COMPARISON OF DYSPHONIA SEVERITY INDEX (DSI) AND CONSENSUS AUDITORY PERCEPTUAL EVALUATION OF VOICE (CAPE-V) IN INDIVIDUALS WITH VOICE DISORDERS FOR INDIAN POPULATION

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Register No: 09SLP018

A Dissertation Submitted in Part Fulfillment of

Final Year M.Sc (Speech - Language Pathology)

University of Mysore, Mysore.

ALL INDIA INSTITUTE OF SPEECH AND HEARING

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JUNE, 2011

CERTIFICATE

This is to certify that this dissertation entitled **"COMPARISON OF DYSPHONIA SEVERITY INDEX (DSI) AND CONSENSUS AUDITORY PERCEPTUAL EVALUATION OF VOICE (CAPE-V) IN INDIVIDUALS WITH VOICE DISORDERS FOR INDIAN POPULATION"** is a the bonafide work in part fulfilment for the degree of Master of Science (Speech - Language Pathology) of the student (Registration 09SLP018). This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other university for the award of any other Diploma or Degree.

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CERTIFICATE

This is to certify that this dissertation entitled **"COMPARISON OF DYSPHONIA SEVERITY INDEX (DSI) AND CONSENSUS AUDITORY PERCEPTUAL EVALUATION OF VOICE (CAPE-V) IN INDIVIDUALS WITH VOICE DISORDERS FOR INDIAN POPULATION"** has been prepared under my supervision and guidance. It is also certified that this has not been submitted earlier in any other University for the award of any Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled **"COMPARISON OF DYSPHONIA SEVERITY INDEX (DSI) AND CONSENSUS AUDITORY PERCEPTUAL EVALUATION OF VOICE (CAPE-V) IN INDIVIDUALS WITH VOICE DISORDERS FOR INDIAN POPULATION"** is the results of my own study under the guidance of Mr. Jayakumar. T, Lecturer in Speech Language Sciences, Dept. of Speech – Language sciences, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier to any other university for the award of any Diploma or Degree.

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Place: Mysore **Register No.** 09SLP018

June 2011

Dedicated to

My Achai, Amma, Kuttu &

Jayakumar sir

With love

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my teacher and guide Mr. Jayakumar, Lecture, Department of Speech Language Sciences, All India Institute of Speech and Hearing, for the constant help. I can't say thank you enough for his tremendous support and help. I feel motivated and encouraged every time I attend his meeting. Without his encouragement and guidance this project would not have materialized. I wish to express my heartfelt gratitude to him for giving opportunity to work on this project. First of all I thank god to give me a guide like you. I am so lucky since I am the first one, who got the opportunity to do Dissertation under your guidance.

I would like to express my sincere thanks to Dr. S. R. Savithri, Director, All India Institute of Speech and Hearing, for providing excellent research environment in the institute.

I would like to express my sincere thanks to Dr. S. P. Goswamy, HOD, Department of Clinical Service, All India Institute of Speech and Hearing, for permitting me to use the required instruments in the department.

I express my sincere thanks to Mrs. Vasanthlakshmi & Mr. Santhosh, who help me in finding the result of this project.

I express my sincere thanks to all the staffs in AIISH for their valuable suggestion during research proposal.

I would like express my sincere thanks to all my subjects, who participated in the project.

My dearest Achai, Amma & Kuttu .... it's hard to find the right words to tell you, how I feel.............I am here because of you........you 've given me so much love..........and much more ....now I'd like to say these words to you........I love you so much....................

I take this opportunity to thank all my classmates and friends who gave their unending support to me throughout the course of my study.

Very special thanks to Robin (Kapeesh), Lydia (Makri),Merlin(Tankam), Kanthi vs Konthiii, Sangu, kutti Sangu Midlu (Hitler Koya), Vipina, Neenu, sssssssVirinda,....................my sweet friends.......................

I extend my thanks to all my classmates for their support.

Sneeha, Madhuben, Heema, Madhu (Rajkumar), adhii,....................

I can't forgot the time we all spend together in Class, Lib, Canteen, B' day parties and........................yes ....finally our class trip.............................

I express my gratitude to the library staffs for their valuable supports

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CHAPTER I

INTRODUCTION

Voice is one of the important tool of communication despite the growing importance of e-mails and text messaging (SMS) for daily contacts. Indeed in modern society people are probably even more dependent on their voice due to various voice applications in the modern computer systems. Currently the traditional vocal performance has increasingly gained interest in our society. This growing interest has consequently induced a lot of research concerning voice assessment and therapy focusing on quantitative and qualitative aspect of voice assessment. Voice is a multidimensional in nature. Hence, varieties of disorders are possible. The quality of voice can be assessed subjectively with the listening ear of the diagnostician and objectively by instruments (Hakkesteegt, 2009).

Voice quality is the term that subsumes a wide range of possible meanings, covering both laryngeal and supra laryngeal aspects. It is a multidimensional vocal attribute that is related to the distribution of acoustic energy in the vocal spectrum. To assess these several systems for perceptual evaluation are developed, like Grade, Roughness, Breathiness, Aesthenia, Strain scale [GRBAS] (Hirano, 1981), Buffalo Voice Screening Profile (Wilson, D. K., 1987), the Darley Rating System (Darley, Aronson & Brown, 1969), and Consensus Auditory Perceptual Evaluation of Voice (CAPE-V) (ASHA, 2002). Of those systems the GRBAS-scale is probably the most widely used system. For each parameter, a four-point scale is used to indicate severity. The scaling system had limitations due to it is large interval. CAPE-V was introduced to overcome the several limitations of previous perceptual voice assessment scales. In CAPE-V apart from Roughness, breathiness, strain, pitch and loudness the judges can introduce the parameters which they feel important for the particular voice sample. Secondly the judges can vary their rating from 0 to 100% which is wide compared to GRBAS and also have visual analogy scale for the same. The Standard CAPE-V protocol includes sustained vowel /a/, /i/ and /u/, sentence repetition, and a brief sample of conversation for the assessment. It is relatively recent and widely accepted perceptual assessment scale.

On the other hand, objective measurements frequently involve instrumentation to quantify voice quality. They are regarded as less subjective and more reliable method to document voice characteristics. For objective evaluation of voice quality, several acoustic and aerodynamic measurements are used, like jitter, shimmer, harmonics to noise ratio, frequency range, maximum phonation time etc. (Askenfeld & Hammarberg, 1986; Baken, 1987; Crevier-Buchman, et al, 1998; Dejonckere & Lebacq, 1996; Dejonckere, Remacle, et al., 1996; Eskenazi, Childers & Hicks, 1990; Hammarberg et al., 1980; Hillenbrand, Cleveland & Erickson, 1994; Hirano et al., 1986 &1988; Kreiman, Gerratt & Berke, 1994; Martin, Fitch & Wolfe, 1995; Piccirillo et al, 1998 & 1998a; Rabinov et al, 1995; Wolfe, Fitch & Cornell, 1995). It is therefore not surprising to find the extensive literature identifying which instrumental measure can best correlates with perceptual assessment, with the intention of replacing perceptual evaluation to objective evaluation. It appears that multi-parametric measurements, combining several objective parameters, are better to assess the voice quality than single parameter measurements (Klein, Piccirillo & Painter, 2000; Michaelis, Frohlich & Strube, 1998; Piccirillo, Painter, Fuller & Fredrickson, 1998; Piccirillo, Painter, Fuller, Haiduk & Fredrickson, 1998a; Yu, Ouaknine, Ravis & Giovanni, 2001; Yu, Revis, Wuyts, Zanaret & Giovanni, 2002; Wuyts, De Bodt & Molenberghs, 2000; Hartl, Hans, Vaissiere & Brasnu, 2003).

The Dysphonia Severity Index (DSI) as proposed by Wuyts et al (2000) is also an objective multi-parametric measurement. The DSI was derived from multivariate analysis of 387 subjects (68 normal and 319 voice disorders) with the goal to describe the perceived voice quality, based on objective measurement it constructed so that perceptually normal voice corresponds with a DSI +5 and severely dysphonic voice corresponds with a DSI of -5, The following parameters were considered to arrive the index: Jitter (%), Shimmer (%), NHR, High-F0 (Hz), Low-F0 (Hz), F0-Range (Hz), Semitone-range, Low-In (dB), High-In (dB), I-Range (dB), Maximum phonation time (MPT, s), vital capacity (VC (cc), Phonation quotient (PQ (cc/s). These were subjected to discriminant analysis to know the weightage of each parameter in classifying normal from disordered voice. The parameters used for the DSI are the highest frequency (F0-High in Hz), lowest intensity (I-Low in dB SPL), MPT (in seconds), and jitter (%). The DSI is constructed as = 0.133(MPT) + 0.00533 (High-F0) - 0.263(Low-In) - 1.183(Jitter %) + 12.4.

DSI constructed in such a way that a perceptually normal voice (Grade 0 in GRBAS scale) corresponds with a DSI of + 5; a severely dysphonic voice (Grade 3) corresponds with a DSI of – 5. Also scores beyond this range are possible (higher than + 5 or lower than - 5). Auditory perceptual judgments are typically the final arbiter in clinical decision making and often provide the standards against the objective evaluation (Kent, 1996). Inherently, the construction of the DSI is based on such a standard, being the Grade of the widely used perceptual GRBAS scale. Another advantage of the DSI is that the parameters can be obtained relatively quickly and easily by speech pathologists, which makes it applicable in daily practice. Age of the subject (20-80yrs) had significant effect on DSI and its parameters namely highest frequency and lowest intensity. Gender had no effect on the DSI, although it has a significant effect on the parameters highest frequency and maximum phonation time (Hakkesteegt, Brocaar, Wieringa & Feenstra, 2006). When using an instruments to assess the effects of intervention on voice quality, it is important to know the variability and the measurement accuracy of that instruments, to be able to interpret differences in measurements, for example before and after therapy (Carding, Steen, Webb, MacKenzie, Deary & Wilson, 2004). DSI showed interobserver variation was less than 5% of the difference between different observers existed. The difference in DSI between two observers (interobserver difference) is not significant. Intraclass correlation coefficient of the DSI was 0.79, which is to be considered a very good agreement between the perceptual and DSI score (Hakkeesteegt, Wieringa, Brocaar, Mullder & Feenstra, 2008). DSI was found to be 4.2 in participants with G0 in GRABS scale, and DSI was 1.4 in participants with G1 in GRBAS scale. DSI discriminated between patients with nonorganic voice disorders, vocal fold mass lesion, and vocal fold paralysis (Hakkeesteegt, Wieringa, Brocaar, Mullder & Feenstra, 2008). Also, there are few studies on DSI in clinical population such as cleft palate, laryngectomee and in voice disorders to evaluate the voice quality and effect of different type of intervention (voice therapy and surgery). All these studies show that DSI was a very good objective measure in evaluating the voice quality and effect of different intervention. (Hakkesteegt, Brocaar & Wieringa, 2010; Leonard, Leah, Nancy, Robin, Joyce, George & Alexander, 2010; Van lierde, Bonte & Baudonck, 2008; Van lierde, Claeyer, De Bodt & Van cauwenberge, 2004; Van lierde, Monstrey, Bonte, Van cauwenberge & Vinck, 2004).

Further, to known the effect of ethnic and geographical variation on dysphonia severity index, the DSI normative was developed in Indian population and compared over European norms (Jayakumar & Savithri, 2010). One hundred twenty voluntary participants (60 males and 60 females) who had G0 on the GRBAS scale were participated in the age range of 18-25 years. The results showed notice able difference between Indian and European population on MPT, High-F0 and DSI values. Significant gender differences were also observed on MPT and High F0 because of the minimal difference (3 seconds) in MPT between males and females of Indian population when compared with European population (6seconds). The MPT decrement lead to a reduction in the overall DSI value in both the genders, the reason could be the differences in the physical make up and vocal and the resonatory structures between the populations. Author suggested for establishing their own norms for different geographical and ethnic groups.

