CHAPTER – V
SUMMARY AND CONCLUSION

5.1 Introduction

The function of hearing is the foundation stone which our intricate human communication system has been constructed. The human baby appears to be born with “preexistent knowledge” of language-specialized neural structures in the brain that wait for auditory experience with language to trigger them into functioning. These structures are dependent on auditory stimulation for their emergence, providing of course that other developmental factors are normal. The normal hearing child is continuously exposed to sounds from birth. It is through this continuous auditory stimulation that a normal child attains speech. The task is, however, very difficult for a child born deaf. Thus hearing controls speech and without hearing speech fails to develop. Hearing impairment has a marked effect on the child’s ability to acquire speech.

Hearing is essential for the natural development of speech and language and communication is interfered with by the presence of a hearing loss. Hearing loss in the children is a silent, hidden handicap. It is hidden because children, especially infants and toddlers, cannot tell us that they are not hearing well. It is a handicap because, if undetected, hearing loss in children can lead to delayed speech and language development, social and emotional problems and academic failure.
The oral communication skills of the hearing impaired children have long been of concern to Educators of the hearing impaired, Speech pathologists and audiologists because, the adequacy of such skills can influence the social, educational and career opportunities available to these individuals.

In the last decade, advancements have been made in studying the speech of the hearing impaired. This is largely due to the development of sophisticated processing and analysis techniques in speech science and computer science that have increased our knowledge of normal speech production. In turn, these technological progresses have been applied to the analysis of the speech of the hearing impaired as well as to the development of clinical assessment training procedures.

Several researchers (Voelkar 1973, Hudgins and Numbers 1942, Boone 1966, Nober 1967, Markids 1970, Smith 1975, Geffner 1980, Angeloce et al 1964, Ravishanker 1985, Shukla 1987, Sheela 1988, Rashitha 1994, Vasantha 1995, Rahul 1997, Rathna Kumar 1998, Ravindar, 2006) have attempted to describe the speech characteristics of individuals with severe to profound hearing impairment. But the knowledge in this area is far from complete. Acoustic analysis of speech production is extremely useful to researchers since the methodologies employed are typically noninvasive, relatively basis with regard to instrumentation, and may be used routinely to depict changes in the physical characteristics of frequency, intensity and duration of speech segments. Therefore, it was considered that it will be useful to study the acoustic aspects of speech of Telugu speaking hearing
impaired children, as it would contribute our knowledge of teaching speech to the hearing impaired, especially to the Telugu language.

The present study is an attempt to investigate some of acoustic characteristics of Telugu speaking hearing impaired children. 48 children in the age range of 6 to 12 years were selected and placed in three experimental groups namely, normal hearing group (NH), hearing aid group (HA) and Cochlear implant group (CI). Each group comprised of 16 children (male- 8, female – 8). The test material consisted to ten Telugu VCV words having the short vowels /a/,/i/,/u/,/e/, & /o/ and long vowels /a:/,/i:/,/u:/,/e:/, & /o:/ . The speech samples of all the children are recorded and the samples were analyzed using PC based PRAAT speech analysis software) version 4.5.06; Paul and David, 2006; University of Amsterdam).

A one-way analysis of variance (ANOVA) was done for all the parameters to study the effect of group. Further, Least Significant Difference post-hoc paired group analysis was performed to examine individual group differences. The parameters analyzed were the following:

1. Fundamental frequency (F0)
2. Formant frequencies (F1, F2 and F3)
3. Bandwidths (B1, B2 and B3)
4. Vowel duration
5. Word duration
5.2. Conclusion

The results of the present study lead to the following conclusions:

5.2.1. Fundamental frequency (F0)

A significant difference in the fundamental frequency was found for all the vowels between normal hearing group (NH) and hearing aid group (HA), normal hearing group (NH) and cochlear implant group (CI) and hearing aid group (HA) and cochlear implant group (CI).

5.2.2. Formant frequencies

(a). First formant Frequency (F1)

A significant difference in the first formant frequency (F1) was found for all the vowels between normal hearing and hearing aid group.

A significant difference in the first formant frequency (F1) was found between normal hearing group and cochlear implant group for vowels /i:/, /i/, /o:/, /o/, /u:/ and /u/ but no significant difference was found between the two groups for vowels /e:/, /e/, /a:/, and /a/.

A significant difference in the first formant frequency (F1) was found between hearing aid group and cochlear implant group for vowels /i:/, /i/, /e:/, /e/ and /a/ but not no significant difference was found between the two groups for vowels /a:/, /o:/, /o/, /u:/ and /u/.
b. Second formant frequency (F2)

A significant difference in the second formant frequency (F2) was found between normal hearing group for all the vowels except /e:/.

