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SPEECH INTELLIGIBLITY IN KANNADA SPEAKING COCHLEAR IMPLANT CHILDREN

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CHAPTER 1

INTRODUCTION

Speech is essential for learning, interacting with others and for people to build up their social skills. Speech begins at an early age and progresses as a person grows. There are different parameters that play a major role in speech development. The words someone uses, how fast or slow they speak, tone of voice and the shortness of speech affect how someone converse a message or idea, that is for effective communication speech should be intelligible.

http://en.wikipedia.org/wiki/speech

Speech intelligibility is the measure used to understand how effectively speech is comprehensible during communication, and other conductions that intelligibility is affected by the quality of speech signal, the type and level of background noise, reverberation and for speech over communication devices. Speech intelligibility does not imply speech quality.

The growth of children's skills to hold an age appropriate activities, their functional speech communication skills and their language skills can be affected due to hearing loss. Cochlear implant is a surgically implanted electronic device that provides a sense of sound to a severe or profound hearing loss individuals. A cochlear implant does not cure deafness or hearing impairment, but it is an instrument as a substitute which directly stimulates the cochlea.

http://www.ncbi.nim.nih.gov/book/207837/

Improvement in speech perception is the major benefit of cochlear implantation. However if the children with cochlear implant are feeling to integrate into the hearing world, they must also obtain the language of their surrounding community are to be able to produce it intelligible. The speech intelligibility and language abilities of children which cochlear implant progress significantly over time.

Abhijith (2008) examined post treatment rating of speech intelligibility in cochlear implanted children. Results indicated that there is a significant difference between the ratings done by mothers and other groups for general conversation & picture description and there is a significant difference between general conversation & picture description. Hence it is concluded that there is a significant improvement in speech intelligibility after cochlear implantation.

Shashikanth & Kumaraswamy (2011) examined speech intelligibility of pediatric cochlear implant recipients with 0-3 years of device experience. Results showed that familiar persons-mothers and speech language pathologists rated speech intelligibility better when compared to NON SLPs (Non Speech Language Pathologist). Familiar topics like repetition of familiar words were rated better when compared to all other tasks. The device usage of more than 2 years was rated better speech intelligibility when compared to 1-2 years & less than 1 year of device experience.

Soumya & Kumaraswamy (2015) examined speech intelligibility of Malayalam speaking on cochlear implanted children. Results showed that familiar persons-mothers and speech language pathologist rated speech intelligibility better when compared to NON SLPs. Familiar topics like repletion of familiar words were rated better compared to all other tasks.

From the above review of literature it can be concluded that for understanding ones speech, speech intelligibility plays a crucial role. Speech intelligibility of a cochlear implantee will apparently make an impact on listeners. A few studies in Indian languages especially in Telugu, Tamil etc. and some western studies have been attempted to study speech intelligibility of cochlear implants.

Providing adequate speech and language therapy for cochlear implanted child will enhance speech and language. Speech intelligibility measurement will give an insight for rehabilitation program to their children. In Karnataka cochlear implantation program have made drastic changes. Hence the present study has been taken up to measure the speech intelligibility of Kannada speaking cochlear implanted children

CHAPTER 2

REVIEW OF LITERATURE

A cochlear implant is a small, complex electronic device that can help to provide a sense of sound to a person who is profoundly deaf or severely hard of hearing. Children with Cochlear Implant demonstrate a large range of listening skills depending, in part on their auditory experience prior to implantation. Many children will have established deviant patterns of speech production & a reliance on visual & or sensory motor feedback at the articulatory level to compensate for the lack of auditory information through their aided residual hearing.

As this feedback mechanisms is used habitually & automatically, it is to remain stable without intervention. Although the speech of some children may not change significantly, it has been shown that improvements can be made with intensive work.
(Osberger, John & Richard, 1991)

Cochlear Implant device provides a unique opportunity for the rehabilitation of deaf individuals who are unable to utilize other assistive devices such as hearing aids or tactile devices for the purpose of understanding speech.

Current implant system officer use auditory information about acoustic signals that occur naturally in the environment. This is accomplished by sending electrical impulses to different locations along the auditory nerve. Two basic principles are inherent in the idea of cochlear implants. First foreign biocompatible materials can be placed within the human body without being rejected &second auditory nerve fibers respond to electrical stimulation.