Need for the study

The DSI was developed using European normal participants and dysphonic subjects. It is found that the DSI value and few basic parameters of DSI were different from European population to Indian population. The DSI value was found to be significantly less in Indian population, mainly due to the reduction in the MPT value (Jayakumar & Savithri, 2010). It is wise think that the DSI value will be different even in dysphonic subjects in compare to the European dysphonic subjects. Therefore, we need evaluate the DSI on Indian dysphonic subjects and to develop separate reference data for the Indian population for dysphonic subjects. Also it needs to be verified with subjective evaluation. Hence, the present study aims to measure DSI on different degree of dysphonic subjects in India and also to correlate with the perceptual assessment (CAPE-V).

Objective of the study

- DSI measures for people with dysphonia in Indian population.
- Comparison of objective evaluation (DSI) with subjective evaluation (CAPE-V).

CHAPTER II

REVIEW OF LITERATURE

Voice is the most important tool of communication in the present world, and it goes without saying that most people need their voice for daily social activities. Any impairment of the voice therefore will have large impact both on daily work and social activities for many people (Hakkesteegt, 2009)**.** Voice disorders have a variety of causes (organic and functional) and can lead to problems in works and social activities. According to the European Laryngeal Society, an assessment of voice disorders should consist of (video) laryngostroboscopy, perceptual voice assessment, acoustic analysis, aerodynamic measurements, and subjective self - evaluation of voice (Dejonckere et. al., 2001). Both the advised assessment has its own advantages and disadvantages.

Perceptual evaluation

The perceptual evaluation in its most simple form is a description of the sound of the voice. But it lacks precision and is hardly useful to compare results of therapy. Besides, communication between clinicians will be difficult, which is due to lack of agreement on definitions and terminology. On top of that, each clinician has own internal standard to compare the perceived voice quality (De Bodt, et al., 1997). This internal standard is partly dependent on the range of severity of dysphonia a clinician uses to judge. To reduce these draw backs and to increase the reliability of the perceptual ratings determined by clinician various rating scales have been created to focus on and describe specific aspects of voice quality. To date, 57 scales have been used in the United States and the United Kingdom to evaluate voice disorders (Carding, et al., 2000). A large literature base has been developed to study the reliability of various perceptual evaluation scales and the three most common scales reported on in the literature are the Vocal Profile Analysis (VPA) and the BUFFALO-III Voice Profile, GRBAS Scale.

The Vocal Profile Analysis (VPA) Scheme

VPA scheme was developed by a phonetician and a speech and language therapist (Laver, 1981; Laver, 1991, Wirz, 1995). It is a descriptive system that allows a trained listener to both describe and analyse conversational or reading voice quality. The overall impression of voice quality is seen as resulting from various potentially independent components or settings at both laryngeal and supra –laryngeal levels and in the prosodic aspects of vocal function. Each feature of voice is compared with a specifically defined "natural" baseline and a rating figure given for each parameter.

BUFFALO-III Voice Profile

The buffalo-III voice profile (Wilson, 1987) was created for the specific evaluation of paediatric voices. This profile uses a five point equal-appearing interval scale, with 1 meaning "normal" and 5 meaning a "very severe" deviation. This profile allows the analysis of 12 major aspects of voice production such as Laryngeal tone, Pitch, Loudness, Nasal resonance, Oral resonance, Breath supply, Muscles, Voice abuse, Rate, Speech anxiety, Speech intelligibility, Overall voice rating. This profile aims to rate both vocal features and more general aspects of voice behaviour.

GRBAS scale

The ‘GRBAS Scale’ was introduced by Isshiki, Okamura, Tanabe, Morimoto, 1969; Hirano, 1981. This scale was developed in an effort to explain the psychoacoustic phenomenon of hoarseness utilizing the Osgood Semantic Differential Technique (Wirz, 1995; Hirano, 1981). This was developed further by Isshiki and the Japanese Society of Logopedics and Phoniatrics resulting in the GRBAS scale.

This scale evaluated five aspects of vocal quality listed below:

G-Grade: “Degree of Abnormality

R-Rough: “Irregularity of Fold Vibration”

B-Breathy: “Air Leakage in the Glottis”

A-Aesthinic: “Lack of Power”

S-Strained: “Hyper Functional State” (Hirano, 1981).

For each vocal parameter, a four-point scale is used to address the severity ranging from zero to three provided for the clinician to make a designation regarding the severity of each feature (De Bodt, Wuyts, Heyning, & Croux, 1997). In this scale ‘0’ equals normal, ‘1’ slight, ‘2’ moderate and ‘3’ severe.

Of those scales mentioned above the ‘GRBAS’ scale is the most widely used among them which was introduced by Hirano. Kreiman, Gerratt, Kempster, Erman, & Berke (1993) reviewed 57 different papers selected from the literature that used various approaches to auditory perceptual analysis of voice. Among these approaches, the GRBAS scale has been widely used for judging disordered voice quality (Caring, et al., 2009).

In a study performed by the British Voice Association (BVA), these three scales were examined in order to develop a recommendation for speech –language pathologists in the United Kingdom concerning which of the scale should be utilized in their clinical practice (Carding, et al., 2000). The author's recommendation at the conclusion of the study indicated there was a strong need for the development of a new perceptual scale. This recommendation is based on the probability that the GRBAS, VRP or the BUFFALO-III do not fulfill all the needs of clinician to adequately complete the task. Furthermore, the authors concluded that a rating system needed to be developed which is clinically realistic, theoretically sound, and proven reliable.

Wuyts, et al. (1999) did a comparison between 2 versions of the GRBAS scale was made: the original GRBAS scale with its original 4 point scale used by the judges for each of the 5 parameters and a visual analog version of scale version of the GRBAS scale, (100 mm); the conclusion was that, in the ordinary GRBAS scale, a clearly higher Interrater reliability existed than among the judges with the visual analog version of GRBAS scale. VAS seems to be advantageous for comparison with absolute acoustic measurement because it offers more detailed information.

De Bodt, et al., (1997) retested the reliability of the GRBAS scale while examining the influence of professional background and experience. Nine pathological voice samples were presented to 23 judges. The judges consisted of experienced and inexperienced otolaryngologists and speech pathologists were presented with sets of voices with a two-week lapse or greater. The study demonstrated only moderate reliability; profession and experience did not influence the outcome, and breaking the results down further between the two specialists (speech-pathologists and otolaryngologists) did not significantly alter the results, but the level of experience among the groups increases the reliability above the moderate level. With regards to the specific terms, the overall rating for the severity of hoarseness was good and was consistent among all of the parameters. Moreover, the speech pathologists were found to be more reliable than otolaryngologists in evaluating the parameters roughness and breathiness, and their reliability increased with the number of years of experience. The reliability of the parameter asthenia was less reliable than all other parameters, was the one area highly susceptible to listener error. The parameter strain also had low reliability and its reliability did not appear to increase with experience. The authors of this study also suggested that the inconsistent internal standards, and the instability present in the ratings, clinician required an average of eight hours of training to achieve 80% inter-judge reliability (De Bodt, et al., 1997). Thus, despite its wide use, GRBAS may not result in reliable or valid voice quality judgments and thus may not provide optimal voice outcome measures for clinical or research purpose. Carding et al., (2000), explained major positives and negatives of these scales. Table 1 shows advantage and limitation of perceptual scale (Source: Carding, et al., 2000)

Perceptual scales	**Advantages**	**Limitation**
VPA	✓ Detailed analysis of vocal tract Configurations ✓ Suggests corresponding therapy interventions ✓ Profiles individual vocal Characteristics	✓ Regular listening skills practice needed ✓ Time consuming compared with GRBAS and Buffalo III

	✓ Suitable for normal and abnormal Voices ✓ Relates to physiological function ✓ Two-day training programme needed	
BUFFALO-III	✓ Simple clinical measurement ✓ Broad range of categories ✓ Overall voice rating (1–5) Easy, quick to use & learn	✓ Includes non-voice quality parameters ✓ No formalized training
GRBAS	✓ Simple clinical measurement ✓ Rates abnormality ✓ Overall severity rating (0–3) ✓ Rates pertinent laryngeal features ✓ Defined terminology ✓ Based on acoustic theory ✓ Easy/quick to use/learn	✓ Rates laryngeal level only (i.e. no supra-glottic parameters) ✓ No rating of commonly used parameters such as pitch and loudness ✓ No formalized training ✓ Large intervals

Table 1: Advantages and Limitation of perceptual rating scales.

To reduce the above mentioned disadvantage and to arrive at good trade off, a new tool for auditory perceptual voice measurement was developed that uses continuous scaling, involves a variety of speaking tasks and voice contexts, and provide a detailed protocol for voice sample recording and data analysis, that is CAPE-V.

Development of Consensus auditory perceptual evaluation of voice (CAPE-V)

The consensus auditory perceptual evaluation of voice (CAPE-V) is a clinical and research tool developed by American Speech-Language-Hearing Association's (ASHA, 2002) along with other expertise in the field of voice assessment to promote a standardized approach to evaluating and documenting auditory – perceptual evaluation of voice quality.

CAPE-V uses continuous visual analog scale for judgment of six parameters of voice such as overall severity, Roughness, Breathiness, Strain, Pitch, and Loudness. Thus, each aspect of the voice quality can be denoted in the continuous interval data between 0 and 100mm. Ratings are based on a clinician's observation of the patient's overall performance on the following tasks: three productions of sustained vowels /a/ and /i/, six standard sentences designed to elicit various laryngeal behaviours, and natural conversational speech. Clinicians also provide separate scores for any of the tasks that produce voice quality that is noticeably different from that produced by the other task. When using the CAPE-V, the clinician places a vertical tick mark on a 100 mm horizontal line to represent the severity of the disorder, with a higher value indicating greater severity. The mark further indicates a general region of severity consisting of "MI" or mildly deviant, "MO" or moderately deviant, and "SE" or severely deviant. CAPE-V also allows the clinician to note other voice features for a particular patient, as needed. The task in the CAPE-V protocol are designed to sample a range of vocal behaviours, but the diverse subject matter included in the CAPE-V also reflects ongoing uncertainty about whether sustained vowel or continuous speech are more appropriate for assessing voice quality.

Advantage

Main advantage of using sustained vowels for voice quality analysis is that production can be easily controlled and standardized. It also provides a static characterization of the voice apparatus that are relatively time –invariant (De Krom, 1994; Klingholtz, 2000). Additionally, sustained vowels are devoid of individual speech characteristics that may influence perceptual judgment of voice quality such as speaking rate, dialect, intonation, phonetic context, stress, and idiosyncratic articulatory behavior (De Krom, 1994; Wilson, 1987; Yiu, Worrall, Longland, & Mitchell, 2000). Apart from sustained vowel production continuous speech also used for voice quality analysis because it contains variations in fundamental frequency and intensity that are important indicators of abnormal voice quality (Fritzell, 1996; Hammarberg, Fritzell, Gauffin & Sundberg, 1986; Parsa & Jamieson, 2001). More specifically, continuous speech incorporates important vocal function attributes such as rapid voice onset and termination (De Krom, 1994). Continuous speech also contains various perceptual cues that do not strictly relate to vocal fold characteristics including dialect, speaking rate, intonation, loudness, articulatory effects and emotional features (De Krom, 1994; Wilson, 1987; Yiu, et al., 2000).

