders of both the sexes.

Table IV : Alpha-ratio in different voice disorders

Type		Mean	S.D.	Range
RLN Palsy (uni)	M	0.77	0.07	0.73 - 0.82
	F	*	*	*
Vocal Polyp	M	0.79	0.07	0.71 - 0.84
	F	0.80	0.10	0.73 - 0.83
Laryn- gites	M	0.85	7.78	0.84 - 0.85
	F	0.86	0.18	0.73 - 0.98
Narrow glottic chink	M	0.86	0.09	0.77 - 0.95
	F	0.63	*	*
Vocal Nodules	M	*	*	*
	F			

An inspection of table iv reveals the following:-

(1) Dysphonic males with Laryngitis or narrow glottic chink show a greater mean alpha-ratio than normal male, and they are similar to that of normal females.

(2) Dysphonic males with unilateral RLN palsy or vocal polyp exhibit alpha-ratio which are similar to that of normal males.

(3) Dysphonic females with narrow glottic chink or vocal nodules show a lower alpha-ratio than normal females.

(4) Dysphonic females with vocal polyp or laryngitis also show slightly lower alpha-ratio than normal females, but they are higher than those of dysphonic females with narrow glottic chink or vocal nodules.

II Energy above 1 KHz

Table V illustrates the Mean, S.D, & Range of "energy above 1 KHz" in different groups.(in dB)

Group	Mean	S.D.	Range
NM	88.93	9.40	77.84-102.26
NF	100.81	7.27	91.78-112.44
DM	97.08	9.11	80.45-112.89
DF	91.88	18.42	74.05-129.94

Comparison of normal males and normal females on this parameter reveals that they are significantly different (T=20) at 0.05 level in normal female exhibits a higher mean energy above lKHz than normal males. This is reflected in alpha-ratio also i.e., normal females exhibited significantly higher alpha-ratio than normal males.

The factors responsible for such difference are not known. Only further studies will be able to answer this.

The comparison of normal males with dysphonic males on this parameter reveals that they don't differ significantly (T=25) at 0.05 level, similar findings were also observed when normal females were compared with normal dysphonic females on this parametric (T-59). However dysphonic female exhibited greater variability on this parameter than any other groups.

However, confronting results are reported by Nataraja(1986) Dejonckere(1986) who found significantly higher levels of energy above 1 KHz in case of dysphonics than normals.

Table VI: Energy above 1 KHz in various voice disorders

Type		Mean	S.D.	Range
RLN Palsy	M	96.03	9.00	94.18 - 97.87
	F	*	*	*
Vocal Palsy	M	90.20	9.34	8.5 - 99.07
	F	91.54	10.38	84.20- 99.88
Laryngitis	M	99.56	1.05	98.83-100.32
	F	107.08	32.36	84.22-129.94
MGC	M	10.3	12.31	89.22-112.89
	F	74.05	*	*
Vocal Nodules	M	*	*	*
	F	87.91	14.06	74.57-102.59

Examination of Table IV reveals the following:-

(1) Dysphonic males with RLN palsy (unilateral) or vocal polyp or laryngitis or narrow glottic chink exhibit greater energy above 1 KHz than normal males but less than of normal females. However dysphonic males group with narrow glottic chink exhibits less than normal female value. However, these differences could not be significantly established because of small size of groups.

(2) Dysphonic females with vocal polyp or narrow glottic chink exhibits less energy above 1 KHz than normal female. Dysphonic female with laryngitis however exhibit greater above 1 KHz than normal female.

Energy below 1 KHz

The results of the parameter "energy below 1 KHz in various groups are shown in Table VII.

Table VII

Group	Mean	S.D.	Range
NM	116.21	4.73	110.2-123.91
NF	116.44	4.18	109.15-122.55
DM	117.37	5.02	112.15-129.83
DF	116.1687	7.34	108.46-132.25

Normal male group and normal female group did not differ significantly (T=47) on this parameter. Dysphonic males group and dysphonic female group also did not differ significantly (T=50) on this parameter. This finding is also observed when dysphonic female group and dysphonic male group is compared with normal female group (T=50) and normal male group (T-44) respectively. Thus all the groups exhibited similar energy below 1 KHz. This finding is in agreement with that of Nataraja(1986) who found that higher energy concentration below 1 KHz in case of normals.

A further comparison between "energy below 1 KHz" and "energy above 1 KHz" reveals that all groups exhibit higher energy concentration below 1 KHz than above 1 KHz. This is in agreement with that of Nataraja' (1986) findings. This finding is obvious since fundamental frequency and first formant frequency are below 1 KHz and they have higher energy concentrations.

The results of the parameter "energy below 1 KHz" in different types of dysphonics is given in table VIII.

Inspection of the table VIII reveals the following:-

(1) Except for dysphonic males and dysphonic females with vocal polyp or narrow glottal chink, all other subgroups exhibit greater energy below 1 KHz than normals.