(Brackman, Nelson & Waring 1985) Intelligibility refers to the understandability of speech, the match between the intention of the speaker & the response of the listener, & the ability to use speech to communicate effectively in everyday situations. It is the most immediate criterion by which a child's communication attempts is judged. Clearly it is a very important concept, but one which is often difficult to measure & address in intervention for children with speech difficulties. (Yan, 2006)

WESTERN STUDIES

Musselman (1990) studied the relationship between hearing loss and speech intelligibility was investigated in a sample of 121 young deaf children. Significant independent effects were associated with the unaided hearing threshold level (HTL), but not with the aided HTL or with shape. Further analysis of the data suggested the existence of 3 distinct groups. Most children with loss of 70-89 dB developed some intelligible speech and unaided HTL had additional predictive validity. Between 90 and 104 dB, considerable variability occurred, and the aided
HTL had additional predictive validity. Above 105 dB, few children developed any intelligible speech.

Osberger, Monica & Sam (1993) studied speech intelligibility of children with cochlear implants, tactile aids, or hearing Aids. Results showed that the subjects with early onset of deafness who received their single or multichannel cochlear implant before age 10 demonstrated the highest speech intelligibility, whereas subjects who did not receive their device until after age 10 had the poorest speech intelligibility.

Nikolopoulos, Thomas & Allan (2001) checked reliability of a rating scale for measuring speech Intelligibility after Pediatric Cochlear Implantation. The study found a high rate of agreement between observers when they used the Speech Intelligibility Rating Scale to assess the speech intelligibility of deaf children after cochlear implantation.

Gao, Chin & Tsai (2003) compared the connected speech intelligibility of children who use cochlear implants with children who have normal hearing. Results showed that for children with CI greater intelligibility associated with both increased chronological age and increased duration of cochlear implant use. As whole children with cochlear implant was significantly less intelligible than children with normal hearing.

Peng & Spencer (2004) investigated speech intelligibility of 24 pre-lingually deaf pediatric cochlear implant recipients with 84 months of device experience by each cochlear participant's speech sample was judged by a panel of 3 listeners. Both age at implication and different speech coding strategies contribute to the variability of CI participant's speech intelligibility. Implantation at a younger age and use of the spectral peak

speech coding strategy yield higher intelligibility scores than implantation at an older age and the use of multi peak speech - coding strategy. These results serve for clinical applications of long term advancements in spoken language development and are considered for pediatric CI recipients.

Allen & Nikolopoulos (2008) evaluated the long-term speech intelligibility of young deaf children after cochlear implantation. All children were congenitally deaf before 3 years of age.
Results concluded that after cochlear implantation, the difference between the speech intelligibility ratings increased significantly each year for 4 years. For the first 2 years, the average rating remained "unintelligible speech at the 4 year 85% of children had some intelligible connected speech. The improvement continued, and at the year 5-year.

Nikolopoulos (2009) assessed the influence of age at implantation speech perception and speech intelligibility following pediatric cochlear implantation. The results of the present study provided strong evidence that pre lingually deaf children should receive implants as early as possible to facilitate the later development of speech perception skills and speech intelligibility and thus maximize the health gain from the intervention. However, because of the wide variation in individual outcomes, age alone should not be used as a criterion to decide implant candidacy.

Wang, Weismer, Chi & Yang (2012) studied speech intelligibility, speaking rate, and vowel formant characteristics in mandarin- speaking children with cochlear implant. Result showed the limitations of speech intelligibility development in children after Cochlear Implantation were related to atypical patterns and to a smaller degree in vowel reduction and slower speaking rate resulting from less efficient articulatory movement transition.

George, Judith & Olivier (2013) study aimed to evaluate the long-term speech perception and speech intelligibility of congenitally and pre lingually deaf children after cochlear implantation. They each received a nucleus multichannel cochlear implant before they were 10 years old. Perception is evaluated using the Test for the Evaluation of Voice Perception and Production (TEPP) and concerns closed-and open- set word and

sentence perception without lip reading. The intelligibility is classified according to the Speech Intelligibility Rating (SIR). The evaluations have been made every 3 months for 1 year, then at 18 months, 2 years, 3 years and 5 years after cochlear implantation. Result revealed, congenitally and pre-lingually deaf children who receive cochlear implant before the age of 10 years develop speech perception and speech intelligibility abilities. The closed-set perception progresses quickly and seems to reach a plateau at 5 years post implantation. The improvement of open-sentence perception is not significant until the first year post implantation. The speech intelligibility improves regularly the five first years of post implantation.