Reliability and validity of CAPE-V

The reliability of a rating scale is the degree to which judgements derived from that scale are dependable or consistent within a rater or across raters on repeated administration. Validity is concerned with the extent, to which a scale’s score’s can be interpreted as representative of a particular underlying construct (Shadish, Cook, & Campbell, 2002; Kelly, O'Malley, Kallen, & Ford, 2005; Sechrest, 2005; cook & Beckman, 2006). There are different types of validity, such as content, face, construct, criterion, empirical, covergent, and predictive validity, can be defined and assessed when new instruments or scales are developed (Devon, et al., 2007)

A master's thesis by Berg & Eden, (2003) compared aspects of the CAPE-V to the Stockholm Voice Evaluation Approach (SVEA) on patients with different voice pathologies. This study involved a translation of the CAPE-V into Swedish. The authors determined that intra- and inter- rater reliability was acceptably high in both protocol, and no significant difference were found between the two approaches in terms of listener variability. And both protocol were able to separate the three disorders from each other and showed significant pre-post treatment changes in voice quality.

Pettis, et al. (2002) examined the reliability of clinician's rating of perceptual parameters utilizing the consensus auditory perceptual evaluation of voice (CAPE-V) protocol on a sample of pediatric voices. The voice samples included 10 disordered and 2 normal voices from a population of children age 3-10 year old. The 12 samples were randomly repeated 3 times. And the results of this study indicated that the group significantly differed in their severity rating of the perceptual indices, suggesting that training affected the participants' judgment of severity.

Karnell, et al. (2007) has examined the reliability of clinician's ratings using the CAPE-V, and compared their ratings to those made using the GRBAS (Hirano, 1981) and two other quality of life scales. They had 4 expert rater's rate 103 voices using both scales, voice set balanced by age and severity, raters used both scales in the same session and CAPE-V Severity was compared to GRBAS Grade only. They reported that the reliability of clinician's rating of overall dysphonia severity using GRBAS and CAPE-V scales was very good, a high level of agreement between the two rating systems and the CAPE-V appeared to be more sensitive to small differences within and among patient than the GRBAS. Further, Zraick, et al. (2007) had compared the reliability of the CAPE-V and that of GRBAS scale, suggested that the CAPE-V results meet or exceed the GRBAS in measurement reliability. Kelchner, et al. (2008) examined CAPE-V reliability for disordered pediatric voice found excellent agreement within and across three raters from the same setting.

Lambert and Vicki Marie (2007) examined the reliability of the two scales used by clinician to perceptually rate voices: the GRBAS and the CAPE-V. Voice samples were collected from eight individuals with voice disorders and two individuals without a diagnosed voice disorder. The samples were rated by six licensed speech- language pathologists the rating were analyzed and both Interrater reliability and intrarater reliability were calculated. The findings revealed that that CAPE-V also had higher mean overall Interrater reliability than GRBAS. This suggests that the CAPE-V may be a more reliable tool for the perceptual rating of voice.

Akanksha and Pushpavathi (2009) investigated the efficacy of CAPE-V rating scale for the reliability of perceptual evaluation of hoarseness of voice for different tasks like phonation, sentences and spontaneous speech, in Indian context, concluding that spontaneous speech sample elicits more reliable perceptual evaluation of voice than reading and sustained phonation of vowel.

(Kelchner, et al., 2010) had done a nonrandomized prospective study to quantify the inter and intra rater reliability for CAPE-V scale. The three experienced speech-language pathologists independently rated randomized voice samples of 50 participants in the age range of 4-20 years, who had acquired or congenital airway conditions requiring at least one post laryngotracheal reconstruction on six salient perceptual vocal attributes such as breathiness, strain, roughness, pitch, loudness, overall severity using the sentence portion of CAPE-V rating scale. The results indicated that there was moderate to strong (ICC=63-93%) intrarater reliability on all but one parameter (strain) and strong Interrater reliability for four of six vocal parameters rated using the CAPE-V in a population children and adolescents with marked dysphonia because parameter of strain was rated by auditory sample alone and apart from the clinical context, was difficult to rate.

Helou et al (2010) conducted a study to determine whether experienced and inexperienced listeners rate postthyroidectomy voice samples similarly using the CAPE-V, concluding that experienced and inexperienced listeners judged voice quality differently given minimal training with the use of the CAPE-V. Speech language pathologies and otolaryngologists rated post thyroidectomy voice quality similarly. These findings indicate that the CAPE-V can be used reliably and similarly by professionals who specialize in voice disorders.

Zraick, et al. (2011) examined the reliability and empirical validity of the CAPE-V when used by experienced voice clinicians (21 raters) judging 22 normal and 37 disordered voices using the CAPE-V and the GRBAS scales. This study reports slightly improved rater reliability using the CAPE-V to make perceptual judgments of voice quality in comparison to GRBAS scale.

Objective evaluation

Objective evaluation uses various instruments and procedures which may be invasive or non-invasive to measure the voice. It gives an accurate, precise and quantitative account of the voice. It has several advantages over perceptual evaluation. First, they are regarded as less subjective and hence are a more reliable method to document vocal dysfunction. Second, they offer uniformity in diagnostic formulation with respect to the different clinicians and clinical settings. But this method of evaluation may be time consuming and is not an economical method. The instrumental evaluation describes the voice based on measurement of aerodynamic parameters (vital capacity, Mean air flow rate, Phonation quotient, Vocal velocity index, Maximum phonation duration & S/Z ratio) and acoustic parameters (Fundamental frequency related measurements, Intensity related measurements & Spectral parameters).

To improve and clarify the communication between clinician and for standardisation purposes, acoustic measurements could be used. Both acoustic measurements and perceptual assessments address voice quality because Perceptual assessment is still regarded as "golden standard" for documenting voice impairment severity (Ma & Yiu 2006). There for acoustic measurement should be compared with the perceptual assessment. Since it involves listener's subjective judgement of voice quality and severity, it is susceptible to various sources of inter and intra listener variability (Kreiman, et al., 1993). By this way single acoustic measures were compared with perceptual evaluation to address voice quality. Table 2 shows relationship between single objective measure and perceptual evaluation.

Study	Number of subjects	Acoustic measure	Perceptual measure	Results & conclusion
Dejonckere & Lebacq (1996)	87 dysphonic patients	Acoustic (jitter), aerodynamic (glottal air leakage)	Harshness, breathiness and roughness	Glottal air leakage gave the impression of breathiness, while jitter is more correlated with roughness.
Rabinov et al (1995)	50 voice samples from normal to severely disordered	Acoustic measure of jitter	75mm visual analog scale.	Overall listeners agreed as well or better than “objective” algorithms. The listeners and analysis packages differ greatly in their measurement characteristics. However reliability is not a good reason for preferring acoustic measure of perturbation to perceptual measure.
Giovanni, Revis & Triglia (1999)	27 consecutive patients who underwent phonosurgery during a 3-month period	Jitter, shimmer, Oral air flow	Perceptual Severity of dysphonia	Oral air flows allows simple, quick, and reliable assessment of the outcome of phonosurgery and be used in every day clinical practice.

Morsomme et al (2001)	28 dysphonic subjects with unilateral laryngeal paralysis and 12 control subjects.	Objective measures obtained using a voice analysis software (EVA)	GRBAS Scale	Grade, breathiness, roughness and asthenia correlated with the objective parameters that express the periodicity of the phonatory signal. The perceptual reality of laryngeal paralysis-induced dysphonia depends more on grade, breathiness and asthenia than it does on roughness.
Heman-Ackah, Michael & Goding (2002)	19 patients with unilateral RLN palsy who undergone operative intervention	Measures of cepstral peak prominence such as noise to harmonic ratio, amplitude perturbation quotient, relative average perturbation, smoothed pith perturbation quotient.	Overall dysphonia and subcategorise of breathiness and roughness	The grade of dysphonia and breathiness ratings correlated better with measures of CPPS than with other measures. CPPS from samples of connected speech (CPPS-s) best predicted overall dysphonia. But none of the measures were useful in predicting roughness.
Heman-Ackah et al., (2003)	281 patients with dysphonia	Measures of CPP (cepstral peek prominence)	Overall serenity of dysphonia	The CPP for running speech is a very good predictors and a

				more reliable measures of dysphonia than other acoustic measures such as jitter, shimmer, and NHR

The disadvantage of using single acoustic or aerodynamic parameters for objective assessment of dysphonia is that different disease processes affect various aspects of voice performance to different degrees. Moreover acoustic measurements cover only part of the information contained in perceptual analysis. For this reason several terms have proposed a multiparametric approach to enhance the scope of data.

Many researchers investigated the relationship between single acoustic measures and perceptual evaluation but the results of these studies are inconclusive (Yiu, & Ng, 2004; Chan, & Yiu, 2002; Hirano, 1989; Revis, et al. 1999; Hillman, et al. 1989; Hillman, et al. 1990). The findings of those studies were inconsistent due to the adoption of different definitions for perceptual qualities, a lack of one-to-one correspondence between a perceptual quality and single acoustic measures and the non-homogeneity of algorithms used to calculate acoustic measures (Eadie & Doyle, 2005). However, a combination of several objective parameters seems to correlate better with perceptual analysis than single acoustic measures (Piccirillo et al, 1998; Goozee et al, 1998; Yiu EM-L, 1999; Yiu et al, 2000; Yiu EM-L, Chan RM-M, 2003;

Sulter AM, Schutte HK, Miller DG, 1995; Higgins MB, Netsell R, Schulte L, 1994; Orlikoff et al, 1999). Because, some researchers considered the multi-dimensional nature of voice and advocated using more than one type of instrumental measure to predict perceptual severity. This multi-parametric approach allows simultaneous inclusion of different instrumental voice measures, and therefore enhances the power in differentiating perceptual severity levels (Wuyts et al, 2000).

Hence, there is extensive literature for identifying which instrumental measure can best predict perceptual severity, with the intention of replacing perceptual evaluation to document voice impairment severity. However, there has been an inconclusive finding of any single instrumental measure can consistently correlate strongly with perceptual judgement. Some researchers considered the multi-dimensional nature of voice advocated using more than one type if instrumental measure to predict perceptual severity. This multi-parametric approach allows simultaneous inclusion of different instrumental voice measures, and therefore enhances the power differentiating perceptual severity levels (Wuyts, et al., 2000).

Along with perceptual evaluation, a number of duration and aerodynamic measures (such as maximum phonation time, phonation quotient, airflow, subglottic pressure, etc.) have been used for the characterization of the voice quality (Hirano, Hibi, Teasawa, & Fijiu, 1986). After, the introduction of computer-based systems has additionally facilitated the use of acoustical analysis of voice samples (Baken, 1987; Rabinov, Kreiman, Gerratt, & Bielamowics, 1995).

Few researchers have investigated the effectiveness of combining different instrumental measures to describe perceptual severity, such effectiveness is commonly evaluated in terms of the association between voice severity levels perceptually judged by listeners and predicted by instrumental measures of the same voice samples. Higher concordance represents stronger association between perceptual evaluation and instrumental measurements. In these studies, the concordance between perceptual and instrumental analysis have been evaluated using two different statistics (Giovanni et al, 1996; Piccirillo et al, 1998a; Piccirillo et al, 1998b; Wuyts et al, 2000; Yu et al, 2001).

Giovanni et al., (1996) employed two acoustic perturbations (jitter and signal-to-noise ratio) with two aerodynamic (voice onset time and glottal leakage) measures that were collected simultaneously using the EVA (evaluation of vocal assistant) system (SQ-Lab, Aix-en-Provence, France) to predict perceptual severity ratings. Perceptual judgement was performed on a 5-point rating scale from '0' normal to '4' severe. Direct-entry discriminant function analysis revealed the four instrumental measures in combination achieved 66.1% (158 out of 239) concordance with perceptual severities. However, this concordance was based on voice samples perceptually rated as '0 (normal)', '2 (moderate)', '3 (intermediate)' and '4 (severe)', Voice samples rated as '1 (very light or intermittent voice abnormalities)' were not included in the analysis because these samples did not show significant differences from Grade '0' and '2' voice samples. In other words, mildly impaired voice quality was not easily discriminated by the set of acoustic and aerodynamic measures.

