SPEECH CHARACTERISTICS IN ADULTS WITH UNREPAIRED CLEFT PALATE

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May, 2016

CERTIFICATE

This is to certify that the dissertation entitled **"Speech Characteristics in Adults with Unrepaired Cleft palate"** is the bonafide work submitted in part fulfillment for the degree of Master of Science (Speech-Language Pathology) of the student (Registration No.14SLP028). 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 the dissertation entitled **"Speech Characteristics in Adults with unrepaired Cleft Palate"** 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 **"Speech Characteristics in Adults with Unrepaired Cleft Palate"** is the result of my own study under the guidance of Dr. M. Pushpavathi , Department of Speech Language Pathology, All India Institute of Speech and Hearing, Mysore, and has not submitted earlier in any other University for the award of any Diploma or Degree.

Mysuru **Register No: 14SLP028**
May , 2016

THOSHI

Dedicated to My lovely and caring Ammu and Papu

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INTRODUCTION

Cleft lip and palate (CLP) is the most common congenital birth defect forming malformation of the face and oral cavity that happens during pregnancy (Kummer, 2008). These malformation in the face and oral cavity will often exhibit multiple difficulties such as early feeding difficulties, developmental delays, abnormal speech and/or resonance, dentofacial and orthodontic abnormalities, hearing loss, and probably, psychosocial issues (D'Antonio & Nagarajan, 2003).

The incidence and prevalence of CLP in India is reported to be 1 in 650 live births and the birth rate of cleft is found to be 1.09 for every 1000 live births. Among them 65% were males in which 33% had only cleft lip, 64% had cleft lip and palate, 2% had cleft palate, 1% had rare craniofacial clefts and 79% had unilateral cleft lip of which 64% had left sided (Srinivas et al., 2001). The incidence of the CLP is also reported to be around 40,000 every year (Shrivatsav, 2013).

As a resultant of inter-related causative factors, various deviations and deficiencies will be exhibited by individuals with CLP. These exhibited deviations and deficiencies would be in terms of cleft type/severity, associated syndromes, age at when palate repair was done and its efficiency, unrepaired residual cleft, presence of fistula, status of velopharyngeal function, hearing status, amount and efficacy of communication interventions and socioeconomic/linguistic status of the family (Scherer, D'Antonio, & McGahey, 2008).

CLP is often associated with communication disorder. Among this speech disorder is often reported in the literature. There are studies, which conclude that essential components related to communication such as, receptive language, expressive language, speech, resonance, voice, hearing, and the social use of language can be affected by the presence of a cleft (Morris, 1962; Chapman, Hardin-Jones, & Halter, 2001; Sunitha, Jacob, Jacob, & Nagarajan, 2004; Peterson, Hardin, & Karnell, 2009).

1.1. Communication Disorders in CLP

Among the speech disorders, articulation disorder is reported to be more. A child with CLP has potential range of articulation problems due to changes in breathing direction and inadequate breath support. Individuals with CLP has difficulty in articulating tongue tip complex sounds and sounds produced with back of the tongue as compared with the articulation of lip or tongue tip simple sounds (Counihan and Starr, 1956). Thus, they state that while articulating consonants, which are produced within oral cavity, may sound inappropriate or as weekend form.

The speech of individuals with CLP is characterized with weaken fricatives, plosives, affricates, audible nasal emission, double articulation, glottal gap, secondary articulation, tendency for contacts to be towards the back of oral cavity, and imprecise tongue tip movements (Stengelhofen, 1989). Children with CLP observed to have more difficulty in producing high pressure consonants, high incidence of misarticulating fricative and affricate sounds, followed by plosives, glides, and nasals (Peterson-Falzone, Hardin-Jones and Karnell, 2001).

Trost (1981) has coined the term called ‘compensatory articulation’ that defines the characteristics of speech in individuals with CLP. These include phonemes produced in a posterior portion of the vocal tract, abnormal positioning of tongue, abnormal positioning and functioning of the larynx and the epiglottis. The types of compensatory errors documented among children with CLP are glottal stop, laryngeal stop, pharyngeal stop, middorsum palatal stops, laryngeal fricative, pharyngeal fricative, posterior nasal fricative, laryngeal affricate, pharyngeal affricate, posterior nasal affricate, mid-dorsum palatal, mid-dorsum palatal fricative and mid-dorsum palatal affricate.

In addition, individual with CLP has also reported having voice disorders and is often influenced by other variables including resonatory and phonatory aspects of voice. Many studies have documented for the presence of voice disorder in individuals with CLP (Westlake, 1953; Hess, 1959; McWilliams, Bluestone, & Musgrave, 1969; Van Lierde, Bodt, Baetens, & Schrauwen, 2003; Gnanavel, Satish, & Pushpavathi, 2013). Individuals with CLP have observed to have significant deviations in terms of their vocal pitch and vocal loudness. Voice problems such as hoarseness (with or without vocal cord pathology), breathiness, reduced loudness, reduced pitch range, strained voice and devoicing are reported (Bzoch, 1964; McWilliams et al., 1969; Van Lierde et al, 2003). However, limited objective analyses have been documented as compared to subjective analysis for the evaluation of voice among individuals with CLP (Dickson, 1962; McWilliams et al., 1969; Gnanavel et al., 2013).

Presence of alterations in speech is due to incomplete separation of oral and nasal cavities resulting in hypernasality, hyponasality, mixed resonance, and cul-de-sac resonance (Scherer et al., 2008). The speech of individuals with CLP is primarily

characterized by abnormalities in nasal resonance due to unoperated cleft/fistula and or velopharyngeal dysfunction leading to nasal escape of sound energy (Bzoch, 2004). Thus, disturbances in articulation and resonance development can directly impact the intelligibility of the speech.

A study was conducted by Van Lierde, De Bodt, Van Borsel, Wuyts and Van Cauwenberge (2002) to understand an effect of cleft type on overall speech intelligibility and resonance. They compared the nasalance and nasality pattern of individuals with CLP and normals. The results indicates that there was no significant difference among type of clefts but there was a significant differences within the normal's and individuals with CLP, in nasalance values as well as nasality data and overall speech intelligibility.

Thus, as mentioned above these are the essential speech parameters which are majorly focused then compared to receptive language, expressive language, and the social use of language, which are equally affected in individuals with CLP (Peterson, Hardin, and Karnell, 2009). Additionally, CLP can be linked with imperfection in any one or in combination of these communication areas and little attention has paid to language development in individuals with CLP.

The presence of CLP affects a child's communication abilities and causes significant social, emotional, and educational difficulty. There are several reports stating that children with CLP shows delay within their expressive language, acquisition of sounds and words and limited inventory of sounds in early infancy (Chapman et, al., 2001 and Sunitha et, al., 2004). It has reported that they acquire words by the age of three, typically after undergoing palate surgery (Scherer, D'Antonio and Kalbfleisch,

1999). During preschool and school age years, children with CLP demonstrates poorer receptive and expressive vocabulary skills (Morris, 1962), poor performance on task involving object identification and naming, and shorter mean length of utterance (MLU) and reduction in both structural complexity and the variety of words used (Peterson, Hardin, and Karnell, 2009).

Thus, individuals with CLP form a heterogeneous group and they require an appropriate assessment tool for a proper treatment to improve their communication skills. However to assess the speech related difficulties in individuals with CLP several protocols have been developed. Since 90's there are several assessment protocols have been proposed for CLP, such as the *Cleft Audit Protocol for Speech* (Harland, 1996), *Evaluation of Speech and Hearing of a patient with Velopharyngeal Dysfunction* (Hirshberg & Van Demark, 1997), *The Great Ormond Street Speech Assessment* (Sell, Harding, & Grunwell, 1999), and *Cleft Audit Protocol for Speech- Augmented* (John, Sell, Sweeney, Harding-Bell, & Williams, 2006).

Among the well-known protocols 'universal parameters for reporting speech outcomes in individuals with cleft palate' (Henningson, Kuehn, Sell, & Sweeney, 2008) is the standard systematical protocol. This is applied to ensure accurate evaluation and provide information to guide effective intervention for individuals with cleft palate. It is one of such protocols used to assess all the speech characteristics and other associated difficulties in Individuals with CLP in one concise form. It has five universal reporting parameters Hypernasality, Hyponasality, voice, nasal air emission, consonant production errors and additionally 2 global parameters of speech understandability and speech acceptability for reporting cleft palate speech outcomes.

1.2. Rehabilitation of Individuals With CLP

From the developmental perspective in CLP, it is well accepted to provide cleft care over a longitudinal period, considering from birth through later adolescence. Provision of cleft care would be possible with an awareness of surgery facilities, which is considerably limited in India and act as a diverse challenge. It has been reported that parents could not afford to miss their livelihood for more than 7 days even to benefit free surgery and treatments under the Smile Train Program (Singh, 2009). These all add on a factor for late surgery and in turn, resultant for late intervention from attending speech and language therapy.

Most of the individuals/care takers of CLP are unaware about the services provided in a speech language therapy and they initiate coming for therapy during adulthood, a stage where they go beyond primary education/start working as an employer and have issues in their vocational setup such as, workplace, on-the-job discriminations, etc. Adolescence is the stage wherein active physical growth, hormonal changes and physiological learning takes place between the puberty and maturity (Riski, 1994). Many studies have put forth a statement that there are possibility of an improvement in articulation proficiency of children as they grow older that is as age increases the proficiency in articulation also improves (Van Demark, Morris, and Vandehar, 1979; Karnell and Van Demark, 1986; Lomander , Friede and Lilja, 2012). Yet, they are unsuccessful to perform similar to their age matched peers.

Few studies that are focused on adolescent's speech skills recommend for being concerned about the management of speech in the younger age itself (Riski, 1994;

Karnell and Van Demark, 1986). Most of the above studies are focused on children population by using subjective and objective methods to determine their articulation, resonance, speech intelligibility and language but considering the similar speech characteristics (articulation, nasality, intelligibility and voice outcome) studies under adult's population is comparatively less and limited attention has been provided.

Need for the study

The importance of early intervention provided to children with CLP in India is considerably limited. Singh (2009) documented a study wherein he opined that most of the individuals with CLP/care taker are unaware about the surgery facilities and speech and language therapy at an earlier age. In such consequence, they may have remarkable effect on their speech and language skills with in their growing period and would persist in adolescence stage as well, which would significantly affect their articulation, resonance, speech intelligibility and voice. Most of the Indian studies of CLP are focused on providing description of speech characteristics in children with CLP (Gopi sankar, & Pushpavathi, 2012; Gnanavel, & Pushpavathi, 2012; Navya, & Pushpavathi, 2014; Gnanavel et al., 2013; Sreedhanya, Hariharan, & Nagarajan, 2015). They are assessed in terms of their articulation, resonance, speech intelligibility and language skills .But, there are no Indian studies that has been conducted to investigate the speech characteristics of adolescence with repaired/unrepaired cleft palate. In this context, it is essential that speech language pathologist should be aware about the abnormal speech characteristics persisting in adolescence with unrepaired CLP and gain knowledge about the type of speech sound errors being persisting or reduced over the age. Hence, there is a need for

the study to understand the perceptual characteristics of the speech in adults with unrepaired CLP.

Aim of the study

The present study is aimed to provide an insight on speech characteristics in Kannada speaking adults with unrepaired CLP using Henningson's perceptual scale.

Objectives

- To investigate the perceptual characteristics related to articulation by using SODA errors, compensatory articulation and other error such as percentage of errors, place/manner of errors.
- To investigate the perceptual characteristics related to resonance (hypernasality, hyponasality, and nasal air emissions).
- To investigate the perceptual characteristics related to voice.
- To compare the speech intelligibility across words and spontaneous speech.

CHAPTER 2

REVIEW OF LITERATURE

Cleft lip and palate (CLP) is a congenital condition, which deals with multiple complex issues. The problems associated with early feeding and nutritional issues, reduced hearing sensitivity, delay in speech and language skills, dentofacial and orthodontic abnormalities, and possible psychosocial problems are the area of concern (D'Antonio and Nagarajan, 2003). Individuals with CLP have difficulties in speech skills, which will persist over longer time, considering from birth through later adolescence (Peterson & Falzone, 1995; Riski, 1994; Karnell & Van Demark, 1986). These persistent errors are significantly present in both the condition whether is repaired or unrepaired. With contemplate the deviant speech characteristics among the individuals with CLP has been associated with four stigmata. The chief stigmata include hypernasality, nasal air emission, weak pressure consonants and compensatory articulation (Trost, 1981).

2.1. Compensatory Articulation

It has been addressed that children and adult individuals with CLP even after considering with adequate velopharyngeal function has articulation errors (Fletcher, 1978). This coincides frequently in speech of individuals particularly in CLP with or without velopharyngeal dysfunction (VPD) (Trost, 1981). As children grow older, these articulation errors increases significantly, suspecting as difficult to resolve instinctively and leads to resistant towards speech therapy (McWilliams, Morris & Shelton, 1990; Noordhoff, Huang & Wu, 1990; Harding and Grunwell, 1993). These compensatory

articulation errors are grouped as substitution error that indicates change of placement or direction of airflow. These errors are learnt behaviors, which are the resultant of an abnormal shift in place of articulation and usually preserving the manner of articulation. They are glottal stop, pharyngeal stop, mid-dorsum palatal stop among stop consonants. Pharyngeal fricative, posterior nasal fricative, mid-dorsum palatal fricative are the compensatory errors produced for fricatives. Pharyngeal affricate, posterior nasal affricate, and mid-dorsum palatal affricate are the compensatory errors produced for affricates (Trost, 1981). These types of compensatory errors among individuals with CLP are described with the pictorial representation for stops, fricatives and affricates.

