# ELECTROGLOTTOGRAPHIC FINDINGS IN THE SPEECH OF STUTTERING AND NONSTUTTERING CHILDREN

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A dissertation submitted in part fulfillment of the
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**ALL INDIA INSTITUTE OF SPEECH AND HEARING**
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MAY, 2001

# CERTIFICATE

This is to certify that this dissertation entitled **"ELECTROGLOTTOGRAPHIC FINDINGS IN THE SPEECH OF STUTTERING AND NONSTUTTERING CHILDREN"** is the bonafide work in part fulfillment of the degree for Master of Science (Speech and Hearing) of the student (Register no. M 9918).

Mysore
May, 2001

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# CERTIFICATE

This is to certify that this dissertation entitled **"ELECTROGLOTTOGRAPHIC FINDINGS IN THE SPEECH OF STUTTERING AND NONSTUTTERING CHILDREN"** has been prepared under my supervision and guidance. It is also certified that this dissertation has not been submitted earlier in any other University for the award of any Diploma or Degree.

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# DECLARATION

This dissertation entitled **"ELECTROGLOTTOGRAPHIC FINDINGS IN THE SPEECH OF STUTTERING AND NONSTUTTERING CHILDREN"** is the result of my own study under the guidance of Dr. M.Jayaram, Director. All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier in any other university for the award of any Diploma or Degree.

Mysore **Reg.No.M 9918**

May, 2001

**Dedicated to**

**my**

**Parents & Parents in law**

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# CHAPTER - 1

# INTRODUCTION

Stuttering is a complex clinical problem that presents a number of faces to the clinician, parents and teachers of the stutters and the stutterer himself. First, there is the motor disturbance that is evident in the abnormal types and amount of speech dysfluencies. This conception is more a perspective than one single viewpoint. Then, there is a complex set of relations between the motor disturbance, the emotional accompaniments of the disorder and further alterations in speech behavior. As these aspects of the disorder feed on each other, there is an increasingly severe disturbance of the individual's social functioning that can interfere with many different aspects of his life (Peters, Hulstijn and Starkweather, 1991)

According to Culatta and Leeper (1988) stuttering is the most common classification of dysfluency. However, for a person to be considered a stutterer many of the following signs and experiences must be part of the case history:

a) Stutttering is a disorder of childhood. It is developmental in nature and follows a fairly predictable path (Bloodstien,1960).

b) Initially, the dysfluency pattern is episodic, but eventually becomes chronic in nature.

c) Most parents or clients cannot point to any specific set of identifiable circumstances closely related to the onset of the disorder.

d) Conforms to several laboratory manipulations that may be employed for differential diagnosis.

Historically, more attention has been paid to the adult stutterer than to the young disfluent child. Such a state of affairs is reasonable from one perspective, but ironic from another. It is reasonable because the segments relating normal nonfluencies in childhood and "true" stuttering are both theoretically and clinically elusive.

**Stuttering In Children**

The procedures that are used to study the speech production of adults cannot be reliably applied to children unless significant modifications are made (Conture, 1987) because findings in the two populations are not always based on similar methods of study . Therefore, a comparison is difficult. Moreover, children are still developing their speech production abilities, whether they are stutterers are not, and thus comparing these still-developing abilities to those of supposedly established adult speakers/stutterers appears to be problematic.

It is not clear how much one can readily generalize the findings on adult stutterers to children who stutter, and vice versa. This apparent inability to extrapolate from adult to child and vice versa seems to come from two sources:

a) History: It is possible that the aberrant speech behaviours of adult stutterers could be the result of well-established, long term history of dealing with and reacting to stuttering.

b) Probability: Two different models were suggested;

   i. not every child who stutterers has equal probabilit}' of becoming an adult who stutters, and

   ii. all young stutterers may have an equal probability of becoming adult stutterers.

It is well recognised that there is very little information about young stutterer's speech production, despite the plethora of studies on adult stuttering and fluency (Zimmerman, 1980a, 1980b:Shapiro, 1980; Stromsta and Fibigu. 1980:Conture, McCall and Brewer, 1977; Conture, Schwartz and Brewer, 1985: Freeman and Ushijima, 1988). In the late 1980s, several studies of young stutterers" speech production during stuttering and fluency were reported (Zebrowski, Conture and Cudahy, 1985; McMillian and Pindzola, 1986; Pindzola, 1986; Conture, Rothenberg and Molitor, 1986; Adams, 1987: McNight and Cullian, 1987; Schwartz, 1987; Caruso, Conture and Colton, 1988; Conture, Colton and Gleason, 1988 ) Efforts to define stuttering (Wingate 1964; Van Riper, 1978: Shames and Florence, 1982; Ingham, 1984; Ham, 1990) have not been particularly successful and widely accepted. According to Bloodstein (1975). it is nearly impossible to develop definitions of stuttering; it is also acknowledged that there are stutterers who do not display all characteristics that one associates with stuttering; and that each stutterer is unique and atypical (Culatta and Leeper, 1988).

**Difficulty In Identifying Stuttering In Children**

Many authors have written about the difficulties of correaly diagnosing stuttering in young children. They can be grouped as follows :

- Difficulties that largely stem from the apparent overlap in the disfluencies of normally talking children and the stuttering of young stutterers (Johnson, 1955; Mann. 1955; Van Riper, 1982:Bloodstein, 1987: Starkweather, 1987)

- Difficulties that arise from lack of agreement between interobserver judgements (Ball 1991; Shriberg and Lot, 1991 Kearns, 1990: Krieman, Gerratt, Kempster, Erman and Berlee, 1993; Cordes, 1994).

- Difficulties that stem from the matter of criteria and basis employed for judgements (Wingate, 1977).

- Difficulties due to the various methodologies and instruments used in the study (Rothenberg, 1981;Baes. Lofuist and McGars, 1983; Childers, Naik, Lazar, Krishnamurthy and Moore, 1983; Watson and Alfonso, 1983, 1987; Freeman, 1984: Adams, Freeman and Conture, 1984; Adams, 1985; Peters and Hulstijn, 1987).

- Difficulties caused by multicultural or cross cultural identification of stuttering. (Finn and Cordes, 1997).

Fields (1980) made some assumptions regarding the difficulty in the identification of stutterers. They are ,

- Stuttering behaviour forms a continuum with normal speech behaviour. All of the behaviours perceived as stuttering are present in normal speakers, although at a much reduced frequency, probability, duration and / or magnitude.

- Stuttering may have multiple etiologies, and therefore, multiple and differential evaluative and remediative strategies are required.

- Stuttering is primarily a production behaviour. All stutterers exhibit basically fluent behaviours and need remediation of only a relatively limited number of conditions to be considered a normal speaker.

- Lack of objective approaches to evaluation of stuttering or stutterers.

Fields (1981) presented a decision model to facilitate the evaluation of stuttering behaviour. This model calls for the evaluation to be conducted along a continuum with specified initiation and termination points. Since stuttering occurs along a continuum from perceived speech to perceived unacceptable speech and then as the intensity or complexity' of the stimuli which govern the stuttering behaviours is manipulated, there should be a corresponding increase or decrease in the amount of stuttering behaviour.

**Laryngeal Behaviour In Stuttering**

In recent years, laryngeal behaviour in stutterers has attracted the attention of many investigators and several attempts have been made, and are being made, to investigate various aspects of phonatory behaviour in stutterers.

As early as in 1820's, some began to speak of malfunctioning of larynx in stutterers (Arnott, 1829; Serre d' Alais, 1829; Avicenna 1837). In feet, altering the manner of vocalization was one of the earliest treatments recommended for stutterers.

Serre d' Alais (1829), Arnott (1829) and Avicenna (1837) regarded chronic spasm of the glottis as the source of stuttering. Kussmaul (1877) defined stuttering as a syllabic dysarthria, produced by lack of coordination of voice, respiration and articulation due to neurological deficits.

Travis (1931) concluded that rational analysis, clinical investigation and systematic research lent support to the feet that many disfluencies judged as stuttering stem from problems of smooth coordination of phonation with articulation and respiration.

Schwartz (1974) attempted to explain the "core of the stuttering block". He believed that the disorder is essentially an inappropriate vigorous contraction of the posterior cricoaryetenoid muscle in response to the build-up of subglottal pressure required for speech.

Wyke (1971, 1974) said that stuttering of laryngeal origin may be a form of phonatory ataxia arising either because of a disorder of voluntary phonatory timing of the vocal fold musculature or from an incorporated reflex modulation of the activity of this musculature during actual utterance.

Adams (1974) offered a physiologic and aerodynamic analysis of stuttering and fluency. He proposed that fluency is dependent, at least in part, upon the correct timing, and the prompt initiation and maintenance of airflow and glottal vibration. Adams and Runyan (1981) stated that even in the absence of perceivable stuttering, the speech of the stutterers contained numerous physiologic, aerodynamic and acoustic abnormalities. They suggested collaboration between clinicians and speech scientists to increase use of laboratory instrumentation for sensitive, objective, clinical analysis of stutterers' speech, other than characterization of perceivable dysfluency.

**Techniques To Study Laryngeal Function**

The production of fluent speech requires precise coordination of respirator}', phonatory and articulatory movements. Abnormal laryngeal function is an important element in several theories of stuttering. Schwartz (1974) and Wyke (1974) described stuttering as a consequence of deviant reflex mechanisms that disrupt normal laryngeal muscle activity.

Laboratory investigators have focussed on the physiology of stuttering in adults in search of a predisposing or etio logical abnormality or a more complete description of both fluent and disfluent speech. A variety of physiological measures that are supposed to occur during stuttered moments and during what is judged to be the stutterers' fluent speech have been analysed. Physiological measures are often influenced by heightened levels of arousal and muscluar effort (Reich, Till and Goldsmith, 1985).

Several investigators have discussed the importance of observing the vocal behaviour of stutterers to improve our knowledge of the disorder (Gregory, 1979). The need for studying the parameters of fluency and the mechanism of disfluency has been stressed. Specifically, it has been proposed that articulatory. respirator}' and laryngeal functioning must be integrated for correct timing and prompt initiation of voicing in fluent speech.

Use of instrumental procedures in stuttering assessment were advocated by Conture (1987). These procedures include:

1) Monitoring changes in vocal fold contact area with an electroglottograph

2) Monitoring respiratory movements through inductive plethysmograpy.

3) Monitoring articulatory-laryngeal-respiratory coupling effects on air flow with a pneumatachograph system.

Thus, the acoustic signal, by itself or in conjunction with kinematic, airflow and electroglottograph (EGG) data has been assumed to allow inferences about respirator}', phonatory and articulatory function in stutterers.

Spectrographic (Lees and Walt, 1993, among others), electromyographic (Shapiro and Delico, 1982, among others), electroglottographic (Packman, Onslow and Van Doom, 1994; among others) and fiberoptic videofluoroscopic. (Conture, McCall and Brewer, 1997, among others) techniques have been employed to study stuttering in both children and adults.

**Electroglottographic Observations In Stutterers**

Use of fiberscope is a problem with children as it is almost an invasive method. Procedures that are noninvasive as well as nonintrutive are preferable with children. Several investigators have found that EGG is an ideal technique suited for studying laryngeal behaviour in the speech of young children ( Fourcin. 1981, Ng and Rothenberg, 1981 and Rothenberg, 1981 Childers, Moore, Naik, Larar and Krishnamurthy, 1983).

Chevrie Muller (1963) and Liorzou et al. (1973) used EGG and acoustical data during conversation speech and phonation to study the laryngeal behaviour in stuttering. They reported a number of irregularities like hard irregular glottal attacks, delayed transitions from voiceless consonants to voiced sounds (greater than 180 msec), unpredictable glottal openings and clonic flutterring of vocal folds.

Freeman and Ushijima (1978), Shapiro (1980), Van Lieshout, Peters, Hulstijn and Starkweather(1988) have demonstrated an abnormal laryngeal behaviour as evident through the inappropriate abductory and or adductory behavoiur. Studies have also been reported which investigated the fluent and dysfluent utterances of stutterers (Borden, Baer and Kenney, 1985). The waveform, during fluent utterances, appeared to be normal with abrupt closing, gradual opening, relatively stable open phase and a rapid build-up of EGG envelope. In the dysfluent utterances of stutterers, voice initiation after a block was characterized by a gradual, instead of abrupt, buildup of the EGG signal.

## Lacunae In Information

It is evident from this review that EGG findings on the laryngeal behaviour in both child and adult stutterers are equivocal. Furthermore, several variables that have been known to be associated with stuttering seem to have been uncontrolled in these studies. For example, the duration of stuttering and severity of stuttering. As there is some evidence that stuttering is associated with abnormal laryngeal behaviour as evident through EGG studies, it is tempting to assign a causal relationship between the two to mean that abnormal laryngeal behaviour in someway precipitates stuttering. However, it is equally possible that the occurrence and practice of stuttering might have resulted in abnormal laryngeal behaviour. If this is true, then stutterers who have been stuttering for a longer time may show greater abnormality in their laryngeal behaviour. Similarly, stutterers who are more severe may show greater abnormality in laryngeal behaviour than the less severe stutterers. Stutterers who show abnormality of laryngeal behaviour even during their fluent speech may present a different meaning to the relationship between stuttering and abnormal laryngeal behaviour.

## Statement Of The Problem

The purpose of this study was to:

a) investigate the laryngeal behaviour, as evident through EGG findings, as a function of the duration of stuttering, and

b) to investigate the laryngeal behaviour as a function of the severity of stuttering.