Montag, Pisoni & Kornenberger (2014) studied speech intelligibility in deaf children after long-term cochlear implant use. Mean intelligibility scores were lower than scores obtained from an age and non verbal IQ- matched normal hearing control sample, although the majority of CI users scored within the range of the control sample. Our sample allowed ask to investigate the contribution of several demographic and cognitive factors to speech intelligibility.CI users who used their implant for longer periods of time exhibited poorer speech intelligibility scores.

Wang, Pan & Deshapande (2015) studied the relationship between ear and auditory performance and speech intelligibility outcomes in pediatric cochlear implant recipients. Result shows children with better CAP growths tended to have lower wave-V thresholds than those with poor CAP growths.

Couloinge, Garabedian & Loundon (2015) evaluated speech perception, production and intelligibility in french-speaking children with profound hearing loss and early Cochlear Implantation after Congenital Cytomegalovirus Infection. CI showed positive impact on hearing and speech in children with post-CCMV profound hearing loss. Our study demonstrated the key role of maximizing post-CI hearing gain.

Hansen & Tobey (2015) researched on evaluation and analysis of whispered speech for cochlear Implant users: Gender identification and intelligibility. Results also suggested that exposure to longer speech stimuli, and consequently more temporal cues, would not improve gender identification performance in I subjects.

Lucchesi, Moreira & Deisy (2018) studied on Evaluation and analysis of Reading and speech intelligibility of a child with auditory impairment and cochlear implant. Results showed improvement in speech intelligibility during picture naming trials after exposure to the curriculum, with a higher percentage of correct responses. (PsycINFO Database Record (c) 2018 APA, all rights reserved)

Fan, Alimu & Kupper (2020) studied long-term functional outcomes of hearing and speech rehabilitation efficacy among pediatric cochlear implant recipients in Shandong, China. The results showed Cochlear implantation appears to make a significant, positive contribution to the development of communication skills of young congenital and prelingually deaf children in China. These improvements continue for up to 3 years after implantation. Positive outcomes appear to be associated with earlier age at implantation and receipt of speech therapy.

Mohammed Ashori (2020) studied speech intelligibility and auditory perception of pre-school children with Hearing Aid, cochlear implant and Typical Hearing. The results showed that auditory perception in children with CI was significantly higher than children with HA. This finding highlights the importance of cochlear implantation at a younger age and its significant impact on auditory perception in deaf children.

Ajalloueyan, Mirdeharbab, Hasanalifard & Masoumeh (2021) studied long-term effects of cochlear implant on the pragmatic skills and speech intelligibility in persian-speaking Children results shows The long-term results of early and late cochlear implants were similar in terms of the development of pragmatic skills but very different in terms of speech intelligibility. The age of cochlear implantation had no effect on the pragmatic of language.

Torfi, Jahangirimehr & Saki (2021) assessed the comparison of speech intelligibility between the cochlear implanted and normal-hearing children. Results shows that analytic cross-sectional study consisted of 60 Persian-speaking children aged 5 to 7-years. Participants were classified into 3 groups of 20 people, including NH (mean age, 71.70±5.05 months), CI (mean age, 72.60±8.20 months), and HA (mean age, 71.45±10.56 months) children. The speech intelligibility rating (SIR) and categories of auditory performance (CAP) tests were conducted for all children to measure their speech intelligibility and auditory perception,

respectively. A one-way analysis of variance (ANOVA) test was used to compare CAP and SIR scores among the 3 groups.

INDIAN STUDIES:

Kameswaran (2006) conducted assessment of outcomes of cochlear implantation taking into account various scoring system like Category of Auditory Performance (CAP) and Speech Intelligibility Rating (SIR).There is a significant improvement in auditory performance and speech intelligibility in the first few years after implantation.

Abijith (2008) examined post treatment rating of speech intelligibility in cochlear implanted children. Results indicated that there is a significant difference between rating done by mothers and other group for general conversation and picture description and there is a significant difference in general conversation and picture description. Hence it is concluded that there is a significant improvement in speech intelligibility after cochlear implantation.