2.2. Stop Consonants

2.2.1. Glottal stop

It is a plosive consonant articulated with dynamic adduction of vocal fold. It is perceptually heard as a grunt sound with the substitution of /h/. It is typically substituted for stops and may also for fricatives and affricates. Figure 2.1 depicts the compensatory articulation with a dynamic adduction of vocal fold as indicated with an arrow symbol.

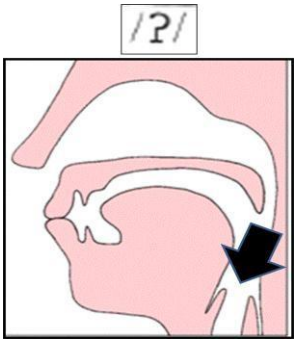

Fig 2.1*: Production of glottal stop (*Peterson- Falzone, Trost- Cardamone, Karnel, & Hardin- Jones, 2006*)*

2.2.2. Laryngeal stop

As the term indicates, it is perceived as substitution of stops wherein base of the tongue moves posterior to the PPW following to contact of epiglottis towards the PPW and blocking the air stream. Thus, these are the sounds produced within the laryngeal area.

2.2.3. Pharyngeal stop

This is produced as lingua- pharyngeal consonant articulation wherein the contact of tongue base is with PPW. The entire tongue shifts and contacts the PPW by building up the air pressure and uses the air pressure in the pharynx before it losses through the velopharyngeal valve. This compensatory error is substituted for the /k/ and /g/. Perceptually there is longer duration of consonant production in CV syllable, due to difficulty in production of such sound. Figure 2.2 depicts the compensatory articulation by shifting entire tongue and contacting the PPW by building up the air pressure as indicated with a dark line.

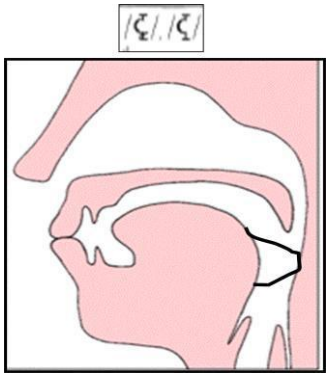

Fig 2.2*: Production of pharyngeal stop (*Peterson- Falzone et al., 2006*)*

2.2.3. Mid dorsum palatal stop

It is also termed as palatal dorsal production. This is a stop consonant articulated by using dorsum of the tongue against the hard palate, which is inexact place of the glide /j/ production. With the contact of mid-section of tongue (dorsum) to mid- section of palate will typically substitute for /t/ or /k/ (voiceless) and /d/ or /g/ (voiced). Perceptually the productions are substitution for the lingual – alveolar sounds (/t/, /d/, /n/, /l/) and often for velar sounds (/k/, /g/). In some cases, it is also used for the production of sibilant sounds (/s/, /z/, /sh/, /zh/, /ch/, /j/). This is typically observed in CLP population where they may have been learned to use tongue to occlude palatal fistula. Figure 2.3 depicts the compensatory articulation by using dorsum of the tongue against the hard palate as indicated with a dark line.

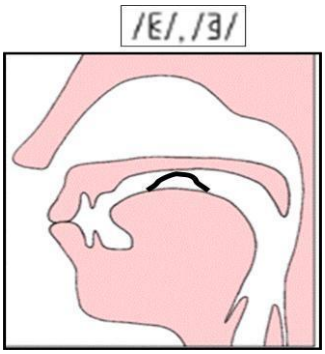

Fig 2.3*: Production of mid dorsum palatal stop (*Peterson- Falzone et al., 2006*)*

2.3. Fricatives

2.3.1. Laryngeal fricative

It is a variant with pharyngeal fricative. The sound most likely produced due to the posterior displacement of tongue base, stricture between the posteriorly inclined epiglottis and the elevated arytenoids wherein larynx move up. It is perceived as

substitution of fricatives. As noticed through flurovideoscopy and nasopharyngo fiberscopy during the production the velopharyngeal port remained open just as for nasal sounds.

2.3.2. Pharyngeal fricative

This is another consonant produced as lingua- pharyngeal fricative articulation. In this production the tongue shifts posteriorly towards PPW wherein tongue dorsum flattened and does not touch the pharyngeal wall. With that, narrow opening constriction of air stream occurs and forms frication. This compensatory articulation is substituted for fricatives and affricates. Perceptually it sounds similar to lateral lisping and substitutes for /sh/, /ch/ and /j/ sounds. Figure 2.4 depicts the compensatory articulation by shifting tongue posteriorly towards PPW wherein tongue dorsum flattened and does not touch the pharyngeal wall as indicated with a dark line.

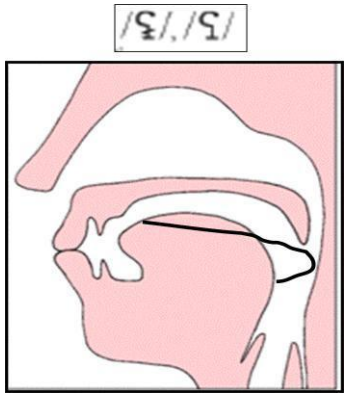

Fig 2.4*: Production of pharyngeal fricative (*Peterson- Falzone et al., 2006*)*

2.3.3. Posterior nasal fricative

It is also termed as *velopharyngeal fricative.* In this production, it is misarticulated with frication or air turbulence that appears to form in velopharyngeal port

(VP). During this production, tongue moves posterior to help in occluding the port wherein velum approximates posterior pharyngeal wall (PPW), resulting in constricted airflow through VP port. Perceptually it sounds as velum 'flutters' against PPW and as frication 'snorting'. This compensatory error is co- produced with any pressure consonants but occurs as selective substitution for any sibilant fricatives and affricates. Figure 2.5 depicts the compensatory production with tongue moving posterior and occluding the port wherein velum approximates posterior pharyngeal wall (PPW) as indicated with a dark line.

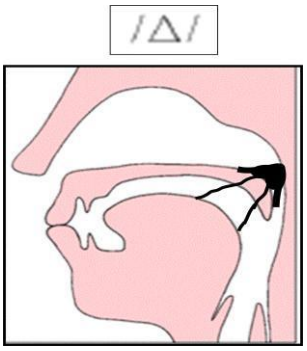

Fig 2.5*: Production of posterior nasal fricative (*Peterson- Falzone et al., 2006*)*

2.4. Affricates

2.4.1. Laryngeal affricate

It is perceived as substitution of affricate due to the posterior movement of base of the tongue, and brief contact of epiglottis with PPW resulting in constriction of air stream.

2.4.2. Pharyngeal affricate

It is a combination of pharyngeal fricative and glottal stop. It is substituted for consonants such as /ʧ/ and /ʤ/ although this error can be substituted for other sibilant sounds. Wherein the dorsum of the tongue moves backward to contact PPW and forming air constrictions thus, creating a stopping followed by frication.

2.4.3. Posterior nasal affricate

For production of this error, there is a posterior movement of tongue dorsum and velum. Perceptually there will be substitution of affricates and these forms as a variant for audible nasal air emission. Along with those chief stigmata individuals with CLP exhibit another pattern of production called weak pressure consonant.

2.2. Weak pressure consonant

Similar to nasal air emission it occurs secondary to velopharyngeal dysfunction. It has a direct consequences on the manner of production wherein due to reduced intraoral pressure, it significantly influence the production of pressure consonants and often turn into weak production of labial or lingual articulatory gesture. In nasal air emission with the similar cause the production of pressure consonants (stops, fricatives and affricates) are articulated with audible or inaudible distortion.

Hence, with those multiple complex issues as discussed previously and leading a life with those issues starting from early stages of infancy to their growing period would be challenging to any individual with CLP. Same holds for the professionals involved in team management, to deal with all of those areas of concern. Practically it is not feasible

for one professional to deal all of those areas, which in turn requires the holistic team approach to benefit individuals and overcome their communication problems. There is a need for medical, surgical, dental, speech pathology and psychological treatment. Hence, a team care is very important to achieve a best treatment outcome.

Thus, it is essential for individuals with CLP to undergo surgery and speech therapy at early age itself. This is beneficial which helps to reduce compensatory articulations and improves speech intelligibility. But due to lack of awareness, the medical management is not endowed at early stages (Singh, 2009). There are conditions where they report for the evaluation and treatment during the adolescence period. But, the studies related to speech skills in unrepaired/repaired CLP adults are limited.

The following section highlights few studies related to speech characteristics (articulation, nasality, intelligibility and voice outcome) reported in adults with repaired/ unrepaired CLP population.

McWilliams (1958) conducted a study wherein the purpose was to study the articulation errors occur in adults with unrepaired cleft palate. The author considered 48 individuals with unrepaired cleft palate in the age range of 17-59 years for the study. The stimuli selected were 23 consonants through which 12 list of words, phrases and short sentences were developed. Each participant's speech samples were recorded and analyzed for the production of 23 consonants by calculating the percentage of errors in the production of specific consonant. The profiling of articulation errors were documented in terms of frequency of errors, consistency in misarticualtion of sounds and number of substitution, distortion, and omission. In terms of frequency of error the

sounds /s/> /z/> /ʤ/> /ʧ/>/ ʃ/> /k/> /g/> /d/> /f/> /t/> /p/> /b/ were found deviant in descending order. In terms of consistency of errors /s/, /z/ and / ʃ / were found with high consistency. Among type of misarticulation, for consonant /s/ there was 63% of error in production with 492 times distortions, 48 times omission and 7 times substitution. For consonant /z/ there was 61% of error in production with 246 times distortions, and 15 times. For consonant /ʤ/ there was 48% of error in production with 23 times distortions. For consonant /ʧ/ there was 44% of error in production with 19 times distortions, 1 time omission and 1 time substitution. For consonant /S/ there was 32% of error in production with 41 times distortions, 4 times omission and 1time substitution. For consonant /k/ there was 32% of error in production with 99 times distortions, and 54 times omission. For consonant /g/ there was 30% of error in production with 61 times distortions, 4 times omission and 2 times substitution. For consonant /d/ there was 61% of error in production with 71 times distortions, and 40 times omission. For consonant /f/ there was 17% of error in production with 35 times distortions, 5 times omission and 1 time substitution. For consonant /t/ there was 16% of error in production with 96 times distortions, and 92 times omission. For consonant /p/ there was 11% of error in production with 26 times distortions, and 6 times omission. For consonant /b/ there was 9% of error in production with 25 times distortions. In conclusion, they stated that the initial step for correcting the articulation proficiency is by attending those phoneme errors, which are produced in consistency. Considering the consistency of errors, sibilant sounds requires greater attention and hence must be attempted at initial level speech therapy.

Rampp and Counihan (1970) conducted a study where they investigated the relationship within vocal pitch intensity among 20 (10 male and 10 female) individuals

with unrepaired cleft palate and 20 normal's with matched in age and gender. The selected subjects were from age range of 15-53 years. The task was to produce four isolated sustained vowels /a/, /i/, /u/ and /æ/ at four intensity levels considering 70dBSPL, 75dBSPL, 80dBSPL and 85dBSPL for four seconds. They used audio recorder, fundamental frequency analyzer and intensity analyzer, for detailed analysis of vocal pitch intensity. The results indicated a difference among groups, wherein among males the highest mean fundamental frequency was found in vowel /i/ (135 Hz) followed by /u/ (131 Hz), /æ/ (127 Hz) and /a/ (125 Hz). Among females the highest mean fundamental frequency was found in vowel /u/ (247 Hz) followed by /i/ (243 Hz), /æ/ (243 Hz) and /a/ (237 Hz). The intergroup difference between the means for fundamentals was significantly varied among cleft palate and normal females with the lower mean fundamentals for vowel /i/ and /u/ but in case of cleft palate and normal males the intergroup differences were small and inconsistent. In conclusion, they documented significant difference in fundamental frequency, which occurs with reference to change in intensity, vowel type and gender.

Landis and Cuc (1972) aimed to describe the articulation, voice quality and speech intelligibility in individuals with unrepaired cleft palate by considering total number of 54 individuals with CLP of 3 to 24 years age range. Among 54 individuals, 21(Group I) had unrepaired cleft of palate and lip in age range of 6-18 years, 18 (group II) had repaired cleft lip with or without overt cleft of alveolus and unrepaired cleft of soft and hard palate in age range of 3.5-25 years and 15 (group III) had unrepaired isolated cleft of the palate in age range of 5-21 years. These individuals had not underwent speech therapy. They conducted articulation assessment by considering 20 of

23 Vietnamese consonants sounds in 30 single words. In results, they profiled intelligibility rating, nasality rating and articulation among participants. For intelligibility, in Group I, 19 participants, in Group II, 13 participants, and in Group III, 5 participants were rated poor. For nasality, they were categorized into severe, moderate, and slight deviancy. Wherein in Group I, 16 were severe, four were deviant and one was slight. In Group II, nine were severe, eight were moderate and one was slight. In Group III, eight were severe and seven were moderate. In articulation, among oldest individuals with CLP (above 15 years), in Group I 21% has documented for percentage of consonant correct, 9.37 % had omission and 68.75% had substitution. In Group II 34.38% had documented for percentage of correct consonant, 6.25% for omissions and 59.38% for substitution and in Group III 71% had scored for percentage of correct consonant, 6.25% had omission and 21.88% had substitution. In conclusion, they considered the relationship between the type of oral cleft and the proficiency of speech skills.