**Objectives Of The Study**

The objectives of this study were to study whether,

a) the fluent and dysfluent utterances of the same word in stutterers are different on a set of EGG measures,

b) fluent utterances of stutterers are different from those of normal children on a set of EGG parameters,

c) whether the fluent and dysfluent portion of the stuttered words in the speech of stutterers are different on a set of EGG parameters

d) differences in EGG measures, either in the fluent or dysfluent utterances in child stutterers are a function of the number of years for which the children have been stuttering, and

e) whether differences in the EGG variables in the fluent and dysfluent utterances of stutterers are related to the severity of stuttering in these children.

# CHAPTER-2

# REVIEW OF LITERATURE

Stuttering has been explained in many ways ; as a learnt behaviour (Weschner. 1947: Sheehan 1958; Brutten and Shoemaker, 1967; Johnson, 1967); as a form of neurosis (Coriat, 1943; Fletcher, 1943; Barbara, 1954; Glauber, 1958); and as resulting from an organic deficit (Travis, 1931; West, 1958; Eisenson, 1958). However, there is no agreement among workers to as the cause and nature of stuttering.

**Stuttering In Children**

Many studies have been published in the past 80 years, which have reported useful information to differentiate stuttering from normal non fluency. This information has been interpreted by some to mean that stuttering and normal disfluency are probably two points in the same continum (Johnson and Associates, 1959; Yairi & Clifton, 1972; Andrews et al., 1983; Perkins, 1983; Bloodstein, 1987) while others have interpreted them as supporting the opposite view (Adams and Runyaru 1981; Wingate, 1984, 1987).

Wall and Meyers (1981) have discussed three issues critical to childhood stuttering. They are:

1) whether to view early childhood disfluencies as heterogenous or homogenous phenomena.

2) whether the relationship between normal childhood nonfluencies and early stuttering is continuous or dichotomous, and

3) whether normal nonfluencies and stuttering differ quantitatively or qualitatively.

**Distinguishing Normal Nonfluency And Stuttering In Young Children**

Nonfluencies are a feature of the speech of preschool children. Therefore, differentiating childhood stutterers and those who are normally dysfluent is tedious. The features in preschool children tend to be word and phrase repetitions, interjections and revisions. Part -word repetitions and prolongations (sometimes called dysrhythmic phonations). do occur, but are more frequent in stutterers than in young preschoolers. However, this is regarded by some as a dimensional and not a categorical difference (Johnson, 1955; Mann, 1955).

In favour of the dimensional point of view, both Yairi and Clifton (1972) and Westby (1979) have presented profile of the speech disfluencies of highly disfluent children regarded as normal speakers in which the disfluencies are comparable in frequency and nature to those of some stutterers.

Conversly, in favour of stuttering being a category, Bjerkan (1980), and Floyd and Perkins (1974) have found the speech of children regarded as stutterers to be qualitatively and quantitatively distinct from the range of utterances of normal speaking children.

Existing data regarding normal expectations of disfluency in young children must be qualified for various reasons. Many attempts at establishing baselines for nonstuttering children were made prior to the advent of electronic recording technology (Davis, 1939; Metreaux, 1950; Egland, 1955). Some investigators did not study specific age levels (Johnson, 1959; Floyd and Perkins, 1974) whereas others involved disfluency levels for only a single age level (Egland, 1955; Silverman, 1969; 1971; Martin, Haroldson and Kuhl, 1972) and the number of subjects within age groups was frequently inadequate for drawing valid conclusions (Fisher, 1932; Branscom, 1942).

Davis (1939) studied the dysfluencies of stuttering children aged 3-4 years. She found that repetitions of syllables, words and phrases were common in this group.

Vodker (1944) compared the dysfluencies of stutterers and nonstutterers aged 12-19 years. He found that the average speaker had no syllable repetitions, but had less than one word and one phrase repetitions for every 100 words. He indicated that the speech of the stuttering group was typified by syllable and word repetitions and prolongations.

Egland (1976) conducted a similar type of study and compared the speech of nonstuttering kindergarten children with the speech of preschoolers diagnosed as stutterers. Both groups demonstrated part -word repetitions. However, the stutterers showed a high frequency of all dysfluency types, a greater number of repetitive syllables within a repetition, and a higher percentage of sound and syllable repetitions.

Bjerkans (1960) suggested that a "word fragmentation" was the most characteristic feature of stuttering children. He found that word fragmentations were extremely rare in the speech of nonstuttering preschoolers, but occurred significantly in the speech of children regarded as stutterers.

Boehlmer (1958) assessed the ability of trained and naive listeners to distinguish the speech of stutterers from nonstutterers. He found that sound and syllable repetitions were identified as stuttering more frequently than revisions or injections.

The probability of speech being identified as stuttered depends not only on the occurrence of audible prolongations and double unit repetitions, but also on the outright frequency of repetitions or prolongations (Sander, 1961 ;Huffman and Perkins, 1974;Curran and Hood, 1977).

Thus, the question that is to be explored is the relationship between the so called "normal dysfluency" and the more pathological dysfluency of the stutterer. Froschels (1969) suggested that normal dysfluency and stuttering continuum and the latter is simply a more severe and more frequent manifestation of the former. Bloodstein (1969) has also put forward a similar hypothesis wherein he opines that the difference between normal and stuttering nonfJuences in one of a degree than entity.

One major problem in any study of normal dysfluency is its variability, making it difficult to observe scientifically. It is well documented that children between the ages of 3-5 years experience periods of dysfluency which vary, often depending

upon the emotional and linguistic load present in the communicative interaction. However, only a small percentage of these children become stutterers (Wingate, 1976).

Johnson (1967) theorized that at the moment a child is diagnosed as a stutterer, the child's speech showed "little or no difference in type of dysfluency" from children who were not diagnosed.

Both qualitative and quantitative aspects of dysfluency have been reported to influence the identification of stuttering. The perceptual studies of Williams and Kent (1958).Boehmler (1959) and Young (1961) suggest that the type of dysfluency exhibited is a distinguishing factor. On the other hand, Berlin (1960)and Sander (1963) demonstrated the importance of frequency of occurrence of dysfluency.

However, the differential diagnosis of stuttering from normal nonfluency is not at all difficult when the disorder is severe or is in its advanced stages. Diagnostic difficulty arises mainly when the disorder is very mild or is in its early stages of development (VanRiper,1971).

It is possible to reliably indentiiy and differentiate the disfluencies of stutterers from nonstutterers through a careful observation and analysis (Winzate, 1976). According to him, the speech characteristics which distinguished stuttering dysfluency from normal dysfluency were audible and silent "elemental repetitions and prolongations". He stated that appropriateness of the identification of these features as "stuttering" will be enhanced when one also considers frequency of

stuttering, amount of effort, spacing of the repetitions and analysis of what occurred during the interval of a repetition.

Adams (1977) devised a strategy to distinguish normally nonfluent children from incipient stutterers. The following factors seems to be useful in differentiating normally nonfluent children from incipient stutterers:

a) Stutterers were twice as nonfluent as nonstutterers.

b) Stutterers produced 1-5 reiterations of a part- word repetition whereas nonstutterers produced 1-3 reiterations.

c) Stutterers demonstrated an abrupt abnormal cessation of voice or airflow whereas this was not evident in nonstutterers.

d) Stutteres displayed "scheme" intrusion in repetitions whereas nonstutterers do not.

Curlee (1980) provided a series of factors that succintly differentiate stuttering and normal dysfluency. He listed signs of visible struggle, noticeable emotions and/or avoidances by Curlee (1981) to aid in the differentiations were associated with stuttering and self-criticism about speech. Other factors identified were:

1) Marked variations in frequency and severity of stuttering as speech situations vary,

2) Part-word repetitions, or two or more repetitions per unit on 2 percent or more of the words spoken.

3) Prolongations longer than two seconds duration on two percent or more of the words spoken,

4) Noticeable increases in loudness, elevationsin pitch in repetitions and prolongation and abrupt terminations.

5) Involuntary stoppages or hesitations that last longer than two seconds during otherwise continuous speech.

Van Riper (1982) reviewed his earlier formulations on factors differentiating stuttering and normal dysfiuency. He is of the view that items like occurence of more than two repetitions per unit, insertion of the schwa vowel, phonatory arrest, and inappropriate articulatory postures are more helpful in differentiating stuttering from normal nonfluency,. while, factors like monotone, poor eye contact, fast rate of speaking, tension, etc., are less helpful in that they often can occur for a number of reasons not necessarily related to stuttering.

Yairi and Lewis (1984) recommended evaluation of the speech of children as soon as possible after their parents have labeled them as stutterers. They indicated that while all typical dysfluencies were present in the speech of nonstuttering children in fairly equal amounts, the stuttering children tend to show a disproportionately high number of increase in part -word repetitions and "dysrhythmic phonations".

**Measures Of Stuttering**

Quantification of disfluency began at the University of Iowa in late 1930s and early 40s. Most current stuttering measurement systems adhere more or less to the

principles of behavioural psychology, favoring the quantification of overt speech behaviors rather than the emotional or physiological, aspects of the disorder. The method of stuttering measurement tend to rely heavily on the judgements of human observers. Direct observation recording systems cannot function as sources of valid and reliable data because of differences among observers (Cordes, 1994).

The diagnosis, assessment and therapy of stuttering has been plagued by variability in, and disagreement over, what should be regarded as stuttering and how it should be assessed. Wingate (1984) criticized the use of various terms and proposed definitions to & cover fluency, disfluency and dysfluency, the last category generally referring to, or at least encompassing, stuttering. In general, disfluency refers to the nonfluent behaviours in the speech of persons who do not stutter, while dysfluency denotes to those involuntary abnormal nonfluencies associated with stuttering.

Ham (1989) agreed that

> all stutterers have some fluent speech,

> all nonstutterers have some disfluent speech,

> all stutterers have some disfluent speech.,and

> all nonstutterers have some dysfluent speech.

Thus, it is difficult to assess either stutterers or nonstutterers simply by noting the presence or absence of fluent, disfluent or dysfluent speech. Extensive discussion of stuttering behviour and definitions of what to measure and in what areas

(Conture, 1982), speech modes to measure (Culp, 1984), specific severity scales (Riley, 1980), interview form (Ryan, 1974; Gregory and Hill, 1984) and linguistic levels and factors (Stacker, 1980) have been reported.

A basic issue to be resolved is to determine whether given samples of phonographically recorded stuttered speech, selected randomly from a large number of subjects and presented to a group of observers, will be consistently judged to display greater / lesser degrees of severity than certain other samples.

A fundamental requirement in all psychological measurement is a collection or array of clearly identifiable specimens of behaviour which possess some common attributes and which are limited in either time or extent. The measurement of speech or other transitory stimuli is best based on some kind of permanent or semi permanent recor&.Since stuttering is ordinarily seen as well as heard, the view might be taken that in any judgement of severity, the visible aspects of stuttering are as important as the auditory aspects.

The selection of sample length for measures of severity of stuttering is another controversial issue. Some aspects that need to be considered in deciding on the length of speech material to base severity measures are:-

a) The type of stuttering.

b) The number of stuttering manifestations, i.e., the number of moments of stuttering per unit of time, and

c) The degree of difficulty at the moment (Wingate, 1976).

Severity of the audible characteristics of stuttering has been reliably measured by the psychological scaling method of equal appearing intervals. Reliable estimates of severity have been obtained for isolated segments, nine seconds long, from recordings of the speech of stutterers (Lewis and Sherman, 1951).

It was feh that severity could not be reliably measured unless restrictions were placed on the aspects which the observers were asked to make in relation to samples of stuttering.

Success in any attempt to define or to examine the effects of stimulus conditions with which severity of stuttering is functionally related is dependent, in part, upon the degree of reliability of the index of severity employed. Also, a reliable index is needed if questions concerning differences between persons labeled as stutterers and so called normal speakers are to be answered satisfactorily.

Wertheim (1972) proposed a quantitative multidimensional approach to clinical diagnosis and management of stuttering. This approach involved,

a) The measurement of stuttering behaviour under a number of contrieved social conditions relevant to a given population of stutterers,

b) A method of measurement which provides separate quantitative estimates of the qualitative aspects of stuttering pattern,

c) An analysis of the quantitative relationship between the social context and the qualitative pattern of stuttering and its severity, and

d) A diagnostic formulation of stutterogenic situations for a given individual and of the stability and severity of the stuttering pattern across the total range of situations.

Gregory and Hill (1984) and Gregory (1986) have evolved a differential evaluation procedure that involves;

a) Informal observations of the child's speech behaviour and the child's interaction with the parents;

b) A case history covering family history of stuttering, general development and medical factors, speech and language development, environmental conditions and educational progress, and

c) A more formal observation and testing covering speech fluency, parent child interaction, articulation and language skills, motor development and psychological status, the latter done by a clinical psychologist.

**Methods Of Evaluating Severity**

There have been many methods to evaluate the severity of stuttering which can be classified under the following categories:

1) Scales
2) Self-reports
3) Observer's judgements and
4) Numerical formulae.

***Scales***

Two procedures **that** have been used to scale speech, language and hearing variables are direct magnitude estimation methods (Martin, 1965; Zemlin, Daniloff and Shriner, 1968) and interval scaling (Hoops and Curtis, 1971; Platt, Andrews, Young & Quinn, 1980).

Interval scaling requires observers to assign numbers to stimuli that correspond to a linear partition of the continuum whereas direct magnitude estimation requires observers to assign number of stimuli that are proportional to the ratios of stimulus magnitude along the continuum. Both interval scaling (Sherman, 1955) and direct magnitude estimation (Martin, 1965) have been demonstrated to yield reliable measures of listeners perception of stuttering severity.