Piccirillo, et al. (1998a, 1998b) carried out two studies in attempt to develop a multiparametric voice function index to describe dysphonia severity. They employed multivariate logistic regression technique and identified a minimal set of four among 14 voice measures such as sub glottal pressure, phonational frequency range, air flow rate measured at lips and maximum phonation time to distinguish between dysphonic and normal voices. However, the correlation between the combination of four measures and perceived overall severity was only moderate (pearson's r =0.58).

Yu et al., (2001) obtained 11 aerodynamic and acoustic perturbation measures using the EVA system. Perceptual severities were taken from the overall grade of the GRBAS scheme. The authors employed stepwise discriminant function analysis and identified a set of six measures such as frequency range, the estimated sub glottal pressure, from /pa/ string, maximum phonation duration of sustained /a/, signal-to-noise ration, and fundamental frequency of sustained /a/, and Lyapunov coefficient, which could most clearly distinguish among perceptual severity levels. This set of measures correctly predicted 86% of the perceptual severities. However, the inclusion of the male subject only in their study limited the generalizability of the results to the whole dysphonic population.

Development of Dysphonia Severity Index (DSI)

Wuyts, et al. (2000) developed the dysphonia severity index form multivariate analysis of 387 subjects with the goal to describe voice quality within objective terms after instrumental analysis using four out of 13 aerodynamic voice range profile and acoustic perturbation measures. Among these 13 measures the four voice measures were statistically selected using stepwise logistic regression procedure and represented the minimal set of instrumental measures that could best predict perceptual severity. These four measures were jitter percent, maximum phonation time of sustained /a/, the highest frequency value and the minimum intensity level. And the DSI was constructed as: DSI = 0.13 x MPT + 0.0053 x F0-High - 0.26 x I-low - 1.18 x Jitter (%) + 12.4. They were compared the perceptual means of the G from the GRBAS scale, in order to reflect the properties of the DSI. And they found a linear relationship between the subjective Grating and the more objective dysphonia severity index, indicating that the more a voice is perceptually rates as hoarse, the more negative its DSI becomes. Hence DSI is constructed so that a perceptually normal voice corresponds with a DSI of + 5 and a severely dysphonic voice corresponds with a -5, but score beyond this range are also possible (higher than +5 or lower than -5). An advantage of DSI is that the parameters can be obtained relatively quickly and easily by speech language pathologists in daily practice.

Hakkesteegt et al., (2006) investigated the age and gender effect on the DSI. The DSI of 118 non smoking adults (69 females, 49 males within the age range of 20-70 years) without voice complaints was measured. They concluded that the age has a significant effect on the DSI and on its parameters highest frequency and lowest intensity only in females. But, gender has no effects on the DSI. Although, it has a significant effect on the parameters highest frequency and maximum phonation time, at the same time this study made normative DSI value for age and gender.

Hakkesteegt et al., (2008) examined the interobserver variability and test-retest variability of the DSI in 30 non-smoking volunteers without voice complaints or voice disorders by two speech pathologists. The subjects were measured on 3 different days with an interval of 1 week. The result of this study shows that the differences in the measurement between different observers were not significant and the interclass correlation coefficient of the DSI was 0.75 which was considered as good.

Application of DSI in clinical population and various voice rehabilitation conditions

Study	**Participants**	**Variables evaluated**	**Results**
Van Lierde et al (2004)	4 subjects who undergone laryngeal and Velopharyngeal treatment	This study investigated the pre post comparison of the vocal and Velopharyngeal performance after a well defined LB and VB treatment using subjective (GRBAS) and objective (DSI) assessment techniques.	This study found that both patients selected for LB and VB treatment showed improvement of their performance in both subjective and objective treatment approaches.
Kristiane M. Van Lierde et al (2004)	2male & 2female Dutch professional voice users with a persistent moderate or severe muscle tension dysphonia. Age range:37-60yrs	Document the outcome of vocal quality after a well-defined Laryngeal manual therapy (LMT) program using DSI.	All of the subjects showed improvement in perceptual vocal quality and DSI values, indicative of improvement in LMT (Laryngeal Manual Therapy)
Van Lierde et al (2004)	28 children with unilateral and bilateral cleft palate.	To examine the vocal quality and to investigate the effects of gender on vocal quality in 28	Both bilateral and unilateral cleft palate subjects demonstrated a significantly lower

		children with a unilateral or bilateral cleft palate	DSI-value in comparison with the available normative data and also significant Gender-related vocal quality differences were found.
Woisard et al (2007)	58 patients	Evaluated the relationship between the VHI and several voice laboratory measurements such as minimum frequency, maximum frequency, range, minimum intensity, subglottic pressure, mean flow, maximum phonation time, jitter and dysphonia severity index.	Acoustic parameter is correlated with the emotional subscale, the parameters of the profile range are more often involved in the emotional subscale, as is the minimal frequency, but never with the physical subscale, and all the subscales are interesting despite the smaller number of differences with the emotional one.
Van Lierde et al (2006)	24 healthy, young professional voice users using oral contraceptive pills	Investigated the vocal quality and resonance during the menstrual cycle using subjective (perceptual evaluation of voice and nasality) and objective (aerodynamic, voice range, acoustic, DSI, and nasometer) assessment	OCPs do not have an impact on the objective and subjective voice resonance parameters in young professional voice users.

		techniques.	
Sophie Schneider et al, (2010)	76 female and 31 male Age range 66–94 years	Self-perception of voice in seniors as assessed by the Voice-Related Quality of Life (V-RQOL) questionnaire, on voice quality as measured by the Dysphonia Severity Index (DSI) and on the correlation between these parameters	Study shows no correlation between the V-RQOL and DSI either in women, men or the whole study group.
Shaheen N. A wan and Anysia J.Ensslen (2010)	36 untrained vocalists and 30 trained vocalists	Compared trained and untrained vocalists on the DSI and also to contribute to normative DSI data for trained singers.	Results of this study indicated that vocally trained subjects have significantly higher DSI scores than untrained subjects.
Nora van Ardenne et al (2010)	24 patients underwent medialization thyroplasty	Assess the vocal outcome after medialization thyroplasty using silicone and titanium implants and to compare the results of the two implanted materials using prospective sequential cohort study using the Voice Handicap Index, the GRBAS scale, maximum phonation time and the Dysphonia Severity Index.	Postoperative analysis of the entire population showed statistically significant improvement for the Voice Handicap Index, maximum phonation time, Dysphonia Severity Index and the parameters G, B and A of the GRBASI scale. Subgroup analysis showed a statistically significant greater improvement of

			Voice Handicap Index of the titanium cohort compared with the silicone cohort. Improvement of maximum phonation time, Dysphonia Severity Index and GRBASI scale of the titanium cohort was greater than improvement of the silicone cohort, but this difference was not statistically significant.
Leonard R Henry et al (2009)	64 patients who undergone thyroidectomy.	Assess the functional voice out come after thyroidectomy using DSI, CAPE-V, and VHI.	This shows significant pre and post therapy changes in the DSI value.
Shaheen N. Awan, (2011)	30 female Smokers & 30 female non-smokers. Age range: 18-24yrs	Capability of the Dysphonia Severity Index (DSI) and its component measures to reveal differences in vocal capability between groups of young adult female smokers and non-smokers.	Significant differences between groups were observed on the DSI, with reduced DSI scores in smokers primarily due to reductions in $F_{0\ high}$ and increases in I_{low}. Significant group differences in the DSI and component measures may be indicative of early changes in vocal

			function secondary to smoking.

Relationship of DSI with other perceptual measures

Wuyts et al (2000) compared DSI and CAPE-V in normals as well as disordered population, had found relationship between G-level of GRBAS and DSI. The Relation between G-level of BRBAS and DSI from this study is given below:

- ✓ Grade 0 of GRBAS scale corresponds to the DSI value of +5 (G0 <=> DSI = 5.0)
- ✓ Grade 1 of GRBAS scale corresponds to the DSI value of 1(G1 <=> DSI = 1.0)
- ✓ Grade 2 of GRBAS scale corresponds to the DSI value of -1.4 (G2 <=> DSI = -1.4)
- ✓ Grade 3 of GRBAS scale corresponds to the DSI value of -5 (G3 <=> DSI = -5.0)

Hakkesteegt et al (2006) investigated the comparison between DSI and GRBAS scale in different group of patients (n=294) and controls (n=118). Furthermore, it was also investigated whether the DSI can differentiate between a group of patients and control group. The voices of all participants were perceptually evaluated on grade of GRBAS scale, and the DSI was measured. The groups of patient voice complaints have a lower DSI and higher scores on grade than control group. That is, the DSI was significantly lower when the score on grade was higher. They also calculated the specificity and sensitivity for DSI cut off points to determine whether the DSI discriminate between patients and controls. They found maximum sensitivity (0.72) and specificity (0.75) at cut off point of 3.0. They concluded that the DSI is a useful instrument to objectively measure the severity of dysphonia.

Jayakumar and Savithri (2009) investigated monozygotic twins (age range 18-25) voice quality using consensus auditory perceptual evaluation of voice (CAPE-V) as qualitative and Dysphonia severity index as a quantitative voice quality. Further they compared both the voice quality measurements.. They concluded that the voice quality of the monozygotic twins was similar in many of the parameters of qualitative and quantitative measures.

Hakkesteegt, et al. (2010) examined the possible relationship between the DSI and the VHI. Pre and post intervention measures were obtained from 171 voice-disordered patients. The subjects were divided in to voice therapy, surgical intervention, and no intervention group. And the results indicated that the DSI and VHI measure were different aspects of the voice disorder, with the VHI being a measure of patient perception and the DSI a measure of vocal performance /capacity. Although both methods were able to show difference between pre and post intervention groups, these authors indicated that DSI and VHI are not necessarily related.

Jayakumar and Savithri (2010) evaluated DSI in Indian population. One hundred twenty voluntary participants (60 males and 60 females within age range of 18-25) who had G0 on the grade, roughness, breathiness, aesthenia, strain (GRBAS) scale participated in the study. They were compared their study with previous studies by Hakkesteeg et al (2006) and Wyts et al (2000) on these parameters such as MPT(s), highest frequency(Hz), lowest intensity (dBSPL), Jitter (%) and finally the DSI. Results of this study showed noticeable difference between Indian and European population on MPT, highest frequency, and DSI values. And they explained that MPT decrement is the major parameter lead to a reduction in the overall DSI value in both genders. The results also showed gender difference on DSI with females exhibiting higher DSI when compared with males which was in contradiction with previous study done by Hakkesteegt et al (2006). These results of the study caution voice professionals to reinvestigate and establish their own norms for their geographical and ethnic groups.

The above literature shows that the DSI is a very good objective measure for addressing voice quality. But in order to prove the usefulness of this objective measure in assessing dysphonia we need to compare it with the perceptual measure. So far many studies which compared DSI and GRBAS scale. However, literature says that GRBAS did not comprehensively reflect the consistency of the measurement, due to its large interval. To address these concerns the present study aimed at comparing objective measure DSI and subjective measure CAPE-V in Indian dysphonic population.

CHAPTER -III

METHOD

Participants

50 participants (33males and 17 females) were participated in this study. All the participants were equally divided in to two groups based on the age (20-40 & 40-60). All participants were diagnosed as having voice problem by speech language pathologist and ENT specialist. Participants were also classified based on the degree of severity (mild, moderate and severe) for further analysis Majority of the participants was from All India institute of speech and hearing, Mysore.

Inclusion criteria

- All the participants were in the age range of 20 – 60years.
- All of them were native speakers of Dravidian language (Malayalam, Tamil, and Kannada)
- The participants diagnosed as having voice problem among different voice disorders were included.