Karnell and Van Demark (1986) conducted a longitudinal study of perceptual analysis of articulation, velopharyngeal competence, ratings of articulation defectiveness and nasality by considering 106 subjects at age range of 6, 12, 14, and 16 with repaired cleft palate. For detailed analysis they categorized the 106 subjects as per their performance in articulation assessment at 4 years of age by using Iowa Pressure Articulation Test (IPAT). They conducted articulation test using 43 item Iowa Pressure Articulation Test and they considered parameters such as type and manner of articulation where in they calculated the total percentage of occurrence of oral distortions, nasal distortions, and different types of compensatory articulation. In results for IPAT the scores for correct consonant production were exceeded after the age of 16 years where in

group I (88.5%) was in lead then followed by group III (82.7%) and II (77.5%). For type and manner of articulation, it indicated an improvement in speech beyond the age wherein, the articulation found to be improved at 16 years of age, glottal stops and pharyngeal fricatives got nonexistent by age 10 and substitutions were rare after 10 years of age in the entire group. In addition, they found persistent errors with respect to types and manner of articulation wherein oral distortions were most common on fricatives and affricates than plosives and incidence for nasal distortions increases after 12 years for group II and at 10 years for group I. In nasality, group I showed marked reduction in mean nasality ratings at the age of 6-8 years, at the age of 8-16 years group I had gradual decline in their nasality but group II and III had increase nasality after 10 years that was gradually declined later. Thus, in conclusion, the proficiency of articulation improves beyond the age of 10 and the improvement in their articulation depends on the early articulatory performances and history of secondary management.

Peterson and Falzone (1995) conducted a perceptual assessment of articulation and resonance by considering 110 non syndromic individuals with unrepaired cleft lip and palate in the age range of 13-19 years wherein 53 were unilateral cleft lip and palate, 46 were bilateral cleft lip and palate and 11 were cleft palate only. These 110 individuals were assessed using IOWA test and conversational speech and the recorded speech samples were given for inter rating. Documentation of the total percentage of normal articulation, compensatory articulation, nasal emission, and the combination of hypernasal, compensatory articulation, nasal emission (distortion) on pressure consonants were done and calculated. The results indicated an improvement in speech parameters over the time. At the age range of 13.0- 13.11, 5.3% had normal articulation, 5.3% had

compensatory articulation (CA), 5.3% had nasal emission (NE), and 5.3% were having distortions at 14.0- 14.11years, 22.2% were normal, 5.5% had compensatory articulation (CA), and 5.5% had nasal emission (NE), at 15.0- 15.11years , 57.1% were normal, 0% had compensatory articulation (CA), 0% had nasal emission (NE), and 0% were having disasters, at 16.0- 16.11 years, 22.2% were normal, 5.5% had compensatory articulation (CA), 5.5% had nasal emission (NE), and 5.5% were having disasters, at 17.0- 17.11 years, 23.5% were normal, 11.8% had compensatory articulation (CA), 5.9% had nasal emission (NE), and 17.6% were having disasters, at 18.0- 18.11 years, 31.2% were normal, 0% had compensatory articulation (CA), 2.5% had nasal emission (NE), and 12.5% were having disasters and at age range of 19 to 19.11 years, 21.4% were normal, no CA, 35.7% had NE, and 35.7% produced the combination of hypernasal, compensatory articulation, nasal emission on pressure consonants. Thus, in this study, they documented an improvement of speech characteristics over the age but do not provide any detailed information related the type of errors with specific to pressure consonants.

Riski (1994) investigated the speech characteristics in a perceptual rating of articulation and resonance during spontaneous speech in 48 subjects were with repaired cleft palate at age range of 12-21 years. For evaluation of articulation, overall rating of articulation in live speech was done by using 5- point rating scale. The results indicated that 54% of them had normal articulation, 29.4% were mild impaired, 3.9% were moderately impaired, 9.8% were moderately-severe impaired, and 2% were severe impaired. For evaluation of resonance, overall rating of nasality in live speech was done by using 3- point rating scale. In resonance 8.3% were mildly hypernasal and 20.8% were

hyponasal. Thus, they conclude that improvement in speech outcome at successive generation but still have severe speech deficits and require intervention.

Van Lierde, Bodt, Baetens, Schrauwen, and Cauwenberge (2003) conducted an objective and subjective assessment to determine intelligibility, articulation, nasalance, nasality and voice in 14 participants with repaired cleft palate at age range of 16.3 -23.1 years. To assess articulation, they conducted picture-naming test and to assess speech intelligibility and resonance. They conducted Gutzman test, objective analysis was carried using Nasometer (6200) and mirror fogging test was also used to check the presence of nasal air emission. They recorded individuals connected speech and nasometric sentences were recorded and analyzed by inter rating.. For voice, subjective analysis GRBAS and as objective analysis DSI was performed. In results, they observed that 14% of them had moderate speech intelligibility and 7% were slightly impaired. In articulation, 86% of them had /r/ derhotacized, 7% had devoicing and 7% had denatalized. In articulation of /s/ 21% had sigmatismus simplex, 14% had sigmatismus stridens, 7% had sigmatismus labiodentals, 21% had sigmatismus simplex and 7% had sigmatismus dentalis. For voice, they found devoicing of /z/ in 71%, /v/ in 71%, /b/ in 36%, and /d/ in 43%. In resonance, hypernasality was found more. Thus, they concluded an improvement in speech characteristics over the age and suggested to pay attention towards correcting place of articulation (/r/, /s/, /z/, /v/,/b/ and /d/) and normal resonance.

Lohmander, Friede and Lilja, (2012) conducted a longitudinal study in perceptually evaluating resonance and articulation of 55 participants with repaired unilateral cleft lip and palate at age range of 5, 7, 16 and 19 years. As a task, they recorded the standardized sentences and connected speech sample of each individual.

For assessing speech variable they applied 5 point rating scale, for assessing velopharyngeal function they applied 4 point scale and for assessing intelligibility they used 3 point rating scale. In results, it indicated that at 16 years of age 92% were with no hypernasality/ not more than mild, at 16 and 19 years only two subjects had moderate or severe audible nasal emission. Compensatory articulation prevalence of retracted oral articulation was reduced from 16 years to 19 years of age but they had distorted /s/ sounds and 98%-100% had normal speech intelligibility at 10 years of age and four individuals of older age had found with mild to moderate degree of hyponasality. In conclusion, they highlighted the importance of medical management wherein with early soft palate repair would facilitate gradual improvement in their speech skills and reduction of non-oral misarticulation (glottal stops, pharyngeal fricatives, nasal fricatives) over the period.

Considering the above studies, it is well documented that individuals with CLP have speech difficulties, which are also persisting over the period, as they grow older. As noticed adult individuals with unrepaired/repaired CLP persists speech difficulties, wherein they have articulation errors may be due to anatomical and learning factors, malocclusions, and strategies employed to compensate for the cleft. Resonance problem may be due to VPD, large nasopharyngeal space, presence of tonsils or adenoids and nasal septum deviation. Voice disorders may be due to inadequate vocal tract vibration that facilitates regulation of air pressure for voicing and due to applying compensatory strategies that result into vocal abuse. Due to all these parameters being affected, it is documented that speech intelligibility get influenced by these parameters and goes in conjunction along with these parameters (Witzel, 1991).

Thus, for comprehensive qualitative study regarding the depth of the speech characteristics in an individual with unrepaired/repaired CLP all these parameters has to be considered. Therefore, with that knowledge it is considered to have an adequate framework for speech analysis. The framework that implies detailed qualitative analysis consider all above parameters for perceptually analyzing the speech of an individual with CLP. More recent approach validated for qualitative assessment called 'Universal parameters for reporting speech outcomes in individuals with cleft palate' (Henningson et al., 2008) is widely applied for the purpose of diagnostic and therapy.

'Universal parameters for reporting speech outcomes in individuals with cleft palate' (Henningson et al., 2008), is a perceptually based protocol. Perceptual evaluation considered as a gold standard for analyzing the speech of an individual with CLP thus, their objective was to achieve greater consistency in exploring speech outcomes based on parameters that can be used globally. Protocol consists of five universal reporting parameters which are hypernasality, hyponasality, voice, nasal air emission or turbulence, consonant production errors and two global parameters of for speech understandability and speech acceptability were developed for documenting the speech outcome of individuals with CLP.

There are many benefits in applying this universal reporting system for documenting speech outcomes for individuals with cleft. This tool can be used in clinical setup with an exception of external factors regardless of individual's country of origin, language or language spoken and other variables that could affect speech behaviour. It provides to stimulate modification and advances the evaluation data to be more valid and reliable. This protocols also provides specific descriptive terms that will categorize and

defines the characteristics of the speech among individuals with CLP. The protocol also equipped with guidelines for constructing speech sample and importance of using speech samples in controlled manner that is most likely to reveal speech deviation characteristics of the speech of individuals with repaired cleft palate. The universal parameters facilitates for comparing the data across centres to check the reliability.

Based on these protocol the difference in an individual speech is easily tackled which relates all important speech parameters (articulation, voice, resonance, speech intelligibility) because these parameters are considered to be essential while judging the speech of an individual with CLP. The above review indicates that, limited studies have been attempted to explore the speech characteristics by including articulation, voice, intelligibility and nasality in adults with unrepaired CLP. Implication of the standard protocol for documenting these speech parameters is considerably not been followed. Lohmander and Olsson (2004), has stated in their review of literature with concern to perceptual assessment that 'there is a lack of reported information and existence of variation in terms of data collection and analyzing the speech characteristics in individuals with CLP'. In this context, the current study focuses systemically on understanding the insight about the speech characteristics, qualitatively in adults with unrepaired CLP by using a standard protocol 'Henningson's perceptual scale'.

CHAPTER 3

METHOD

The purpose of the current study was to profile speech characteristics among adults with unrepaired CLP by following a standard protocol proposed by Henningson,G et al.,(2008). Following procedure was adopted to investigate the cited objectives.

3.1. Participants

In the present study, 13 participants with unrepaired CLP (6 females and 7 males) in the age range of 14-25 years (mean age=19.5 years) participated. Few of the participants were selected from 'All India Institute of Speech and Hearing' (AIISH) and others were recruited from the 'St. Joseph's Hospital Bannimantap, Mysore'. Participants selected from AIISH were those who had come to 'Unit for Structural Oro Facial Anomalies' (USOFA) for availing the clinical services. Other participants were recommended from the hospital before undergoing surgery.

3.2. Inclusion criteria

All the participants were adult individuals within the age range of 14-25 years. These individuals had unrepaired cleft of palate (presence of cleft of lip and type of cleft palate was the exception) and they were native speakers of Kannada. Participant's demographic data, the date of evaluation, participant age at the time of evaluation, all the participants were from middle socio- economic status, mental abilities ,information about medical and non-medical details were documented before collecting the audio video recording of speech sample. Participants recruited were free of known syndromes, and

had not undergone any stages of palatal surgery or used any prosthesis in their earlier period. Participants with normal hearing were considered for the present study.

3.3. Exclusion criteria

The participants who were suspected having associated syndromes, neurological and psychological problems were not considered. Participant, who had undergone surgical management, used any form of prosthesis in their growing period and participants with residual palatal fistula were excluded from the current study. The profiling of participants according to age, gender and cleft type is depicted in Table 3.1.

Table 3.1
Details of the participants with unrepaired CLP

Sl.No	Gender	Age (years)	Cleft type
1	M	20	Bilateral cleft of soft palate
2	M	18	Bilateral complete cleft of primary and secondary palate
3	M	25	Bilateral complete cleft of primary and secondary palate
4	M	15	Bilateral incomplete cleft of primary and secondary palate
5	M	23	Bilateral cleft of soft palate
6	M	24	Bilateral cleft of soft palate
7	M	23	Bilateral complete cleft of primary and secondary palate
8	F	20	Bilateral incomplete cleft of primary and secondary palate
9	F	22	Bilateral complete cleft of primary and secondary palate
10	F	23	Bilateral complete cleft of primary and secondary palate
11	F	25	Unilateral complete cleft of primary and secondary palate
12	F	25	Bilateral incomplete cleft of primary and secondary palate
13	F	19	Bilateral complete cleft of primary and secondary palate

[*Note: M- Male; F- Female]*

For the present study speech characteristics of participants were not analyzed based on their anatomical variations such as type of cleft palate (cleft of primary palate/secondary palate, unilateral/bilateral, complete/incomplete), width of cleft, and length of palate.

3.4. Procedure

The study was aimed to assess the different parameters of speech. The below section explains the procedure applied to study each speech parameters (articulation, resonance, voice and speech intelligibility) separately.

Primarily the participants were made to seat comfortably in noise free room. Prior to recording, they were informed briefly about the purpose of the study and duration of the test that would require. Following these descriptions, written consent form from each participant was also taken.

3.4.1. Articulation

3.4.1.1 Material

To analyze the articulation errors and cleft type errors among the pressure consonants 'Kannada Diagnostic Photo Articulation test (KDPAT)' (Deepa.A, 2010) was used. KDPAT is a diagnostic tool used to assess the proficiency in articulation of Kannada words. It considers all the phonemes of Kannada language wherein it has 10 vowels, 2 diphthongs, 21 consonants and 11 clusters. The words loaded with stop, fricatives and affricates were selected. Total 48 words formed the material. The list of Kannada words used for articulation analysis is depicted in Table 3.2 and these words were classified based on the manner of articulation.