As a group, scales offer a simple estimate of the severity, but a limited number of increments. The Iowa Scale for Rating Severity of Stuttering (Johnson, Darley and Spriestersbach; 1963; Sherman, 1952) has a range of zero to seven where each level is a composite of several variables. Many of the items on rating scales require judgements of the stutterer's motivation for a given behaviour (Meyer, 1953). The use of such terms as avoidance, anxiety and cancellation implies that the examiner can readily ascertain these motivations.

The Sherman - Lewis scale (Lewis and Sherman, 1951; Sherman, 1955) uses a different approach. Nine tape recorded samples of stuttering are ranked from mild to severe. A taped sample of a given stutterers speech can then be played and matched to these nine criteria of severity. This procedure is complicated and ignores the possible significance of visible manifestations. Visual cues are not very

important in determining frequency (Williams, Wark and Minifie, 1963), but when a more complete clinical description of the severity of individual moments of stuttering is desired, the visual manifestations take on some importance. A stutterer might decrease his observable distracting behaviour and still be matched auditorily to the same level after considerable therapy.

Franken, Bezooizen and Boves (1997) developed and evaluated an instrument for assessing the communicative suitability of speech of people who stutter. Listeners judged the suitability of speech at three stages of treatment (before, immediately-after and 6 months later) and that of people who did not stutter. The listeners rated the suitability of speech, using a 10 point scale, for 10 speaking situations that supposedly make different demands.The listeners were of types: unsophisticated listeners, clinicians specializing in the treatment of stuttering and stuttering listeners. Result indicated that the rating instrument could be scored reliably. Analysis of variance for the ratings of the reference speakers showed that the factor "situation" had a significant effect on the suitability ratings, with more demanding situations receiving lower suitability scores than the less demanding ones. Also, the speech of people who stutter was judged significantly less suitable than the speech of the reference speakers. Furthermore, unsophisticated listeners were considerably less tolerant in their judgments than clinicians and stuttering listeners.

Schiavelti, Sacco, Metz and Silter (1983) reported the appropriateness of direct magnitude estimation and interval scaling in assessing stuttering severity. They determined whether the continuum of the stutterers' judged severity was prothetic or metathetic. As operationally defined by Stevens (1967), prothetic continua show a curvilinear relation between magnitude estimates and interval scale values

of the same set of stimulus whereas metathetic continua show a linear relation between these scale values. The stuttering severity of 20 stutterers was scaled by three groups of fifteen listeners who used both interval scaling and direct magnitude estimation. Further, direct magnitude estimation was done with both and without standard or modulars. The results indicated that the two sets of direct magnitude estimation scale values were related to the interval scale values in the curvilinear fashion that is typical of prothetic continua. These findings suggest that direct magnitude estimation is preferable to interval scaling for measuring stuttering severity.

Listener's ratings of severity of stuttering is a subjective measure giving full play to the judgmental nature of the criteria. However, it is also by far the oldest and the most familiar type of measurement in general use, in the sense that we employ it on every occasion on which we characterize stuttering as "mild", "moderate" or 'severe".

Studies have shown that listeners' ratings are reliable methods for scaling the severity of stuttering of continuous speech, of short samples, and of individual moments (Lewis and Sherman, 1951; Sherman, 1952; Sherman, 1955; Sherman and Trotter; 1956; Sherman and McDermott, 1958).

Several studies have also shown that, by and large, the reliability of the measurers is not critically affected by such factors as the type of scale used, the number of scale points, the definition of scale points, the addition of visual or "line" cues, the number of judges, their sophistication, or the kinds of instructions they receive.

***Numerical Indices Of Stuttering Severity***

The Stuttering Severity Instrument, designed by Riley (1972) for clinical and research use, yields a single numerical representation of severity within a range of 0 to 45. It is designed to improve on previous methods by meeting six criteria:-

1) It must be simple enough to be used by a trained clinician in any reasonable clinical setting, such as community clinic or a public school and should not require a great deal of equipment.

2) It must be as objective as possible. The definition of the moment of stuttering (the block) must be understood and all related behavior must be judged by externally visible or audible components.

3) It must be sensitive enough to register changes in severity which are clinically significant even though the difference is not readily apparent to the untrained observer.

4) The statistical characteristics must be acceptable for clinical and research use. Test/retest, spart / whole, and inter-observer reliability measures are important. Its validity, as measured against other commonly used instruments and clinical judgment, should be reasonably high.

5) Normative data must be available so that a given sample of stuttering can be placed on a standardized severity scale.

6) The test should be usable with both children and adult.

Riley and Riley (1979, 1983) organized assessment procedures in terms of their model of nine components related to the development of stuttering in children. These are:

> Neurologic components - Attending disorders; processing disorders; sentence formulative disorders; oro- motor disorders

> Intrapersonal components - High self-expectation by the child; manipulative behaviour by the child.

> Interpersonal components - Disruptive communicative environment; Unrealistic parental expectations; parental need for the child to stutters.

**Technique Of Electroglottography**

Historically, physicians have relied on two basic techniques in the assessment of laryngeal pathology; listening to the voice and viewing the larynx (with mirror or any other device). While much can be learned by the perceptual evaluation of voice quality, the judgements are often unreliable in a clinical setting. Although careful visual examination is of fundamental importance, indirect laryngoscopy is limited by lack of objective documentation. Normal speed line or video documentation of the laryngoscopic examination allows the examiner to review the movements of the laryngeal structures at a slightly reduced speed, but fine details of vocal fold vibration which are intimately related to voice production are not captured by these techniques (Hanson, Gerralt and Ward, 1983).

Measurements that can be directly related to the pathophysiology of laryngeal behaviour is highly desirable. Since phonatory dysfunction usually manifests itself in abnormal oscillatory movements, the measurement and analysis of the vibratory pattern of the vocal folds has the potential to provide detailed information on the pathophysiology of the vocal folds during phonation.

As a rapid and relatively inexpensive technique to high-speed filming, glottographic techniques have received considerable attention in the study of laryngeal activity. The analysis of glottal waveforms that is waveforms that describe glottal movement during phonation, has potential for measuring vocal fold activity with little discomfort to the subject (Hanson, Gerralt and Ward, 1983).

Three glottographic techniques are commonly used :

1) Inverse filter glottogrphy

2) Photoglottography

3) Electroglottography

Electroglottography (EGG) is a technique employed to investigate the motion of the vocal cords. It makes use of motion induced variations of the electrical impedance between two electrodes placed on the larynx. This variation of impedance is detected as an amplitude and/or phase change of a high frequency voltage over the two electrodes (Lecluse, Brocaar, and Verschure, 1975).

**Speech And Electroglottography**

The EGG data has been used to predict of glottal closure from just the speech waveform. The EGG signal nearly always coincides with the zero crossing of the speech waveform that just precedes the largest postitive peak in the speech waveform or with the largest negative peak in the speech waveform. The maximum glottal opening occurs within the vicinity of the second positive peak in the speech waveform. This is true whether the subject is a normal male or female. The break (if one is present) in the negative slope of the EGG waveform coincides closely with the negative peak in the speech waveform which occurs just prior to the largest positive peak. The maximum speech excitation occurs very near to the glottal closure but only partially. These observations are dependent upon the sound produced.

Though the current versions of the EGG are limited in terms of "Fine-grained"' analysis as cycle to cycle changes in absolute glottal area, the EGG appears to be a relatively sensitive index of onset and offset of vocal fold vibration (Baer et al, 1983; Childers et al., 1983; Gilbert, Potter and Hoodin, 1984). With appropriate filtering (Ng and Rothenerg, 1982) as well as adjective circuitry, the EGG can be used to indicate cycle-to-cycle changes in relation to the degree of glottal opening (Conture,Rothenberg and Molitor, 1986).

Experimenters will be able to quantitatively document the physiological correlates of the EGG slowly varying, low frequency aspects in order to make statements about various laryngeal articulatory judgements, bringing vocal folds into midline

in preparation for voicing already. Some preliminary attempts have been made to use the EGG this way (Baken, McManus and Cavallo, 1985).

Baken, McManus and Cavallo (1985) strongly suggest that EGG is suitable for studying young stutterers' laryngeal behaviour. The EGG senses the variation in transverse electrical impedance created by vocal fold vibratioa It can be used to measure onset and offset of vocal fold vibration, the fundamental frequency of vocal fold vibration and certain aspects of the laryngeal waveform in particular, the waveform associated with vocal fold contact area.

Abnormal EGG has been considered in five different ways :

1) Pitch characteristics too low or too high (Kitzing, 1979).

2) Vibration irregularity (jitter) demonstrated by Fo histograms (Kitzing, 1979;Fourcin, 1981)

3) Special features of the signal in the case of diplophonia (Dejonekere and Letraeq, 1983).

4) Qualitative description of the modified waveform (Van Michel, 1967: Wechsler, 1977;Fourcin, 1981).

5) Spectral analysis of the waveform (Kelman, 1981).

**Electroglottographic Findings In Stutterers**

Over the years, many physiological studies have suggested that there is a close relation between problems in the co-ordination of respiratory, phonatory and

articulatory processes and dysfluencies in speech production. The production of fluent speech requires a precise coordination of these systems (Van Riper, 1982; Adams, 1974; Wingate, 1976; Agnello, 1975). This has been substantiated by the work of conture (1977), Freeman (1979), Shapiro (1980) and Yoshioka and Lofqvist (1981) who reported substantial differences in laryngeal activity between stutterers and nonstutterers when producing auditorily fluent utterances.

Bakker and Brutten (1980) studied the laryngeal reaction time for stutterers using ECG measures. They studied 24 male adult stutterers and age and gender matched non stutterers. The subjects were instructed to respond by saying /a/ as quickly as possible, when a visual, nonauditory or somatosensory stimulus event was presented. The laryngeal reaction time (time between stimulus onset and the first vertical line of oscillation in the EGG signal that indicated vocal fold vibration), laryngeal premotor time (time between the onset of the stimulus event and the onset of low frequency EGG changes that preceded voice initiation) and laryngeal adjustment time (time during which prephonatory laryngeal adjustments for voice initiation were being made) were measured. The results indicated that in all the three measurements done, the stutterers were slower than the nonstutterers in each of the stimulus conditions.

Yoshioka and Lofquist (1981) studied the laryngeal involvement in stuttering using a reaction time paradigm. The subject, a college age male, diagnosed as moderate stutterer, was asked to say several CV and CVC words as well as few words beginning with a vowel or a liquid. They used the photoelectric glottographic

signals, sensed by a phototransistor placed on the throat just below the lower edge of the cricoid cartilage. The results can be summarised as below :

- The first two oral releases were improperly timed with respect to the glottal movements.
- Unnecessary opening gestures of the glottis well before the initial voiced sound production was found.
- The onset of frication noise for the initial voiceless fricative almost coincided with the second peak of the two opening gestures. This was seldom found in normal subjects. This was explained on due to insufficient supply of air from the respiratory system to generate audible friction noise.
- Long delay between the glottal closure and the acoustic output for the fluent /ei/ production. This long latency may again be related to the timing discordance between laryngeal and respiratory events.
- The glottogram also revealed a sort of paradoxical opening gesture prior to the vocalization for the initial vowel segment. It was emphasized that such apparently abnormal movements can occur, even when they are not directly related to the perceptual judgement.

Thus, they concluded that stuttering may be linked to a temporal disruption of the control of adductory and abductory gestures of the glottis, particularly in relation to supraglottal articulation and respiratory function in speech. It is suggested that

even perceptually fluent utterances by the stutterer can be associated with underlying abnormal physiology.

Weiner (1984) studied adult stutterers by analyzing 114 tokens of stuttering for patterns of vocal fold vibration as observed in eight types of stuttering. Results suggested that stuttering events shared certain phonational attributes, such as,

- Absence of major perturbations surrounding phonation,
- Perturbations persisting in ways that suggest that the subject persistently "overshoots the mark" until the open or close gestures are abruptly released,
- Failure to initiate vocal fold observation during a series of almost regularly timed attempts to open the glottis,
- Indications of the possibility of tremor of the vocal folds,
- Irregularity in voicing, and
- Absence of sharp peaks in the impedance signal during the block suggesting relatively little movement of the vocal folds.

Valsalva (1985) indicated that several laryngeal, aerodynamic and articulatory abnormalities occuring during nonfluency might be because of the abnormal functioning of speech musculature, abnormal neural impulses to the speech musculature or abnormally functioning higher speech centres.

Borden, Baer and Kenney (1985) analyzed EGG and acoustic waveforms obtained at the onset of voicing in stutterers and nonstutterers during a postblock adaptation task. Substantial EGG differences pertaining to onset of voicing during stuttering, and early fluent postblock adaptations were documented.

Conture, Rothenberg, and Molitor (1986) compared the laryngeal behaviour associated with the perceptually fluent speech of young stutterers with that of their normally fluent peers. Laryngeal behaviour during fluent productions of the initial and final consonants and medial vowels in each of the four CVC words (pete, bake, face and veal) was observed by means of an EGG. The recorded signal was electrically processed to obtain a measure of vocal fold abduction from the "open quotient" (glottal open time divided by glottal period) during consonant - vowel (CV) vowel - consonant (VC) transitions and the central portion of the voweL The normally fluent children exhibited significantly more typical patterns (during the vowel, the abduction measure trace was either roughly parallel to the time axis or sloping smoothly in one direction.) during the CV/VC transitions than did the stuttering youngsters, with 72% of the total transition samples from normally fluent youngsters being typical as against 42% for the young stutterers.

These findings suggested that some young stutterers tended to have difficulty stabilizing and controlling laryngeal gestures even during speech judged fluent by trained listeners, particularly at those points in the utterance where these youngsters must move between sound segments.