Shashikanth & Kumaraswamy (2009) studied speech intelligibility of cochlear implant children and result showed that speech intelligibility is better for familiar words and poorer for conversation. And also speech was more intelligible for speech language pathologist.

Patil, Sindhura & Reddy (2010) examined acoustic features of speech stress fundamental frequency, duration and intensity in children using cochlear implant and compared the features with those in normal hearing. Children with cochlear implant distinctly produced sentence stress but the acoustic correlates of stress are significantly different from those produced by individuals with normal hearing.

Sindhu (2011) compared the communication development in children who receive cochlear implant before the age of 12 months and 12 to 24 months. Result showed that mean rates of receptive (1.12)and

expressive(1.01) language growth of children receiving implants before the age of 12 months were significantly greater than the rates achieved by children receiving implants between 12 and 24 months matched growth rates achieved by normal hearing children.

Soumya & Kumaraswamy (2015) examined speech intelligibility of Malayalam speaking cochlear implant children. Results showed that familiar persons-mothers and speech language pathologists rated speech intelligibility better when compared to NON SLPs. Familiar topics like repletion of familiar words were rated better compared to all other tasks.

NEED OF THE STUDY

From the above review of literature we can conclude that, speech intelligibility plays a crucial role in understanding ones speech. Speech intelligibility of cochlear implanted will apparently make an impact on listeners, various western studies the have been attempted on speech intelligibility of cochlear implant & as well as Indian studies have attempted various languages like Telugu, Malayalam, Tamil, Kannada etc.

In Karnataka there is a drastic change in cochlear implantation program. Speech & language therapy plays an adequate role after the cochlear implantation & helps to enhance speech. Measuring the speech intelligibility of these children gives an insight of rehabilitation program no attempts have been made to study speech intelligibility Kannada speaking cochlear implant children. Hence the present study has been taken up to measure the speech intelligibility of Kannada speaking cochlear implanted children.

CHAPTER 3

METHOD

AIM

The aim of the present study is two folded.

1 To compare the speech intelligibility of cochlear implant individual's for different tasks, familiar words, unfamiliar words, & nonsense.

2. To compare speech intelligibility rating of cochlear implant children between 3 groups SLP (Speech Language Pathologist), NON SLP (Non Speech Language Pathologist) and mothers of cochlear implant children.

In present study ten Kannada speaking children were given three different tasks to repeat familiar words, non-familiar words & nonsense words and their speech intelligibility was rated by three different groups namely speech pathologists, non-speech language pathologists, and mothers of cochlear implant children.

Participant selection criteria

Participant selection criteria was based on the criteria in which twenty of the cochlear implant children were taken whose pure tone average before the surgery was above 90db and all who were undergone surgery at the age of 2 years or before. The speech intelligibility of these children was rated by three different groups including.

Ten speech language pathologists

Ten non speech language pathologists

Ten mothers of cochlear implanted children

Procedure

Audio samples were recorded by using Oppo voice recorder.

The response was taken using a microphone which was placed 15cm away from the mouth. A recording of 8 to 10 minute was taken for each of the 3 tasks including words which should be repeated back after the clinician.

• Familiar words: repetition of few familiar words.

• Non familiar words: repetition of few non familiar words.

• Nonsense words: repetition of few nonsense words.

Analysis

Intelligibility rating of cochlear implants was done by three groups of listeners with normal hearing sensitivity. First group of listeners included ten speech language pathologists with master's degree. Second group consist of ten mothers of cochlear implant children.

Rating scale used was a 4 point in which '0' indicate unintelligibility & '4' indicate complete intelligibility.

CHAPTER-4
RESULT AND DISCUSSION

Speech intelligibility plays a crucial role in understanding speech. Speech intelligibility of cochlear implantee will apparently make an impact on listeners. A few studies in Indian languages especially in Telugu, Tamil, Malayalam, Kannada etc. and some of the western countries have been attempted to study speech intelligibility of cochlear implants.

The aim of the present study was two compare the speech intelligibility rating of cochlear implant individuals for 3 different tasks. Familiar words, non familiar words and nonsense words and compare speech intelligibility rating of cochlear implant children between 3 groups SLP, NON SLP and mothers of cochlear implant children

The obtained data was analyzed statistically and results are discussed below.

