CHAPTER I
INTRODUCTION

Communication is an act of passing information by means of exchange of thoughts, messages and information using gestures, signs, writing and speech or through oral means. It is considered as a meaningful exchange of information between living beings. This can be an animal/human communication, which includes both verbal and nonverbal communication.

In verbal communication, human communication is considered as the most powerful, effective and complex communication system. This is being achieved through speech/ oral communication. Speech depends on various factors such as the development of anatomical structures, psychosocial and environmental factors. Failure in any one of these systems can affect the oral communication. One of the most frequently occurring birth defects/ deformity is cleft lip and palate (CLP). Children with CLP are often associated with feeding problems, nutritional concerns, and middle ear problems/ reduced hearing sensitivity, communication problems, dental problems and psychosocial impairments. The commonly observed speech related problems in children with CLP are hypernasality, compensatory articulation, hoarse voice quality and unintelligible speech.

The occurrence of CLP in India is estimated as 1 in 781 live births (Raju, 2000). As per NSSO (2002) report the incidence of CLP is 17 per 1000 persons in all sectors that can cause speech disability. Another report by Banerji and Dhakar (2013) estimated the occurrence of clefts approximately between 27,000 and 33,000 clefts per year. Although the occurrence of CLP was high, only 25% of the individuals with CLP undergo surgical correction (Raju, 2000). This is due to the lack of awareness about the condition and intervention facilities. However, even after the surgical correction speech problems are frequently observed in individuals with CLP. Speech is assessed as one of the main outcome methods of CLP management and yet its assessment method is challenging for Speech-Language Pathologists (SLPs). In spite of the challenges, there are no universal agreements for speech evaluation methods for CLP.
The speech of individuals with CLP was subjected to different types of analyses. The perceptual analyses of speech have been cited extensively in the literature (Grunwell et al., 1993; Hennningson et al., 2008; Howard & Heselwood, 2002; Kuehn & Moller, 2000; Lohmander & Olsson, 2004; McWilliams et al., 1990; Sell, 2005). However, the acoustical analyses of speech of individuals with CLP are limited (Bechet, Hecker, Sock, Vaxelaire & Stierle, 2008; Casal et al., 2002; Forner, 1983; Gaylord & Zajac, 2006). Millard (1968) proposed that the spectrographic analyses could provide objective information, which would be of help in deciding the type of treatment, evaluating the results of service and diagnosing the speech disorders of those who have Velopharyngeal dysfunction (VPD). Forner (1983) reported that speech segment duration measures can provide information about the coordinated speech movements and durational properties of the speech signal.

Few studies were conducted to measure temporal and spectral parameters in children with CLP. Forner (1983) acoustically analyzed the segment duration uttered by 15 children with repaired cleft palate in five to six years of age with different grades of hypernasality and compared with 15 typically developing children. She reported that children with repaired CLP (RCLP) had longer Voice onset time (VOT) and longer segmental duration than normal children. She concluded that consistent patterns of lengthening segments were seen in specific measures, contexts, and suprasegmentals in children with RCLP when compared to that of normal children. In the Indian context, Vasanthi (2001) investigated a few temporal and spectral parameters of speech characteristics in 2 adults with RCLP and compared with typical adults. She reported increased vowel duration, burst duration, and VOT. She reported lower F2 and terminal frequency F2 in the spectral parameters. She concluded that this may be due to the Velopharyngeal insufficiency observed in the adults with repaired CLP which caused longer VOT and lower F2 in her study.

Amongst the acoustic parameters, VOT is one of the temporal parameters studied frequently in the CLP population. Shin et al., (1998) used objective methods to analyze speech characteristics of children with CLP in Korea. Spectrographic analyses method was used to measure VOT in children with CLP. Results of spectrographic analyses showed longer VOT were observed for children with CLP compared to the normal children. Bechet et al., (2008); Gaylord and Zajac (2006)
reported that VOT was found to be shorter in children with CLP. In contrast, Esghi, Bijankhan, Shirazi and Nourbakhsh (2011) reported that VOT values were found to be similar as in the normal group. Among the pressure consonants, fricatives are often reported to be frequently misarticulated compared to the other sounds. Frication duration was studied by Gopi Sankar and Pushpavathi (2012); Pereira (2009) and they found that frication duration was shorter in children with cleft palate.