Newman, Harris and Hilton (1989) compared the jitter and shimmer measures of 14 stutterers (age range: 12 to 46 years) with age and gender matched

nonstutterers. The subjects were asked to sustain the vowels, 'ae', 'u' and 'a' for approximately 5 seconds. Jitter and shimmer measures were recorded through a miniature accelerometer. The results showed a significant difference between nonstutterers, and stutterers on measures of shimmer, but the results were statistically not significant on jitter. Mean jitter and shimmer of stutterers were larger than those of nonstutterers thereby indicating that the sustained phonations of the stutterers were less stable than those of nonstutterers in terms of both vocal frequency and intensity. They concluded that steady state phonation of stutterers are different from those of nonstutterers.

Debrowski and Watson (1991) used a single - subject experimental design to investigate the feasibility of noninvasive laboratory instrumentation for examining speech physiology. The speech task analyzed from the adult subject consisted of a reading of a 30-syllable (all-voiced) passage, a reading of a combined 30 syllable passage, a single sentence picture description beginning with a prescribed vowel (in an initial carrier phrase) and a single sentence picture description without any prescribed carrier phrase.

The measures that were extracted from the EGG signal included the number of EGG irregularities (defined as visually evident variations of continuity, periodicity, amplitude and waveform shape of the periodic EGG waveform at the onset or during the course of voiced segments, or at phonetic transition points).

MoIt (1991) explored temporal characteristics of both stuttered and fluent utterances of young stuttering children and fluent utterances of nonstuttering children. Subjects consisted of 5 male nonstuttering children (mean age 5.9 years)

and 5 age-matched male nonstuttering children (mean age : 5.4 years). The measures included electrographic and spectrographic evaluations. The speech sample consisted of the voiceless bilabial stop consonant /p/ followed by a vowel and either a voiceless fricative or a nasal consonant (example, "pass", "pan",) produced within the carrier phrase "say————again" and also within a short meaningful phrase. The results showed no statistically significant differences between the groups either in the abruptness or gradualness of the vocal fold contact.

Watson and Debrowski (1991) analyzed EGG signals of an adult stutterer. They showed the acoustic and EGG signals during the transition form the word "sitting" to the word "'on". The EGG signal revealed discontinuities in the amplitude and periodicity of vocal fold vibration at the transition from /i/ to /a/. Thus, it can be concluded that EGG signals permitted identification of specific physiologic disruption associated with the elements of dysfluencies.

Packman, Onslow and VanDoorn (1994) studied the acoustic and EGG duration measures of stutterers during fluency-inducing prolonged speech conditions. The subjects were 4 young adult male stutterers (age range: 18 to 32 years) who were made to speak in continuous monologue for 5 minutes. The results indicated reductions in stuttering in all subjects to be associated with changes in the duration and distribution of acoustic and EGG segments.

**Need For The Study**

It has been shown by many that EGG can be an effective technique for studying the laryngeal parameters in stutterers, and that it can reliably identify certain of these vocal cord behaviours which are different between stutterers and nonstutterers. The fact that it is a noninvasive technique has particularly enhanced its utility with young stutterers. However, many of the studies in this area have not considered controlling their subjects for severity of stuttering as well as the duration for which they have been stuttering. If aberrant vocal cord behaviour is associated with the moment of stuttering, then a stutterer who has been stuttering for longer years can be expected to show different vocal cord behaviour for the simple reason that as he is nonstuttered for a longer duration, he might have developed certain yet unidentified compensatory actions. The questions of interest are two :

a) Could a group of stutterers who have been stuttering, say for 5 years, show a different kind of vocal cord behaviour, during the moment of stuttering, than a young stutterer whose onset of the problem was 3 years back?

b) Could a group of stutterers who are considered severe stutterers, whatever the subjectivity of the rating, show a different vocal cord behaviour than a group of stutterers who are considered to be mild?

Also, vocal cord vibratory behaviour during fluent and disfluent production of the same phonetic sequence may give valuable information in understanding the moment of stuttering per se.

Therefore, the purpose of this study was to investigate the vocal cord vibratory behaviour in two groups of stutterers who have been controlled for years of stuttering as well as severity and compare them with a group of normal children.

# CHAPTER-3

# METHODOLOGY

The purpose of the study was to study the laryngeal behavior, through electroglottography,as a function of the duration and severity of stuttering.

**Subjects**

A group of 9 male children diagnosed as stutterers by an experienced speech pathologist, in the age group of 6 to 12 years (mean age 9.1 years), served as subjects in the study. Another group of 9 male children , also in the range of 6 to 12 years (mean age 10.2 years), who had no history of any fluency disorder participated in the study.

All subjects, both within and between the groups, were matched for medical, social, and linguistic history as well as socio-economic status. All subjects were studying in schools, came from low or middle socio-economic strata of the society, spoke Kannada as primary language, but were exposed to English in their schooL Children studying in higher standards were obviously exposed to English to a greater extent than children in the lower standards. Thus the two groups of children were comparable to each other. Details of children selected for the stutterers group are given in Table 1.

**Tablel:ChiIdren selected for the stutterers group**

| SI. No. | Age/Sex | Severity of Stuttering | Type of Blocks |
|---|---|---|---|
| 1. | 6 Yr. lmth/M | Moderate | Syllable repetition, inaudible pause, prolongations, audible inspirations. |
| 2. | 7 Yr. 6 mth/M | Mild | Sound/syllable repetition, audible pause, prolongations. |
| 3. | 7 Yr. 6 mth/M | Mild | Sound/syllable repetition, audible pause. |
| 4. | 8 Yr. 4 mth/M | Moderate | Sound/syllable repetition, part word repetition, audible pause. |
| 5. | 9 Yr. 3 mth/M | Mild | Syllable repetition, rapid air intake, part word repetition, audible pause. |
| 6. | 9 Yr. 6 mth/M | Moderate | Syllable repetitions, articulatory fixations, rapid air inspiration, break in transition, prolongatioa |
| 7. | 12 Yr./M | Moderate | Syllable repetition prolongations |
| 8. | 11 Yr. 6 mth/M | Mild | Prolongations, audible inspirations |
| 9. | 11 Yr.9 mth/M | Moderate | Syllable and word repetition, prolongation, audible pause. |

***Inclusion and Exclusion Criteria***

Only those subjects,

> whose intelligence was in the normal range,

> who had no history of any other speech and hearing problem such as hearing loss, delayed speech and language, misarticulation, etc.,

> who were native speakers of Kannada, and

> who had not received any kind of therapy for their stuttering were selected material

Three types of speech samples were recorded from all the subjects. They were:

(i) **Phonation of vowel**

Phonation of/a/ in isolation

**(ii) Sequences of CVCV syllable**

Three words with vowel /a/ in three phonetic environments, such as 'pata', 'tata' and 'kata'. The first consonant in the CVCV sequence was a stop consonant, either a bilabial, retroflex or a velar. All electroglottographic (EGG) analysis was made on the vowel of the first CV of the CVCV sequence in which the second consonant was always a retroflex stop.

**(iii) Spontaneous Speech**

Picturised chart of the story 'The Thirsty Crow" was used to elicit spontaneous story description. Contents of spontaneous speech was ensured to be uniform by this. This is a familiar fable of which the majority of children of this region are aware of.

**Procedure**

The subjects were tested individually. They were asked to be seated comfortably on a chair with hand and head rest in a sound treated room. They were instructed to:

(i) phonate /a/ at their natural and comfortable loudness and pitch levels. Each sample was recorded for a duration of at least 5 seconds ,

(ii) repeat the sentence spoken by the experimenter, at an interval of 10 seconds, and

(iii) narrate the story following picture sequences of the story . They were shown a sequence of the 6 pictures and encouraged to tell the story. No trials were given to the children. However, a preparation time of 2 minutes was allowed for each child to tell the story.

A two channel recording was made of speech (Microphone Alcom Aud 80) and glottal pulses through electrodes (kay Elemetrics). Microphone was held around 8 centimeters from the mouth. The electrodes were placed on the sides of thyroid

cartilage. Quality EGG recording was ensured by preliminary trials in which we looked for quasi amplitude recordings. All recordings were made on to a Pentium-Ill, through the sound blaster card .

*Identification of stuttering*

Spontaneous speech samples were transcribed by the experimenter with no markings to indicate the presence of stuttering. Later, a speech pathologist listened to all the samples, identified all instances of stuttering and marked them on the transcribed material. As many listenings were allowed as required until the speech pathologist was sure that all stutterings have been identified. Stuttering was defined, following Wingate (1964), as any audible or silent, repetition of a sound or syllable, or any audible or silent prolongation of a sound, or any part-wood repetition, or any interjection, or a word repetition. However, while analyzing the words for EGG parameters, only audible repetitions or prolongation of a sound was considered.

*Judgement of severity*

A group of three speech pathologist aiong with the experimenter,listened to all the audio -recordings of spontaneous speech and categorized the children into according to the severity of stuttering ,mild ,moderate or severe. No criteria were given to the judges for judging the severity ,but ,ass the speech pathologist remarked later ,it appeared that they based their decisions of severity ,primarily on the frequency of occurrence of stuttering instances and the struggle or tension

exhibited by children Judges were to give only one category of severity for each child on which they all agreed .

Later, the reliability of the speech pathologist's judgement of stuttering instances was established by asking a second Speech Pathologist to judge percentage of the stuttering of each subject and then computing a Product Moment correlation (0.92).

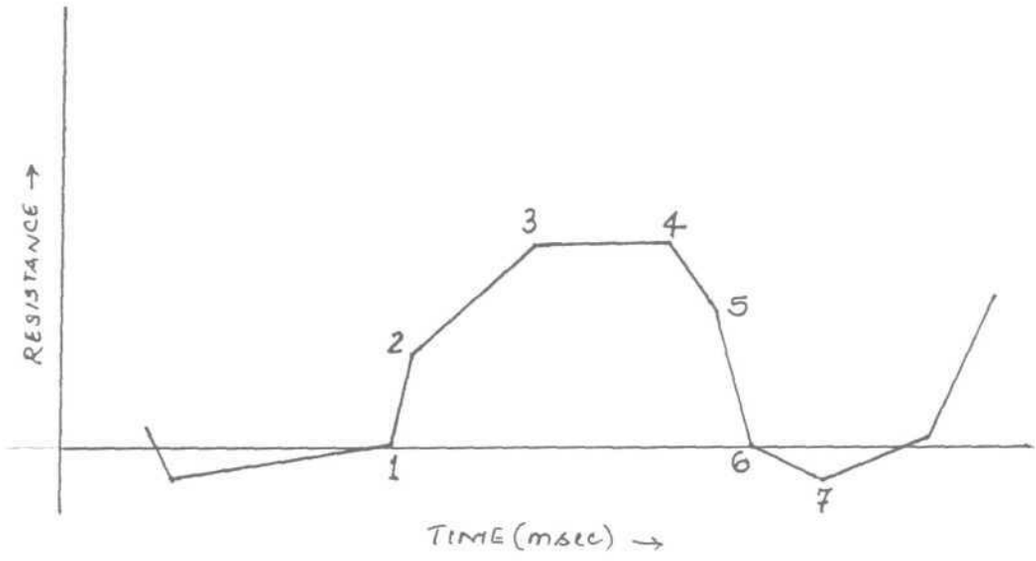
**Principle of Measurement**

A radio frequency (rf) signal (about 1 Mega Hz) is applied across the throat through an electrode. The amplitude of the rf current depends on the electrical resistance of the path from the transmitter electrode to the path from the transmitter electrode to the receiver electrode. As the vocal folds vibrate the air gap (glottal area )changes .When the vocal folds are in contact .the resistance is determined by the vocal fold contact area of the tissues. When the vocal folds are open ,then the resistance is determined by both the tissues and the air gap. As the vocal folds vibrate the rf current is modulated. The modulating signal is recorded as EGG. All EGG measures were obtained on EGG (Kay Elemetrics) with gold plated electrodes.

***Parameters** Measured:*

The important duration and the points at which they are measured on a laryngeal (Lx) waveform are shown in the figure (1).

Figure-1 GLOTTAL WAVEFORM.




- Point 1 corresponds to the point of initial contact of the vocal folds before closure. Point 2 corresponds to the maximum amplitudes in the derivative.

- Interval 2-3 corresponds to the vertical phase movement resulting in the increasing of vocal fold contact area.

- Interval 3-4 is the close phase. During this , the folds are abutting and the inertial force of collision is being absorbed by the tissues.

- Interval 4-5 represents the opening phase of the vertical phase movement but still ,there is no flow of air .However, due to separation of the folds, the resistance is increasing and the current is decreasing.

- Interval 5-6 represents the actual separation of the vocal folds and between 6 and 7, the folds are maximally separated. At point 7, the current is minimum and hence folds are maximally separated.

- Between 7 and 1 the folds are approximating. Thus, EGG represents changes in tissue contact more faithfully compared to changes in air gap.

The parameters for EGG waveform analysis were as follows:

> Opening time - Interval between 5 and 7 (vocal folds moving away from each other).

> Open time - Interval between point 7 (maximum value in EGG maximum separation of vocal folds) and point of initial contact (1) for the next cycle.

> Closing time - from the instant of initial contact to cessation of flow (closing of the glottis) - Interval between 1 and 3.

> Close time - Interval between 3 and 4.

> Open phase - Duration for which there is an airflow - glottis is open. Interval between 5 and 1 of the next cycle.

> Close phase - Interval between 3 and 4 vocal folds pressing against each other.

$$\text{Open quotient} = \frac{\text{Open phase}}{\text{Total Period}}$$

$$\text{Speed Quotation} = \frac{\text{Opening Time}}{\text{Closing time}}$$

**Analyses**

Three types of materials were analyzed. They are:

1) Phonation of vowel /a/ in iso lation

2) The vowel portion of CVCV sequences in which the first consonant was a stop (bilabial, retroflex or velar) while the second consonant was a retroflex stop.