(2) Only dysphonic males with RLN palsy and dysphonic females with laryngitis exhibit greater variability than normals.

(3) All other subgroups show variability less than normals.

Table VIII: Energy below 1 KHz in different groups

TYPE		Mean	S.D	Range
RLN Palsy	M	124.36	7.56	119.04 - 129.73
	F	*	*	* *
Vocal Polyp	M	114.48	2.68	112.15 - 117.41
	F	114.16	1.94	112.78 - 115.58
Laryn-gitis	M	117.50	2.30	115.87 - 119.12
	F			115.44 - 132.25
Narrow glottic	M	115.49	2.83	112.27 - 117.41
chink	F	108.46	-	-
Vocal nodules	M	-	-	-
	F	114.98	4.58	109.78 - 118.45

IV. Energy in the frequency band 5-8 KHz

Inspection of table IX reveals that normal males do not differs significantly from normal females (T=66) on this parameter at 0.05 level. That is there is no significant sex difference with respect to this parameter.

Table IX :Energy in 5-8 KHz in groups

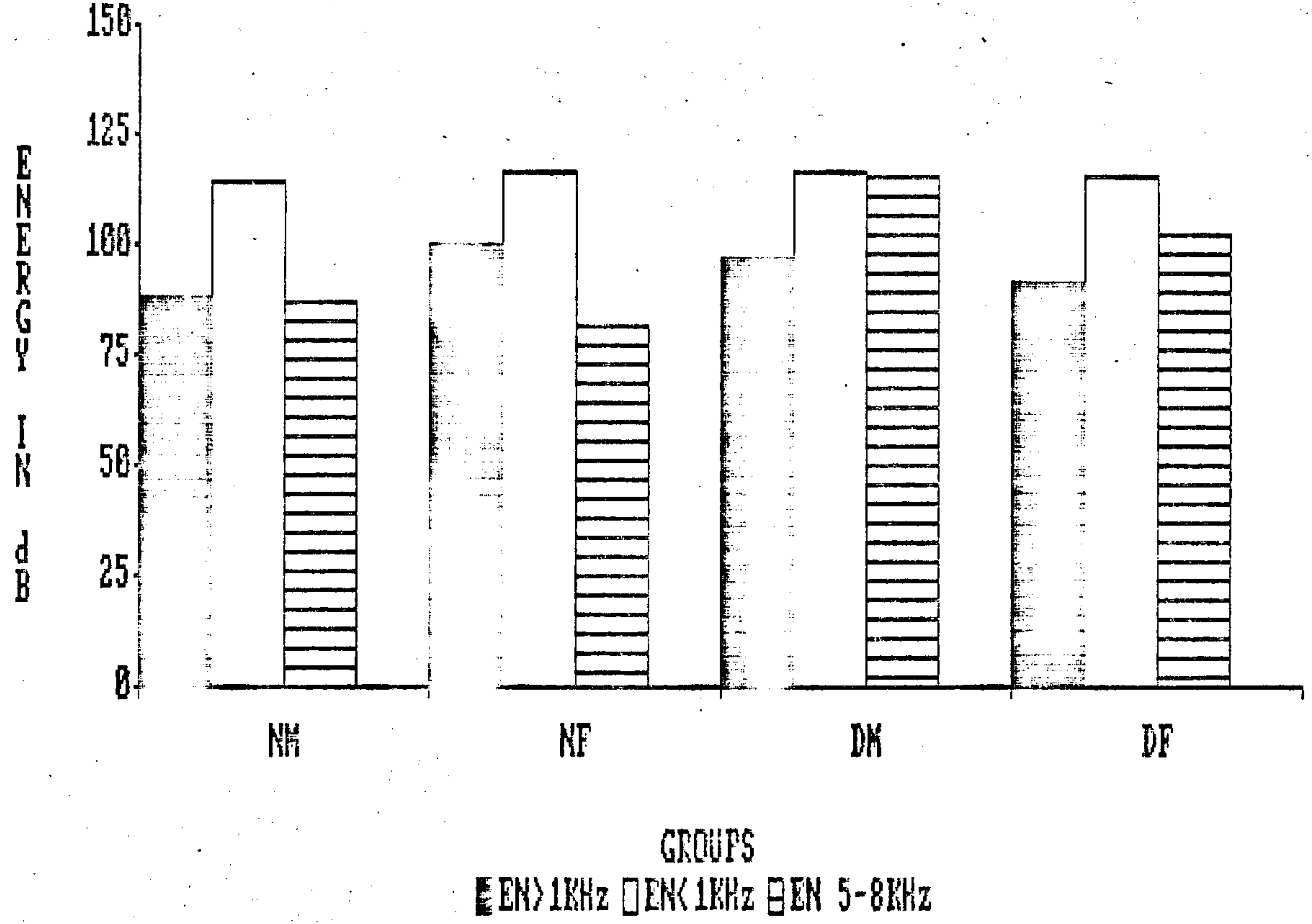
Group	Mean	S.D.	Range
MM	87.28	15.15	71.66 - 126.75
NF	82.51	17.87	66.17 - 123.82
DM	116.08	17.87	83.28 - 129.26
DF	102.41	17.88	86.3 - 128.18

Also, there is no significant difference (T=46) between dysphonic females group and dysphonic male group.