Figure-4.1

Showing the comparison of familiar words, non familiar words and non sense words amongst Speech Language pathologist

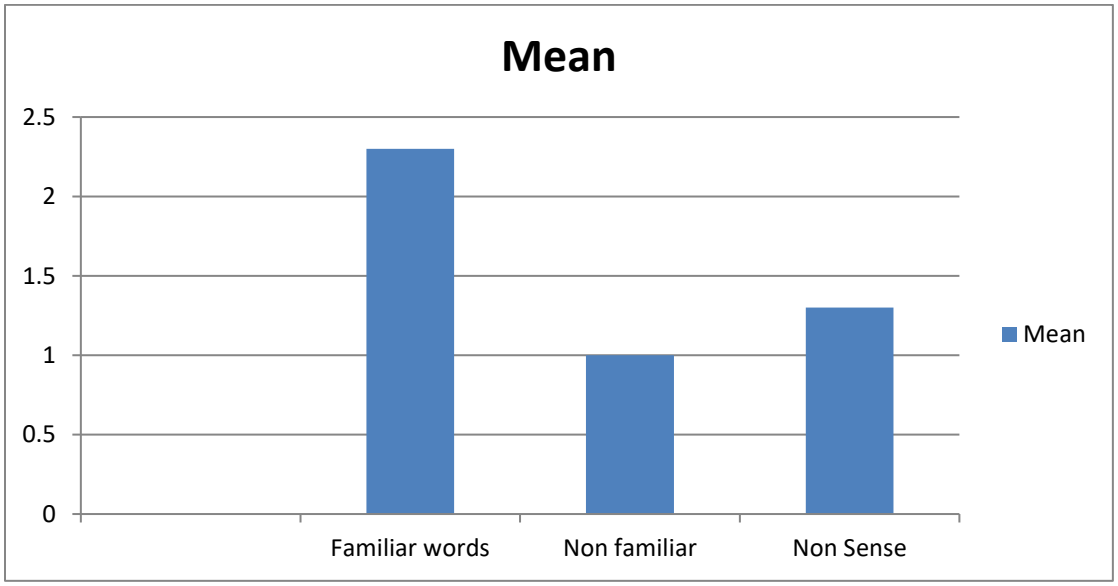

Table-4.1

Showing the comparison of familiar words, non familiar words and non sense words amongst Speech Language pathologist

Words	N	Mean	Std. Deviation	Median (QR)	Friedman Test value	P
Familiar words	10	2.30	.483	2(2-3)	18.242	P< 0.001
Non familiar	10	1.00	.471	1(1-1)		HS
Non Sense	10	1.30	.483	1(1-2)		

Group- Speech Pathologist

From the above table 4.1 & Fig 4.1 speech intelligibility rating for 3 different task can be seen (familiar words, unfamiliar words and non sense words) where SLP score of speech intelligibility was better for familiar words and intelligibility scores observed to reduce for following hierarchy, non sense words and then familiar words. Speech intelligibility was better for familiar words for SLP with mean score of 2.30 and poorer in non familiar words with mean score of 1.00. The results shows there is high significant difference between three groups (P=00.1).

FIGURE 4.2

Showing the comparison of familiar words, non familiar words and non sense words amongst Non Speech Language pathologist

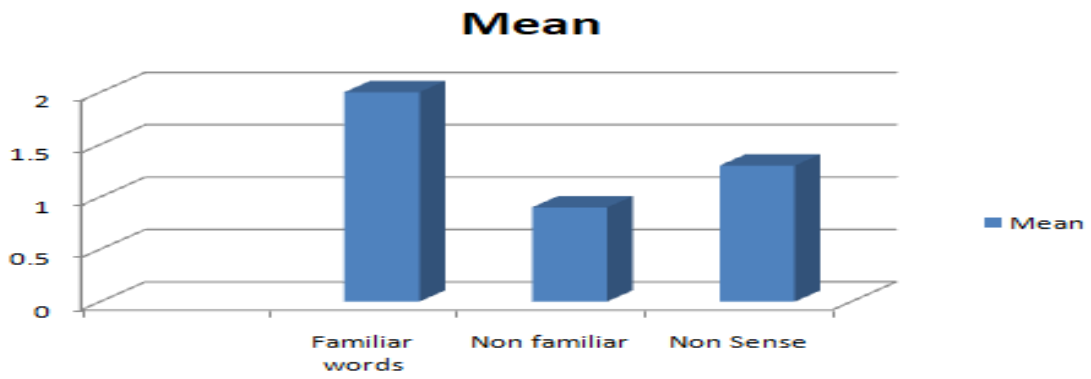

Table 4.2

Showing the comparison of familiar words, non familiar words and non sense words amongst Non Speech Language pathologist