3) Spontaneous Speech: From the spontaneous speech ,only those words which were both stuttered and produced normally by all the subjects were considered. For example, a word like 'ni:ru' was stuttered by all the subjects, and all the subjects had produced this word without stuttering at some other point in their spontaneous speech. Thus, this word was selected for analysis as it facilitates comparison. Similarly, a word like 'mele' was stuttered by stutterers , but we could not find a normal production of this word in their speech . Therefore, this word was not selected for analysis.

The following comparisons were made:

(a) The EGG parameters selected were analysed in the production of vowel /a/' and were compared between,

(i) stutterers and non-stutterers, as a group

(ii) stutterers who had stuttered for more than 4.5 years and stutterers who had stuttered for less than 4.5 years.

(iii) stutterers who were judged to be mild and stutterers who were judged to show moderate degree of stuttering.

(b) The vowel portion of CVCV sequences was subjected to EGG analysis and comparisons made as in (a) above.

(c) Spontaneous Speech

(i) words stuttered by stutterers and the same word in the speech of nonstutterers were compared for EGG parameters on the vowel portion,

(ii) dysfiuent and the fluent production of the same word in the spontaneous speech of stutterers, and

(iii) dysfiuent and the fluent portion of the stuttered word. For example, when the word /ni:ru/ was stuttered like ni:(l), ni: (2) ru, both the dysfiuent production 'ni:(I) and the fluent production /ni:ru/ (underlined portion) was analysed and compared for EGG parameters.

Tnese comparisons (i. ii & iii), under spontaneous speech were also made between different groups of stuttering children as given in (a),

Appropriate statistics, basically t-test for significance of difference of means at the 5% confidence level were computed.

# CHAPTER-4

# RESULTS

The results will be presented in three separate sections, one dealing with the sample on phonation of vowel /a/ in isolation, a second, the CV part of the CVCV words, and the last results from spontaneous speech. On EGG analyses, the following measurements were obtained for all types of speech material, (a) Open time, (b) Opening time, (c) Open phase, (d) Close time, (e) Closing time, (f) Close phase, (g) Open quotient and (h) Speed quotient.

**Analysis of Obtained Samples**

Three types analysis were done on the obtained samples. They are:

(a) Comparison of nonstutterers and stutterers

(b) Comparison between stutterers who were judged to have mild or moderate degree of stuttering.

(c) Comparison between stutterers who stuttered for less than, and more than 4.5 years.

I. Analysis of Phonation of/a/ In Isolation

The EGG findings for all the 18 subjects (9 nonstutterers and 9 stutterers) were obtained. The unweighted mean, standard deviation and results of significance of difference between means are shown in Table 2.

**Table 2: Mean, Standard deviation (SD) and the t-test results for the significance of difference of means between nonstutterers and stutterers on phonation of /a/.**

| | Nonstutterers | | Stutterers | | | |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | t | P |
| Open time | 1.03 | 0.29 | 0.84 | 0.41 | 1.14 | 0.27 |
| Opening time | 0.95 | 0.35 | 0.75 | 0.44 | 1.01 | 0.32 |
| Open phase | 1.36 | 0.27 | 1.34 | 0.49 | 0.09 | 0.92 |
| Close time | 0.73 | 0.27 | 0.56 | 0.37 | 1.11 | 0.28 |
| Closing time | 0.5 | 0.2 | 0.69 | 0.22 | 1.6 | 0.12 |
| Close phase | 1.26 | 0.33 | 1.12 | 0.5 | 0.67 | 0.57 |
| Open quotient | 0.61 | 0.33 | 1.12 | 0.5 | 0.67 | 0.51 |
| Speed quotient | 1.69 | 0.41 | 1.42 | 0.75 | 2.67 | 0.07 |

**Table 3: Mean, Standard deviation and t-test results for the significance of difference of means between mild and moderate stutterers on phonation of /a/.**

| | Mild Stutterers N=4 | | Moderate Stutterers N = 5 | | | |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | t | **P** |
| Open time | 0.82 | 0.52 | 0.86 | 0.37 | 0.12 | 0.9 |
| Opening time | 0.95 | 0.45 | 0.67 | 0.42 | 1.17 | 0.27 |
| Open phase | 1.5 | 0.62 | 1.15 | 0.29 | 1.36 | 0.21 |
| Close time | 0.59 | 0.41 | 0.54 | 0.38 | 0.19 | 0.85 |
| Closing time | 0.66 | 0.16 | 0.71 | 0.27 | 0.31 | 0.76 |
| Close phase | 0.79 | 0.24 | 1.39 | 0.52 | 1.6 | 0.47 |
| Open quotient | 0.36 | 0.11 | 0.57 | 0.19 | 1.66 | 0.14 |
| Speed quotient | 1.27 | 0.94 | 1.53 | 0.64 | 0.48 | 0.68 |

**Table 4: Mean, Standard deviation and t-test results for the significance of t-test results for the significance of difference of means between stutterers less than and more than 4.5 years of stuttering on phonation** /a/

| | Duration less than 4.5 years (N=4) | | Duration more than 4.5 years( N=5) | | | |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | t | P |
| Open time | 1.02 | 0.53 | 0.7 | 0.28 | 1.13 | 0.9 |
| Opening time | 0.91 | 0.43 | 0.63 | 0.46 | 0.92 | 0.38 |
| Open phase | 1.5 | 0.62 | 1.19 | 0.35 | 1.07 | 0.31 |
| Close time | 0.7 | 0.47 | 0.45 | 0.26 | 1.06 | 0.33 |
| Closing time | **0.64** | 0.2 | 0.72 | 0.25 | 0.54 | 0.6 |
| Close phase | 1.39 | 0.26 | 0.88 | 0.45 | 1.89 | 0.08 |
| Open quotient | 0.48 | 0.56 | 0.53 | 0.22 | 0.48 | 0.64 |
| Speed quotient | 1.53 | 0.66 | 1.58 | 0.75 | 1.48 | 0.18 |

The results showed that none of the EGG parameters compared here were statistically different between stuttering and nonstuttering children (P=>0.05). In general, the nonstuttering children had longer measurements than stuttering children, but the difference was not statistically significant (Table 2).

A similar analysis between stutterers who were judged to have mild or moderate degree of stuttering (Table 3) and between stutterers who stuttered for less than 4.5 years or more than 4.5 years (Table 4) also did not reveal any statistically significant difference in means between the respective groups. However, the results will have to be interpreted with caution because of the small sample size (mild = 4; moderate = 5; < 4.5 years of stuttering = 4; > 4.5 years of stuttering = 5),

*II. Analyses of CVCV Word*

Three words 'pata','tata' and 'kata', embedded in a carrier phrase were recorded and EGG analysis was done for the initial CV portion of these words. In the EGG signal, only the first 5 waveforms were considered for analysis. The measurements on all the three words were combined to yield a single set of scores .

EGG findings for ail the 18 subjects (9 normals and 9 stutterers) were obtained. The unweighted mean, standard deviation and result of significance of difference between means are shown in the Table 5, 6 and 7.

**Table 5 : Mean, Standard deviation and t-test results for the significance of difference of means between stutterers and non stutterers for 'pata\ 'tata' and 'kata' (Vowel nucleus of the first syllable).**

| | Non stutterers (N=9) | | Stutterers (N=9) | | T | Sig. (2 tailed) |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | | |
| Opentime | 1.06 | 0.54 | 0.54 | 0.22 | 6.28 | *0.000 |
| Opening time | 1.05 | 0.4 | 1.02 | 0.45 | 0.23 | 0.81 |
| Open phase | 1.13 | 0.37 | 1.03 | 0.36 | 1.05 | *029* |
| Close time | 0.74 | 0.34 | 0.45 | 0.37 | 2.88 | *0.006 |
| Closing time | 0.89 | 0.33 | 0.67 | 0.34 | 1.93 | *0.05 |
| Close phase | 1.2 | 0.42 | 1.19 | 0.47 | 0.12 | 0.9 |
| Open quotient | 0.85 | 0.22 | 0.71 | 0.54 | 1.3 | 0.17 |
| Speed quotient | 1.97 | 1.13 | 1.17 | 0.9 | 4.65 | *0.000 |

**Table 6 : Mean, Standard deviation and t-test results for the significance of difference of means between mild and moderate stutterers: data on cvcv syllables.**

| | Mild stutterers (N=4) | | Moderate stutterers (N=5) | | T | Sift (2 tailed) |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | | |
| Opentime | 0.84 | 0.32 | 0.76 | 0.47 | 0.66 | 0.51 |
| Opening ti me | 0.95 | 0.45 | 1.14 | 0.36 | 1.65 | 0.1 |
| Open phase | 1.14 | 0.34 | 1.62 | 0.4 | 1.17 | 0.24 |
| Close time | 0.62 | 0.4 | 0.56 | 0.35 | 0.54 | 0.59 |
| Closing time | 0.58 | 0.4 | 0.58 | 0.27 | 0.02 | 0.97 |
| Close phase | 1.26 | 0.43 | 1.12 | 0.45 | 1.16 | 0.24 |
| Open quotient | 0.71 | 0.49 | 0.54 | 0.36 | 1.52 | 0.13 |
| Speed quotient | 1.92 | 1.1 | 1.14 | 1.33 | 0.65 | 0.51 |

**Table 7 : Mean, Standard deviation and t-test results for the significance of difference of means between the stutterers who stuttered for less than or more than 4.5 years of stuttering: data on cvcv syllables.**

| | Less than 4.5 years (N=4) | | More than 4.5 years (N=5) | | $T_1$ | Sig. (2 tailed) |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | | |
| Opentime | 0.56 | 0.35 | 0.73 | 0.44 | 1.12 | 0.26 |
| Opening time | 0.98 | 0.47 | 1.1 | 0.35 | 1.03 | 0.3 |
| Open phase | 1.14 | 0.32 | 1.00 | 0.42 | 1.38 | 0.17 |
| Close time | 0,6 | 0.34 | 0.59 | 0.42 | 0.09 | 0.9 |
| Closing time | 0.63 | 0.39 | 0.52 | 0.27 | 1.15 | 0.25 |
| Close phase | 1.3 | 0.44 | 1.06 | 0.42 | 1.99 | 0.05 |
| Open quotient | 0.68 | 0.5 | 0.56 | 0.28 | 0.99 | 0.32 |
| Speed quotient | 1.8 | 1.06 | 1.75 | 1.21 | 0.97 | 0.22 |

As can be seen from Table 5, open time, close time and speed quotient were significantly different between stuttering and nonstuttering children. The duration of all EGG parameters were, in feet longer in the case of nonstutterers compared to stutterers, but the difference in means was statistically not significant.

Within-stutterers, there was no difference between stutterers who were judged as mild or moderate (Table 6) or between stutterers who stuttered for a duration of less than or more than 4.5 years (Table 7).

*III. Analysis of Spontaneous Speech*

Data from spontaneous speech was analyzed for the following comparisons:

a) Stuttered words in the speech of stutterers were compared with the same words fluently produced by the nonstuttering children.

b) Stuttered words in the speech of stutterers were compared with the same words fluently produced by the stuttering childrea

c) Stuttered and fluent portions of the words which were stuttered by the stutterers in their speech. For example, in the stuttering'ni: ni:ru, the dysfluent 'ni:(first) and the fluent "ni:(Second) were compared for EGG waveform.

Comparisons (a) and (b) above restricted the sample of spontaneous speech analysed to just 9 words. If a word was stuttered by the stutterers and if fluent productions of the same word could not be found either in the speech of stutterers or nonstutterers, then such stuttered words were not considered for analysis. Obviously, the CV portion of the word ( more than 80% of the syllables in Kannada are CV syllables, Jayaram, 1985). These 9 words stuttered had short vowel ^ as in "bur", long vowel ɔ as in "father", long vowel 'i:' as in "pete" and short vowel' u' as in "book".

### *a)* Comparison of Stuttering and Nonstuttering Children

A comparison of the stuttered words by stutterers (as a group) and fluent production of the same words by the nonstuttering children was made for all the EGG parameters. The results of the significance test (t-scores) for difference in mean are given in Table 8 (for short vowel A ), in Table 9 (for long vowel ^ ) , in Table 10 (for long vowel i:), and in Table 11 (for short vowel u).