Details of participants are given below

Sl no	Age	ENT diagnosis	Severity of dysphonia
1	43/F	Vocal nodule	Mild hoarse voice
2	55/M	Glottic chink	Mild hoarse voice

3	60/M	Early vocal nodule	Mild hoarse voice
4	52/F	Vocal nodule	Mild hoarse voice
5	20/F	Early vocal nodule	Mild hoarse voice
6	26/F	Early vocal nodule	Mild hoarse voice
7	48/M	Spasmodic dysphonia	Mild hoarse voice
8	36/M	Vocal nodule	Mild hoarse voice
9	29/M	Early vocal nodule	Mild hoarse voice
10	30/F	Glottis chink	Mild breathy voice
11	20/M	Phonatory gap with thick vocal cord	Mild hoarse voice
12	35/M	Vocal cord palsy	Mild hoarse voice
13	60/M	Early vocal nodule	Mild hoarse voice
14	60/M	Vocal polyp	Mild hoarse voice
15	48/F	Vocal cord nodule	Mild hoarse voice
16	40/M	Post thyroidectomy right vocal cord palsy	Mild hoarse voice
17	60/M	Vocal cord nodule	Mild hoarse voice
18	20/F	Chronic laryngitis	Mild hoarse voice
19	30/M	Vocal nodule	Mild hoarse voice
20	24/M	Chronic laryngitis	Mild hoarse voice
21	35/F	Early vocal nodule	Mild hoarse voice
22	23/F	chronic laryngitis	Mild hoarse voice
23	23/M	Early vocal nodule	Mild hoarse voice
24	20/M	Early vocal nodule	Mild hoarse voice
25	20/M	Early vocal nodule	Mild hoarse voice
26	42/F	Vocal cord palsy	Moderate hoarse voice

27	32/M	Sulcus vocalis	Moderate hoarse voice
28	55/F	Vocal nodule	Moderate hoarse voice
29	50/M	Vocal nodule	Moderate hoarse voice
30	43/F	Vocal cord palsy with glottic chink	Moderate hoarse voice
31	20/F	Glottic chink	Moderate hoarse voice
32	56/M	Dysphonia plica ventricularis	Moderate harsh voice
33	22/F	Glottis chink	Moderate breathy voice
34	20/M	Early vocal nodule	Moderate hoarse voice
35	55/M	Vocal nodule	Moderate hoarse voice
36	52/M	Vocal nodule	Moderate hoarse voice
37	50/M	Early vocal nodule	Moderate hoarse voice
38	55/M	Vocal cord paralysis	Severe hoarse voice
39	55/M	Vocal nodule	Severe breathy voice
40	59/M	Vocal cord paralysis	Severe breathy voice
41	30/M	Left vocal cord palsy	Severe breathy voice
42	27/M	Laryngeal web	Severe breathy voice
43	60/M	Right vocal cord palsy	Severe breathy voice
44	60/M	Left vocal cord paralysis	Severe hoarse voice
45	58/F	Leukoplakia	Severe hoarse voice
46	60/F	Left vocal cord paresis	Severe hoarse voice
47	33/F	Glittic chink with thickened cord on phonation	Severe hoarse voice
48	19/M	Glottis chink	Severe hoarse voice

49	40/M	Early vocal nodule	Severe breathy voice
50	58/M	Chronic laryngitis	Severe hoarse voice

Table 4: Participants details

Procedure and measurement

The audio recordings of the speech samples were done in a quiet room in CSL 4500 (Kay Elemetrics, NJ) with sampling frequency of 44.1 KHz and 16 bit resolution Shure (SM48) dynamic microphone. Before the recording Participants were instructed to sit straight and in a relaxed manner. During recording the microphone was placed 6 cm away from the patient's mouth to avoid breathing noise. The similar recording setting was used for the subjective and objective audio sample recordings.

Objective evaluation

Dysphonia Severity Index (DSI)

Dysphonia severity index (DSI) was used for the objective evaluation of the dysphonic voice. DSI measurement is a multiparametric approach to the evaluation of voice quality objectively. DSI is based on the weighted total of the following selected set of voice measurements:

• Highest frequency (in hertz);

• Lowest intensity (in decibels);

• Maximum phonation duration (in sec);

• Jitter (in percent);

DSI is constructed as:

DSI= 0.13(MPT) +0.0053 (High-FO) - 0.02(low-In) - 1.18(jitter %) +12.4.

It is constructed such that a perceptually normal voice corresponds with a DSI of +5; a severe dysphonic voice corresponds with a DSI of -5. The score beyond this range are also possible (higher than+5 or lower than -5).

Maximum phonation time (MPT-sec)

The participants were instructed to inhale deeply and sustain vowel |a| for as long as possible at a comfortable pitch and loudness. This was recorded three times. Phonation time was measured as the time duration between the onset and offset of regular waveform and the average of the three measured MPTs was used for further analysis.

Frequency and Intensity (High-FO - Hz & low-In -dB SPL)

Voice range profile of CSL 4500(Kay Elemetrics) programme was used for recordings. Participants were asked to phonate on vowel /a/ as softly as possible at a comfortable pitch. After that, they were instructed to phonate on vowel /a/, starting at a comfortable pitch going up to the highest and down to the lowest pitch. The clinician prompted and modeled the subject to achieve the highest possible pitch. The frequency was measured in Hertz, intensity in dBSPL.

Jitter (%)

Participants were asked to sustained phonation of the vowel /a/ three times at a comfortable pitch and loudness for 5 seconds. The sample was analyzed using MDVP Advance programme of the CSL 4500. Percent jitter was calculated on a sample of 4 seconds. The first and last half-second of the sample was eliminated for the analysis. The lowest of the three calculations was used for DSI calculation.

Perceptual evaluation

Consensus Auditory - Perceptual Evaluation of Voice (CAPE-V)

Consensus Auditory - Perceptual Evaluation of Voice (ASHA, 2002) rating scale was used for perceptual evaluation in this study. CAPE-V rates the voice based on six parameters namely Roughness, Breathiness, Strain, Pitch, loudness and Overall Quality of voice.

Following figure shows the complete CAPE-V form given by ASHA, 2002.

Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V)

Name:______________________________ **Date:**__________

The following parameters of voice quality will be rated upon completion of the following tasks:

1. Sustained vowels, /a/ and /i/ for 3-5 seconds duration each.
2. Sentence production:
   a. The blue spot is on the key again.
   b. How hard did he hit him?
   c. We were away a year ago.
   d. We eat eggs every Easter.
   e. My mama makes lemon muffins.
   f. Peter will keep at the peak.
3. Spontaneous speech in response to: "Tell me about your voice problem." or "Tell me how your voice is functioning."

Legend: C = Consistent I = Intermittent
MI = Mildly Deviant
MO =Moderately Deviant
SE = Severely Deviant

SCORE

Overall Severity ________________________________ C I ____/100
MI MO SE

Roughness ________________________________ C I ____/100
MI MO SE

Breathiness ________________________________ C I ____/100
MI MO SE

Strain ________________________________ C I ____/100
MI MO SE

Pitch (Indicate the nature of the abnormality): ____________
________________________________ C I ____/100
MI MO SE

Loudness (Indicate the nature of the abnormality): ____________
________________________________ C I ____/100
MI MO SE

__________ ________________________________ C I ____/100
MI MO SE

__________ ________________________________ C I ____/100
MI MO SE

COMMENTS ABOUT RESONANCE: NORMAL OTHER (Provide description):______________
____

ADDITIONAL FEATURES (for example, diplophonia, fry, falsetto, asthenia, aphonia, pitch instability, tremor, wet/gurgly, or other relevant terms):

Clinician:________________

Figure1: Score sheet of CAPE-V (ASHA, 2002)

Procedure

Each participant was audio recorded in the CSL 4500 (Kay Elemetrics) on three tasks

- ✓ Vowel
- ✓ Sentence
- ✓ Conversational speech (running speech)

Task 1: Sustained vowel

Three vowels /a/, */i/* and /u/ were selected in this task. Here, the participants were instructed to take deep breath and phonate vowel /a/ continuously as much as he/ she can possible in typical voice. Each vowel was repeated 3 times for each individual.

Task 2: Sentences

Standard passages of all Dravidian languages (Tamil, Malayalam, and Kannada), taken from Savithri and Jayaram (2005) was used as a reading passage for this study.

Task 3: Running speech

The clinician was elicited at least 20 second of natural conversation speech at comfortable level using standard interview questions such as, "Tell me about your voice problem" or "tell me your hobbies"

The three tasks were recorded with an interval of 5 sec between each task. These samples (sustained phonation, conversation and Running speech) were given to the ten speech language pathologist for rating of the voice samples in on Consensus Auditory - Perceptual Evaluation of Voice (ASHA, 2002). The raters had minimum of two year experiences in voice assessment and management. Before perceptual evaluation each raters were presented with information on the history of the CAPE-V and the definition and meaning for each of the perceptual terms. And a model of the CAPE-V evaluation was also given to each rater to get reduce the difference in the internal standard between raters

Procedure for CAPE-V rating

All rater were asked to listen the phonation, reading and conversation samples before rating the CAPE-V parameters based on the ASHA (2002). The voice samples were presented through head phone. All ten SLP were listened 58 voice disorder samples, among the 58 sample eight samples (15%) were repeated randomly to check the intra rater reliability. Two sessions were used for the complete rating of all the fifty eight samples. The collected data was tabulated on to SPSS software (version-18) for further appropriate statistical analysis. Ten raters rating average was taken for the comparison with DSI value.

Statistical analysis

The data obtained after objective evaluation of voice by clinician and perceptual evaluation of voice by various raters was subjected to statistical analysis using SPSS (version 18) in order to determine if there is,

- ✓ Test retests reliability across all objective parameters which were used for the calculation of Dysphonia Severity Index.

- ✓ Intra and inter judge reliability of all parameters of CAPE-V across and within raters
- ✓ Comparison of DSI with CAPE-V across all subjects.

Reliability correlation coefficient was used to calculate the test retest, inter-rater and intra rater reliability. MANOVA was used to find the age and gender difference in CAPE-V and DSI parameter. Also one – way ANOVA was used to find the effect of degree of severity on DSI and CAPE – V. Pearson correlation coefficient was used to made comparison between DSI and its parameters with CAPE-V and its parameters.

CHAPTER-IV

RESULTS

The purpose of the present study was to compare the Dysphonia severity index (DSI) with Consensus auditory perceptual evaluation of voice (CAPE-V) in individuals with voice disorders for Indian population. The SPSS (version 18) was used for the statistical analysis. The present study results were described under the following headings:

- ✓ Mean standard deviation of DSI and CAPE-V parameters
- ✓ Age and gender effect on DSI and CAPE-V parameters
- ✓ Correlation between DSI and CAPE-V parameters for all dysphonic
- ✓ Correlation between DSI and CAPE-V parameters for different degree of dysphonic
- ✓ Reliability measures

Mean and standard deviation of DSI and CAPE-V parameters

The DSI was calculated for each participant by applying the values of MPT, jitter, highest fundamental frequency, and lowest intensity to the equation of DSI Using Excel sheet. Similarly, the CAPE-V was calculated for each participant by averaging the ten judges rating on each parameter (roughness, breathiness, strain and overall severity). Pitch and loudness were not analyzed as there was many judges did not indicate the abnormality by ratings. Table 5 shows mean standard deviation and range for all the parameters of DSI and CAPE-V. In CAPE-V parameters,

parameter		Mean (SD)	Range
	DSI	-3.52(3.83)	(-16.9) – (+2.70)
DSI parameters	MPT	8.49 (4.9)	1.75 - 23.75
	Jitter	3.44(2.68)	0.58 - 12.81
	High-F0	279.5(103.7)	146 – 739
	Low In	55.5(8.04)	40 – 68
CAPE-V Overall Severity		56.25(19.41)	19 – 86
CAPE-V parameters	Roughness	46.8(19.01)	11 – 79
	Breathiness	47.75(21.24)	11 - 83.5
	Strain	45.05(21.19)	7.5 – 86

Table 5: Mean and SD of DSI and CAPE-V parameters.