Words	N	Mean	Std. Deviation	Median (QR)		
					Friedman Test value	P
Familiar words	10	2.00	.471	2(2-2)	17.093	P< 0.001
Non familiar	10	.90	.316	1(1-1)		HS
Non Sense	10	1.30	.483	1(1-2)		

Group- Non Speech Pathologist

From the above table 4.2 & Fig 4.2 Speech Intelligibility rating for 3 different task can be seen (familiar words, unfamiliar words and non sense words) where SP score of speech intelligibility was better tor familiar words and intelligibility scores was observed to reduce for following hierarchy, non sense words and then familiar words. Speech

Intelligibility was better for familiar words for SLP with mean score of 2.00 and poorer in non familiar words with mean score of 0.90. The results shows there is a high significant difference between three groups (P<00.1).

Figure 4.3

Showing the comparison of familiar words, non familiar words and non sense words amongst Mothers

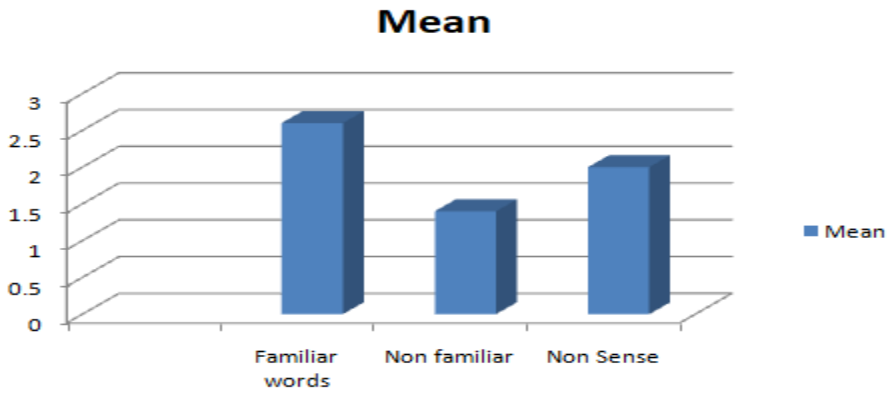

Table 4.3

Showing the comparison of familiar words, non familiar words and non sense words among Mothers

Words	N	Mean	Std. Deviation	Median (QR)		
					Friedman Test value	P
Familiar words	10	2.60	.516	3(2-3)	16.033	P< 0.001
Non familiar	10	1.40	.699	1.5(1-2)		HS
Non Sense	10	2.00	.000	2 (2-2)		

Group- Mothers

From the above table 4.3 & Fig 4.3 speech intelligibility rating for 3 different task can be seen (familiar words, unfamiliar words and non sense words) where SLP score of speech intelligibility is better for familiar words and intelligibility scores observed to reduce for following hierarchy, nonsense words and then familiar words. Speech intelligibility was better for familiar words for SLP with mean score of 2.60 and poorer in non familiar words with mean score of 1.40. The result shows there is high significant difference between three groups (P≤00.1).

Table 4.4

Showing the mean, median, and standard deviation for familiar words, non familiar words and non sense words among SLP, Non SLP and mothers

Words	Groups	N	Mean	Std. deviation	Median (IQR)		
						Krustkall Wallis	P
Familiar Words	SLP	10	2.30	.483	2(2-3)	6.194	.045 Sig
	Non SLP	10	2.00	.471	2(2-2)		
	Mothers	10	2.60	.516	3(2-3)		
Non Familiar	SLP	10	1.00	.471	1(1-1)	5.075	.079 NS
	Non SLP	10	.90	.316	1(1-1)		
	Mothers	10	1.40	.699	1.5(1-2)		
Non Sense	SLP	10	1.30	.483	1(1-2)	12.688	.002 HS
	Non SLP	10	1.30	.483	1(1-2)		
	Mothers	10	2.00	.000	2(2-2)		

From the above table 4.4 it can be observed that there was a significant difference of p value .045 in familiar words, high significant difference of P value0.002 for nonsense words and there was no difference seen for non familiar words when it was compared across SLP, Non SLP and mothers.