**Table 8: Mean, Standard deviation and t-test results for the significance of difference of means between the fluent production of nonstutterers and dysfluent utterance of stutterers for the vowel ^ (spontaneous speech).**

| | Stutterers' dysfluent | | Nonstutterers' fluent | | | |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | **SD** | t | P |
| Open time | 0.57 | 0.18 | 0.83 | 0.45 | 1.61 | 0.12 |
| Opening time | 0.76 | 0.24 | 1.16 | 0.35 | 2.09 | 0.07 |
| Open phase | 0.96 | 0.38 | 1.32 | 0.37 | 1.67 | 0.13 |
| Close time | 0.33 | 0.26 | 0.65 | 0.31 | 1.73 | 1.22 |
| Closing time | 0.62 | 0.32 | 0.64 | 0.23 | 0.12 | 0.9 |
| Close phase | 1.34 | 0.58 | 1.41 | 0.1 | 0.27 | 0.79 |
| Open quotient | 0.35 | 0.4 | 0.55 | 0.11 | 3.15 | 0.01* |
| Speed quotient | 1.23 | 0.22 | 1.82 | 0.93 | 1.37 | 0.20 |

**Table 9: Mean, Standard deviation and t-test results for the significance of of difference of means between the fluent production of nonstutterers and dysfluent utterance stutterers for the vowel 3 (spontaneous speech).**

| | Stutterers' dysfluent | | Nonstutterers' fluent | | | |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | **t** | P |
| Open time | 0.55 | 0.25 | 0.93 | 0.4 | 1.77 | 0.11 |
| Opening time | 0.77 | 0.32 | 1.18 | 0.32 | 2.6 | 0.018* |
| Open phase | 0.99 | 0.43 | 1.26 | 0.34 | 1.33 | 0.203 |
| Close time | 0.56 | 0.3 | 0.59 | 0.41 | 0.07 | 0.94 |
| Closing time | 0.59 | 0.16 | 0.81 | 0.46 | 1.08 | 0.29 |
| Close phase | 1.08 | 0.56 | 1.64 | 0.46 | 2.11 | 0.05* |
| Open quotient | 0.48 | 0.15 | 0.94 | 0.47 | 2.24 | 0.043* |
| Speed quotient | 1.23 | 0.85 | 1.25 | 0.7 | 2.35 | 0.035* |

**Table 10: Mean, Standard deviation and t-test results for the significance of of difference of means between the fluent production of nonstutterers and dysfluent utterance of stutterers for the vowel i: (spontaneous speech).**

| | Stutterers' dysfluent | | Nonstutterers' fluent | | | |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | **SD** | **t** | **P** |
| Open time | 0.48 | 0.28 | 0.84 | 0.4 | **1.6** | **0.14** |
| Opening time | 1.07 | 0.54 | **1.2** | **0.54** | 2.2 | **0.67** |
| Open phase | 0.37 | 0.2 | 0.72 | 0.21 | **0.8** | 0.41 |
| Close time | 0.37 | 0.25 | 0.45 | 0.11 | 0.4 | 0.7 |
| Closing time | 0.65 | 0.36 | 0.78 | **0.14** | **0.46** | **0.6** |
| Close phase | 1.13 | 0.6 | 1.6 | 0.27 | 1.01 | 0.35 |
| Open quotient | 0.88 | 0.92 | 0.92 | 0.07 | **0.65** | 0.53 |
| Speed quotient | 1.25 | 0.53 | 1.41 | 0.31 | **0.32** | 0.75 |

**Table 11: Mean, Standard deviation and t-test results for the significance of difference of means between the fluent production of nonstutterers and dysfluent utterance of stutterers for the vowel u (spontaneous speech).**

| Parameters | Stutterers' dysfluent | | Nonstutterers' fluent | | | |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | t | P |
| Open time | 0.83 | 0.64 | 0.62 | 0.25 | 0.79 | 0.44 |
| Opening time | 0.77 | 0.34 | 0.9 | 0.46 | 0.4 | 0.69 |
| Open phase | 1.31 | 0.39 | 1.3 | 0.22 | 0.1 | 0.92 |
| Close time | 0.3 | 0.32 | 0.59 | 0.3 | 1.6 | 0.13 |
| Closing time | 0.58 | 0.35 | 0.54 | 0.7 | 0.29 | 0.77 |
| Close phase | 1.56 | 0.54 | 1.18 | 0.38 | 1.42 | 0.18 |
| Open quotient | 0.39 | 0.12 | 0.66 | 0.21 | 2.4 | 0.03* |
| Speed quotient | 1.08 | 0.77 | 1.35 | 0.57 | 1.86 | 0.091 |

As can be seen from the, tables, mean open quotient for vowel A (Table 8) opening time, close phase, open quotient and speed quotient for vowel *D* (Table 9) and open quotient for 'u' (Table 11) were significantly different between stuttering and nonstuttering children. Normal children exhibited bnger durations on all these four laryngeal parameters. In feet, the duration of all parameters of Lx waveform were longer in the production of normal children compared to the production of the same words by stuttering children, but the differences in mean durations were statistically not significant.

**b) Comparison between fluent and stuttered productions of the same words in stutterers**

Similarly Lx waveform measurements on a number of parameters were compared between the fluent and dysfluent productions of the same word in the speech of stutterers. Results are tabulated in the Tables, 12, 13, 14 and 15 for words with vowels, ‘ʌ‘, ‘ ɔ’ ,‘ i:’ and ‘u’, respectively.

**Table 12: Mean, Standard deviation and t-test results for the significance of difference of means between dysfluent and fluent utterance of stutterers for the vowel /\ (spontaneous speech).**

| | Stutterers' dysfluent | | Stutterers' Fluent | | | |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | **SD** | t | **P** |
| Open time | 0.57 | 0.18 | 0.79 | 0.36 | 1.72 | **0.1** |
| Opening time | 0.76 | 0.24 | 0.99 | 0.49 | 0.97 | 0.35 |
| Open phase | 0.96 | 0.38 | 1.09 | 0.23 | 0.72 | 0.48 |
| Close time | 0.33 | 0.26 | 0.59 | 0.38 | 1.32 | 0.21 |
| Closing time | 0.62 | 0.32 | 0.79 | 0.64 | 0.53 | **0.6** |
| Close phase | 1.34 | 0.58 | 1.78 | 0.53 | 0.17 | 0.86 |
| Open quotient | 0.35 | 0.4 | 0.67 | 0.52 | 1.29 | 0.22 |
| Speed quotient | 1.23 | 0.22 | 1.53 | 0.6 | 1.07 | 0.3 |

**Table 13: Mean, Standard deviation and t-test results for the significance of difference of means between dysfluent and fluent utterances of the vowel ɔ (spontaneous speech).**

| | Stutterers' dysfluent | | Stutterers' fluent | | | |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | **SD** | t | **P** |
| Open time | 0.55 | 0.25 | 0.76 | 0.23 | 1.5 | 0.15 |
| Opening time | 0.77 | 0.32 | 1.05 | 0.35 | 1.5 | 0.13 |
| Open phase | 0.99 | 0.43 | 1.32 | 0.36 | 1.53 | 0.15 |
| Close time | 0.56 | 0.3 | 0.62 | 0.39 | 0.64 | 0.53 |
| Closing time | 0.59 | 0.16 | 0.48 | 0.18 | 1.34 | 0.2 |
| Close phase | 1.08 | 0.56 | 1.23 | 0.63 | 0.43 | 0.66 |
| Open quotient | 0.48 | 0.18 | 1.08 | 0.58 | **2.4** | 0.03* |
| Speed quotient | 123 | 0.85 | 1.84 | 0.50 | 1.02 | 0.32 |

**Table 14: Mean, Standard deviation and t-test results for the significance of difference of means between dysfiuent and fluent utterances of the vowel i: (spontaneous speech).**

| | Stutterers' dysfluent | | Stutterers'fluent | | | |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | t | P |
| Open time | 0.48 | 0.28 | 0.91 | 0.11 | 0.33 | 0.75 |
| Opening time | 1.67 | 0.54 | 1.98 | 0.36 | 0.28 | 0.78 |
| Open phase | 0.87 | 0.2 | 1.22 | 0.31 | 2.1 | 0.06 |
| Close time | 0.37 | 0.25 | 0.39 | 0.47 | 0.38 | 0.71 |
| Closing time | 0.65 | 0.36 | 0.84 | 0.21 | 1.01 | 0.34 |
| Close phase | 1.13 | 0.6 | 1.4 | 0.31 | 0.9 | 0.39 |
| Open quotient | 0.88 | 0.92 | 0.89 | 0.56 | 0.29 | 0.97 |
| Speed quotient | 1.25 | 0.53 | 1.54 | 0.67 | 0.77 | 0.46 |

**Table IS: Mean, Standard deviation and t-test results for the significance of difference of means between dysfluent and fluent utterance of the vowel u (spontaneous speech).**

| | Stutterers' dysfluent | | Stutterers' fluent | | | |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | t | **P** |
| Open time | 0.83 | 0.64 | 0.66 | 0.24 | 0.53 | 0.6 |
| Opening time | 0.77 | 0.34 | 0.92 | 0.6 | 0.57 | 0.61 |
| Open phase | 1.31 | 0.39 | 1.4 | 0.26 | 0.39 | 0.7 |
| Close time | 0.3 | 0.32 | 0.91 | 0.28 | 1.2 | 0.24 |
| Closing time | 0.58 | 0.35 | 0.69 | 0.16 | 0.52 | 0.61 |
| Close phase | 1.56 | 0.54 | 1.72 | 0.51 | 1.05 | 0.32 |
| Open quotient | 0.39 | 0.12 | 0.61 | 0.1 | 2.9 | 0.018* |
| Speed quotient | 1.08 | 0.77 | 1.67 | 0.35 | 1.08 | 0.31 |

Except the two differences in respect of open quotient, on vowel ɔ and 'u' (Table 13 and 15) none of the other differences in means, for any vowel, was statistically significant. In both instances, the fluent production of the vowel in nonstutterers had a significantly longer open quotient than in stutterers. It may also be noted that the fluent vowels in nonstutterers had longer open time, closing time, closed phase, open quotient and speed quotient then the same words in the dysfluent words of stutterers, but the differences was not statistically significant.

**c) Stuttered and fluent portions of the words which were stuttered by the stutterers in their speech**

A comparison was made, of the dysfluent and fluent portion of the words, stuttered by the stutterers during spontaneous speech. The results of the significance test (t-score) are given in Tables 16, 17, 18 and 19 for the vowels with ʌ, ɔ i: and u respectively.

**Table 16 : Mean, Standard deviation and t-test results for the significance of difference of means between the dysfluent and fluent portions of the stuttered word in the speech of stutterers for the vowel ^ (spontaneous speech).**

| | Dysfluent portion | | Fluent portion | | | |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | T | Sig. (2 tailed) |
| Open time | 0.64 | 0.3 | 0.67 | 0.3 | 0.13 | 0.71 |
| Opening time | 0.87 | 0.19 | 1.03 | 0.31 | 0.72 | 0.5 |
| Open phase | 1.19 | 0.24 | 1.24 | 0.37 | 0.81 | 0.46 |
| Close time | 0.27 | 0.03 | 0.35 | 0.18 | 0.72 | 0.51 |
| Closing time | 0.83 | 0.38 | 1.17 | 0.22 | 1.33 | 0.25 |
| Close phase | 1.55 | 0.67 | 1.64 | 0.69 | 0.16 | 0.88 |
| Open quotient | 0.36 | 0.5 | 0.49 | 0.14 | 4.2 | 0.27 |
| Speed quotient | 1.18 | 0.21 | 1.28 | 0.28 | 0.48 | 0.65 |

**Table 17 : Mean, Standard deviation and t-test results for the significance of difference of means between the dysfluent and fluent: portions of the stuttered word in the speech of stutterers for the vowel ɔ: (spontaneous speech).**

| | Dysfluent portion | | Fluent portion | | T | Sig. (2 tailed) |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | | |
| Open time | 0.41 | 0.91 | 0.43 | 0.97 | 0.001 | 0.99 |
| Opening time | 0.46 | 0.95 | 1.15 | 0.35 | 2.71 | 0.11 |
| Open phase | 0.47 | 0.99 | 1.15 | 0.35 | 2.61 | 0.12 |
| Close time | 0.34 | 0.12 | 0.43 | 0.19 | 0.57 | 0.65 |
| Closing time | 0.56 | 0.13 | 0.8 | **0.9** | 1.99 | 0.18 |
| Close phase | 1.18 | 0.63 | 1.91 | 0.16 | 0.5 | 0.66 |
| Open quotient | 0.34 | 0.24 | 0.45 | 0.54 | 2.94 | 0.09 |
| Speed quotient | 1.14 | 0.67 | 1.95 | 0.23 | 0.37 | 0.74 |

**Table 18 : Mean, Standard deviation and t-test results for the significance of difference of means between the dysfluent and fluent portions of the stuttered word in the speech of stutterers for the vowel i: (spontaneous speech).**

| | Dysfluent portion | | Fluent portion | | | |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | T | Sig. (2 tailed) |
| Open time | 0.32 | 0.8 | 0.34 | 0.8 | 0.303 | 0.77 |
| Opening time | 0.91 | 0.3 | 1.06 | 0.47 | 0.46 | 0.66 |
| Open phase | 0.77 | 0.21 | 0.78 | 0.22 | 0.24 | 0.82 |
| Close time | 0.34 | 0.16 | 0.41 | 0.21 | 0.42 | 0.69 |
| Closing time | 0.35 | 0.02 | 0.57 | 0.46 | 0.31 | 0.091 |
| Close phase | 0.89 | 0.31 | 1.11 | 0.37 | 0.76 | 0.48 |
| Open quotient | 0.77 | 0.71 | 0.94 | 0.77 | 0.27 | 0.79 |
| Speed quotient | 1.15 | 0.52 | 1.59 | 0.69 | 1.1 | 0.33 |

**Table 19 : Mean, Standard deviation and t-test results for the significance of difference of means between the dysfluent and fluent portions of the stuttered word in the speech of stutterers for the vowel u (spontaneous speech).**

| | Dysfluent portion | | Fluent portion | | | |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | T | Sig. (2 tailed) |
| Open time | 1.42 | 0.63 | 1.89 | 0.82 | 0.04 | 0.97 |
| Opening time | 0.85 | 0.83 | 0.98 | 0.29 | 0.8 | 0.55 |
| Open phase | 1.63 | 0.42 | 1.88 | 0.63 | 0.46 | 0.68 |
| Close time | 0.83 | 0.06 | 0.86 | 0.83 | 1.5 | 0.27 |
| Closing time | 0.35 | 0.83 | 0.54 | 0.07 | 0.55 | 0.63 |
| Close phase | 1.3 | 0.32 | 1.42 | 0.14 | 0.49 | 0.67 |
| Open quotient | 0.6 | 0.24 | 0.69 | 0.11 | 1.05 | 0.4 |
| Speed quotient | 1.33 | 0.62 | 1.36 | 0.4 | 0.06 | 0.95 |

The results of the comparison did not show any statistically significant differences in means, for any vowel, between the stuttered and the fluent portions of the words stuttered. However, the EGG parameters of the fluent portion of the dysfluent word had longer durations compared to the stuttered portion, but the difference was not statistically significant.