Age and gender effect on DSI and CAPE-V parameters

To find the age and gender effects on the DSI and CAPE-V parameter the MONOVA was carried out. MONOVA did not show any interaction effect between age and gender for any of the DSI and CAPE-V parameters.

The table 6 shows mean standard deviation, F-value and p-value between the age groups for DSI and CAPE-V parameters. In general, all the voice parameters were affected in greater degree in the older group compared to younger group. Specifically jitter, roughness, and strain showed significant difference between the two age groups.

Parameters	**Younger (20-40)**	**Older (40-60)**	**F-value (1,46)**	**p-value**
	Mean(SD)	**mean (SD)**		
DSI	-2.69(3.9)	-4.36(3.5)	2.267	0.139
MPT	8.23(4.26)	8.74(5.64)	0.157	0.694
Jitter	2.56(2.60)	4.32(2.50)	3.856	0.048*
High-F0	293(123.72)	265(79.11)	0.530	0.470
Low In	56.52 (8.69)	54.64(7.40)	0.006	0.940
CAPE-V Overall Severity	51.44(18.36)	61.07(19.58)	2.271	0.139
Roughness	40.30(19.20)	53.30(16.7)	4.584	0.038*
Breathiness	42.58(21.09)	52.93(20.5)	2.058	0.158
Strain	37.17(19.10)	53.02(20.51)	6.234	0.016*

***** Significant at the 0.05 level

Table 6: Mean, SD, F-value and p-value for between age group.

Similarly, the table 7 shows mean, standard deviation, F-value and p-value between the male and female for DSI and CAPE-V parameters. In general the male dysphonic were more affected than female dysphonic. In majority of the voice parameters females showed better voice parameters than male. Specially, jitter, High-F0 and Roughness showed significant difference between male and female. In jitter and High-F0 female had higher value than male, female roughness value was lower than male.

Parameters	Male	Female	F-value	p-value
	Mean(SD)	Mean (SD)	(1,46)	
DSI	-4.21(4.33)	-2.20(2.17)	2.395	0.129
MPT	8.8264(5.694)	7.8382(3.123)	0.328	0.570
Jitter	4.1052(2.967)	2.1598(1.335)	5.625	0.022*
High-F0	256.84(80.21)	323.70(130.22)	4.324	0.043*
Low In	54.90(8.60)	56.88(6.90)	0.805	0.090
CAPE-V Overall Severity	59.99(19.05)	49.0(18.51)	3.006	0.057
Roughness	51.16(17.8)	38.32(18.76)	4.584	0.038*
Breathiness	50.94(21.65)	41.55(19.54)	1.702	0.198
Strain	48.79(21.37)	37.91(19.44)	2.206	0.144

***** Significant at the 0.05 level

Table 7: Mean, SD, F-value and p-value for between genders.

Comparison of DSI with CAPE-V across all dysphonic

Pearson correlation coefficient values were calculated to compare the DSI Vs CAPE-V. Also the coefficient values were obtained across each parameter. Table 8 shows the coefficient values of DSI parameters Vs CAPE-V parameters. A Significant negative correlation showed between DSI and all parameters of CAPE-V and MPT Vs all parameters of CAPE-V, and significant positive correlation showed between Jitter Vs all parameters of CAPE-V.

n = 50 DSI / CAPE-V	**MPT**	**High-F0**	**Low In**	**jitter**	**DSI**
Roughness	-0.294*	-0.196	-0.066	0.649**	-0.577**
Breathiness	-0.467**	-0.052	-0.154	0.672**	-0.556**
Strain	-0.434**	-0.142	-0.086	0.704**	-0.628**
Overall severity	-0.500**	-0.178	-0.095	0.670**	-0.611**

***** Significant at the 0.05 level, ******Significant at the 0.01 level

Table 8: Coefficient values for DSI Vs CAPE-V for all dysphonics.

Comparison of DSI with CAPE-V in different degree of dysphonic

To compare the DSI Vs CAPE-V across different degree of dysphonic, all the participants where categorized according to the degree of dysphonic. Similarly, Mean and standard deviation for different severity of dysphonic subject were also calculated. Table 9 shows the mean, standard deviation, and range for mild moderate and sever degree of dysphonic. Majority of parameters in the DSI are less affected in mild dysphonic compared to moderate and severe dysphonic and similar trend is seen in CAPE-V parameters.

Parameter	**Mild dysphonic**		**Moderate dysphonic**		**Sever dysphonic**	
	Mean (SD)	**Range**	**Mean (SD)**	**Range**	**Mean (SD)**	**Range**
DSI	***-1.63(2.5)***	***(-6.80)-(+2.3)***	***-3. 89(3.5)***	***(-10.21)-(+2.7)***	***-6.83(4.01)***	***(-16.94)-(-2.3)***
MPT	10.60 (5.5)	3.83-23.75	6.45 (2.9)	1.75-12.05	6.30(3.40)	1.91-14.36
Jitter	2.12(1.4)	0.58-7.19	3.97(2.3)	1.04-7.43	5.48(3.44)	1.66-12.81
High-F0	275.12(116.6)	164-739	296. 5(112.9)	146-466	272.46(68.16)	164-415
Low In	55.24(8.4)	41-67	53.91(9.5)	40-66	57.76(5.30)	49-68
Overall Severity	***41.3(12.6)***	***19-67***	***56. 04(12.7)***	***35-68***	***65.15(9.61)***	***50.5-79***
Roughness	32.82(13.7)	11-56.5	58.5(12.6)	39.5-77.50	69.10(12.92)	44-83
Breathiness	31.50(13.5)	11-63	55.8(12.9)	39.5-72.50	67.86(11.62)	51.5-86
Strain	28.08(11.48)	7.5-51	65.5(12.9)	44-81	76.48(11.62)	58.5-86

Tables 9: Mean SD and range for different degree of dysphonics.

One-way ANOVA performed to find the differences among the degree of dysphonics in DSI and overall severity of CAPE-V. Table 10 shows the F-value and the p-value for different degree of dysphonic. It showed significant difference among the different degree of dysphonic for DSI and overall severity of CAPE-V. Overall severity showed greater difference for different degree than DSI. Figure 2 & 3 shows the mean and 95th confidence interval for all the degree of dysphonics.

Parameters	d f	F -value	p-value
DSI	2	11.2	0.000***
Overall Severity	2	42.9	0.000***

*****Significant at the 0.001 level

Table 10: F-value and p-value for different degree of dysphonics.

Further, Post-Hac test was done to find among which degree of dysphonic, the difference was present. Table 11 shows the p –value for comparison among the different degree of dysphonic. It shows that mild and severe category shows significant difference in DSI value and overall severity of the CAPE –V, mild and moderate category shows no significant difference in the DSI value, but it shows significant difference in the overall severity of the CAPE-V, whereas moderate and severe category shows no significant difference in DSI and overall severity of CAPE-V.

Parameters	Comparisons	p-value
DSI	Mild - Moderate	0.155
	Mild – Sever	0.000***
	Moderate - Sever	0.083
Overall Severity	Mild -Moderate	0.000***
	Mild – Sever	0.000***
	Moderate - Sever	0.073

*****Significant at the 0.01 level

Table 11: p –value for comparison among the different degree of dysphonic

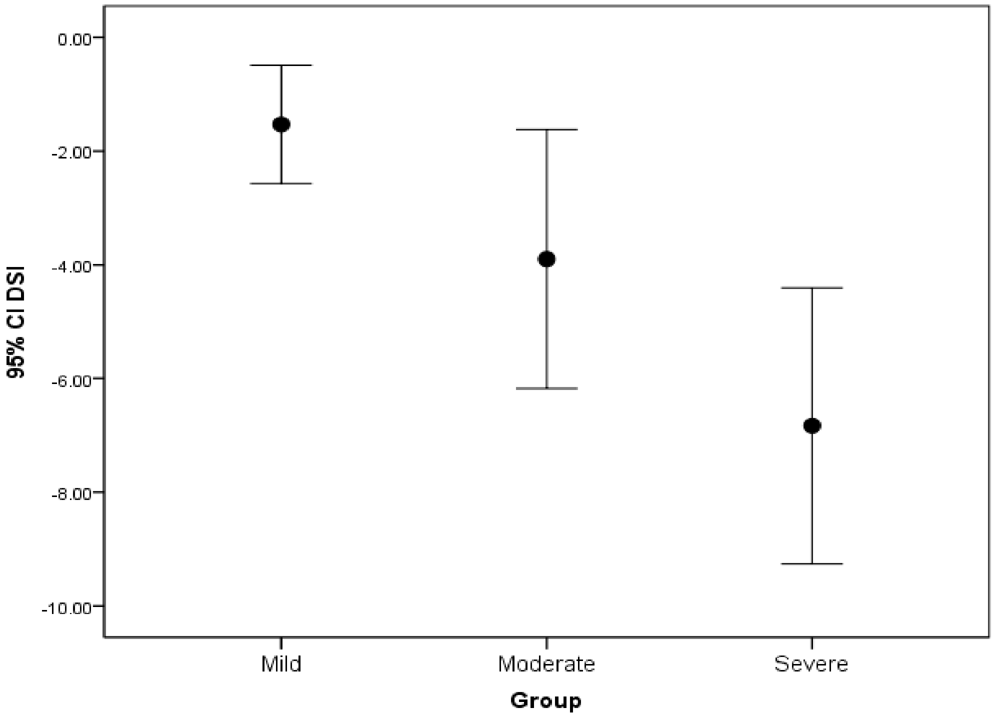

Figure 2: Mean and distribution of DSI across different dysphonics.

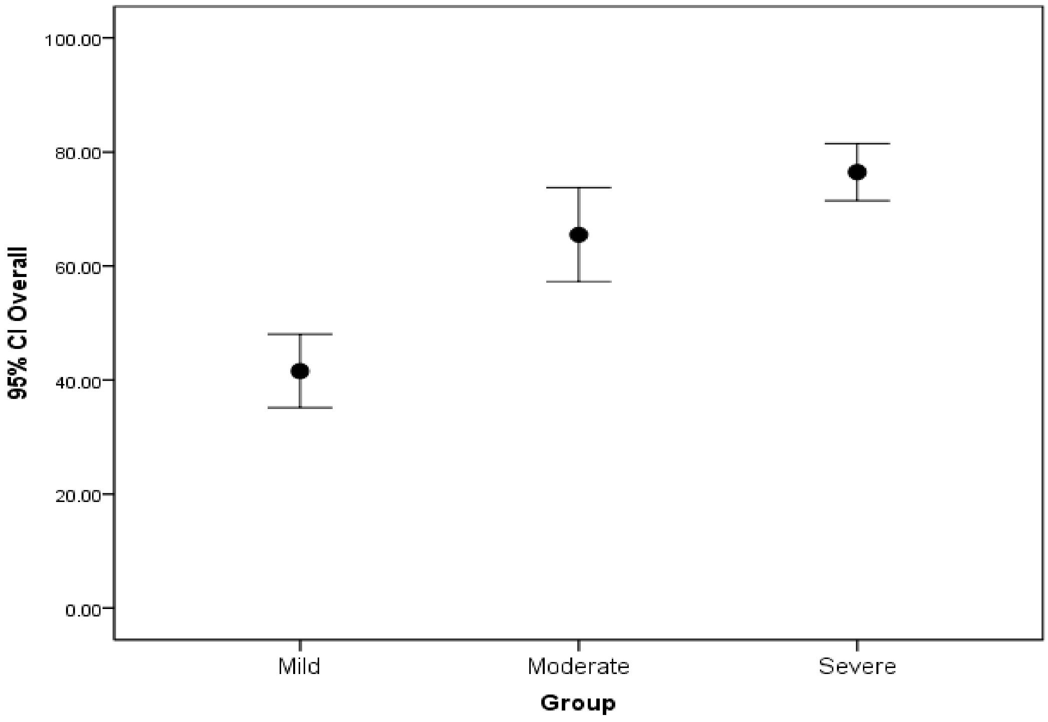

Figure 3. Mean and distribution of overall severity of CAPE-V across different dysphonics.