Table 3.2

List of Kannada words based on the manner of articulation

Target Sounds	KDPAT Words
Stops (32 words)	
/k/	/kattari/, /bekku/, /ka:ru/, /saIkallu/
/g/	/gadIja:ra/, /mu:gu/, /ga:lipata/, /ka:ge/
/p/	puri , kappe , penn8u , ʧappali
/b/	/ba:gilu/, /kabbu/, /bassu/, /dImbu/
/	o pi , ʧi e , omo o/, ki akI/
/	a ktar , Anga i , abbI , kanna aka/
ʈ	ʈatte , ko ʈi , ʈabala , kaʈʈe
ɖ	ɖa ra , ku ɖure , ɖo se , go ɖI
Fricatives (8 words)	
/s/	/se:bu/, /mi:se/, /si:re/, /hasu/
/ʃ/	/ʃartu/, /braʃ/, /ʃanka/, /gane:ʃa/
Affricates (8 words)	
ʧ	ʧapa ti , ba ʧanige , ʧakkuli , ma ɳʧa
ʤ	ʤi ɳke , pu ʤa ri , ʤade , su ʤI

3.4.1.2. Instruction

Participants were instructed to repeat Kannada words loaded with pressure consonants after the investigator by looking in front of the camera. They were also instructed to be comfortable and request for repetition of the stimuli if in case they do not perceive words. They were instructed to repeat in their habitual pitch.

3.4.1.3. Recording

For Audio- Video recording ‘Sony handy-cam digital video camera’ was placed at a distance of 5-6 feet and audio recorder was placed at 10-12 cm from mouth. As per the stimuli, 48 words loaded with pressure consonants /k/, /g/, /p/, /b/,/ʧ/, /ʤ/, /ʈ/, /ɖ , ,

/,/s/ and /ʃ/ at initial and medial position from KDPAT (Deepa.A, 2010) were recorded with inter stimulus duration gap of 5-6 seconds. Before proceeding to further recordings, it was made sure that the recording was completed with good audio and video quality by playing the articulation samples of each participant.

3.4.1.4. Perceptual training

The target 48 words had to analyze with reference to different types of articulatory errors such as SODA and compensatory articulation analysis. Prior to analyze, the investigator had undergone the perceptual training by using the training material developed by Gnanavel (2014). The material provides information for training and to identify the various productions of compensatory articulation (nasal air emission, backing errors, fronting errors, glottal stops, pharyngeal fricative and weak pressure consonants) in individuals with CLP for better understanding of terminologies that are used in Henningson's protocol.

Following this, the investigator analyzed the five samples (which were not considered for the final analysis) on all the parameters that are used in the current study. This was verified by the supervisor.

3.4.1.5. Transcription and Analysis

Following these perceptual training, the articulation samples of 13 participants were analyzed by using SODA errors and cleft type errors. Whereas, the responses from each participants were phonetically transcribed into IPA format. Total 48 words (32 words in stops, 8 words in fricatives and 8 words in affricates) were transcribed, later that was qualitatively analyzed and profiled in terms of SODA and compensatory errors.

Compensatory errors considered were weak pressure consonant, audible nasal emission, glottal stop, mid dorsum palatal stop, pharyngeal stop, mid dorsum palatal fricative, pharyngeal fricative, posterior nasal fricative, mid dorsum palatal affricative, pharyngeal affricative and posterior nasal affricative. Profiling sheet for articulation errors is depicted in Appendix I. The presence of any articulation errors and cleft type errors with respect to the pressure consonants were marked '+' that indicates 'present'.

3.4.2. Resonance and speech intelligibility

3.4.2.1 Material

To analyze these parameter 'universal parameters for reporting speech outcomes in individuals with cleft palate' (Henningson et al., 2008) was used. This tool assess and rate the four parameters which are hypernasality, hyponasality, ANE/NE and speech intelligibility. Kannada oral sentences and nasal sentences (*Jayakumar &Pushpavathi, 2005)* were used. These sentences are loaded with pressure oral consonants and nasal consonants. The lists of sentences are depicted in Table 3.3, which was used as stimuli in assessing resonance and speech intelligibility.

Table 3.3

List of Kannada oral sentences and nasal sentences

Oral sentences	Nasal sentences
/ka:ge ka:lu kappu/	manu a neannu no iḏa/
/giṭa bega ho:gu/	/navi:na manejinḏa banḏanu/
/ḏana ḏa:ri ṯappiṯu/	.na nu a ne annu no iḏe/
/	/ma ŋga maneja me:liḏe/
/ba:lu :risu/	/ma:ma mandja:ḏinḏa banḏaru/
/sariṭa kaṯṯri ṯa:/	/minalige negaḏI banḏiḏe/
/Iḏ /	/nari nelaḏinḏa negejiṯu/
ḏa/	/ma:mana mane mu ŋgalu:rinaliḏe/

3.4.2.2. Instruction

The participants were instructed to repeat/read Kannada sentences in their habitual rate after the investigator by facing the camera.

3.4.2.3. Recordings

For analyzing this parameter, *recording was* conducted by facing the camera placed at a distance of 5-6 feet and audio recorder placed at 10-12 cm from mouth. Following instructions, total 6 oral and 6 nasal sentences in Kannada as developed by Jayakumar &. Pushpavathi (2005) were recorded by providing inter stimulus duration gap of 5-6 seconds. Followed by recording *of* connected speech sample (conversation) spoken for 5 minutes (approximately 100 words) by each participant was recorded.

3.4.2.4. Analysis

To analyze the resonance, investigator qualitatively analyzed these parameters by listening to the participant's speech samples (oral sentences, nasal sentences and their connected speech samples) and later proceeded with rating by using the format as provided in 'Universal parameters for reporting speech outcomes in individuals with cleft palate' (Henningson et al., 2008**).**

Using this standard protocol, the severity of resonance was analyzed. Resonance deviations such as for hypernasality, hyponasality, and nasal air emission (audible and inaudible) were analyzed and rated. The scoring sheet is depicted in Table 3.4, 3.5 and 3.6 for hypernasality, hyponasality and audible nasal air emission respectively. The severity was assessed by using the following rating scales.

Table 3.4

The universal parameter rating for hypernasality

WORDS	RESPONSE	SENTENCES	RESPONSE
0 Within normal limits		0 Within normal limits	
1 Mild		1 Mild	
2 Moderate		2 Moderate	
3 Severe		3 Severe	

Table 3.5

The universal parameter rating for hyponasality

WORDS	RESPONSE	SENTENCES	RESPONSE
0 Withinnormal limits		0 Within normal limits	
1 Present		1 Present	

Table 3.6

The universal parameter rating for audible nasal air emission

WORDS	RESPONSE	SENTENCES	RESPONSE
0 Within normal limits		0 Within normal limits	
1 Present Intermittent/variable Frequent/pervasive		1 Present Intermittent/variable Frequent/pervasive	

Speech intelligibility was analyzed in terms of speech understandability and speech acceptability in each participant's speech across word and sentence level. The severity rating was documented by using the scoring format as provided by Henningson et al., (2008**).** The guideline for scoring is depicted in Table 3.7.

Table 3.7

The universal parameter rating for speech intelligibility

	Severity rating	Speech Understandability	W	S	Speech Acceptability	W	S
0	Within normal limits	• Speech is always easy to understand			• Speech is normal		
1	Mild	• Speech is occasionally hard to understand			• Speech deviates from normal to a mild degree		
2	Moderate	• Speech is often hard to understand			• Speech deviates from normal to a moderate degree		
3	Severe	• Speech is hard to understand most or all of the time.			• Speech deviates from normal to severe degree		

[Note: 'W' denotes at word level and 'S' denotes at sentence level]

3.4.3. Voice

3.4.3.1. Material

For assessing this parameter, a perceptual scale GRBAS (Hirano, 1981) scale was used which is a perceptual voice assessment tool that provides grade in terms of roughness, asthenic, breathiness and strain in an individual. It is a scale with four points rating that analyze the voice quality.

3.4.3.2. Recording and analysis

Elicited samples of conversation from each participant were qualitatively analyzed using GRBAS. This rating scale was applied to rate five different parameters that pertain to voice quality as G- Overall grade, R- Roughness (irregularity in vocal fold vibration/ hoarseness), B- Breathiness (air leakage from glottis while speaking), A-

Asthenic (weakness in voice), and S- Strained (hyper function of voice). Thus, voice quality under each parameter was analyzed and the following scoring sheet was used as depicted in Table 3.8.

Table 3.8

Severity rating of voice

Severity Rating		Response
0	Normal	
1	Slight	
2	Moderate	
3	Severe	

3.5. For Inter-judge and Intra Judge Reliability

For inter judge reliability, an experienced Speech Language Pathologist from the 'Unit for Structural Oro Facial Anomalies'(USOFA) was chosen who had an experience of one year in the field of perceptual analysis of speech characteristics in individuals with CLP. Considering the sample size, 50% sample of each parameter recordings was subjected to inter judge. The samples were chosen randomly and their related audio – video samples were given for rating. Instructions were provided related to the objectives of the study, procedure implied, and the protocol used before grading each speech parameters. Rating of each speech samples were done separately in a quiet room situation.

Similarly, for intra judge reliability randomly six samples were chosen and were reanalyzed after two weeks from the date of first analysis to check for the reliability. The

average mean values were calculated separately for the perceptual judgment and hence, by the investigator reliability was calculated.

3.5. Statistical Analysis

The data was analyzed separately for articulation (SODA errors and Compensatory articulations), resonance (hypernasality, hyponasality, and ANE), speech intelligibility (speech understandability and acceptability) and voice by using descriptive statistics. The total percentage of speech impairment among the adults with unrepaired CP/L was calculated under each parameter and the results were represented in the form of pie chart. Pie chart was employed to analyze each objectives of the present study.

Cronbach's alpha coefficient was utilized for inter and intra reliability of parameters.

CHAPTER 4

RESULTS AND DISCUSSION

The primary aim of the present study was to provide an insight on speech characteristics in Kannada speaking adults with unrepaired CLP using Henningson's perceptual scale. The results are discussed with the following headings:

- Inter and Intra reliability.
- Perceptual characteristics related to articulation.
- Perceptual characteristics related to resonance (hypernasality, hyponasality, and nasal air emissions).
- The perceptual characteristics related to voice.
- Speech intelligibility across words and spontaneous speech.

4.1. Inter and Intra reliability

For inter judge reliability 50% of samples were analyzed by following the above procedures and similarly other 50% of samples were reanalysed by the investigator after two weeks to check the intra reliability. Thus, to check the reliability for both inter and intra Cronbach's alpha coefficient was utilized. Tables from 4.1 to 4.5 depicts the inter and intra judge reliability of articulation, resonance, ANE, speech intelligibility and voice respectively.

Below table 4.1, shows the inter judge reliability among SODA and compensatory errors varying from 0.5% - 0.97%. Among fricatives it was varying from 0.6% - 0.92% and in affricates it was varying from 0.7% - 0.97%. In intra udge, Cronbach's alpha

coefficient for SODA and compensatory errors were varying from 0.6% - 0.94% for stops, 0.5% - 0.95% for fricatives and for affricates it was varying from 0.6% - 0.92%.

Table 4.1

Intra and inter judge reliability of articulation

Articulation	**Intra – judge**		**Inter – judge**	
	SODA	**CA**	**SODA**	**CA**
Stops	0.7 %-0.94%	0.6%- 0.9%	0.6%- 0.97%	0.5%- 0.96%
Fricatives	0.6-0.95%	0.5-0.94%	0.6%- 0.92%	0.7%- 0.9%
Affricates	0.7%- 0.92%	0.6%- 0.9%	0.7%- 0.9%	0.7%- 0.97%

In table 4.2, inter judge reliability of words varied between 0.84% - 0.92% and the same was found in sentences 0.8%-0.95%. For intra judge reliability among words, the alpha value was 0.7%-0.9% and in sentences it was 0.79%- 0.85%. Further, in hyponasality it was found with 1.0% agreement in both words and sentences.

Table 4.2

Intra and inter judge reliability of resonance

Resonance	**Intra – judge**		**Inter – judge**	
	Words	**Sentences**	**Words**	**Sentences**
Hypernasality	0.84%- 0.92%	0.8%-0.95%	0.7%-0.9%	0.79%- 0.85%
Hyponasality	1%	1%	1%	1%

When the alpha value was calculated for ANE among words and sentences, it was found that for intra judge reliability alpha value for words were ranging from 0.5% - 0,6% and in sentence it was from 0.6% to 0.7%. Whereas, in inter judge reliability the words got an alpha value of 0.6% and in sentences it was 0.5% -0.6%. The result is indicated in Table 4.3.

Table 4.3

Intra and inter judge reliability of ANE

ANE	**Intra – judge**		**Inter – judge**	
	Words	**Sentences**	**Words**	**Sentences**
Intermittent	0.5%	0.6%	0.6%	0.5%
Frequent	0.6%	0.7%	0.6%	0.6%

Further Cronbach's alpha coefficient was calculated for speech intelligibility among words and sentences. As observed among intra judge reliability of words the alpha coefficient was varying from 0.6% to 0.8% and in sentences it was varying from 0.7% to 0.9%. Under inter judge reliability the words alpha coefficient was 0.7% to 0.8% and in sentences the alpha value was 0.69% to 0.92%. The values of alpha coefficient is depicted as follows

Table 4.4

Intra and inter judge reliability of speech intelligibility

Speech intelligibility	**Intra – judge**		**Inter – judge**	
	Words	**Sentences**	**Words**	**Sentences**
Understandability	0.6%- 0.7%	0.7%- 0.8%	0.7%- 0.8%	0.7%- 0.8%
Acceptability	0.6%- 0.8%	0.7%- 0.9%	0.72%- 0.9%	0.69%- 0.8%

The last parameter analyzed for calculating the Cronbach's alpha coefficient was voice. Alpha coefficient for voice under inter judge reliability was varying from 0.55% to 0.96% and under intra judge reliability the alpha coefficient was varying from 0.6% to 0.95%.