However, dysphonic male group and normal male group (T-87) and also dysphonic female group and normal female group (T=69) differed significantly with respect to this parameter. Dysphonic female and male groups showed significantly higher energy concentration in 5-8 KHz frequency band than normal female and male groups respectively. This result is in accordance to Yanagihara (1967) who states that a higher level of energy at these frequencies is associated with noise components of the source in a hypo-functional voice.

Table X highlights the findings of different subgroups on this parameter.

The following observations are made based on the findings on table X.



ENERGY IN dB
150
125
100
75
50
25
0
NM
NF
DM
DF
GROUPS
EN>1KHz
EN<1KHz
EN 5-8KHz

(1) Dysphonic males with any type of voice disorders studied show greater concentration of energy in the frequency band 5-8 KHz than normals.

(2) Dysphonic females with any of the subtypes show greater energy in this frequency band than normal females.

Table X:5-8 KHz energy in different voice disorders.

Sub-groups		Mean	S.D.	Range
RLN Palsy (uni)	M	124.40	7.56	119.04 - 129.73
	F	*	*	*
Vocal Polyp	M	118.27	4.52	115.24 - 120.27
	F	120.34	8.56	112.38 - 129.46
Laryngitis	M	120.48	7.10	113.79 - 125.87
	F	126.12	9.8	121.62 - 134.86
Narrow glottic chink	M	130.64	10.43	115.67 - 125.42
	F	140.60	*	* *
Vocal nodules	M	*	*	* *
	F	132.64	9.40	120.60 - 137.62

V. Frequency of the highest peak (FHP).

Examination of table XI reveals that normal males and normal females do not differ significantly on this parameter (T-25). However normal female exhibited higher frequency of the frequency at highest peak than normal male group. This finding is in agreement with Nataraja's (1986) and Kim et.al.,(1982).

Table XI FHP in different groups.

Group	Mean	S.D.	Range
NM	340.6	97.14	250 - 500
NF	425.2	89.92	250 - 531
DM	394.6	112.41	250 - 563
DF	363.38	38.72	219 - 469

No significant difference between normal male group and dysphonic male group (T=36), and normal female group an dysphonic female group (T-56.5) were found in this study. This result is similar to Nataraja's (1986) findings. However, Yoon et.al.,(1984) found this parameter to be significantly different in a group of early carcinoma of the larynx when compared to the normals.

A comparison of dysphonic female group and dysphonic male group on this parameter reveals that they are not significantly different. This result is in opposition to that of Nataraja's(1986) results.

The results of frequency at highest peak for various voice disorders is given in table XII.