Pearson correlation coefficient values were calculated to compare the DSI Vs CAPE-V for mild dysphonic participants. Also the coefficient values were obtained across each parameter. Table 12 shows the coefficient values of DSI parameters Vs CAPE-V parameters for mild degree. No Significant correlation between DSI and any of the parameters of CAPE-V although all the coefficient values were in negative. However, jitter showed significant correlation with roughness and strain. In general, poor correlation coefficient value showed between DSI and CAPE-V parameters in mild dysphonic.

(n=25) DSI / CAPE-V	MPT	High-F0	Low In	jitter	DSI
Roughness	0.228	-0.308	-0.257	0.424*	-0.075
Breathiness	-0.012	-0.075	-0.408*	0.377	-0.077
Strain	0.088	-0.259	-0.328	0.488*	-0.085
Overall severity	-0.189	-0.271	-0.355	-0.403	-0.113

***** Significant at the 0.05 level, ******Significant at the 0.01 level

Table 12: Coefficient values for DSI Vs CAPE-V parameters for mild dysphonic.

Table 13 shows the correlation coefficient values of DSI parameters Vs CAPE-V parameters for moderate degree of dysphonic. A Significant negative correlation showed between DSI and overall severity of CAPE-V and roughness. High-F0 also showed significant negative correlation with roughness, strain and overall severity. In general a good negative correlation coefficient values found between DSI and CAPE-V parameters.

(n=12) DSI / CAPE-V	MPT	High-F0	Low In	jitter	DSI
Roughness	-0.186	-0.721**	-0.099	0.701*	-0.602*
Breathiness	-0.615*	-0.441	-0.386	0.503	-0.251
Strain	-0.520	-0.618*	-0.183	0.605*	-0.491
Overall severity	-0.397	-0.691*	-0.178	0.659*	-0.532*

***** Significant at the 0.05 level

Table 13: Coefficient values for DSI Vs CAPE-V parameters for moderate dysphonic.

Table 14 shows the correlation coefficient values of DSI parameters Vs CAPE-V parameters for severe degree of dysphonic. A Significant negative correlation showed between DSI and breathiness, strain and overall severity of CAPE-V. MPD showed significant negative correlation with roughness, strain and overall severity. Also jitter showed significant positive correlation with roughness, strain and overall severity. In general a high negative correlation coefficient values found between DSI and CAPE-V parameters.

(n=13) DSI / CAPE-V	MPT	High-F0	Low In	jitter	DSI
Roughness	-0.543	0.332	-0.166	0.465	-0.443
Breathiness	-0.776**	0.198	-0.218	0.682*	-0.683*
Strain	-0.705**	0.104	-0.374	0.696**	-0.643*
Overall severity	-0.822**	0.215	-0.161	0.609*	-0.631*

* Significant at the 0.05 level, **Significant at the 0.01 level

Table 14: Coefficient values for DSI Vs CAPE-V parameters for moderate dysphonic.

Figure 4a, 4b and 4c shows the scatter plot of correlation between DSI and breathiness, strain and overall severity of CAPE-V for sever degree of dysphonic. Among the three parameters, breathiness is more negatively correlated with DSI.

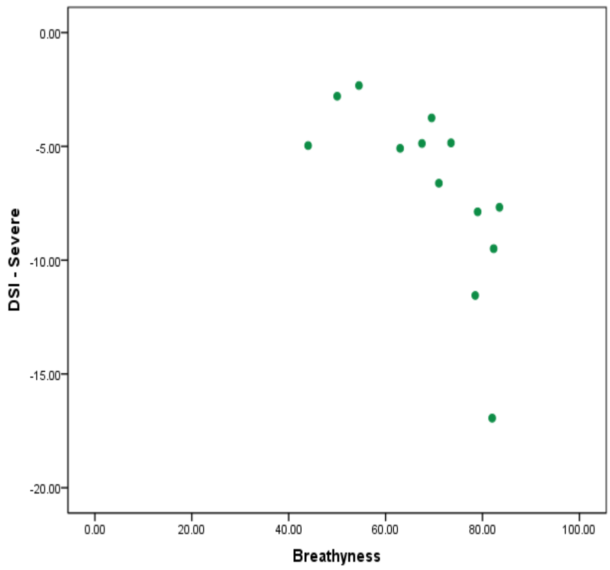

Figure 4a: Scatter plot of DSI Vs breathiness in severe dysphonic.

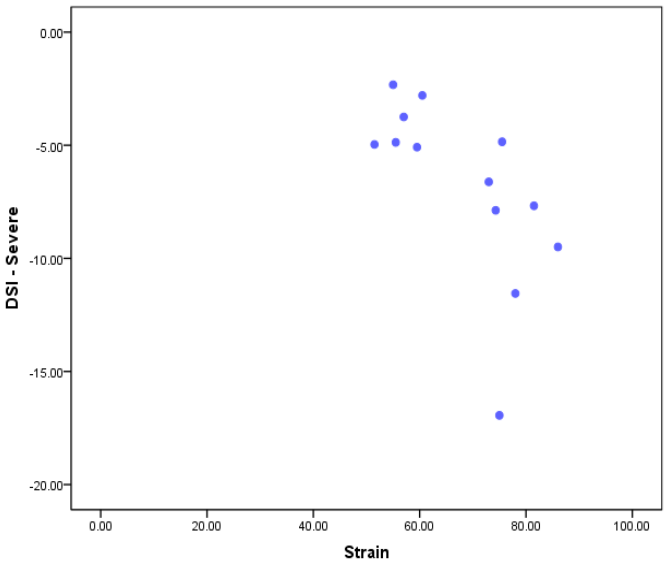

Figure 4b: Scatter plot of DSI Vs Strain in severe dysphonic

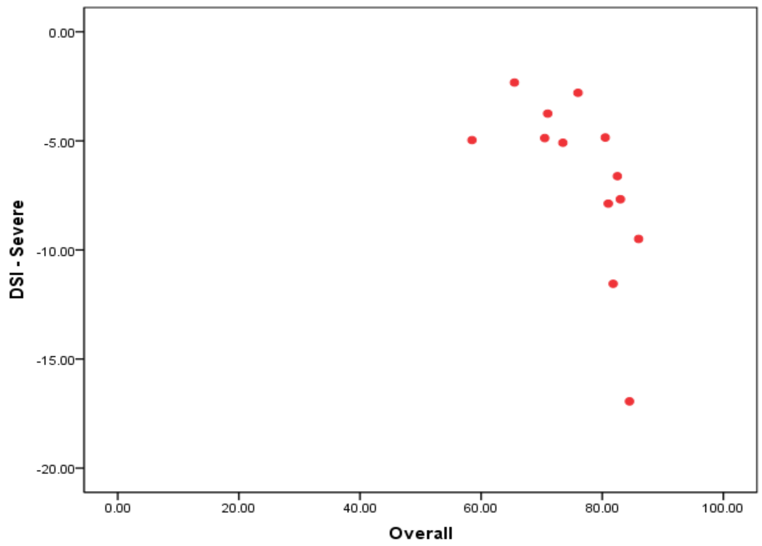

Figure 4c: Scatter plot of DSI Vs overall severity in sever dysphonic.

Reliability measures

(i) Test retests reliability of objective parameters

To find the test retest reliability for objective parameters, the second repetition of voice sample was compared with the third repetition voice sample. The reliability coefficient (Cronbach's alpha-α) was calculated using SPSS. Table 15 shows the test retest reliability of MPT and Jitter. The alpha (α) coefficient was more for MPT compared to jitter percent.

Sl. No	Parameters	Reliability coefficient (α)
1	MPT	0.966
2	Jitter (%)	0.916

Table 15: Test-retest reliability of MPT and jitter.

Inter and intra rater reliability of CAPE-V parameters

Table 16 illustrate inter rater reliability across each parameters (roughness, breathiness, strain, pitch, loudness, overall). Cronbach's alpha (α) coefficient was computed for reliability between the judges in each parameter. All six parameters showed very good cronbach's alpha (α) value. Among these parameters, overall (0.952) got high inter rater reliability and pith (0.876) got low inter rater reliability. However the inter rater reliability is good for all parameter of CAPE-V.

Sl. No	Parameters	Reliability coefficient (α)
1	Roughness	0.933
2	Breathiness	0.951
3	Strain	0.947
4	overall	0.952

Table 16: Inter-rater reliability for CAPE-V parameters

Similarly intra-judge reliability within each judge across each parameter was also calculated using cronbach's alpha; here 20% of samples were rated two times by each judges. Table 17 depicts the intra judge reliability across each parameter. All parameters got good cronbach's alpha (α) value. Among them strain got high and loudness got low intra-rater reliability. However the intra rater reliability is good for all the parameters.

Sl. No	Parameters	Reliability coefficient (α)
1	Roughness	0.978
2	Breathiness	0.986
3	Strain	0.995
4	overall	0.971

Table 17: Intra-rater reliability for CAPE-V parameters

CHAPTER-V

DISCUSSION

Many researchers are of the view that there is not a single instrumental voice measure which can adequately quantify voice quality and severity (Yu, et al, 2001). Therefore, multi-parametric evaluation of dysphonia has been advocated. This approach considers the multi-dimensional nature of voice and integrates different voice measures to describe dysphonia. Wuyts, et al. (2000) developed an objective multi-parametric measurement to assess voice quality. Since then several studies had compared the DSI with GRBAS scale because, it is the most widely used perceptual rating scale for voice evaluation. But, it has several limitations due its large interval. Hence the presents study aimed at compare DSI with CAPE – V in Indian dysphonic population. The objective of the study was to calculate the DSI value for people with dysphonia in Indian population and comparison this objective measure (DSI) with subjective measure (CAPE-V). The current study investigated 50 (33 males and 17 females) dysphonic subjects with different degree of severity.

Mean and standard deviation of DSI and CAPE-V parameters

The mean value of all the voice parameters were affected in compared to the normal range. The mean value of the DSI value for the present study is (-3.50), which was found to be well below the normal voice DSI in Indian population (jayakumar & savithri, 2010). Wuyts et al (2000) also showed that DSI value for dysphonic subjects ranges from 1.02 to –5. 0 for G1 – G4 voices in GRBAS scale.

Age effect on DSI and CAPE parameters

The current study did not show a significant effect on age for most of the DSI and CAPE-V parameters. However, in general all the voice parameters were affected in greater extent in the older group compared to the younger dysphonic, specifically the parameters jitter, roughness and strain showed significant difference between the older and younger group. The possible reason many be age related change in the vocal track is added along with dysphonia in older group than younger group. Jitter was higher in older population than younger population. This was supported by several studies, investigated pitch perturbation (Jitter), and indicated that jitter value increases with increasing age (Benjamin, 1981; Benjamin, 1997; Biever & Bless, 1989; Casiano et al., 1994; ferrand, 1995; Hagen & Lyons, 1996; Mueller, 1997; Raming, Gray, Baker, Corbin-Lewis, Buder, Luschei et al., 2001; Xue, 1995). Acoustic analyses of sustained vowel production revealed that higher jitter in the elderly than in younger participants (Linville & Fisher, 1985; Ramig & Ringel, 1983; Wilcox & Horii, 1980). This was in concordance with the previous study by Jayakumar and Savithri (2010). But Hakkesteegt et al (2006) showed significant difference between older and younger age group on DSI value and its parameters. CAPE –V parameter showed only roughness and strain was higher in older than younger group across different age group. Again this can be attributed to age related change in the vocal track. Akanksha and pushpavathi (2009) showed there is no age related differences in CAPE-V measurements.