Table 4.5

Intra and inter judge reliability of voice

Voice	Intra - judge	Inter - judge
Grade	0.8- 0.95%	0.75%- 0.9%
Rough	0.72%- 0.92%	0.55%- 0.69%
Asthenic	0.6%- 0.79%	0.65%- 0.7%
Breathy	0.64%- 0.82%	0.5%- 0.7%
Strain	0.8%- 0.95%	0.82%-0.96%

4.2. Perceptual characteristics related to articulation

4.2.1. Stops consonants

Total eight stop consonants were tested in 32 words from each participant. The words uttered by participants were analyzed to calculate the total percentage of SODA and compensatory articulations and consistency of errors. Figure 4.1 provides the total percentage of SODA errors among stop consonants. The results indicated that most of the subjects (n=10, 40%) exhibited distortion errors followed by omission (n=9, 36%) and substitution (n=6, 24%). However, none of them had exhibited addition errors.

The analyses were also performed based on calculating the consistency of errors. It was observed that nine participants had consistent difficulty to produce voiced consonants than voiceless consonants. Thus, they substituted voiceless for voiced cognate. Further, it was also noted that distortions and omissions were frequent among all voiced and voiceless dental, alveolar and velar consonants. But, substitution errors were mainly seen among voiced bilabial and voiceless velar consonants.

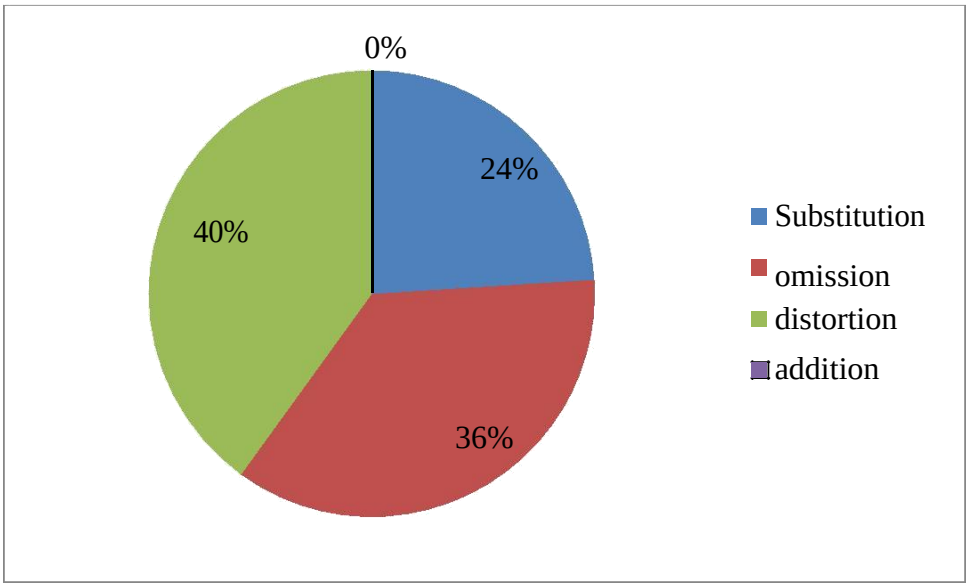

Fig 4.1: *Total percentage of SODA errors in stop consonants*

Apart from SODA errors, the stop consonants were further analyzed for the presence of compensatory articulation. The total percentage of compensatory articulation among all participants is depicted in Figure 4.2. In general, the weak pressure consonants were exhibited by all (32%), followed by ANE (n=13, 32%). Other compensatory errors perceived were glottal stops (n=8, 19%), mid dorsum palatal stops (n= 6, 15%), and pharyngeal stop (n=1, 2%).

The third type of analysis was done based on voiced voiceless distinction. When the errors were compared among all the participants, they had difficulty in producing voiced consonants. Additionally it was also noted that participants were majorly producing glottal production while articulating voiceless velar stop but less while articulating voiced velar, alveolar and dental stops. WPC and ANE were noticeably consistent while producing stop consonants regardless of whether voiceless or voiced stops.

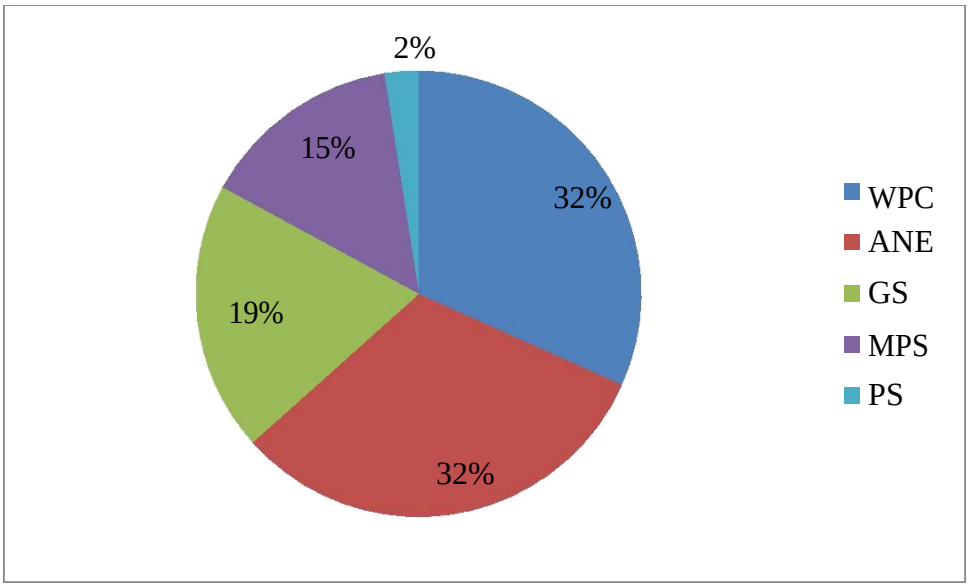

Fig 4.2: *Total percentage of compensatory articulations among stop consonants*

Overall, it was noticed that among stop consonants distortions were predominant followed by omissions, and substitution. In addition among compensatory errors, participants had more of weak pressure consonants and ANE, followed by glottal stops, mid- dorsum palatal stops and pharyngeal stops.

4.2.2. Fricatives

Thirteen participants produced eight words having /s/ and /ʃ/ fricatives, which were analyzed for the percentage of errors. The percentage of SODA errors and compensatory errors in fricatives are depicted in Figure 4.3 and 4.4 respectively.

As depicted in Figure 4.3, among SODA analysis distortion errors were predominant 50% participants (n= 8), followed by substitution in 7 (44%) participants, and omission error (n=1; 6%). However, none of them had exhibited addition errors while producing words with fricatives.

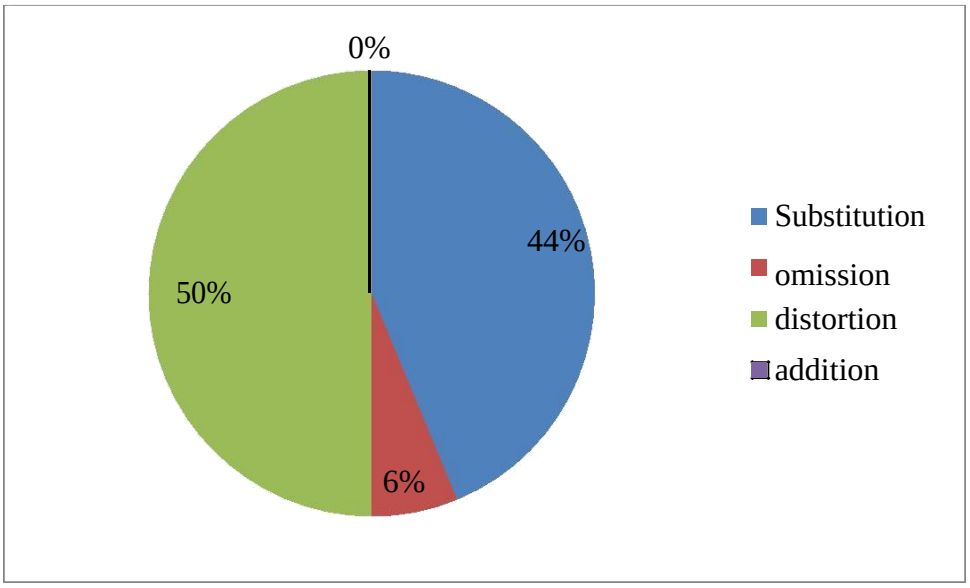

Fig 4.3: *Total percentage of SODA errors in fricatives*

The analysis related to compensatory articulation revealed that among all cleft type errors weak pressure consonants (n=13, 48%) were exhibited at most, followed by ANE n=11 (41%). The other errors such as mid- dorsum palatal fricative (MPF) (4.0%), pharyngeal fricative (4.0%) (PF) and posterior nasal fricative (PNF) (3.0%) productions were found in 1 individual.

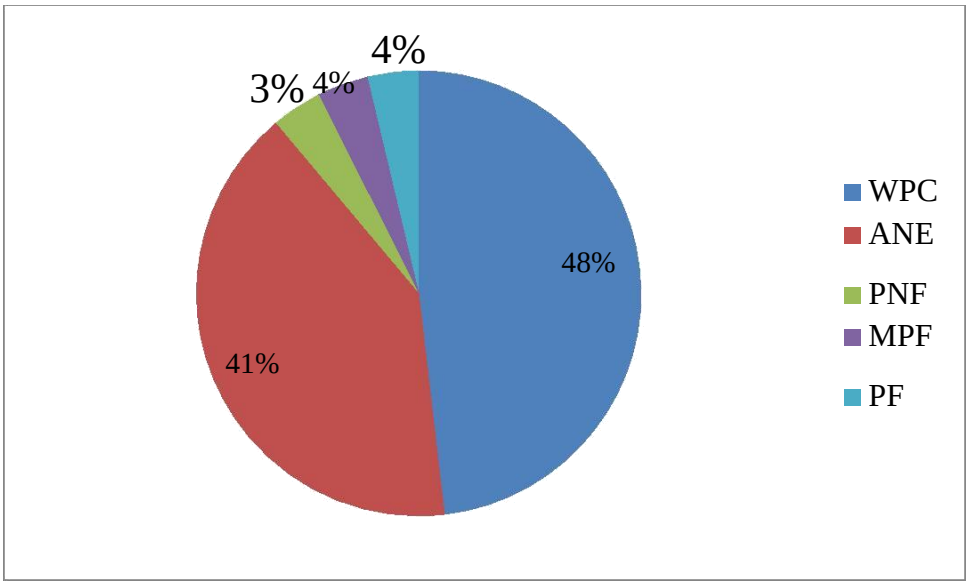

Fig 4.4: *Total percentage of compensatory articulations in fricatives*

Over all it was noticed while producing words and sentences, consisting fricative consonants the participants had distortions followed by substitutions and omissions. Among compensatory errors, participants predominantly exhibited weak pressure consonants, followed by ANE, mid- dorsum palatal fricative, posterior nasal fricative and pharyngeal fricative.

However, another salient feature observed was that all the participants were exhibiting substitution, omission and distortion while producing /ʃ/ consonants. The distortions were highly consistent irrespective of words or in sentences.

4.2.3. Affricates

Percentage of errors while articulating affricates /ʧ/ and /ʤ/ within a word was calculated among 13 participants. Following this, the total percentage of SODA errors and compensatory articulations were documented. The percentage of SODA errors in affricates and compensatory articulations are depicted in Figure 4.5 and 4.6 respectively.

The traditional analysis of SODA errors indicates that distortion (n= 11, 73%) errors were more followed by 3 (20%) participants uttering affricates as substitution, 1 (7.0%) participant exhibited omission and none of them had addition error.

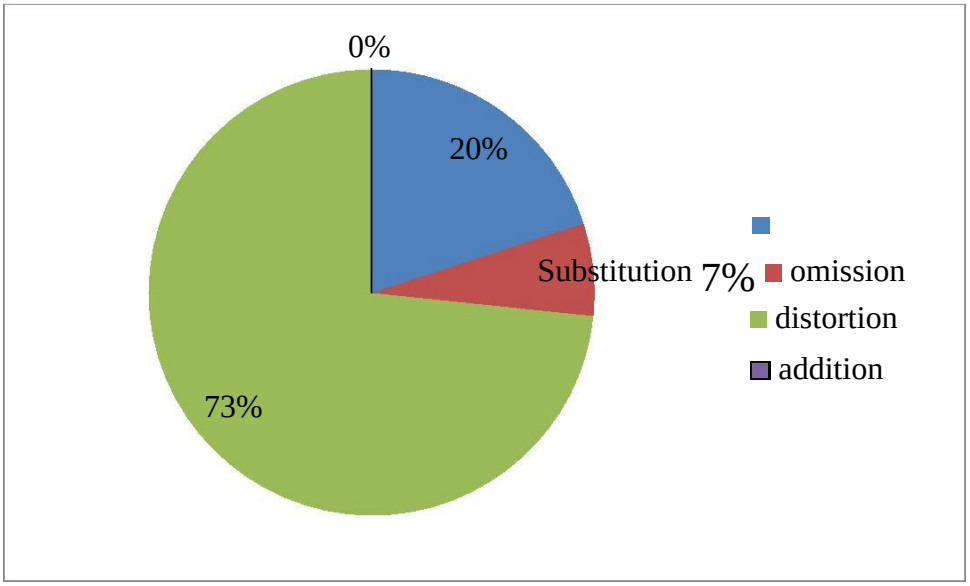

Fig 4.5: *Total percentage of SODA errors in affricates*

Similarly for compensatory articulation, the results indicated that the participants speech were predominantly characterized with ANE (n=11, 35%) and WPC (n= 11, 36%). Another cleft type errors which were perceived were mid dorsum palatal affricate in 8 (26%) participants, 1 (3%) participant with pharyngeal affricate (PA) production.