Table XII:FHP in different voice disoders

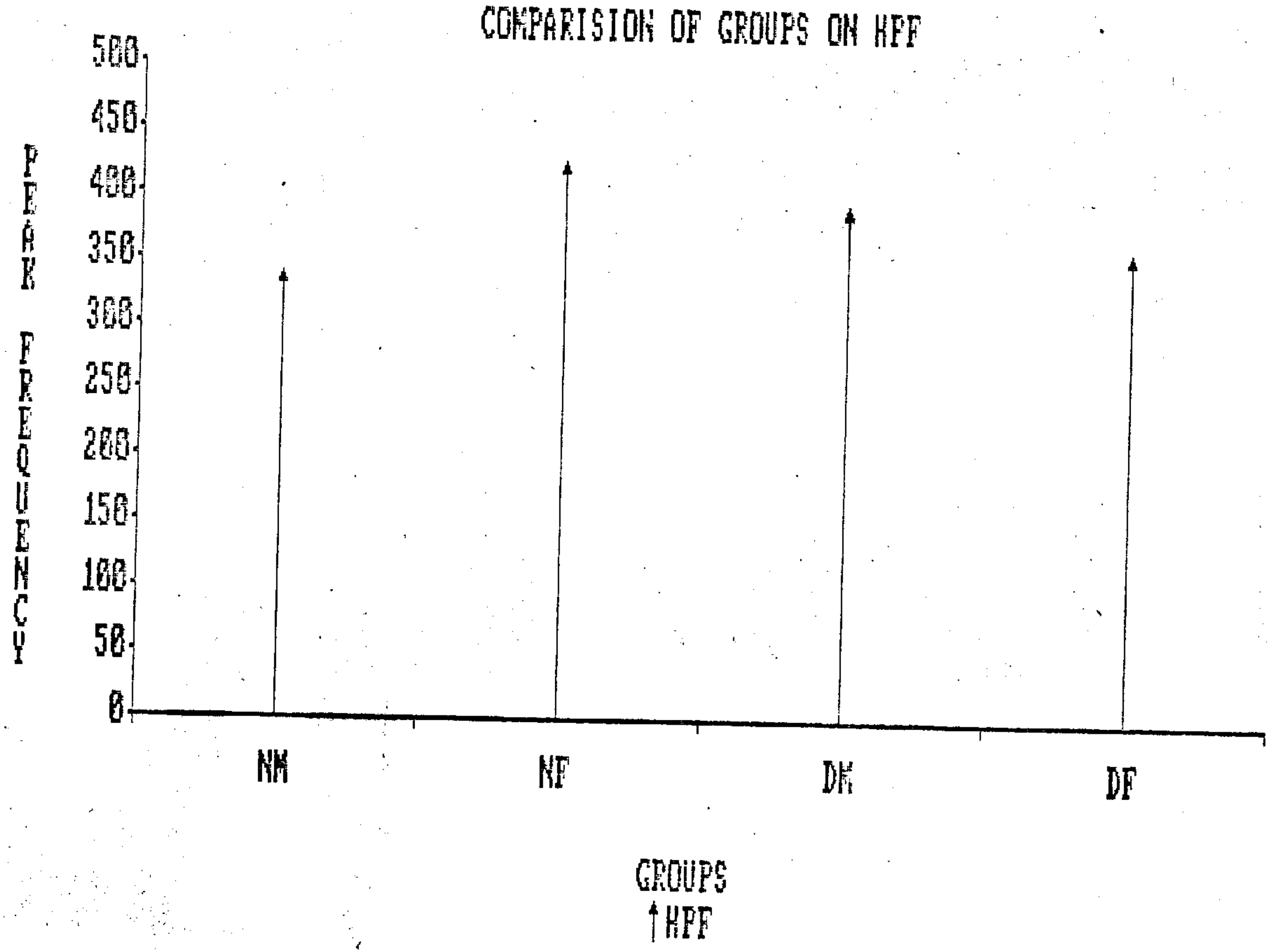
TYPE		Mean	S.D.	Range
RLN Palsy	M	469	132.94	375 - 563
	F	*	*	*
Vocal Polyp	M	333.33	144.34	250 - 500
	F	390.5	21.92	375 - 406
Laryn-gitis.	M	391	66.46	344 - 438
	F	406.5	88.39	344 - 469
Narrow glottic chink	M	408.67	116.22	313 - 538
	F	281	*	* *
Vocal nodules	M*		*	* *
	F	344	125	219 - 469

By examining table XII, the following observations were noted.

(1) Dysphonic male group with unilateral RLN palsy or narrow glottic chink exhibit higher frequency at highest peak than normal male.

(2) Dysphonic male group with polyp or laryngitis exhibit lower frequency at first formant than normal male.

(3) Dysphonic female with any of the types of the disorders studied in this study exhibit lower frequency of the (first formant) than normal female group.


COMPARISION OF GROUPS ON HPF
PEAK FREQUENCY
500
450
400
350
300
250
200
150
100
50
0
NM
NF
DM
DF
GROUPS
↑HPF

E.G.G. PARAMETERS:-

(1) Open Quotient:-

From table XIII it can be observed that both dysphonic male and dysphonic female exhibit lesser OQ than normal male group and normal female group respectively.

Table XIII (OQ in different groups).

Group	Mean	S.D.	Range
NM	.69	0.097	0.23
NF	0.74	0.06	0.19
DM	.54	.19	0.53
DF	.53	.24	0.82

A comparison of dysphonic male group OQ and normal male group OQ reveals that they are significantly different (T-5) at 0.05 level. Dysphonic male exhibits significantly lower OQ than normal male group. A similar statistically significant different (T=0) is observed when normal female OQ is compared with dysphonic female OQ. Dysphonic female OQ is found to be significantly lower than normal female OQ.

A further comparison of dysphonic male group and dysphonic female group on this parameter reveals that they are not significantly different (T-48.5) at 0.05 p.

These results are in agreement with Chandrashekar's (1986) findings. This reduction of OQ values in both males and females dysphonic subjects indicates that the vocal cords remain for lesser than normal duration in open phase(as described by Dejonckere & Lebacq,1985) of each vibratory cycle.