Gender effect on DSI and CAPE parameters

The current study did not show a significant effect on gender for most of the DSI and CAPE-V parameters. However, in general all the voice parameters were affected in greater extent in the male compared to the female dysphonic except MPT, specifically the parameters jitter, roughness and High-F0 showed significant difference between the male and female.

Male had high jitter and roughness than female and female had High-F0 than male. Nam, Nam and Lee (1997) suggested that elderly females showed the same levels of jitter and shimmer as younger females, but older males showed greater jitter and shimmer than younger males. Wuyts, et al. (2000) showed no gender difference on DSI because the difference in High F0 (Higher in females) and MPT (higher in males) are opposite and counteracted each other to balance the final DSI value. Although Hakkesteegt, et al. (2006) did not find difference in gender on DSI, they predicted normative DSI value based on age and gender, and considered gender difference for DSI and females had a better DSI value than males. Jayakumar and Savithri (2010) showed a gender difference in DSI value. However, above mention studies had been done in subjects with normal voice rather than dysphonic. Jitter had significant difference among gender in this current study, the values of males (4.10%) were found to be higher than females (2.15%). This is contrast with Fitch, 1990; Van de Heyning, et al. 1998 and Wuyts, et al. (2000) reported higher jitter for females (0.79 %) than for males (0.63%). Along with the jitter there was a significantly greater High-F0 for females compared to males. Due to vocal fold length and structural difference in larynx among the gender is the most probable cause for the greater high-F0 in females (Hollien, et al., 1971; Van de Heyning, et al., 1998; Wuyts, et al., 2000). However, the present study is on subjects with dysphonic rather than subjects with normal voice. Among the CAPE-V parameters none of the parameter showed significant difference among gender except roughness. Roughness was high in males compared to female. This can be attributed to the structural difference in the vocal fold between males and females. Similar finding was shown by Akanksha and pushpavati (2009).

Comparison of DSI with CAPE-V across all dysphonic

In the preset study, a significant negative correlation showed between DSI Vs all parameters of CAPE-V and MPT also showed significant negative correlation coefficient with all parameters of CAPE-V.

First, DSI had high negative correlation coefficient value with overall severity (-0.611**), roughness (-0.577**), breathiness (-0.556**) and strain (-0.628**) of CAPE-V. As the CAPE-V parameter value increases the DSI value decreased, which shows that DSI value decreases as the degree of dysphonia increases. i. e., as the severity of the any of the vocal parameters of the CAPE-V increases the DSI value decrease. Hakkesteegt, et al. (2008) and Jayakumar and Savithri (2009) also showed similar pattern of negative correlation was observed between DSI and CAPE-V parameters across all dysphonics. Hakkesteegt, et al. (2008) compared the DSI with the grade on the GRBAS scale on 294 clients with voice compliant and 118 volunteers without voice complaint. The result showed that DSI significantly lower when the score on GRBAS scale grade was high.

Second, jitter significant positive correlation with roughness, breathiness, strain and overall severity of the CAPE-V. Literature shows that perceptual parameters roughness, breathiness, and overall severity increased as the jitter percentage increases. Dejonckere, Remacle, Fresnel-Elba, Woisard, Crevier-Buchman, Millet (1996) investigated 943 voice patients and showed a good correlation between jitter and roughness on GRBAS scale. Jayakumar and Savithri (2009) also showed positive correlation between jitter and parameters of CAPE-V (roughness, breathiness, and overall severity).

Third, MPT showed significantly negative correlation with roughness (-0.294*), breathiness (-0.467**), strain (-0.434**) and overall (-0.500**) of the CAPE-V parameters. MPT is regarded a relevant variable in the DSI may lie in the fact that MPT can be regarded as a phonatory ability measure (Hirano, 1981). It reflects the efficacy of several mechanisms necessary for voice production such as subglottic pressure, airflow resistance, closure of the vocal folds, and so forth. Hence we can assume that if there is any reduction in the MPT will directly affects the perception of roughness, breathiness, strain, and overall severity. Jayakumar and Savithri (2009) also showed positive correlation between MPT and the parameters of CAPE-V.

In concordance with the current study, Leonard R Henry et al (2010) compared three measures (DSI, CAPE-V and VHI) in 64 patients who undergone thyroidectomy. This shows significant pre and post therapy changes in the DSI and CAPE-V, where both the parameters are comparable.

Comparison of DSI with CAPE-V in different degree of dysphonic

Comparison of the DSI and CAPE –V in different degree of dysphonics reveals that majority of the parameters in CAPE -V are less affected in mild dysphonic compared to moderate and sever dysphonia (table 9). This means there is linear positive correlation between CAPE –V parameter and severity of dysphonia. In contrast, the DSI value is high for mild group compared to moderate and severe dysphonic. Whereas for DSI, there is linear negative correlation between DSI and severity of dysphonia, Hence we can say that both DSI and CAPE –V are inversely correlated with each other. Similar findings were seen in previous literatures (Jayakumar and Savithri, 2009; Hakkesteegt, et al. 2006; Wuyts, et al. 2000).

Correlation of CAPE-V and DSI among different dysphonic

The current study indicated that, there was positive correlation between overall severity of CAPE-V and different degree of dysphonic, i.e. as severity increases CAPE-V scores will also increase. But, high positive correlation was found between DSI and different degree of dysphonics, i.e. as severity increases DSI value will decreases. This kind of correlation pattern was observed across different degree of dysphonic.

Reliability measures

The current study incorporated Dysphonia severity index (DSI) as objective measure and Consensus auditory perceptual evaluation of voice (CAPE-V) as a subjective measure. The present study showed high test rest reliability for DSI parameters (MPT = 0.96; jitter = 0.91). CAPE –V parameters also showed good inter and intra rater reliability (table 16 & 17) This is in concordance with the previous study done by Akanksha & pushpavathi (2009), they investigated the reliability of perceptual evaluation of voice disorders using CAPE –V scale in Indian context and they concluded that CAPE – V scale was a good perceptual measure for the evaluation of the voice quality. This also was supported by various researchers like Wolf et al (1995), Munoz et al (2002) and Zraick et al (2005) for reliability in perceptual evaluation.

In general, the result of the current study reveals that DSI (objective measure) has good correspondence with CAPE – V (subjective measure). Most of the parameters in DSI also had good association with CAPE-V parameters. In this study we found a significantly lower DSI with higher perceptual score of overall severity of CAPE – V scale in Indian dysphonic population. This result is supporting with the previous study done by Jayakumar and Savithri (2009), they had good negative correlation with perceived roughness and breathiness of CAPE – V and DSI in Indian population.

Hence, DSI can be clinically useful in quantifying dysphonic severity. Although DSI was not able to differentiate the degree of severity as like CAPE-V, It could unambiguously differentiate among different dysphonic severity levels in an objective manner. This is clinically critical because it ensures a valid evaluation of dysphonia and treatment outcomes. Despite the number of studies which attempted to identify the best combination of instrumental measures for predicting perceptual severity with the intention of quantifying dysphonic severity, reports in the literature revealed that the percentage of concordance between the two measurements could range from 49.9%5 to 86.0%. Such inconsistent levels of association between perceptual and instrumental measures point to a definite need of more evidence before one can confidently replace perceptual judgement with instrumental evaluation. Until more information on the validity of voice measures is available, one should not over-rely on instrumental voice measures to quantify dysphonic severity. Some authors suggested a comprehensive approach and considered instrumental measures as a complement for perceptual evaluation in assessing dysphonic severity (Orlikoff et al. 1999). Based on the results of previous and the present study, we agree with these authors and recommend both perceptual and instrumental voice measurements should be included in a clinical voice assessment protocol because so far research did not find the correct objective measure (either single or multiparametric) that can replace the perceptual measurement.

CHAPTER-VI

SUMMARY AND CONCLUSIONS

The human voice is a complex and multidimensional sound signal and as a consequence measuring its quality is difficult. Hence, the assessment of voice disorders should be multidimensional as well. Literature shows that there is not a single instrumental voice measure which can adequately quantify voice quality and severity. Therefore, multi-parametric evaluation of dysphonia has been advocated. Wuyts, et al. (2000) developed an objective multi-parametric measurement to assess voice quality. Several authors have investigated studies on DSI in clinical population and various rehabilitation conditions to improve the reliability and acceptability of the DSI. But still to improve the usefulness of this objective measure in assessing dysphonia, it is necessary to compare it with the perceptual measure because the perceptual assessment is still regarded as the "golden standard" for the voice quality. Since then several researchers had compared the DSI with other perceptual rating scales such as GRBAS, VHI etc. GRBAS scale considered as most widely used system among them. On the other hand, it has several limitations. Hence, Consensus auditory perceptual evaluation of voice was developed by ASHA (2002) to overcome the limitation of the GRBAS scale. The DSI was developed using European normal participants and dysphonic subjects. It is found that the DSI value and few basic parameters of DSI were different from European population to Indian population. The DSI value was found to be significantly less in Indian population, mainly due to the reduction in the MPT value (Jayakumar & Savithri, 2010). It is wise think that the DSI value will be different even in dysphonic subjects in compare to the European dysphonic subjects. Therefore, need of the study was to address these concerns the present study aimed at comparing objective measure DSI and the subjective measure CAPE- V in Indian dysphonic population.

The main objective of the present study was to develop DSI measure for people with dysphonia in Indian population and to compare objective evaluation DSI and subjective evaluation CAPE-V.

In the present study 50 participants, who were diagnosed as having voice problem by speech language pathologists and ENT specialist were taken. The subjects considered were in the age range of 20-60 years of age. Two type of assessment, objective evaluation using DSI and subjective evaluation using CAPE-V were done. For the calculation of DSI all the parameters such as MPT, Jitter %, highest - F0 and low - In were calculated using advanced MDVP program in CSL 4500 (Kay Elemetrics, NJ) with sampling frequency of 44.1KHz and 16 bit resolution shure (SM48) dynamic microphone. And for the perceptual evaluation 10 raters, who had 2 year of experience in voice assessment and management were asked to rate on CAPE-V based on its parameters. The data obtained after objective evaluation of voice by clinician and perceptual evaluation of voice by various raters was subjected to statistical analysis using SPSS (version 18) for appropriate further analysis. MANOVA was used to find the age and gender difference and one way ANOVA was carried to find correlation of CAPE-V and DSI across different dysphonic, finally Pearson correlation coefficient was to compare the CAPE-V and DSI parameters. Reliability coefficient was used to find test retest and inter-intra rater reliability of different parameters of the DSI and CAPE – V parameters.

The present study showed the DSI mean value of -3.52 for individual with voice disorders for Indian population. It also showed no significant age and gender effect on DSI and CAPE-V parameters. However, older group had affected more on voice parameters than younger group and only jitter showed significant difference between genders.

The comparison of DSI with CAPE-V showed significant correlation in most of the parameter. However DSI value (objective measure) was negatively correlating with CAPE-V parameters (Subjective measure). But this correlation found to be different across different dysphonics categories. This correlation was more significant for severe category than mild and moderate category. In mild category, there is no direct correlation between DSI value and CAPE-V parameters. But roughness, breathiness, and strain of CAPE- V were correlated with low-In and jitter measures of DSI. In moderate category, roughness and overall severity of CAPE-V shows direct correlation with CAPE-V. Finally, in severe category breathiness and strain of the CAPE-V shows correlation with DSI. However, across all the dysphonic, there was significant correlation between DSI and CAPE-V.

Further similar studies needs to be done with larger sample to check the validity of the current result.

Implication of the study:

- ✓ DSI value for different degree of dysphonic can be used in clinical population
- ✓ Also using DSI value, we can classify the degree of dysphonia with caution.

Future direction

- ➢ Whether can able to differentiate DSI different type of disorder.
- ➢ DSI validity need to evaluated more number of subjects in mild dysphonics
- ➢ Present study need to be repeated with greater number of subjects

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