**d) Comparison of Mild and Moderate Stutterer**

Mean, standard deviation and results of t-test analysis, in respect of a comparison between mild and moderate stutterers are given in Table 20 (vowel A ) Table 21 (vowels), Table 22 (vowel i:) and Table 23 (vowel u) in spontaneous speech.

Table 20 : Mean, Standard deviation and t-test results for the significance of difference of means between the mild and moderate stutterers for vowel ^ (spontaneous speech).

| | Mild (N=4) | | Moderate (N=5) | | T | Sig. (2 tailed) |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | | |
| Open time | 0.41 | 0.12 | 0.64 | 0.3 | 0.95 | 0.41 |
| Opening time | 0.57 | 2.12 | 1.1 | 0.38 | 121 | 0.11 |
| Open phase | 0.63 | 0.33 | 1.64 | 0.25 | 3.9 | 0.029* |
| Close time | 0.21 | 2.21 | 0.46 | 0.29 | 1.16 | 0.32 |
| Closing time | 0.41 | 2.21 | 0.53 | 0.29 | 0.53 | 0.63 |
| Close phase | 0.81 | 2.21 | 1.6 | 0.13 | 7.6 | 0.005* |
| Open quotient | 0.36 | 0.07 | 0.48 | 0.12 | 1.26 | 0.29 |
| Speed quotient | 1.37 | 0.31 | 1.9 | 0.09 | 9.7 | 0.4 |

**Table 21 : Mean, Standard deviation and t-test results for the significance of difference of means between the mild and moderate stutterers for the vowel ɔ. (spontaneous speech).**

| | Mild | | Moderate | | T | Sig. (2 tailed) |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | | |
| Open time | 0.47 | 0.18 | 0.6 | 0.18 | 0.78 | 0.47 |
| Opening time | 0.59 | 0.19 | 1.11 | 0.4 | 2.3 | 0.083 |
| Open phase | 1.02 | **0.44** | 1.89 | 0.07 | 0.37 | 0.72 |
| Close time | 0.54 | 0.38 | 0.85 | 0.44 | 1.54 | 1.19 |
| Closing time | 0.58 | 0.5 | 0.85 | 0.14 | 2.2 | 0.09 |
| Close phase | 0.82 | 0.41 | 0.92 | 0.43 | 0.27 | 0.79 |
| Open quotient | 0.44 | 0.18 | 0.44 | 0.66 | 0.053 | 0.96 |
| Speed quotient | 1.48 | 0.55 | 1.69 | 0.9 | 0.48 | 0.65 |

**Table 22 : Mean, Standard deviation and t-test results for the significance of difference of means between the mild and moderate stutterers for the words with i: (spontaneous speech).**

| | Mild | | Moderate | | T | Sig. (2 tailed) |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | | |
| Open time | 0.67 | 0.42 | 0.6 | 0.78 | 0.21 | 0.85 |
| Opening time | 0.79 | 0.24 | 1.16 | 0.19 | 0.94 | 0.41 |
| Open phase | 0.53. | 0.07 | 1.14 | 0.72 | 3.66 | 0.035* |
| Close time | 0.29 | 0.83 | 0.34 | 0.46 | 0.4 | 0.71 |
| Closing time | 0.67 | 0.45 | 0.66 | 0.86 | 0.37 | 0.97 |
| Close phase | 0.97 | 0.23 | 1.32 | 1.84 | 1.01 | 0.38 |
| Open quotient | 0.37 | 0.19 | 0.83 | 0.67 | 0.89 | 0.43 |
| Speed quotient | 1.36 | 3.5 | 1.69 | 0.71 | 0.51 | 0.64 |

**Table 23 : Mean, Standard deviation and t-test results for the significance of difference of means between the mild and moderate stutterers for the words with u. (spontaneous speech).**

| | Mild | | Moderate | | T | Sig. (2 tailed) |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | | |
| Open time | 0.18 | 0.61 | 0.81 | 0.12 | 1.87 | 0.15 |
| Opening time | 091 | 0.16 | 0.99 | 0.83 | 0.16 | 0.88 |
| Open phase | 1.2 | 0.27 | 1.4 | 0.7 | 1.3 | 0.27 |
| Close time | 0.66 | 0.28 | 0.73 | 0.95 | 2.43 | 0.093 |
| Closing time | 0.56 | 0.35 | 0.71 | 0.25 | 0.4 | 0.65 |
| Close phase | 1.57 | 0.48 | 1.69 | 0.16 | 0.32 | 0.77 |
| Open quotient | 0.49 | 0.19 | 0.60 | 0.24 | 0.75 | 0.5 |
| Speed quotient | 1.4 | 0.46 | 1.7 | 0.41 | 1.03 | 0.37 |

Within stutterers, comparison between mild and moderate stutterers, showed that mild stutterers were significantly different from moderate stutterers on open and close phase (vowel A, Table 20), and open phase (vowel i:, Table22 ).None of the other differences in means were statistically significant between the two groups. However, it was seen that all the parameters of EGG were longer in moderate stutterers than in mild stutterers.

e) **Comparison of those stutterers who stuttered for less than or more than 4.5 years**

A similar analysis of fluent and dysfluent portion of the stuttered words in the speech of stutterers was made and compared between stutterers who stuttered for less than, or more than 4.5 years. The results of the comparison are given in Table 24 to 27 for the vowelA,3, i: and u, respectively. None of the differences in means for any of the EGG parameters were statically significant at 5 %confidence level.

**Table 24 : Mean, Standard deviation and t-test results for the significance of difference of means between those who stuttered less than or more than 4.5 years for the words with A (spontaneous speech).**

| | Less than 4.5 years | | More than 4.5 years | | | |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | T | Sig. (2 tailed) |
| Open time | 0.53 | 0.28 | 0.66 | 0.32 | 0.5 | 0.63 |
| Opening time | 0.68 | 0.26 | 0.75 | 0.26 | 0.31 | 0.76 |
| Open phase | 0.93 | 0.75 | 1.09 | 0.82 | 0.44 | 0.68 |
| Closetime | 0.41 | 0.3 | 0.54 | 0.31 | 0.45 | 0.67 |
| Closing time | 0.48 | 0.07 | 0.5 | 0.31 | 0.08 | 0.93 |
| Gose phase | 0.84 | 0.85 | 1.33 | 0.53 | 1.2 | 0.28 |
| Open quotient | 0.37 | 0.4 | 0.44 | 0.14 | 0.63 | 0.56 |
| Speed quotient | 1.37 | 0.3 | 1.46 | 0.27 | 0.35 | 0.74 |

**Table 25 : Mean, Standard deviation and t-test results for the significance of difference of means between those who stuttered for less than or more than 4.5 years for the words with ⊃ (spontaneous speech).**

| | Less than 4.5 years | | More than 4.5 years | | | |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | T | Sig. (2 tailed) |
| Open time | 0.59 | 0.23 | 0.61 | 0.16 | 0.09 | 0.93 |
| Opening time | 0.52 | 0.3 | 1.14 | 0.36 | 2.12 | 0.12 |
| Open phase | 0.64 | 0.33 | 0.98 | 0.12 | 1.28 | 0.28 |
| Close time | 0.28 | 0.13 | 0.55 | 0.8 | 2.6 | 0.07 |
| Closing time | 0.51 | 0.13 | 0.76 | 0.14 | 2.05 | 0.13 |
| Close phase | *126* | 0.46 | 1.38 | 0.21 | 0.32 | 0.76 |
| Open quotient | 0.47 | 0.21 | 0.51 | 0.16 | 0.21 | 0.84 |
| Speed quotient | 1.5 | 0.76 | 1.72 | 0.29 | 0.59 | 0.59 |

**Table 26 : Mean, Standard deviation and t-test results for the significance of difference of means between of those who stuttered for less than or more than 4.5 years for the words with i: (spontaneous speech).**

| | Less than 4.5 years | | More than 4.5 years | | | |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | T | Sig. (2 tailed) |
| Open time | 0.28 | 0.07 | 0.6 | 0.32 | 1.33 | 027 |
| Opening time | 0.92 | 0.43 | 1.2 | 0.71 | 0.5 | 0.64 |
| Open phase | 0.71 | 0.26 | 0.96 | 0.53 | 1.79 | 0.17 |
| Close time | 0.25 | 0.83 | 0.48 | 0.53 | 1.07 | 0.36 |
| Closing time | 0.35 | 0.00 | 0.6 | 0.34 | 0.99 | 0.39 |
| Close phase | 0.73 | 0.16 | 1.04 | 0.36 | 1.08 | 0.35 |
| Open quotient | 0.28 | 0.86 | 0.45 | 0.11 | 1.13 | 0.34 |
| Speed quotient | 1.8 | 0.4 | 1.96 | 0.8 | 1.44 | 0.244 |

**Table 27 : Mean, Standard deviation ancI t-test results for the significance of difference of means between those who :stuttered less than or more than 4.5 years for the words with u (spontaneous speech).**

| | Less than 4.5 years | | More than 4.5 years | | T | Sig. (2 tailed) |
|---|---|---|---|---|---|---|
| | Mean (msec) | SD | Mean (msec) | SD | | |
| Open time | 0.53 | 0.23 | 0.36 | 0.12 | 1.09 | 0.35 |
| Opening time | 1.4 | 0.6 | 1.35 | 0.44 | 0.09 | 0.93 |
| Open phase | 1.36 | 0.95 | 1.69 | 0.2 | 2.1 | 0.12 |
| Close time | 0.32 | 1.41 | 0.71 | 0.19 | 1.54 | 0.22 |
| Closing time | 0.98 | 2.12 | 0.59 | 0.35 | 1.4 | 0.23 |
| Close phase | 1.97 | 0.23 | 1.94 | 0.3 | 0.1 | 0.92 |
| Open quotient | 0.35 | 0.6 | 0.47 | 0.15 | 0.99 | 0.39 |
| Speed quotient | 1.5 | 0.26 | 1.3 | 0.77 | 0.31 | 0.77 |

# CHAPTER-5

# DISCUSSION

The aim of the study was to compare the laryngeal behaviour of stutterers and nonstutterers and among stutterers as a function of duration of stuttering and severity of stuttering , for phonation of /a/ , initial nucleus vowel in the cvcv sequences and spontaneous speech, on set of electroglottographic measurements .

**Comparison of Stuttering and Nonstuttering Children as a Group**

Stuttering children in the age group of 6-12 years and a matching group of nonstuttering children were compared on three different tasks, namely, phonation, of vowel /a/ in isolation ,repethion of three CVCV syllables ,and spontaneous speech .In the spontaneous speech , the interest was to compare the dysfluent words in the stutterers speech with the fluent production of the same words in the speech of nonstuttering children . Eventually, such an analysis had to be restricted to 9 words ; these 9 words were stuttered by the stutterers and were also found in the speech of nonstutterers . Words which were stuttered by stutterers in their speech but were not produced by nonstuttering children were not considered for analysis . Similarly , words which were stuttered by the stutterers ,but were not produced by them fluently at some other point in their speech were also not considered for analysis.

The results showed that none of the laryngeal parameters pertaining to the vowel /a/ were different between stuttering and nonstuttering children . On the production

of CVCV syllables, the laryngeal parameters pertaining to open time, close time and speed quotient were significantly lower in the production of stuttering children compared to those of nonstuttering children . On the other parameters on the laryngeal waveform, stutterers had lower duration compared to nonstutterers, but the difference in means was not statistically significant.

As said above, the analysis of spontaneous speech had to be restricted to 9 words with vowel ,ʌ , ɔ ,i: and u . Some differences in the laryngeal waveform measurements were noted for the stuttering and nonstuttering children, partly for the vowel ɔ , specifically the duration of opening time ,open time , open quotient and speed quotient were significantly lower in the speech of stuttering children compared to that of nonstuttering children .

In general, the differences between stuttering and nonstuttering children indicate the tendency of the vocal folds to remain open for longer time in the case of stuttering children. Physiologically , this can be interpreted that the stuttering children may not have much difficulty in sustaining voicing . It should also be noted that for all types of speech material analysed in this study, the duration of all laryngeal parameters were suppressed in the speech of stuttering children compared to that of nonstuttering children. However, most of these differences in means were not statistically significant between the two groups investigated .T he implication is that the laryngeal behavior as studied through electroglottography, lies outside the edge of normality in stutterers and that, when these deviations cross a yet to be identified criticality may in someway will lead to dysfluent behavior."

Studies of laryngeal behavior during stuttering indicate that laryngeal disruptions are characterized by excessively high levels of muscular activity **as** well as inappropriate abductory and adductory gestures (Conture, Schwartz and Brewer, 1985,among others ).However, it is not known if these disruptions are merely reactions to some other aspects of the stuttering , or are related to stuttering ,per se .The results of the present study suggest that stutterers show a deviant coordinaation necessary to maintain appropriate laryngeal adduction or abduction necessary to maintain a sound ,or more from one sound to another sound .Such deviance in laryngeal behaviori seen not only in their dysfluent utterances, but also in their fluent production , but the deviance was greater in the former instances. These findings contradict the findings of Conture ,Rothenberg and Moliter (1986)who interpreted their results to mean that young stutterers are likely to show subtle , inappropriate laryngeal behavior during transitions between sounds .but essentially normal behavior within sounds .