A significant difference in the second formant frequency (F2) was found between normal hearing group and cochlear implant group for vowels /e:/, /a:/, /o/ and /u:/ but no significant difference was found for vowels /i:/, /i/, /e/, /a/, /o:/ and /u/.

A significant difference in the second formant frequency (F2) was observed for all the vowels except for vowels /u:/ between hearing aid group and cochlear implant group.

c. Third formant frequency (F3)

A significant difference was found in the third format frequency (F3) between normal hearing group and hearing aid group for all the vowels.

A significant difference was seen in the third formant frequency (F3) between normal hearing group and cochlear implant group for vowels /i:/, /i/, /e/, /a/, /o/, /u:/, and /u/ but no significant difference was found for vowels /e:/, /a:/, and /o:/.

A significant difference was observed in the third format frequency (F3) between hearing aid group and cochlear implant group for vowels /i:/, /i/, /e/, /a/ and /o:/ but no significance difference was observed for /e/, /a/ and /o/.
5.2.3 Bandwidth Characteristics

a. First bandwidth (B1)

A significant difference in the first bandwidth (B1) was found among normal hearing group and hearing aid group, normal hearing group and cochlear implant group for all the vowels. On the other hand there was a significant difference for all the vowels except /a:/ and /a/ between hearing aid group and cochlear implant group.

b. Second bandwidth (B2)

A significant difference in the second bandwidth (B2) was found between normal hearing group and cochlear implant group and normal hearing group and hearing group and hearing aid group for all the vowels.

A significant difference in the second bandwidth (B2) was found between the hearing aid group and cochlear implant group for vowels /i/, /e:/, /e/, /o:/, /o/ and /u:/ but no significant difference was found between these two groups for vowels /i:/, /a:/, /a/ and /u/.

c. Third bandwidth (B3)

A significant difference in the third bandwidth (B3) was found between normal hearing group and hearing aid group, normal hearing group and cochlear implant group all the vowels.
No significant difference was noticed in third bandwidth (B3) between cochlear implant group and hearing aid group for all the vowels.

5.2.4 Vowel Duration

A significant difference in the vowel duration was found for all the vowels between normal hearing group and hearing aid group, normal hearing group and cochlear implant group, and hearing aid group and cochlear implant group.

5.2.5 Word Duration

A significant difference in the word duration was observed for all the words between normal hearing group and hearing aid group, normal hearing group and cochlear implant group, and hearing aid group and cochlear implant group.

5.3. Implications and usefulness of this study:

The findings of the study have implication for Audiologists, Speech Pathologists, Educators and Researches.

1. The training program designed to improve the speech characteristics of hearing impaired children must take note of the hierarchy of development of structures under consideration in both normal hearing children and hearing impaired children establishing such hierarchy however, awaits further research.

2. The information obtained from this study would help in understand the normal and abnormal acoustic characteristics of speech sounds in normal and children with hearing impairment.
3. The information from acoustics analysis will also help in making use of the advances in cochlear implant technology as in with maximal effectiveness.

4. It helps in facilitating the oral production skills of the children with hearing impairment.

5. The information from the study determines the acoustic parameters that are deviated and also the extent of deviation.

6. It acts as a precursor to plan therapy accordingly, to improve the speech intelligibility.

7. The information on the speech of children with hearing impairment using hearing aids and cochlear implants helps to determine the effectiveness of the type of listening devices used by the hearing impaired.

5.4. Limitations of the study:

- The sample size was small.

- Age of intervention was not controlled, i.e. age at which the intervention was started for the hearing impaired group.

- Method of instruction (oral-aural approach, multi-sensory approach and oral communication) was not controlled.

- The type of amplification used by the subject (analog-digital) and the type of speech processor and number of channels used in the cochlear implant group were not controlled.
5.5. Recommendations for further research:

- Similar studies on a larger population may be undertaken.
- Other parameters like Voice Onset Time (VOT), Formant transition, closure duration, burst duration, pause duration etc. may also be studied using various VCV combinations.
- The study may be done across ages to delineate the development stages of speech acquisition in the hearing impaired.
- Various spectral parameters and their relations to the factors affecting speech intelligibility, in the hearing impaired children may be studied. Such information may be useful in planning therapy for children with hearing impairment.
- The variables such as age at which hearing aid are cochlear implant fitting was done, type of hearing aid used, analog or digital hearing aid, type of speech processor, number of channels can be controlled in further investigations.
- A similar study can be carried out on a different group of subjects.
- A similar study can be carried out in different Indian Languages.
- Future research can be done in phrase and sentence level.