Table XIV illustrates the findings of OQ for different types of voice disorders. An inspection of these findings reveals the following:-

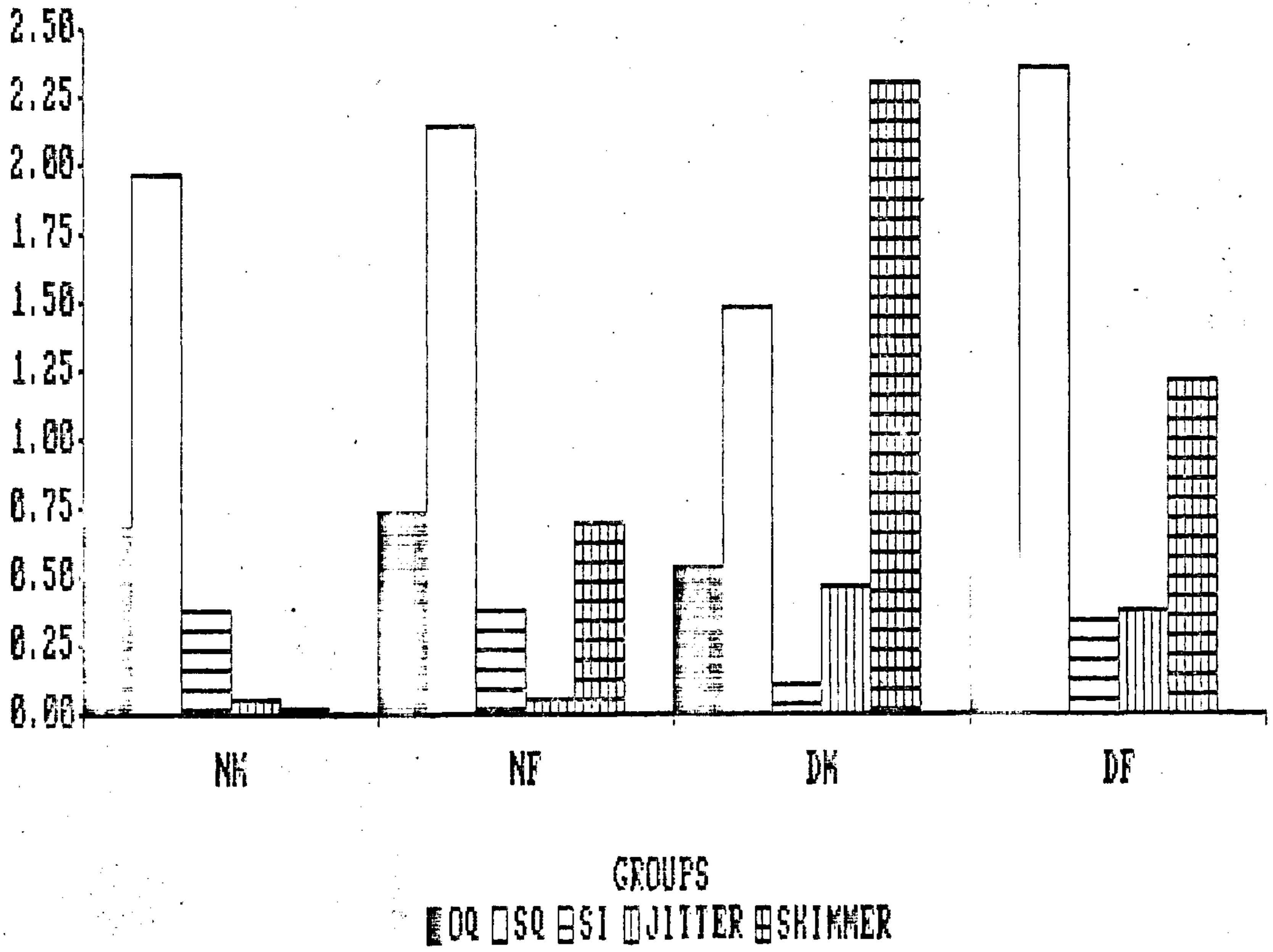
(1) Dysphonic male group with RLN Palsy or vocal polyp or laryngitis narrow glottic chink exhibits lower OQ than NM.

(2) Dysphonic female group with vocal polyp or laryngitis or narrow glottic chink or vocal nodules also exhibit lower than normal female group.

(3) This reduction in OQ in dysphonic male OQ is also reported by Chandrashekar (1986), Childers et. al.,(1984), Fourcin & Abberton ,(1972) & Kitzing & Lofqvist, (1979).

Table XIV (OQ in different types of voice disorders).

Group		Mean	S.D.	Range
RLN Palsy (uni)	M	0.45	0.28	0.25 - 0.653
	F	*	*	* *
Vocal Polyp	M	0.43	0.19	0.20 - 0.55
	F	0.50	0.02	0.48 - 0.52
Laryngitis	M	0.52	0.18	0.39 - 0.64
	F	0.53	0.03	0.51 - 0.521
Narrow glottic Chink	M	0.709	0.01	0.689 - 0.73
	F	0.51	*	* *
Vocal nodules	M	*	*	* *
	F	0.48	0.09	0.39 - 0.56



2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
NK
NF
DK
DF
GROUPS
OQ SQ SI JITTER SHIMMER

II. Speed Quotient:-

The comparison between normal male and dysphonic male groups on this parameter reveals that they are significantly different (T-10) at 0.05 level. Dysphonic female group is compared with normal female (T-21). These results are in agreement with the findings of Chandrashekar's (1987) who reports that SQ failed to differentiate between normals and dysphonics.