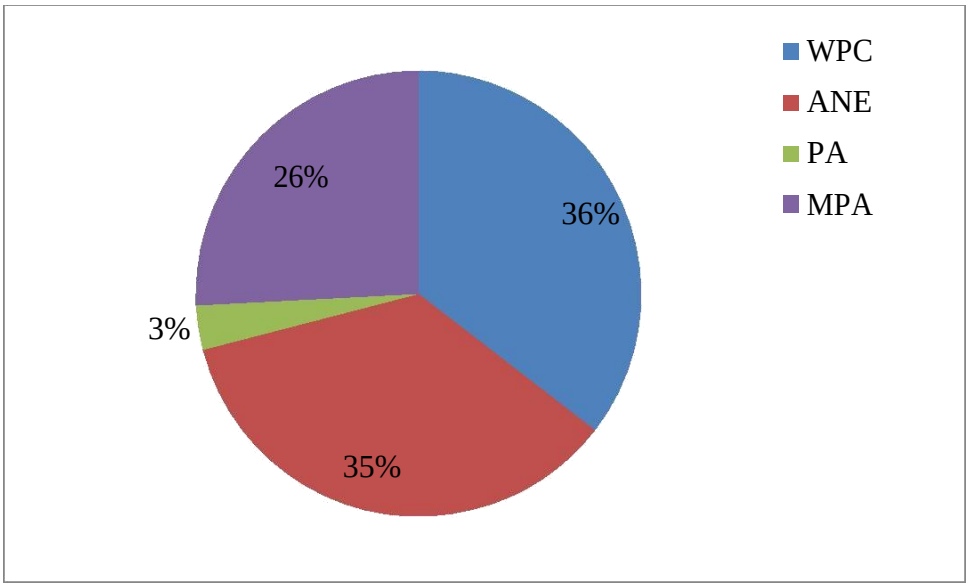

Fig 4.6: *Total percentage of compensatory articulations in affricates*

Individuals with CLP were consistent in producing cleft type errors while articulating voiced affricate and limited for voiceless affricate. Hence, by considering articulatory consistency among all participants, they majorly had distortions followed by substitution and omission. Among compensatory errors, ANE was predominantly seen, followed by production of weak pressure consonants. Other compensatory errors which were persistent among these participants were mid dorsum palatal affricate, and pharyngeal affricative which was perceived while producing words with affricates.

The results of the present study provide an insight about different types of SODA and compensatory errors seen among the pressure consonants in adults with unrepaired CLP. The results provides several point of interest wherein, among SODA errors within the pressure consonants (stops, fricatives and affricates) distortion errors were perceived to be considerably higher compared to other articulation errors. These results supports the agreement of McWilliams (1958) who stated that adult individuals with urepaired CLP

were predominant in exhibiting distortions while producing all pressure consonants. Another longitudinal study Karnell and Van Demark (1986) documented that these individuals with repaired CLP at the age of 16 years were more consistent in producing oral distortions in fricatives and affricates than plosives. The result of the present study supports the above findings. The authors have also opined an improvement in articulation after the age of 10 years. Thus, incidences of distortion errors among other articulatory errors are comparatively more (McWilliams, 1958; Karnell & Van Demark, 1986)

The distortion errors were followed by substitution errors in fricatives and affricates, followed by omissions. Among them substitutions were perceived to be more for fricatives than in affricates and perception of omissions among participants were least. Among the stop consonants, the omissions were predominant as compared with other manner of articulation (affricates, fricatives) followed by substitutions. McWilliams (1958), also reported that among adults with unrepaired CP distortions were more followed by omission and the least for substitution for the production of fricatives, affricates and stops. This supports the finding related to stop consonants but contraindicates the findings of fricatives and affricates. These variations may be due to the heterogeneity of type of cleft palate selected for the study which is not specified in the study conducted by McWilliams (1958). Thus, it indicates that the adults with unrepaired CP/L do persist speech sound errors due to placement error.

Further, the speech samples were analyzed for compensatory errors among all the pressure consonants. Compensatory articulations are typical in speech of individuals with CLP and they are broadly classified at the level of glottal, pharyngeal, laryngeal and mid dorsum along with the presence of WPC and ANE. When the compensatory errors were

analyzed, it was noticed that participants were persistent in producing errors at the level glottal, pharyngeal and followed by laryngeal level. The results highlighted that these participants had more of weak pressure consonants and ANE among all other compensatory errors. This could be attributed to the fact of an inadequate air pressure due to the presence of cleft and to some extent due to the presence of VPD which could lead to ANE (Peterson-Falzone et al., 2006) and distortions among all participants while producing pressure consonants. Thus, resulting in formation of distorted consonants and production of weak pressure consonants. Similarly, the results also supports the findings by Warren (1986) who opined the presence of compensatory errors in relation to individual's ability to build up air pressure and reported the similar fact wherein individuals with CL/P attempt to produce sounds with insufficient air pressure. The other compensatory errors which were noticed among stops, fricatives and affricates were perceptually limited as compared to WPC and ANE. The compensatory articulations at laryngeal, pharyngeal and glottal level were less compared to WPC and ANE. This supports the findings Van Demark, Morris, and Vandehaar (1979), Karnell and Van Demark (1986), Lomander , Friede and Lilja (2012) who reported reduction in compensatory articulations as the age increases.

It was appeared that among stops, glottal stops were perceived more as indicated in above figures and the other predominant errors were MPS and PS. It has been documented that children with unrepaired CLP, develop glottal stops at their initial stages of phonatory development as compensatory production (Harding & Grunwell, 1996; Kummer, 2008). These is speculated to be as one of the reason for the persistence of glottal stops because as they children grow older they increasingly get habituated to the

pattern of their articulation and becomes resistant for the treatment at older ages (Kuehn & Moller, 2000; Peterson-Falzone et al., 2001). Additionally, it was appeared that voiceless sounds are frequently replaced by glottal stops as compared to voiced sounds. This was reported in few studies that individuals with CLP appear to misarticulate voiceless sounds frequently than voiced and this kind of misarticulation was present in production of glottal stops (McWilliams, 1958; Sherman, et al., 1959; Scherer, D'Antonio, & McGahey, 2008).

Among the other cleft type errors, the participants were also exhibiting mid – dorsum production among stops. As reported by Peterson-Falzone et al., (2006, 2010) mid-dorsum palatal production are frequent among un-operated cleft and was reasoned as a compensatory production with anterior and posterior placement, that would be learnt during their speech development. Wherein, the individuals with unoperated cleft try to fill up the space as an action to search the articulatory contact (Mekonnen, 2013).

Additionally, it was also observed that few participants were persistent in producing glottal and pharyngeal placement errors. But this was considerably less in frequency. Pharyngeal production is one of the compensatory errors observed among these participants. It was reported in a study conducted by Sell and Grunwell (1990) that even with surgical management the adult individuals with CLP had misarticulations due to glottal and pharyngeal placement error. Similarly, it was reported in another study wherein they observed the presence of posterior production even after surgical correction of structural anomalies (Peterson-Falzone et al., 2010) and this suggest a fact that it is a behavioural aspect within their articulatory process. Individual with CLP develop some backing errors at earlier stages as an attempt to achieve VP closure or may be to block the

escape of fluid because of being in a condition of unoperated palate (Mekonnen, 2013). A study conducted by Peterson and Falzone (1995) reported the presence of compensatory articulation among adults with unoperated CLP, which was also supported by Van Lierde et al., (2003). There are authors who have reported contrastive findings based on the persistence of compensatory articulation. Karnell and Van Demark (1986) reported that articulation skills improved after the age of 10 years and the presence glottal stop and pharyngeal stop reduced after 10 years of age these was also supported by Lohmander, Friede and Lilja, (2012). These contradiction findings could be due to differences in selection of participants as they had considered participants with operated cleft which would definitely implies changes in speech characteristics.

4.3. Perceptual characteristics of resonance

4.3.1. Hypernasality

Severity rating (normal/mild/moderate/severe) was used for analyzing the parameters related to resonance. The total percentage was determined for entire words and conversation samples of 13 participants which is depicted in Figure 4.7. Among words, it was found that most of the participants (n=11, 87%) exhibited moderate nasality, followed by mild degree among two (13%) participants. But none of them exhibited normal or severe degree of nasality within a word.

The severity of nasality among sentences were perceived to be distinct as compared with words, that is most of the participants n= 10 (77%) had moderate degree of nasality and few exhibited n=3 (23%) severe nasality. Among sentences none of the participant's speech was perceived to be within normal or mild degree.

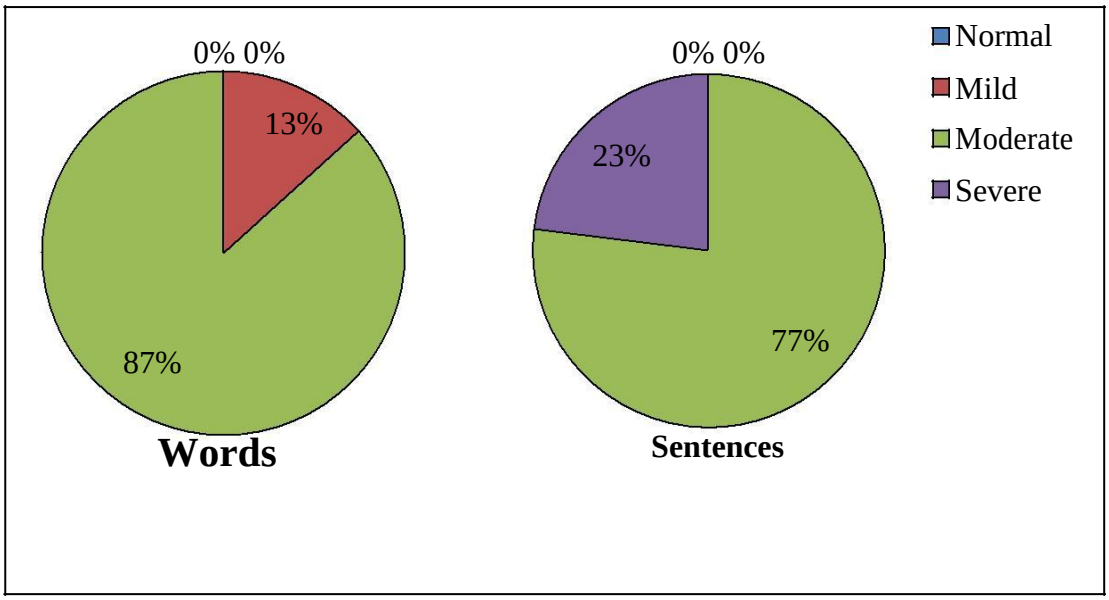

Fig 4.7: *Total percentage in severity of hypernasality across stimuli*

Overall, it was observed that among all participants the moderate degree of nasality was predominant across words and sentences. Hypernasality is reported to be frequent among adult individuals with CLP irrespective of operated or unoperated and reported persistence of hypernasality of mild to modeate degree (Riski, 1994; Peterson & Falzone,1994; Van Lierde et al., 2003; Lohmander, Friede & Lilja, 2012) . Studies regarding the effect of the length of stimulus on perceptual evaluation has been documented which states that perceptually rating nasality was more for sentences followed by words, and then in isolation (Lewis, Watterson, & Quint, 2000; Watterson, Lewis, & Foley-Homan, 1999).

Thus, the variation of perception of nasality among words and sentences would be due to the combination of pressure consonants and vowel (high and low vowel) production while eliciting sentences wherein, it sums up to excessive requirement of air pressure, co-articualtion effect. Other reason would be the presence of associated speech

sound errors such as presence of distortion, ANE, use of compensatory articulation, which increases additionally as length of the sentences increases. It has been reported that individuals with CLP having hypernasality, perceptually listeners would perceive increase nasality among high vowels than in low vowels considering being in isolation, words and sentences (Henningson et al., 2008).

The perception differences of nasality are also based on speaking duration, changes within the pitch (Hess, 1959), intensity (Hess, 1959), speaking rate, and more over it is speculated that these differences are due to the structural differences rather than on muscle function of VP (Webb, Starr, & Moller, 1992). In addition, both mouth opening and tongue height and front to back position tends to influence hypernasality. Considering these factors it is reported that hypernasality increases when an individuals with CLP tends to have more closed mouth and higher, more backed tongue posture (McDonald & Koepp – Baker, 1951; Falk & Kopp, 1968; Cullinan & Counihan, 1971). The above findings supports the present findings as the participants had backed tongue posture while articulating pressure consonants.