Very few studies have been reported in the literature on spectral parameters for speech characteristics in children with CLP. Zhang, Guan and Yang (1995) conducted a spectrographic analysis of vowel /a/ and /i/ in thirty children with CLP in the age range of 6 to 8 years in pre and post-operative conditions and compared it with the typically developing children. The results showed a significant difference in F3 value for /a/ in the pre-operative condition in children with CLP. In the post-operative condition, the results revealed that F2 and F3 values were lower in CLP than the normal subjects. They concluded that spectrographic analysis is a better method to analyze speech of individuals with cleft palate objectively and quantitatively. Similar results were reported by Shin et al., (1998). Their results showed F1 and F2 for vowels were reported to be lower than that of the normal control group.

Few Chinese studies have been reported in the literature highlighting vowels in before and after surgical condition in children with CLP. Xing-hua, Jai-hua, Li-jun, Wei, and Ya-hui (2003) studied the formants of Chinese vowels before and after the surgical condition in children with cleft palate and compared with normal children. They reported that frequency of the formant was significantly lower in the pre-operative condition compared to the post-operative condition. Xuecai, Ningyi, and Lingxue (2003) studied the formant characteristics of vowels in the speech of individuals with CLP in the post-operative condition with and without speech therapy and compared with normal children. Results of their study showed that mean values of F1, F2, and F3 did not show significant difference across groups. It was reported that the mean values of F2, F3 in the post-speech therapy group decreased significantly compared to the control group. Their findings also indicated that surgical repair of cleft palate did not contribute for achieving perfect Velopharyngeal closure, while speech therapy can improve the closure and articulation. The authors recommended
using the spectrographic analysis to document the effect of speech therapy objectively.

Wang, Jiang, Huang, et al. (2005) analyzed the acoustic features of speech in individuals with a CLP before and after surgery. They measured F_1, F_2, and F_3 in 32 individuals with cleft palate during the pre and post-operative conditions. Sixteen normal subjects served as a control group for their study. Results of their study showed that the mean values of F_1, F_2, and F_3 showed no difference between the groups. They also found that F_3 values in individuals with cleft palate in the pre-operative condition were significantly lower than the control group. It was reported that post-operative F_3 values were significantly higher than the pre-operative condition in individuals with CLP. F_3 values across groups did not show any difference. The authors recommended that greater attention should be given for correcting habituated abnormal articulation to get better speech results during speech therapy. Deepthi (2008) investigated the spectrographic aspects of children with repaired CLP in ten children with RCLP in the age range of 5 to 11 years in Kannada speaking children. She reported that fundamental frequency values were higher in children with CLP when compared to that of normal children. Children with cleft palate were reported to show higher bandwidths in B1, B2, and B3 when compared to that of typically developing children.

To sum up, there are limited studies reported on acoustic analysis of speech characteristics in persons with CLP pre and post surgically. However, the studies conducted using acoustic analyses have studied vowel formant frequencies and VOT in persons with CLP. There are no studies, which provide detailed information on acoustic analyses in terms of temporal and spectral parameters of the speech characteristics in children with CLP before and after surgery and their comparison with normal children.

Perceptual analysis of speech is considered as an essential speech outcome method of assessment related to children with cleft palate. Extensive research in this area has focused on studies related to inter-subject and intra-subject variability and have discussed the role of various variables such as the type of the stimuli, inter and intrajudge reliability, type of rating scale used in the analysis of speech of CLP. McWilliams et al., (1990) stressed on the need for detailed and reliable perceptual
speech assessment data, which should be confirmed with the instrumentation analyses. Researchers like Howard and Heselwood (2002); Kuehn and Moller (2000) have also supported perceptual analysis as essential measure along with instrumental analyses.

Grunwell et al., (1993) provided the common policies for perceptual assessment to be followed in the clinical settings. Lohmander and Olsson (2004) have reported rating scales that can be used for perceptual analysis of speech in persons with CLP. They indicated that, scales, which are used for perceptual analyses, do not provide adequate information on the items to be collected in sample data. They also indicated there are huge differences in the way collected data are analyzed related to speech of person with CLP.

