CHAPTER VI

SUMMARY AND CONCLUSION

Speech is measured as one of the primary outcomes of surgical correction in persons with CLP. There are many challenges regarding the assessment of speech using various methods. Despite the challenges, there is no universal consensus on speech assessment approaches for persons with CLP. Acoustic, aerodynamic and perceptual methods have been used to analyze the speech in CLP. However, there are no studies, which give information on detailed acoustic analyses of temporal and spectral parameters of speech characteristics. Scanty knowledge of acoustic and perceptual analyses 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. The aim of the present study was to investigate the acoustic and perceptual characteristics of speech in children with CLP across pre and post-operative conditions and to compare the acoustic characteristics with the typically developing children. In the present study, the perceptual analyses of speech are considered only for children with CLP.

The present study considered 14 Kannada speaking children with congenital unoperated cleft palate (Clinical group) in the age range of five to ten years and they were considered as Group I (pre-operative). The same children of group I who underwent surgical intervention were considered as Group I (post-operative). Post-surgical recording for the group I (post-operative) was done after one month from the date of surgery when the children were brought for a follow-up visit. Age and gender matched 50 typically developing children (TDC) were considered as Group II (Control group). The test stimuli consisted of words, sentences, and conversational speech. Children were asked to listen to the speech model provided to them and to repeat bisyllabic words three times clearly and repeat the sentences once, clearly in their comfortable pitch and loudness. The speech samples were audio-video recorded for acoustic and perceptual analyses.

The collected speech samples were subjected to two types of analyses, which included acoustic and perceptual analyses. The acoustic analyses were carried out for children with CLP across pre and post-operative conditions and compared with age and gender-matched typically developing children. Recorded speech samples of
Children with CLP were subjected to auditory perception and spectrographic inspection by experienced SLP before the acoustic analyses. Selected audio-recorded speech samples of children with CLP (words) were analyzed using Praat software version 5.3.35 (Boersma & Weenink, 2010) for calculating temporal and spectral parameters from waveform and wideband bar type spectrogram as a reference. Ten percent of the speech samples of typically developing children were selected randomly for acoustic analyses of Intra and inter-judge reliability. Sixty percent of the clinical group (pre-post) samples were selected randomly for both acoustic and perceptual evaluation of Intra and inter-judge reliability. Inter-judge reliability for all the subjects was done after six weeks of the completion of the analyses.

In general, the temporal and spectral parameters were investigated and compared across conditions (Pre Vs post) and across groups (Pre Vs TDC, Post Vs TDC). Results of the present study showed there was no significant difference across conditions for temporal and spectral parameters in children with CLP. However, children with CLP in the present study showed longer vowel duration, total duration, closure duration and voicing duration and higher F₁ in the pre-operative condition when compared to the post-operative condition. This may be due to the compensatory mechanism used by children with CLP in using the oral/pharyngeal muscles to achieve the normal oral production which can lead to longer duration. In the pre-operative condition, longer duration was observed for temporal parameters when compared to the post-operative condition. This may be due to an attempt to achieve the normal production, children with CLP in the pre-operative condition may prolong the vowel in the preceding position which could lead to longer VD, TD, and CD in the pre-operative condition.

Children with CLP in the post-operative condition showed longer word duration, syllable duration, burst duration, and frication duration. This may be due to prolongation of the segmental duration as a purposeful feature used to compensate for damped sound energy. A higher F₂, F₃, B₁, B₂ and Lower F₂ onset was observed when compared to that of children with CLP in the pre-operative condition. It may be due to abnormal use of the respiratory mechanism may result in a stress-like emphasis on all the utterances or it may be a combination of factors related to compensation and abnormal use of the mechanism to reach the feature of the target phoneme.
The analyzed temporal and spectral parameters for children with CLP and TDC were compared across groups. Children with CLP exhibited longer word, vowel duration, syllable, total duration, closure duration and affrication duration when compared to that of TDC. This may be due to persistence of VPD and inability to sustain intraoral pressure due to nasal air emission in children with CLP which can lead to a longer duration in an attempt to rebuild sufficient intraoral pressure to produce the consonants. Results of the present study also indicated that children with CLP exhibited shorter VoD, burst, and frication duration compared to that of TDC. Children with CLP may not be able to sustain intraoral air pressure for a long time in the oral cavity leading to a shorter duration. It was also observed that VOT of unvoiced consonants was found to be longer in children with CLP across condition than TDC. It was also observed that VOT for voiced consonants was found to be longer in TDC when compared to that of children with CLP in the pre and post-operative conditions. Syllable duration, closure duration, and total duration were found to be decreased as the place of articulation moved backward in the oral tract.