4.3.2. Hyponasality:

This was the second parameter considered for analyzing the resonance characteristics. Through perceptual analysis, it was observed that none of the participants exhibited hyponasality, at words or sentences. It indicates the lack of resonance while uttering nasal consonants. But as noticed none of them had reduced nasality and all of them had hypernasality. This supports the findings of Grunwell et al., (2000) who documented the similar findings wherein hypernasal was perceived to be predominant

among individuals with CLP as compared to hyponasality. The reason for the absence of hyponasality would be completely depended upon the fact that the degree of nasality is an indication of the extent of palatal deviation/ defect (Law & Fulton, 1959).

Law and Fulton (1959) opined that the individuals with unrepaired cleft of the hard and soft palate reported to have more nasalance than other types of cleft. The perception of nasality depends on the separation of the oral and nasal cavities, and as the separation increases the higher will be the perception of nasality. In these study most of the selected participants were diagnosed with complete bilateral/unilateral CLP. Hence, perceptually speech was graded as hypernasality.

4.3.3. Audible Nasal Air Emission

The total percentage of ANE was calculated among words and sentences in all participants. These uttered words and sentences were analyzed in terms of their frequency of occurrence that is whether intermittent/frequent ANE. The total percentage of ANE in words and sentences are depicted in Figure 4.8. Among words, 8 (62%) participants had intermittent degree of ANE followed by frequent degree among 5 (38%) participants.

Further, at sentence level, the presence of ANE was perceived to be higher among 8 (62%) participants with frequent ANE perception and remaining 5 (38%) participants had ANE with intermittent degree. Thus, considering ANE both in words and sentences it was perceived to be highly frequent while uttering sentences than in words.

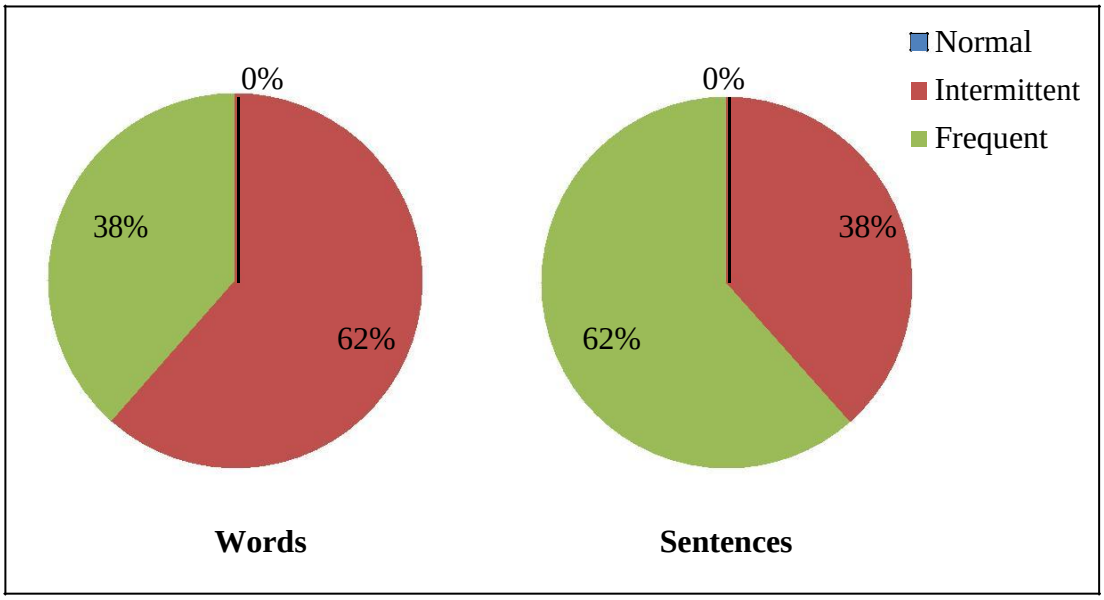

Fig 4.8: *Total percentage in severity of audible nasal air emission across stimuli*

Through analysis, it was confirmed that these individuals had persistence of ANE. Lohmander- Agerskov and Söderpalm (1993) had reported presence of nasal escape and snorting among adults with unoperated CLP. Another study by Peterson and Falzone (1994) reported the similar findings among adults with unrepaired CLP. The ANE often leads to distortion errors and WPC due to VPD, as they had not attended speech therapy also the nasal air emission lead to the increased incidence of WPC.

The results of the present study also indicate a difference in perceiving ANE across words and sentences. As stated by Henningson et al., (2008) it is possible to perceive differences in the perception of ANE at word and sentence level. Additionally, it is essential to understand the variations within the facial movements among individuals with CLP who had persistent ANE. Thus, it was noticed that eight participants had persistent ANE but perceptually in mild to moderate degree along with the presence of nasal grimaces and these were occasionally present and barely noticeable. The nasal grimace was consistently perceived in remaining five participants and the similar

performance was appreciated in all levels that are in isolation, word and sentence level. Furthermore, in observation these were marked nasal grimace and exceedingly distracting the listeners.

4.4. The perceptual characteristics related to voice.

The voice quality was evaluated based on the 4 parameters that is grade, roughness, asthetic, breathiness and strain among all participant. These four parameters were analyzed on the basis of severity (normal/mild/moderate/severe) of pathology. The total percentage of severity among all parameters (grade, roughness, asthetic, breathiness and strain) is depicted in Figure 4.9.

Among 13 participants mild degree was noticed in total n=7 (54%) participants. Few participants had moderate (n=3, 23%) and few n= 3 (23%) were with normal degree and none of them perceived with severe degree of voice pathologies. The total percentage of severity of rough voice was analyzed and n=7 (54%) participants exhibited moderate degree followed by mild degree by 5 (38%) participants and with normal voice quality was observed in n= 1(8%). The results also indicated that few participants n=6 (46%) exhibited moderate asthenic voice, followed by mild asthenic voice in 4 (31%) participants and n=3 (23%) were with normal voice. But none of the participants exhibited severely asthenic. Among the breathy, 7 (54%) participants exhibited moderate breathy voice, followed by n= 5 (38%) with mild breathy voice. It was also observed that perceptually n=1 (8%) had normal voice quality. Among 13 participants the percentage of strain voice was calculated wherein it was noticed that n= 12 (48%) participants had moderate and mild strain voice followed by 1 (4%) participant with normal voice quality.

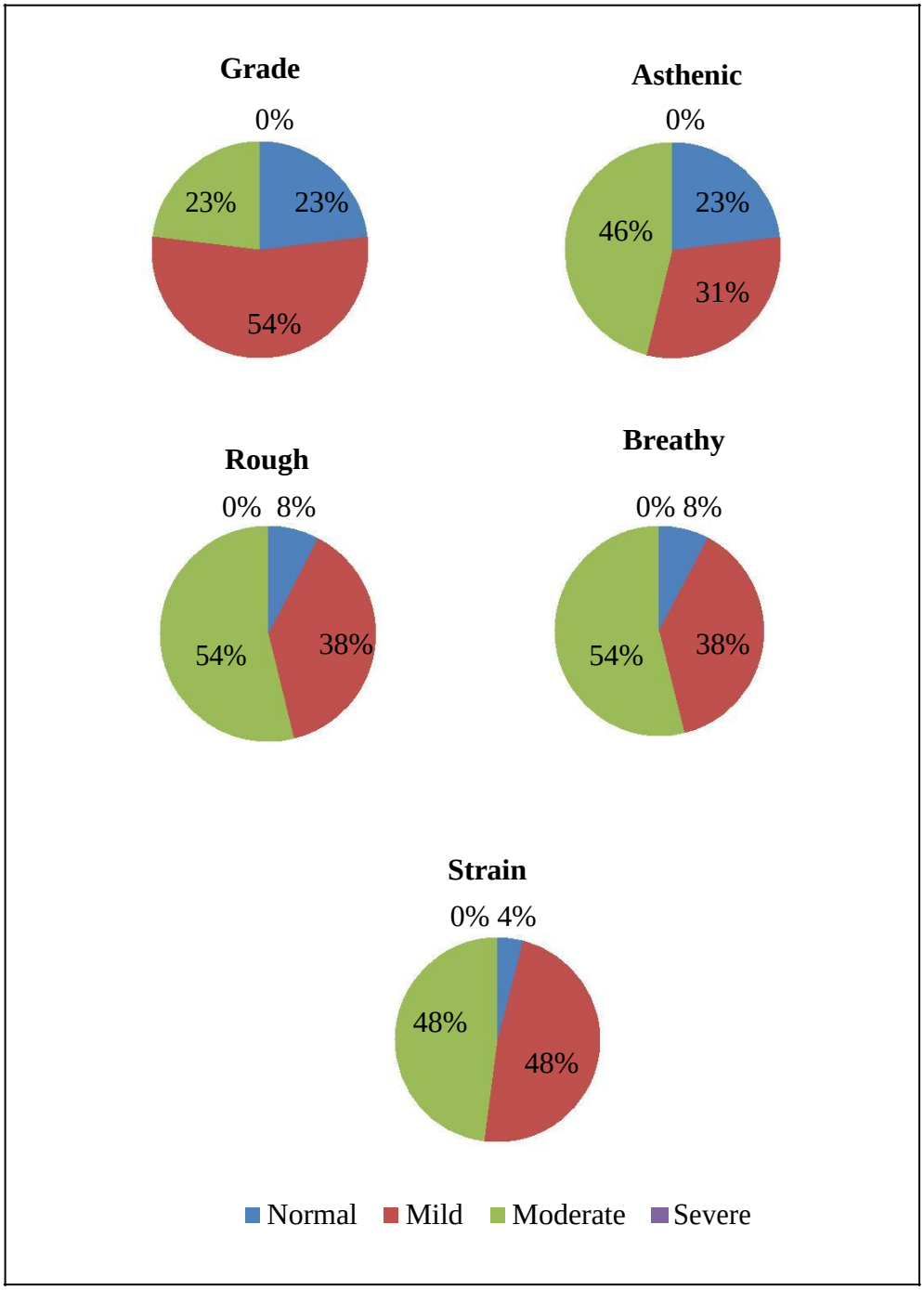

Fig 4.9: *Total percentage of severity in voice*

The voice impairment among these individuals was significantly less than other speech parameters (articulation, resonance and speech intelligibility). Bressmann et al., (1998) also reported less incidence of voice problems among CLP compared to other

speech problems. The present findings even support the agreement stated by Van Lierde et al., (2003) who reported slightly or minimal voice impairment from both objective and subjective assessment.

The participants were also perceived to have hoarseness, breathiness, strain and weak voice. But, the severity was towards mild to moderate. Individuals with cleft palate have high prevalence of laryngeal symptoms, which are considerably hoarseness, breathiness, low volume and abnormal pitch (Hocevar-boltezar, Jarc, & Kozelj, 2006). In an acoustic analysis, the similar findings were reported by Leder and Lerman (1985) who studied the acoustic evidences between hypernasality and laryngeal impairment among adults with repaired CP. Their findings indicated an abnormal laryngeal activity in individuals with severe hypernasality than with a mild hypernasality. This provides an indication of abnormal laryngeal valving and inappropriate adduction as a compensatory action towards velopharyngeal incompetency. Thus, through providing an alteration for regulating the VP port often improves the laryngeal function and in turn reduces the voice symptoms (McWilliams, Lavorato, & Bluestone, 1973). Therefore, due to the presence of hypernasality and compensatory articulation it can be assumed that there is a glottal tightness as secondary to hypernasality that leads to vocal abuse forming hoarseness, harshness and vocal nodules (Hamlet, 1973).

Among children with CLP, it is commonly found that they have increased risk of developing vocal nodules due to extensive laryngeal hyperfunction, which are presumed as secondary to abusive use of vocal folds as a compensatory speech valving mechanism (Peterson- Falzone, Trost- Cardamone, Karnel, & Hardin- Jones, 2006). Another study based on the relationship between laryngeal and VPD by D'Antonio et al., (1988)

documented the nasoendoscopic or aerodynamic assessments of velopharyngeal dysfunction wherein, there was a greater respiratory effort or abnormal laryngeal valving among cleft and non-cleft individuals with velopharyngeal insufficiency. Overall, the present finding shows a positive indication of voice pathology and this was correspondingly document in other studies among adults (Rampp & Donald, 1970; Van Lierde et al., 2003).

4.5. Comparison of speech intelligibility across words and spontaneous speech

Speech intelligibility among participants was documented based on their speech understandability and speech acceptance. Speech understandability and acceptance was calculated across words and sentences.

4.5.1. Speech understandability across words and sentences

The total percentage in severity of speech understandability in words and sentences is depicted in Figure 4.10 and 4.11 respectively. It was found that among 13 participants, 11 (85%) exhibited moderate degree of nasality followed by 2 (15%) participants with mild speech understandability in words. None of the participant's speech was perceptually graded as normal and severe degree when the analysis was based on words. Among sentences, it was found 9 (69%) participants exhibited moderate degree followed by 4 (31%) participants with speech understandability in severe degree. None of the participant's speech was perceptually graded as normal and moderate degree.