There have been arguments and controversies about the parameters that should be considered for measurements of speech in persons with CLP reported in the literature. Dalston et al., (1988) suggested that articulation, hypernasality, hyponasality, nasal escape, speech intelligibility have be considered in the protocol. Witzel (1991) suggested that speech intelligibility have to be reported with the combination of consonants and resonatory characteristics. Sell et al., (1994) and Witzel (1991) reported that, one should be cautious while reporting on intelligibility, because it is hard to rate consistently. It can be affected by many factors such as articulatory errors related to hearing, developmental errors, and experience of the rater. A study by Whitehill et al., (2002) has emphasized a need for global measures of speech performance with a detailed quantitative methodology. Lohmander and Olsson (2004) have recommended that resonance, nasal airflow, and consonant productions should be considered for the evaluation of speech outcome studies. Disagreements in studies are also prevalent about the scales that are used to assess the different speech parameters in CLP.

There are a number of scales developed and used for the perceptual evaluation of speech parameters in children with CLP. McWilliams and Philips (1979) developed Pittsburgh scale and Ainoda and Okazaki (1993) developed a categorical system of articulation problem in cleft palate which focuses on Velopharyngeal function, with minimal details recorded about consonant errors. Sweeney (2000) developed Temple street scale of nasality and nasal airflow errors. However this scale does not evaluate
the consonant errors, but it provides information about the hypernasality, hyponasality, and nasal airflow errors and this has been tested for validity and reliability. Euro cleft speech group was developed to facilitate and document the cross-linguistic speech outcomes across five northern European languages (Euro cleft Speech group, 1994; 2000). However, this was developed specifically for older children to provide a detailed analysis of the phonetic characteristics of speech. The Great Ormond Street Speech Assessment was developed as a standardized and comprehensive method of perceptual assessment. It was developed to assess the speech of individuals with CLP in clinical settings at the UK cleft centers with good levels of Interrater reliability (Sell et al., 1994, 1999).

Several studies have reported a number of factors, which can affect the speech outcome assessment in children with CLP. Use of common terminologies and their description are rarely included in the cleft palate measures (Kent et al., 1999; Whitehill, 2002). Other issues such as reliability and validity of the assessment methods are not often reported (D’Antonio & Scherer, 1995; Lohmander & Olsson, 2004; Wyatt et al., 1996).

Sell (2005) reviewed issues related to the perceptual analysis of speech in individuals with CLP and associated disorders. She opined that assessment at the problem level requires extremely trained professionals and systematic method of data sampling, acquiring, and documentation. She also reported consistent method to analyze the sample and understanding the results accordingly. It is suggested that outcome measure should also provide information on functional issues that affects the quality of life in individuals with CLP.

Considering the above issues few universal reporting perceptual scales are developed recently. These scales are developed in such a way that it can be used within and across languages, at different centers, and in other countries. Considering the above, cleft audit protocol for speech-augmentation (CAPS-A) was developed by John, Sell, Sweeny, Harding-Bell, and Williams (2006). It provides information on cleft type speech characteristics on the principle of traffic light system, which gives information on both speech outcome and potential intervention needs. This developed system had sufficient levels of validity and interrater reliability. This system has a
number of detailed audit measures, which can be used for auditing across centers and across countries.

Scand cleft speech project group developed a methodology for speech assessment. Speech samples, recordings, and method of analysis were developed for a cross-linguistic study and Lohmander et al., (2009), tested the same in a pilot study. Speech assessment in the Scand cleft appeared to be valid and reliable cross-linguistically. However, at times this method also seems to be hard to follow and may require additional modification as a method of analyses.