Among spectral parameters, a higher \( F_1 \), \( F_2 \) was observed in children with CLP in the pre-operative condition when compared to TDC. This could be due to a pharyngeal constriction used by children with CLP in the pre-operative condition as a compensatory strategy which could have led to a higher \( F_1 \), \( F_2 \). Higher \( F_1 \), \( F_2 \), \( F_3 \) and \( F_2 \) onset frequency was observed in children with CLP in the post-operative condition when compared to that of TDC. This could be due to varying of the tongue height and jaw movement using abnormal articulatory pattern to compensate for the target sound production, which narrows the region of the oral cavity. Other spectral parameters such as \( B_1 \), \( B_2 \), and \( B_3 \) were found to be higher in children with CLP compared to that of TDC. This may be due to the spread of low-frequency energy across the spectrum, which could have lead to an increase in the formant bandwidths in children with CLP. Statistical results revealed a significant difference for few consonants in temporal and spectral parameters when they were compared across groups. Results were analyzed across the gender, and there was no significant difference observed for all the temporal and spectral parameters in both TDC and children with CLP for gender. Further, temporal parameters were compared across voiced and unvoiced consonants. Results of the present study indicated a significant difference for all the temporal parameters between voiced and unvoiced consonants in TDC.
Another objective of the present study was to analyse the perceptual characteristics of speech in children with CLP. Perceptual analyses of speech characteristics in children with CLP were done using universal reporting parameters given by Henningsson et al. (2008). Perceptual analyses were done for analyzing articulation, resonances and intelligibility parameters. The speech sample considered for perceptual analyses in the present study included words, sentences loaded with pressure consonants and conversational speech. Speech samples were randomized and presented to the judges for perceptual analyses.

Results of the perceptual assessment were described in terms of articulation, resonance, and speech intelligibility. The results for articulation in the pre-operative condition indicated that articulatory errors were found to be greater in the pre-operative condition in children with CLP. The results also indicated that among words and sentences, the occurrence of the mid-dorsum palatal stops were found to be greater followed by, glottal stops (ʔ) and pharyngeal stops/fricative/affricatives. Among errors due to nasalization, nasal fricatives were found to be higher followed by weak oral pressure consonants (WOPC), substitution of nasal for oral consonants and nasalization of oral consonants.

In general, the articulatory errors of children with CLP in the post-operative condition included the occurrence of glottal stops (ʔ), mid-dorsum palatal stops and pharyngeal affricates/fricative. However, percentages of occurrences of compensatory articulatory errors reduced in the post-operative condition when compared to the pre-operative condition. However, the improvement was observed in errors due to nasalization post-operatively in the present study. Statistical results revealed that there was no significant difference across stimuli and conditions in the articulatory errors for stop consonants and fricatives and affricates. Statistical results revealed that there was no significant difference across stimuli and conditions in articulatory errors due to nasalization except WOPC across conditions.

The second parameter considered for perceptual assessment was resonance. Among the resonance parameters, hypernasality and nasal air emission were considered. The overall degree of hypernasality reduced from ‘moderate’ to the pre-operative condition to ‘mild’ in post-operative condition. The results showed that the overall mean scores for hypernasality were found to have reduced for the post-
operative condition in both words and sentences. The results showed that there was a significant difference across conditions for words and sentences and there was no significant difference observed across the stimuli. The nasal air emission was found to be present in the post-operative condition for words. Perceived nasality in individuals with CLP in the post-operative condition could be due to poor timing of velopharyngeal movements relative to the activity of other articulators and persistence of velopharyngeal dysfunction even after the surgical correction which can lead to hypernasal speech.

The third parameter considered in the perceptual assessment was speech intelligibility. Speech intelligibility was assessed for speech understandability and speech acceptability. The results showed an overall improvement in the mean rating scores of speech understandability and acceptability from pre-operative to the post-operative condition. Speech understandability and acceptability rating scores were found to be ‘moderate’ in pre-operative condition and ‘mild’ in the post-operative condition. The results showed significant difference across conditions for speech understandability and speech acceptability.

To conclude, the findings of the present study have provided information on some acoustical and perceptual speech characteristics in children with CLP before and after surgery and yielded results in comparison of the acoustical parameters with TDC. It can be concluded from the present study that, typically developing children and children with CLP showed no significant difference across the gender for all the acoustical parameters. Voiced and unvoiced consonants showed a significant difference for all the temporal parameters in TDC and few parameters in children with CLP. The findings of the present study revealed that children with CLP showed improvement in some of the temporal, spectral and perceptual parameters after the surgical correction. However, not all the parameters indicated improvement after the surgical correction. The findings of the study thus indicated that surgical correction alone may not be successful in improving parameters of speech. It also indicated the importance of speech therapy after the surgical correction in children with CLP.
Implications of the Study

- Acoustic analyses through spectrographic measures in terms of spectral and temporal parameters could provide a quantitative and objective method of measuring CLP speech relevant to articulatory dimensions. This may prove as a valuable supplement to perceptual assessment.

- The acoustical measures can be used by SLPs as an effective protocol for assessment of cleft palate speech in the clinical situation and compare across surgical and rehabilitation method.

- The outcome of the present study could also contribute to the existing scanty knowledge of acoustic and perceptual analyses of speech in CLP in general and specifically to the Indian context.

Future Recommendations

- The present study is limited only to children with cleft palate and the results of the present study cannot be generalized to the other types of clefts.

- Future studies may be conducted on investigating the speech characteristics in early Vs late palatal repair children with CLP.

- Acoustic analyses can be used along with perceptual method in documenting the effect of speech therapy in children with repaired CLP.