Table 4.5

Showing the multiple comparisons of 3 different tasks
(Familiar words, non familiar words, and non sense words)

Words	Groups		Mean whitneytest P	
Familiar words	Speech pathologist	Non SLP Mothers	0.45 .549	Sig
	Non SLP	Mothers	.033	Sig
Non familiar words	Speech pathologist	Non SLP Mothers	1.000 .291	
	Non SLP	Mothers	.122	
Non sense	Speech pathologist	Non SLP Mothers	1.000 .001	HS
	Non SLP	Mothers	.001	HS

As we can observe from the above table 4.5, significant difference was noted when compared with SLP and Non SLP, Non SLP and mothers and no significant difference noted when compared to SLP and mothers for familiar words. There is no significant difference observed for non familiar words across SLP, Non SLP and Mothers, but high significant difference were noticed when compared SLP and mothers, and Non SLP and mothers for nonsense words, no significant difference was noticed comparing SLP and Non SLP

DISCUSSION

The three different tasks were rated by SLP, Non SLP and Mothers by using 4 point rating scale and the obtained data was statistically analyzed and results indicated that familiar words was rated better and rating was reduced for following hierarchy, non meaningful words and then non familiar words among SLP and Non SLP and Mothers.

Among SLP, Non SLP and Mothers, SLP scored better for all three tasks familiar words, non familiar words and non sense words than Non SLP and Mothers.

SLP rated better for all three tasks than Non SLP and Mothers because they are professionally trained and have vast knowledge about cochlear implantee speech. Non SLP rated poor score as they are lacking knowledge in the field of Speech and Hearing.

The present study is in accordance with Shashikanth and Kumaraswamy (2009) who studied speech intelligibility in 23 cochlear implanted children showed that speech intelligibility is better for familiar words

and poorer for conversation. And also speech was more intelligible for speech language pathologists when compared with mothers and Non SLP. Also correlated with Soumya and Kumaraswamy (2015) reported that familiar persons-mothers and speech language pathologists rated speech intelligibility better when compared to Non Speech Language Pathologists. Familiar topics like repetition of familiar words were rated better compared to all other tasks.

CHAPTER 5

SUMMARY AND CONCLUSION

The aim of the present study was to evaluate the benefit and outcome after the cochlear implant surgery through rating speech intelligibility by different listening group such as SLP, Non SLP, and mothers of implanted children using 3 tasks that is familiar words, non familiar words and non sense words.

Ten cochlear implanted children who were implanted before the age of 3 years and having a device experience of more than 2 years were selected as subjects. All the subjects had a pre surgical hearing threshold above 90dB and were attending auditory training.

Subject selection criteria was based on the criteria in which ten of the cochlear implant children were taken whose pure tone average before the surgery was above 90db and all who were undergone surgery at the age of 2 years or before. The speech intelligibility of these children was rated by three different groups including.

- Ten speech language pathologist
- Ten non speech language pathologist
- Ten mothers of cochlear implanted children

Three group of evaluators 5 SLP, 5 NON SLP, and 5 mothers of cochlear implanted children rated the speech samples on a 4 point rating scale. They were asked to rate separately for the 3 tasks. The data has been subjected relevant for to statistical analysis. Results showed that Mothers and SLP rated speech intelligibility better when compared to Non SLP's and familiar words were rated better when compared to all other words. The results indicated that it was not easy for unfamiliar listeners to understand the intelligibility of speech in cochlear implanted children.

LIMITATION OF THE STUDY

- The number of participants for the study was less
- The materials used were less

FUTURE IMPLICATIONS

- Video recording of the responses of cochlear implant children can be used for better rating.
- The number of tasks can be increased.
- The number of participants can be increased.
- Duration of cochlear implant usage can be taken to consideration.
- Different language of cochlear implant children can be used in the study.

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