The perceptual speech assessment in CLP needs to have extensive speech sample for details on phonetic analysis and suggestions provided by the way reliability has to be addressed. Presently available methodologies on perceptual speech analysis focused speech as a primary result of outcome. Hence, the studies should include, SLPs in the data sampling, analyses and for further intervention. Considering the above points, Hennningson et al., (2008) developed universal speech parameters for detail speech outcome for individuals with CLP. They have developed a set of five universal speech parameters. These parameters included consonant production errors, resonatory characteristics such as, hypernasality, hyponasality, audible nasal air emission and voice disorders. Speech understandability and acceptability as global parameters were also included as they suggested that they can be reported for any type of speech disorders. Lohmander (2008) reported that universal speech parameters system uses a minimal standard protocol that is very easy to comprehend, and easy to evaluate within and across languages, and also across cleft centers. To summarize, there are few studies on perceptual speech analyses of persons with CLP before and after surgery. Most of the perceptual analysis studies are limited only to pre or post-operative speech characteristics and use of various methods for perceptual analysis. However, there are no Indian studies, which provide information on the detailed perceptual analyses of speech in children with CLP.
1.1 Need for the study

The previous studies indicated that most commonly used methods for assessment of speech of children with CLP by Speech-Language Pathologists (SLPs) included the qualitative/perceptual/phonetic transcription methods. Acoustic analysis through spectrographic measures in terms of spectral and temporal parameters is scanty. However, the available reports suggested that acoustic analysis could provide a quantitative and objective method of measuring CLP speech relevant to articulatory dimensions. This may prove as a valuable supplement to articulatory assessment through phonetic transcription or even perceptual assessment. The spectrographic method can also be used for the assessment of CLP during the early treatment stages and also used to follow-up individuals with CLP over a period of time or it can be used to study outcome measures of speech.

Studies on acoustic analyses of speech in individuals with cleft palate before and after surgery are limited. As a part of acoustic analysis, most of the previous studies are limited to few temporal parameters, and concentrated on formant frequencies of vowels in individuals with CLP (Bechet et al., 2008; Casal et al., 2002; D’antonio, Muntz, Province, & Marsh, 1988; Forner, 1983; Gaylord & Zajac, 2006; Shino et al., 1998; Vasanthi, 2001; Wang et al., 1993).

Literature suggests that acoustical and perceptual studies have been done in different languages such as English, Chinese, Swedish and Japanese languages (D’Antonio & Scherer, 1995; Grunwell et al., 1993; Kuehn & Muller, 2000; Lohmander & Olsson, 2004; Lohmander et al., 2009; McWilliams et al., 1984, 1990; Sell, 2005; Wyatt et al., 1996). As the phonologic and phonetic characteristics vary across languages, the data obtained in these languages cannot be generalized to the Indian languages. In addition, existing scanty knowledge of acoustic and perceptual analysis of speech in CLP in general and specifically to the Indian context necessitated a study to investigate these attributes of speech in Kannada speaking children with congenital cleft palate in the pre and post-operative conditions. There are no studies, which provide detailed information on acoustic analyses in terms of temporal and spectral parameters of the speech characteristics in children with CLP before and after surgery and comparison with normal children. Hence, there is a need
to study the acoustic and perceptual speech characteristics in children with CLP across pre and post-operative conditions.

1.2 **Aim of the study**

The aim of the present study was to investigate some acoustic and perceptual speech characteristics in children with a cleft palate before (Pre-operative) and after (Post-operative) primary palate surgery and to compare with typically developing children.

1.3 **Objectives of the study**

- To investigate and compare temporal and spectral parameters of speech in subgroups of clinical group I (children with cleft palate in the pre-operative condition and children with cleft palate in the post-operative condition) and control group II (Typically developing children).

- To study the perceptual correlates of speech in subgroups of clinical group I (children with cleft palate in the pre-operative condition and children with cleft palate in the post-operative condition) in word and sentence context.

1.4 **Hypotheses to be verified**

The following null hypotheses were formulated for verification in the present study.

**Hypothesis 1:** It is hypothesized that there would be no significant difference in temporal and spectral parameters in be pre and post-operative conditions in children with cleft palate (CLP).

**Hypothesis 2:** It is hypothesized that there would be no significant difference in temporal and spectral parameters in children with cleft palate (CLP) when compared with typically developing children (TDC) in the pre and post-operative conditions.

**Hypothesis 3:** It is hypothesized that there would be no significant difference in perceptual speech characteristics in children with cleft palate in the pre and post-operative conditions.

1.5 **Research Design**

A Single group pre-test post-test design was employed for the study.