Table XV. (SQ for different groups).

Group	Mean	S.D.	Range*
NM	1.98	0.72	3.48
NF	2.25	0.37	0.89
DM	1.49	0.99	3.32
DF	2.36	1.08	2.86

* Range = Highest S.Q. - Lowest S.Q. of individuals.

However, when dysphonic female is compared with dysphonic male, it is found that they are significantly different (T-22) from each other at 0.05 level.

Table XVI reveals the findings of various types of voice disorders on this parameter.

An observation of these values yields the following.

(1) Dysphonic male group with RLN palsy or laryngitis or narrow glottic chink exhibit low SQ than normal male groups.

(2) Dysphonic female group with vocal polyp or narrow glottic chink or vocal nodules exhibit lower SQ than normal female group.

These results are in agreement Chandrashekar's (1987) who also found similar results although with significant. This reduction in SQ possibly implies that there is a reduction of duration of opening phase in these subjects.

(3) However, dysphonic male groups with vocal polyp and dysphonic female group with laryngitis exhibit greater SQ than normals.

Table XVI (SQ for different voice disorders).

TYPE		Mean	S.D.	Range
RLN Palsy	M	0.855	0.25	0.68 - 1.03
	F	*	*	*
Vocal polyp	M	2.49	1.33	1.49 - 4.00
	F	2.40	1.97	1.01 - 3.79
Laryngitis	M	0.82	0.20	0.68 - 0.96
	F	3.00	0.03	2.98 - 3.03
Narrow glottic chink	M	1.15	0.66	0.70 - 1.90
	F	1.56	*	*
Vocal nodules	M	*	*	*
	F	2.17	1.17	0.83 - 3.00

III. Speed Index.

A comparison of normal male group and dysphonic male group on this parameter reveals that they are significantly different (T=4) at 0.05 level. Dysphonic male exhibited a significantly lower speed index values than normal males.

However when normal female group is compared with dysphonic female group, they are found not significantly different. A further comparison between dysphonic male group and dysphonic female group, on this parameter reveals that they are significantly different. Dysphonic female group exhibits significantly greater SI than dysphonic male groups.

Table XVII (SI values for different groups).

Group	Mean	S.D.	Range*
NM	0.38	0.34	0.46
NF	0.38	0.07	0.50
DM	0.11	0.25	0.76
DF	0.34	0.25	0.68

* Range - maximum SI - minimum SI (for groups)

Chandrashekar (1987) also reports of similar results only for dysphonic male group and normal male group comparison. When dysphonic female group were compared with normal female group, he found them to be significantly different.

Table XVIII highlights the findings of various types of voice disorders on this parameters.

On examination of table XVIII reveals the following:-

(1) Dysphonic males (with any type of voice disorders) exhibits lower **SI** than normal males.

(2) Dysphonic females with narrow glottic chink or laryn gitis exhibits larger SI than normal females.

(3) The SI values of dysphonic females with vocal nodules or vocal polyp, however are lower than **SI** values of normal females.

Table XVIII (SI values for different tvpes of voice disorders).

TYPE		Mean	S.D.	Range
RLN Palsy (uni)	M	0.08	0.10	0.01 - 0.15
	F	*	*	*
Vocal polyp	M	0.36	0.2	0.20 - 0.6
	F	0.29	0.41	0.005- 0.58
Laryngitis	M	-0.11	0.11	-0.02 - 0.19
	F	0.50	0.01	0.49 - 0.19
Narrow glottic chink	M	0.19	0.16	-0.08 - 0.31
	F	0.51		* *
Vocal nodules	M	*	*	*
	F	0.35	0.22	-0.09 - 0.50

Jitter.

The comparison of normal male group and dysphonic male group on this parameter shows that they are significantly different(T=54) at 0.05 level. A similar comparison with respect to females also yielded the same results (T=36) at 0.05 level.

However, a comparison between dysphonic male group and dysphonic female group on this parameter reveals that they are not significantly different.

Table XIX illustrates the jitter values for various groups.

Table XIX. (jitter values of various groups).

Group	Mean	S.D.	Range*
NM	0.065	0.04	0.16
NF	0.058	0.04	0.10
DM	0.47	0.38	1.34
DF	0.38	0.23	0.62

* Range - maximum J - minimum J (for groups).

Dysphonic male group and dysphonic female group exhibited greater jitter values than normal male group and normal female group respectively. These results are agreement with Chandrashekar (1987), Sonesson (1967), Kitajima & Gould (1976).

According to Michel and Wendahl, (1971), Iwata(1972), Deal and Emanuel(1978), Koike(1969), presence of excessive jitter gives an abnormal voice quality which are often identified as hoarse or harsh voice.

Examination of table XX which gives the means, S.D. and range of jitter in various pathologies that are studied yield the following :-

(1) All dysphonic males and dysphonic females with any type of voice disorders that are studied exhibited greater jitter values and also greater variability, a finding similar to Chandrashekar's (1987) study.