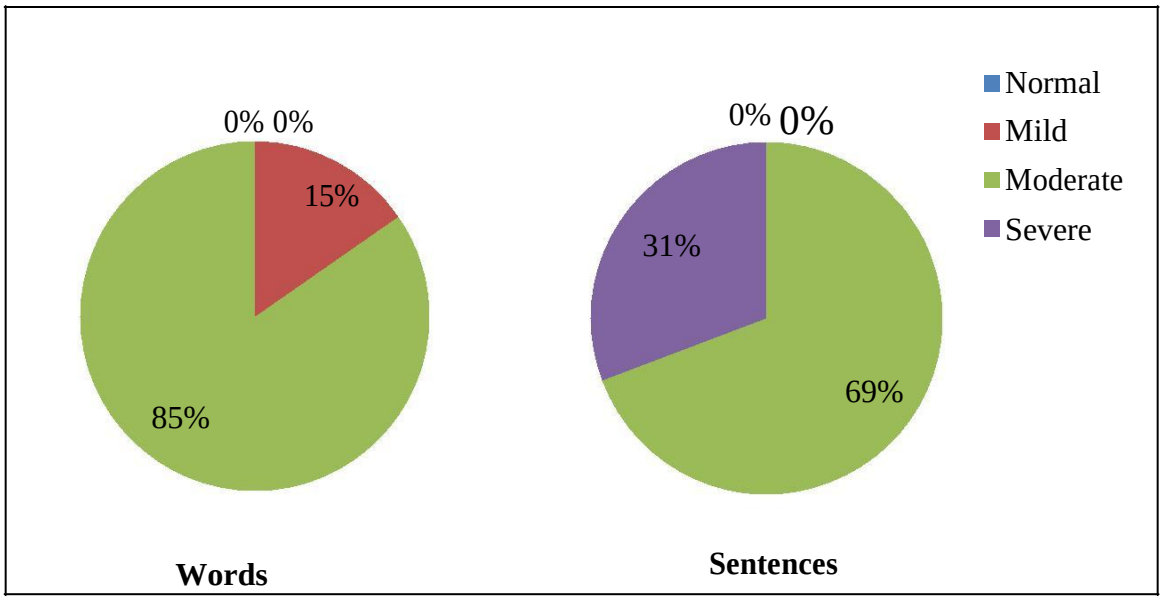

Fig 4.10: *Total percentage in severity of speech understandability across stimuli*

4.5.2. Speech acceptance across words and sentences

The total percentage in severity of speech acceptance is depicted for words and sentences in Figure 4.11. The moderate acceptance was observed in 12 (92%) participants followed by mild in 1 (8%) participant. None of the participant's speech perceptually was analyzed to be normal or severe degree. Among sentences it was seen that the speech acceptance rating was severe in n= 8 (62%) and n= 5 (38%) under moderate. None of the participant was graded as normal or mild for speech acceptance among sentences.

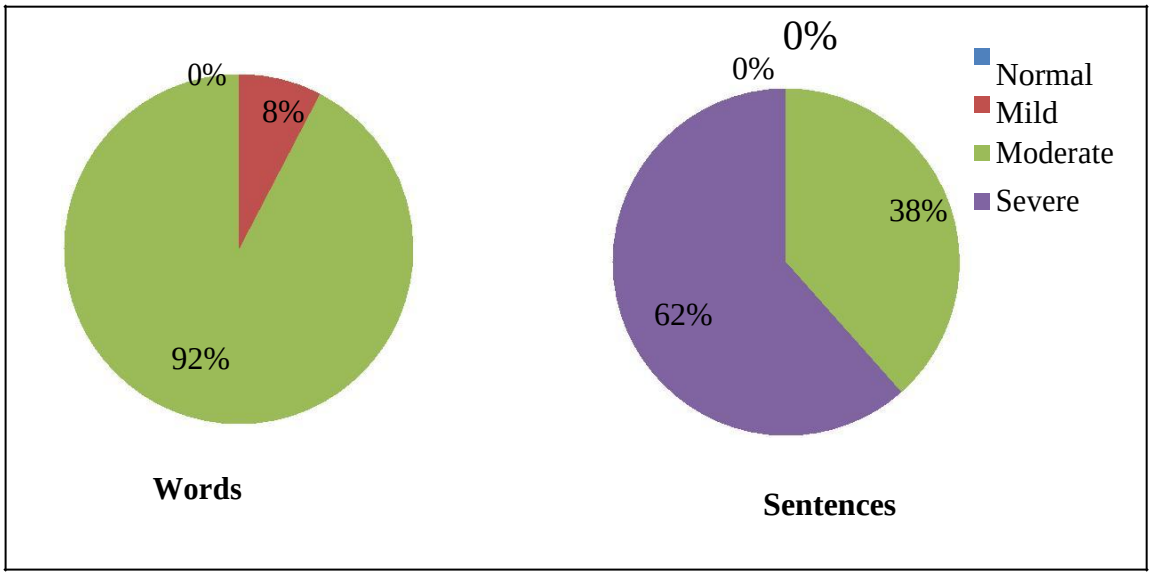

Fig 4.11: *Total percentage in severity of speech acceptance across stimuli*

Hence, the present findings on the speech intelligibility based on their understandability and acceptability cannot be compared to the earlier studies as there are no studies cited in the literature on these variables (understandability and acceptability) for adults with unrepaired CLP. It was found that words were mild to moderately impaired and sentences were moderate to severely impaired for both understandability and acceptability. Hence, it is predicted that perceptually speech intelligibility differs across words and sentences and was followed the same for understandability and acceptability. This supports the findings of Henningson et al., (2008) where it was reported that speech in an individual with CLP may be graded understandable. But the speech can draw attention due to a compensatory articulation and hypernasality. Hence, even though it is understandable it is not acceptable to the listeners.

The poor speech intelligibility observed in the present study is due to the presence of WPC, ANE, hypernasality, mild to moderate impaired voice quality. All this contribute to the reduced intelligibility among individuals with CLP (Fletcher, 1978;

Warren, 1986). Additionally, all these variables in speakers with CLP might decrease their speech acceptability (Whitehill, 2002; Hutters & Henningsson, 2004; Lohmander & Olsson, 2004).

Further, to specify the correlation among the variables over the speech intelligibility McWilliams (1954) concluded that there is a correlation between intelligibility and articulation errors along with severity of nasality. Correspondingly, Subtelny et al., (1972) reported a negative consequence of nasalized speech and nasal emission, towards the intelligibility. Studies have reported a positive relation towards the present findings and reports presence of reduced/ poor intelligibility/unacceptable among CLP speakers irrespective of whether repaired or unrepaired (Copeland, 1990; Landis & Cuc, 1972).

Thus, the present study is an initial attempt to explore the different speech characteristics such as articulation, resonance, voice, and speech intelligibility among adults with unrepaired CLP. The overall results indicated that the speech of adults with unrepaired CLP is characterized with articulatory errors such as hypernasality, nasal air emission and compensatory articulation. They also exhibited more of distortion errors and weak pressure consonants. These errors further leads to unintelligible speech. This study indicates necessary rehabilitation for individuals with unrepaired CLP.

CHAPTER 6

SUMMARY AND CONCLUSIONS

Individuals with CLP face many difficulties to develop normal speech and language throughout their life. Their foremost challenge is to acquire adequate speech and language skills. Speech in individuals with CLP irrespective of whether repaired or unrepaired appeared to have speech difficulties predominantly. In context to the speech, they significantly have articulation errors, compensatory articulations, resonance problem, unintelligible speech and voice disorders. These difficulties would be noticed at their earlier stages itself which would be persistent at their later stages as well that is during the adult stage.

There are several studies (Lomander , Friede & Lilja, 2012; Karnell & Van Demark, 1986; Van Demark, Morris, & Vandehaar, 1979) which reports that misarticulations in individuals with CLP disappears as the age increases. However, there are limited studies that are focused in-depth to understand the speech parameters among adults with repaired/unrepaired CLP. In order to assess the speech characteristics among individuals with CLP there is a necessity to follow a standard protocol, which accounts all the factors that are, must to judge the speech impairment among individuals with CLP. In that note, well-known protocol called ‘universal parameters for reporting speech outcomes in individuals with cleft palate’ (Henningson et al., 2008) is the standard protocol, that follows a systematic order, and provides information to direct to an effective intervention.

The present study examined the speech characteristics in Kannada speaking adults with unrepaired CLP using Henningson's perceptual scale. A total of 13 (6 females and 7 males) native Kannada speaking adults with unrepaired cleft lip and palate between 15-25 years of age participated in the study. The participants were examined in terms of their articulation (SODA and compensatory articulation), resonance (hypernasality, hyponasality), audible nasal air emission (ANE), and voice and speech intelligibility.

The first parameter analyzed was articulation and to test this KDPAT (Deepa.A, 2010) was used wherein the task was to repeat 48 Kannada words loaded with pressure consonants (stops, fricatives and affricates). These were further analyzed by SODA errors and compensatory articulations. The responses were transcribed into IPA and the total percentage of errors was calculated under each variable (SODA, compensatory errors, and consistency among voiced and voiceless production). Among the SODA analysis most of the participants were having distortions while producing pressure consonants. This was followed by omission and substitution in stop consonants and in fricatives. But in affricates distortion was followed by substitution and omission. Hence, it indicates that their speech was characterized by nasal air emission that leads to distortion errors and also due to lack of precise placement of articulators they exhibited substitution errors.

Further, to analyse the articulation proficiency among these participants compensatory articulation was also examined and these were analyzed for the glottal, laryngeal, pharyngeal articulation. Apart from these the presence of WPC and ANE were also analyzed under each manner of articulation. It was found that among stops, weak pressure consonants and ANE were more, followed by presence of glottal stops, mid-dorsum palatal stops and pharyngeal stops. In fricatives, weak pressure consonants were

predominantly exhibited, followed by ANE, mid- dorsum palatal fricative, pharyngeal fricative and posterior nasal fricative. Among affricates ANE and weak pressure consonants were majorly seen along with mid dorsum palatal affricate. Pharyngeal affricates were very less. The result of the study indicated that the participants had persistence of WPC and ANE followed by the other atypical compensatory articulation at the pharyngeal, laryngeal and glottal level. This supports the findings that compensatory articulation was persistent even in adulthood but the extent of persistency is less as compared to WPC and ANE.

The second aim of the study was to analyze the resonance related parameters such as hypernasality, hyponasality and ANE.). The stimuli for testing the resonance include repetition of Kannada oral and nasal sentences *(*Jayakumar & Pushpavathi, 2005) and conversation samples (approx. 100 words) which were audio video recorded. A standard protocol 'universal parameters for reporting speech outcomes in individuals with cleft palate' (Henningson et al., 2008) was used to quantify all these three parameters across words and sentences level. In results, among words moderate nasality was exhibited by most of them followed by mild degree of nasality .Among sentences, moderate degree of nasality was observed followed by severe nasality. This indicates that the perception varies across words and sentences. This variation is due to increase in length of utterance which affected the perception of nasality.

Another parameter considered was hyponasality. But none of them was perceived to have hyponasality across stimuli. Additionally, ANE was also analyzed and most of them exhibited intermittent ANE in words most often than in sentences.

Speech intelligibility (speech understandability and speech acceptability) was analyzed by using the same stimuli, which was considered for analysing the above parameters. In perceptual analysis, it was found that among words the speech understandability was predominantly rated as moderate degree followed by mild degree whereas, among sentences, most of them exhibited moderate understandability and few of them had severe degree. Another variable under speech intelligibility was speech acceptability wherein among words they were predominantly perceived to have moderately acceptable followed by mildly acceptable, in sentences most of them were analyzed to have severe, and few were scored moderate. This was due to the presence of more distortions, presence of compensatory articulations along with ANE, WPC and hypernasality across words and sentences.

The last parameter was voice analysis that was carried out by perceptually analysing the spontaneous speech samples of participants by using GRBAS scale. The severity (normal/ mild, moderate/sever) was rated individually for grade, roughness, asthenic, breathy, and strain voice quality. It was found that most of them were graded to have mild to moderate voice impairment due to the presence of hoarseness, breathiness, and weak voice and strain voice in their speech.

To conclude, the present study is an attempt to profile the speech parameters in adults with unoperated CP/L. The parameters considered to analyze were articulation, resonance, speech intelligibility and voice. The study indicated adults with unrepaired CLP have atypical speech characteristics due to the persistence of articulation, resonance, voice, and speech intelligibility problems. The results also highlight the need of assessment of speech in adults with repaired/ unrepaired by using appropriate subjective

and objective methods. The results also throw light on need of initiating surgery/prosthetic management followed by speech therapy in these participants.

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Appendix I

Profiling sheet for articulation errors

Target sounds	Words	IPA	SODA errors				Compensatory articulation				
			S	O	D	A	GS	MPS	PS	WPC	ANE
STOPS											
/k/											
/g/											
/p/											
/b/											
/											
/											
t/											
d/											
Target sounds	Words	IPA	SODA errors				Compensatory articulation				
			S	O	D	A	MPF	PNF	PF	WPC	ANE
Fricatives											
/s/											
/S/											
Target sounds	Words	IPA	SODA errors				Compensatory articulation				
			S	O	D	A	MPA	PNA	PA	WPC	ANE
AFFRICATES											
ʧ											
ʤ											

[*Note*: S- substitution, A-addition, O-omission, D- distortion, GS- glottal stop, MPS- mid dorsum palatal stop, PS- pharyngeal stop, PF- pharyngeal fricative, PNF- posterior nasal fricative, MPF- mid dorsum palatal fricative, PA- pharyngeal affricate, PNA- posterior nasal affricate, MPA- mid dorsum palatal affricate, WPC- weak pressure consonant, ANE- audible nasal emission]

Appendix II

Analysis sheet of one client