**Fluent and Dysfluent Words of Stutterers**

Stuttered words and their fluent productions in the speech of stutterers were compared for EGG parameters . Again , the analysis had to be restricted to just 9 words and the analysis was obviously of the vowel nucleus of the first CV syllable . The results showed that except for open quotient of vowel nucleus involving,, 'ɔ' and 'u', none of the mean differences on any other EGG parameter for any vowel was statistically significant. The mean open quotient for vowel ɔ , and 'u' was significantly lower in the dysfluent word compared to the same word produced fluently by the stutterers .

The results, perhaps imply that the vocal cord behavior has a critical range of performance and that when they cross this critical range, results in abnormal behavior. It may be pertinent to note that parameters of EGG like open time, opening time, close time ,closing time ,etc, were all shorter in the case of dysfluent productions of stutterers when compared to the fluent productions of the same words, but the differences in mean durations were statistically significant. In other words, the vocal cords showed a tendency to be open for a lesser duration in each cycle of vibration during dysfluent production . However, this observation is outside the test of statistical significance.

Another facet of the results was that the vowel nucleus in the dysfluent productions was produced fester than the vowel nucleus in the fluent productions of the same words . This was not subjected to statistical test, but deducted from the short duration of all EGG parameters in the dysfluent production . The shorter duration of the vowel in the stuttered production implies that vocal cords were tensed and therefore resulted in stuttered production. All the explanations here are extremely hypothetical in nature, and more vigorous experiments have to be designed to test the veracity of the observations.

The stuttering children in this study, showed similar pattern of deviant laryngeal abduction/adduction adjustments in both their fluent and dysfluent productions. However, the deviance was much more away from the norms on dysfluent productions, than on the fluent productions of the same words (as indicated in vowel nucleus).

**Dysfluent and Fluent portion of the Stuttered Word**

Only audible repetitions of a sound or syllable were considered here for analysis. What is being analysed here is this: when a word is stuttered, a sound or syllable is repeated. For example, 'ni: ni:ru' the first 'ni' is stuttered followed by the fluent produaion of the same syllable 'ni' to result in fluent production of the word. The first 'ni:' (dysfluent) and the second 'ni': (fluent) were compared for all the EGG parameters. The results showed that none of the EGG parameters were significantly different, involving any vowel, between the dysfluent and fluent syllables in the stuttered word. However, outside statistical significance, all EGG parameters on all words were shorter in the dysfluent portion compared to the fluent portion. The most obvious explanation is that the vocal cords are tensed, for some unknown reason, and a more relaxed vocal cord, lead to fluent production. More critical experiments are warranted ,not only to test this hypothesis ,but also to identify the source (s) of vocal cord tension that momentarily affects speech productions.

Also, the set of factors which bring about a state of relaxation of the vocal cords need to be examined.

**Comparison between Mild and Moderate Stutterers**

It was hypothesized that if abnormal vocal cord behaviour was causally related to stuttering, then stutterers varying in the degree of their severity of stuttering should demonstrate varying degrees of vocal cord abnormal behaviour. The stuttering severity of subjects here was as judged by three speeches pathologists, who

considered mainly frequency of stuttering. However, severity of stuttering encompasses more than the frequency of stuttering. Therefore, the classification of stuttering into mild and moderate groups was at best inconclusive.

Theoretically, these stutterers judged to be in the moderate severity category should have demonstrated greater abnormality of vocal cord behaviour if it is true that stuttering and vocal cord behaviour are in someway related. In the proceeding sections, it was argued that the shorter durations of all EGG parameters in the dysfluent words in comparison with fluent productions (of the same words or the dysfluent portion of the stuttered word) imply a momentary or transitory tension of the vocal cords. If this is to be a valid explanation, then stutterers in the moderate category in this study should have evidenced a more abnormal vocal cord behaviour than those in the mild severity category. However, the obtained results are contrary to this and quite perplexing.

The results indicated that none of the difference in means, in respect of any EGG parameters and for any vowel was statistically significant between mild and moderate stutterers. The exceptions were open phase and closed phased durations for vowel ' / \ ' and open phase duration for vowel 'i:' which were significantly lower in mild stutterers compared to moderate stutterers. However, the duartions of all the EGG parameters for all the vowels, were shorter in the case of mild stutterers compare to moderate stutterers. No valid explanation can be put forward to explain this other than speculating in three dimensions:

a) the judgement of stuttering severity by speech pathologists based on such overt factors like frequency of stuttering, difficulty in social context, etc., is only one dimension of the severity,

b) the severity of an individual stuttering moment is another dimension of the severity of stuttering which may not always be perceived by others, other than the stutterer himself, and

c) deviant vocal cord behaviour, as seen through EGG measurements are coexisting with but not related to stuttering.

**Comparison between Stutterers Stuttering for less than, and more than 4.5 years**

The nine stuttering children in the study were categorized in to two groups as stutterers stuttering for less than ( assumed onset of stuttering was 4.5 years back or even less) and stutterers stuttering for more than 4.5 years. The onset of stuttering was deduced based on the description given by the parents of stuttering children and therefore, the validity of the judgement is not known. Also, selecting 4.5 years as the criteria for separating the two groups was artificial. Such a criteria was adopted just to equate the sample size in the two groups (< 4.5 years = 4; >4. 5 years = 5).

These results perhaps indicate that even if stuttering and deviant vocal cord behaviour, as seen through EGG, are related, the relationship holds good only in the beginning years of stuttering. As stutterers continue to stutter for longer, continue to learn, modify and adapt to stuttering ,deviant behavior of vocal cords

become less relevant in perpetuating or precipitating stuttering. Future research can more rigorously investigate, through more vigorously controlled experiments, the validity of this hypothesis.

Any aberrant laryngeal behaviour detected through EGG in stutterers might be the result of a well established long term history of stuttering. This study was planned to verify this assumption by taking stutterers who have been stuttering for varying periods of time. If the results of the present study did not show a deviant (statistically valid) laryngeal behaviour between the two groups of stutterers, then selecting and categorizing stutterers into two groups with one group having stutterers who were stuttering for less than 4.5 years and a second group having stutterers who were stuttering for more than 4.5 years was unacceptable. The arbitrary criterion of 4.5 years was, perhaps, too long. Conture, Rothenberg and Molitor (1986) included young stutterers (age range 3.5 to 6.8 years) in their study and found that they are young stutterers (who had been stuttering for a lesser period in comparision with the stutterers in the present study) demonstrated a difficulty in stabilizing and controlling laryngeal gestures even during their fluent speech.

Deviations in laryngeal adjustments which were found to be lower in stutterers who have been stuttering for more than 4.5 years than in stutterers who have stuttered for less than 4.5 years may be explained as follows: stutterers who have stuttered for long may have learned to manage their stuttering over a period of time. Such an explanation has been put forward by Onslow and Ingham (1987) to explain the longer intervals of phonation in adult stutterers during their stutter-free speech compared to their stuttered speech.

**CHAPTER-6**

# SUMMARY AND CONDUSION

In a clinical setting ,there are two basic techniques involved in the assessment of laryngeal behavior; listening to the voice and viewing the larynx. While much can be learnt through perceptual evaluation, the judgements are often unreliable, especially with regards to for stuttering evaluation, due to the atypical signs and symptoms observed. Thus measurements that can be directly related to the pathophysiology of laryngeal behaviours are highly desired (Hanson, Gerrah and Ward, 1982).

Laryngeal behavior in stutterers has been studied since 1820"s (Arnott,1829; Serre d'A lais, 1829; Avicenna. 1837).Since then, there have been several findings on stuttering as new techniques to study laryngeal behaviour evolved. Among the techniques used to study the glottal behaviour in, the electroglottography was found to be most suitable for children due to it's noninvasive and nonintrutive nature.

A review of the several studies on EGG findings in stutterers reveals that the findings are not unequivocal (Conture, Rothenberg and Molitor,1986; Newman, Harris and Hilton, 1989; Molt, 1991). A review of studies on EGG finding in both children and adults shows that these studies have not considered the duration of stuttering or the severity of stutterers that are known to be relevant to a study of

variables related to stuttering. It was hypothesized here that if deviant laryngeal behaviour was associated with stuttering, then more severe stutterer should show greater deviations of laryngeal behaviour than less severe stutterers. Similarly, the stutterers stuttering for longer years should show greater abnormality of vocal cord behaviors than stutterers who have stuttered for shorter duration (years).

The present study attempted to compare vocal cord behaviour as seen on EEG between,

a) Stuttering and non-stuttering children

b) Mild and moderate stutterers, and

c) Stutterers stuttering for less than 4.5 years and more than 4.5 years.

Within- group comparisons, among stutterers was also carried out between

a) stuttrered words and their fluent production in the speech of stutterers, and

b) dysfluent syllable and the fluent production of the same syllable within a word, in the speech of stutterers. For example in "ni: ni:ru", the two ni:'s were compared.

The study included 9 stuttering children in the age group of 6 to 12 years, who had been stuttering for 3 to 8 years. A group of normal children, matched for age, gender, schooling, socio-economic status and linguistic background served as the control group.

Each of the 18 children produced three types of speech materials, phonation of/a/ in isolation, sequences of three CVCV words embedded in a carrier phrase and story narration. The three words 'pata' 'tata' and 'kata' were repeated by the children in a carrier phrase "i:ga. . . . . endu helu"

Briefly, a dual channel recording of speech (Microphone Alcom Aud 80) and glottal pulses through electrodes( Kay Elemetrics), placed on either side of the thyroid cartilage was made. All recordings were made into a Pentium III PC through the sound blaster card, and all analysis was done on VAGHMI package of Voice and Speech Systems.

For identifying stuttering, the spontaneous speech samples were transcribed by the experimenter with no markings. Later a speech pathologist along with the experimenter identified the instances of stuttering and marked them on the transcribed material. The reliability of identification of stuttering was established by asking a third speech pathologist to judge portion of speech of each subject(10%) and then computing a Product- Moment correlation (0.92).

A group of three speech pathologists, along with the experimenter listened to the recorded sample and categorized the stutterers into mild and moderate categories of stuttering severity. The age at which the onset of stuttering might have taken place was determined by the experimenter based on the report of parents of stuttering children. A rough criterion of 4.5 years was selected, and accordingly stuttering children were categorized in to "less than 4.5 and more than 4.5 years of stuttering" group.

Between-group and within-group comparisons were made on three types of materials. They are,

a) phonation of vowel /a/,

b) repetition of CVCV syllables ("pata, tata and kata"), and

c) spontaneous speech.

The results in general indicated,

a) no statistically significant difference between stuttering and nonstuttering children in EGG behavior on the phonation of vowel /a/,

b) no statistically significant difference between stuttering and nonstuttering children in EGG behavior on the repetition of CVCV syllables,

c) no statistically significant difference between stuttering and nonstuttering children in EGG behavior on the 9 words analysed from spontaneous speech,

d) no statistically significant difference between mild and moderate stuttering children on the 9 words analysed from spontaneous speech.

e) no statistically significant difference between stutterers stuttering for less than 4.5 years and more than 4.5 years on any of these nine words.

f) no statistically significant difference between dysfluent words and the fluent productions of the same in the stutterers speech, and

g) no statistically significant difference between dysfluent and fluent syllable of the stuttered words in the speech of stutterers.

However ,there were some parameters of EGG wave form on which stuttering and non stuttering children , or mild and moderate stutterers showed a significant difference in means. Such instances were very few and there was no orderly pattern or uniformity in such differences. Also, all EGG parameters pertaining to the test sequences (phonation of /a/, vowel nucleus of the first syllable in the CVCV sequence, or a given word for the spontaneous speech) were shorter in the speech of stutterers compared to those of nonstuttering children. It was tentatively concluded that, through the laryngeal behaviour as seen through EGG analysis may not be abnormal in stutterers, they lie outside the edge of normality.

Even such a simplistic explanation appears to be unreliable because the EGG measurements were shorter in the speech units of mild stutterers than a moderate stutterers, and in the speech units of stutterers who have been stuttering for more than 4.5 years than in those who where stuttering for less than 4.5 years. If occurrence of stuttering was in any way associated with deviant laryngeal behaviour, one would have expected a reversal of the above results. However, this is not to suggest that laryngeal behavior and stuttering are not related. There are any number of variables related to laryngeal behaviour like abnormal subglottal pressure, asymmetry of vocal cord movement, out of phase vocal cord vibration, etc., that are not reflected through EGG waveforms, but that is beyond the purview of the study.

**limitations Of The Study And Future Research**

Though three CVCV syllables were used, the data on them was combined for analysis as they all had the same vowel nucleus 'ɔ' and were in a similar phonetic context except for the initial consonant. As long as the measurements, pertained to the vowel nucleus preceded by a stop consonant, it was assumed that the analysis will not compromise the results. There is nothing in the literature to suggest that EGG parameters on the vowel will be influenced by the preceding stop consonant. The veracity of this assumption, however, needs to be validated.

The spontaneous speech sample to be analysed had to be restricted to just nine words by the nature of the comparison attempted here. Drawing conclusion from the sample consisting of just nine words and extrapolating them would be patently wrong. Also, the sample included only nine stuttering children. Again, generalizing the results of this study to the stuttering population cannot be justified. Therfore, the results of the study should be viewed and interpreted in the light of these limitations.

The explanation given for the observations made in this study are extremely speculative and hypothetical. More vigorously controlled experiment are warranted to examine the speculations and assumptions made in this study.

This study was planned to study severity of stuttering as one of the variable influencing the laryngeal behaviour in stutterers. Therefore, measures of severity of stuttering employed in such studies needed to be more objective than here. The subjectivity apparent in this study, in judging the severity of stuttering based on the perception of speech pathologists is not at all adequate for studies of this nature.

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