(2) Greater jitter values are obtained by dysphonic males and dysphonic females with narrow glottic chink than other types of pathologies.

Table XX :- jitter values of different types of voice disorders.

TYPE		Mean	S.D.	Range
RLN Palsy (uni)	M	0.37	0.44	0.06 - 0.68
	F	*	*	*
Vocal polyp	M	0.40	0.18	0.26 - 0.60
	F	0.32	0.34	0.08 - 0.56
Laryngitis	M	0.30	0.09	0.22 - 0.35
	F	0.34	0.37	0.08 - 0.60
Narrow glottic chink	M	0.72	0.61	0.20 - 1.40
	F	0.43	*	*
Vocal nodules	M	*	*	*
	F	0.02	0.14	0.06 - 0.31

V. Shimmer.

Table XXI summarizes the findings of all the groups with respect to the parameter "shimmer".

A comparison of normal male group with dysphonic male group on this parameter reveals them to be significantly different (T=54) at 0.05 level. Dysphonic male group shows significantly greater shimmer value when compared with normal males.

A comparison between normal female and dysphonic female on this parameter however reveals that they are not significantly different. However, dysphonic female exhibits greater shimmer value than normal female.

Table XXI:- Shimmer values of different groups.

Group	Mean	S.D.	Range *
NM	0.03	0.12	0.40
NF	0.70	0.82	2.80
DM	2.32	1.98	6.25
DF	1.23	0.78	2.38

* Range = maximum S - minimum S (for groups).

A further comparison between dysphonic male and dysphonic female reveals that they are significantly different (T=52) at 0.05 level. Dysphonic male exhibits greater shimmer than dysphonic female.

Several investigators(Heiburg, & Horii, 1982; Zyski et.al., 1984; Kitajima & Gould, 1976; Haji.et.al, 1986; Chan drashekar, 1987) have reported greater shimmer values in dysphonic subjects than normals.

An inspection of table XXII reveals the following.

(1) All dysphonic males group exhibit greater shimmer when compared to normal male group with dysphonic male group. Narrow glottic chink exhibits the greatest shimmer value of all types of dysphonic males.

(2) All types of dysphonic males exhibit greater variability than normal male.

(3) Dysphonic female group with any of the types of voice disorders exhibit great shimmer than normal female but less than dysphonic male.

Table XXII:- Shimmer values of different type of voice disorders.

TYPE		Mean	S.D.	Range
RLN Palsy	M	0.21	0.28	0 - 0.41
(uni)	F	*	*	*
Vocal polyp	M	2.82	2.07	0.5 - 3.5
	F	1.94	0.98	1.25-1.70
Laryngitis	M	2.07	1.51	1.00-3.13
	F	1.67	0.05	1.63-1.70
Narrow glottic chink	M	3.13	2.76	1.00-6.25
	F	*	*	*
Vocal nodules	M	*	*	*
	F	0.99	0.37	0.36-1.25

Table XXIII:- Difference between different groups for LTAS Parameters.

TYPE	Alpha-ratio (0.05p)Ho	5-8 KHz Ho(0.05p)	> 1 KHz Ho(0.05p)	<1 KHz Ho(0.05p)	FHP
NM vs. NF ([redacted]	R (T=8[redacted])	A (T=66)	R ([redacted] (T=20)	A [redacted] (T=47)	A (T=25)
NM vs. DM	A (T=27)	R (T=87)	A (T=28)	A (T=44)	A (T=36)
NF vs. DF	A (T=54.5)	R (T=69)	A (T=59)	A (T=50)	A (T=56)
DM vs. DF	A (T=46)	A (T=52)	A (T=53)	A (T=50)	A (T=46)

Table XXIV:- Difference between different groups for EGG parameters.

TYPE	OQ	SQ	SI	J	S
NM vs. DM	R	A	R	R	R
T values	5	10	4	54	54
NF vs. DF	R	A	A	R	A
T values	0	21	16	36	\8
DM vs. DF	A	A	A	A	A
T values	48.5	40	22	49.5	52

"R" implies that Ho is rejected i.e., null hypothesis is rejected.
"A" implies that Ho is accepted i.e.,null hypothesis is accepted.

Thus it may be stated that the hypothesis,

1(a) stating that there is no signficant difference between normal males and females with respect to alpha ratio is rejected.

1(b) stating that there is no significant difference between normal males and dysphonic males is accepted.

1(c) stating that there is no significant difference between normal females and dysphonic females is accepted.

1(d) stating that there is no significant difference between dysphonic males and dysphonic females is accepted.

2(a) stating that there is no significant difference between normal males and normal females with respect to "5-8 KHz" is accepted.

2(b) stating that there is no significant difference between normal males and dysphonic males with respect to "5-8 KHz" is rejected.

2(c) stating that there is no significant difference between normal females and dysphonic females with respect to "5-8 KHz" is rejected.

2(d) stating that there is no significant difference between dysphonic males and dysphonic females with respect to "5-8 KHz" is accepted.

3(a) stating that there is no significant difference between normal males and normal females with respect to" energy > 1 KHz" is rejected.

3(b) stating that there is no significant difference between normal males and dysphonic males with respect to " energy > 1 KHz" is accepted.

3(c) stating that there is no significant difference between normal females and dysphonic females with respect to "energy > 1 KHz" is accepted.

3(d) stating that there is no significant difference between dysphonic males and dysphonic females with respect to "energy > 1 KHz " is accepted.

4(a) stating that there is no significant difference between normal males and normal females with respect to " energy < 1 KHz " is accepted.

4(b) stating that there is no significant difference between normal males and dyshonic males is accepted.

4(c) stating that there is no significant difference between normal females and dysphonic females with respect to "energy < 1 KHz " is accepted.

4(d) stating that there is no significant difference between dysphonic females and dysphonic males with respect to "energy < 1 KHz" is accepted.

5(a) stating that there is no significant difference between normal males and normal females with respect to "FHP" is accepted.

5(b) Stating that there is no significant difference between normal males and dysphonic males with respect to "FHP" is accepted.

5(c) stating that there is no significant difference between normal females and dysphonic females with respect to "FHP" is accepted.

5(d) stating that there is no significant difference between dysphonic females and dysphonic males with respect to "FHP" is accepted.

6(a) stating that there is no significant difference between normal males and dysphonic males with respect to "OQ" is rejected.

6(b) stating that there is no significant difference between normal females with respect to "OQ" is rejected.

6(c) stating that there is no significant difference between dysphonic males and dysphonic females with respect to "OQ" is accepted.

7(a) stating that there is no significant difference between normal and dysphonic males with respect to "SQ" is accepted.

7(b) stating that there is no significant difference between normal and dysphonic females with respect to "SQ" is accepted.

7(c) stating that there is no significant difference between dysphonic males and dysphonic females with respect to "SQ" is accepted.

8(a) stating that there is no significant difference between normal and dysphonic males with respect to "SI" is rejected.

8(b) stating that there is no significant difference between normal and dysphonic females with respect to "SI" is accepted.

8(c) stating that there is no significant difference between dysphonic males and females with respect to "SI" is accepted.

9(a) stating that there is no significant difference between normal and dysphonic males with respect to "J" is rejected.

9(b) stating that there is no significant difference between normal and dysphonic females with respect to "J" is rejected.

9(c) stating that there is no significant difference between dysphonic males and females with respect to "J" is accepted.

10(a) stating that there is no significant difference between normal and dysphonic males with respect to "S" is rejected.

10(b) stating that there is no significant difference between normal and dysphonic females with respect to "S" is accepted.

10(c) stating that there is no significant difference between dysphonic males and females with respect to "S" is accepted.

****

SUMMARY AND CONCLUSIONS

As majority of phonatory dysfunctions are associated with abnormal vibrations of the vocal cords, analysis of the vibration of vocal cords in terms of different parameters constitute an important aspect to be considered in the diagnosis and differential diagnosis of voice disorders (Hanson et.al., 1983).

Further more many dysphonic characteristics also occur between vowels and during c v c transitions, (Fritzell, 1986). Thus spectral analysis of dysphonic voice also yields considerable information regarding their laryngeal system.

The present study was undertaken to find out the parameters of LTAS & EGG which can differentiate normals from dysphonics.

Five parameters of LTAS and five parameters of EGG were studied, in 10 dysphonic males and 8 dysphonic females. They are:-

LTAS parameters

(1) Alpha ratio,

(2) 5-8 KHz,

(3) energy above 1 KHz,

(4) energy below 1 KHz, &

(5) frequency of the highest peak (FHP).

EGG Parameters.

(1) Open Quotient (OQ),

(2) Speed Quotient (SQ),

(3) Speed Index (SI),

(4) jitter &

(5) Shimmer.

A control group of 10 normal males, 10 normal females were studied with respect to LTAS parameters. The EGG norms given by Sridharan (1986) were used to compare dysphonic groups.

The statistical analysis using Mannn Whitney 'U' test and Wilcoxon paired test revealed the following results.

(i) Dysphonic male as a group differed from normal male with respect to the following parameter.

(a) energy in the frequency band 5-8 KHz,

(b) Open Quotient,

(c) Speed Index,

(d) Jitter &

(e) Shimmer.

(ii) Dysphonic female as a group differed from normal female with respect to:-

(a) Energy in the frequency band 5-8 KHz,

(b) Open Quotient,

(c) Jitter.

(iii) Dysphonic female did not differ from dysphonic male in any of the ten parameters studied.

(iv) Dysphonic males differed from normals on more parameters than dysphonic female.

(v) Electroglottograph could differentiate normals and dysphonics on more parameters than the long term average spectrum.

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