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Original Research Article

Effect of age at cochlear implantation on speech and auditory performance

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ABSTRACT

Background: Cochlear implants (CI) are currently widely accepted as treatment for patients with severe bilateral hearing loss. The outcomes of cochlear implantation among post lingual and crossover patients measuring surgical and functional outcomes and identifying areas which require further attention or improvement.
Methods: This is retrospective clinical study was performed in a total of 80 children purposively screened from the patients who attended the outpatient clinic with complaints of hearing, speech or language impairment. The study group consisted those children who fit into the candidacy norms for cochlear implantation at the Department of ENT and Head-Neck Surgery, Combined Military Hospital, Dhaka from January 2017 to June 2019. Children with bilateral severe to profound sensori-neural hearing loss, age less than 5 years and prelingual deafness was included in this study.
Results: Mean categorical auditory performance (CAP) and speech intelligibility rating (SIR) at 6 month and 12 month were statistically significant ($p<0.05$) compare with at 3 month. The mean post-operative CAP score was found significantly increased at 6, 12 and 24 month follow up age ≤3 years than >3 years ($p<0.05$). The mean post-operative SIR score was found significantly increased at 6, 12 and 24 month follow up in children age ≤3 years than >3 years ($p<0.05$).
Conclusions: The majority of implanted have significantly gained auditory improvement as shown by the CAP and SIR scores in both group. Comparison between age group CAP and SIR score was significantly increased when children age <3 years than >3 years.

Keywords: Early cochlear implantation, CAP, SIR

INTRODUCTION

Cochlear implants (CI) have revolutionized the manner in which rehabilitation of patients with severe to profound hearing impairment in restoring speech understanding isapproached.[1] CI are currently widely accepted as treatment for patients with severe bilateral hearing loss. Recently, the indications for CI have been widened to include patients with more residual hearing, single-sided deafness, and asymmetric hearing loss and even those with long-time deafness.[2] The outcomes of cochlear implantation among post lingual and crossover patients measuring surgical and functional outcomes and identifying areas which require further attention or improvement. Sensory neural deafness can often be successfully habilitated with hearing-aids if the impairment is mild or moderate. However, in severe to profound sensory neural hearing loss, the amplication provided by hearing aids may be inadequate. Cochlear implant is a successful technology which has been used to rehabilitate this group of patients.[3]

Several studies have shown the effectiveness of the CI through the assessment of hearing and language skills; however, these tests are limited in terms of the impact of such treatment on social relations, well-being, and the individual's ability for easy communication, all aspects related to the quality of life.[4] CI are most commonly used to treat adults as well as prelingual deaf children with severe to profound hearing loss who cannot benefit from hearing aids.[5-7] Performance of CI in adults depends on several preoperative factors. Many factors including age at CI operation, duration of hearing loss, the presence of residual hearing, previous hearing aid use, and the presence of cochlear anomaly are considered to be related to the outcomes. Other factors including the technique of CI operation, etiology and the brand of device also have an effect on CI performance.[8-10]

METHODS

This is retrospective clinical study was performed in a total of 80 children screened purposively from the patients who attended the outpatient clinic with complaints of hearing, speech or language impairment.

The study group consisted those children who fit into the candidacy norms for cochlear implantation at the Department of ENT and Head-Neck Surgery, Combined Military Hospital, Dhaka between January 2017 to June 2019 two years and six months study. Children with bilateral severe to profound sensori-neural hearing loss, age less than 5 years and prelingual deafness was included in this study. Incomplete follow-up, incomplete insertion of cochlear implant assessed by intra-op neural response telemetry and explantation on account of any reason were excluded in this study. Informed written consent was taken from the parents for the study and follow-ups required during the study. A detailed history and thorough physical and ENT examination was carried out. The subjects then underwent pediatric examination to rule out any neurological condition, which may hamper the child's postoperative performance. Behavioral observational audiometry, auditory brainstem response thresholds and auditory steady-state response was determined to evaluate the degree of hearing loss. Each child was subjected to undergo a high-resolution computed tomography (CT) scan and magnetic resonance imaging (MRI) scan of temporal bones. Speech perception was also assessed by categories of the auditory performance (CAP) test which was used as an index of outcome of cochlear implant on speech perception. The child was also evaluated by a child psychologist to determine the IQ.

Counseling of parents was done regarding regular follow-ups and therapy/support to the child at home. They were also made to realize the realistic expectations about the cochlear implant. It is of paramount importance to that they realize that a cochlear implant does not produce a normally hearing child but rather that an implant is a very sophisticated hearing aid, without which the child remains deaf. Postoperatively the subjects were followed up for a maximum period of 1 year at intervals of 3 months, 6 months, 12 months and 24 months after implantation. During these visits the evaluation of outcome was carried out. The outcome measures were followed as under: CAP consists of a set of eight indices of performance, ranges from no awareness of sound to using telephone. The children were assessed prior to implantation, immediately at switch on, at 3, 6, 12 and 24 months post implant. Demographic and clinical data were collected by a structured questionnaire and analysis was done with the help of statistical package for social science (SPSS) version-23. Paired t-test and unpaired t-test were used to analyze the significance level of $p<0.05$. Continuous scale data were presented as mean standard deviation and Categorical data were presented as number percentages. The summarized data were present in the table.

RESULTS

Mean age was found 3.5±1.1 years with range from 1.5 to 5.0 years.

Table 1: Demographic characteristics of the study patients.

Age (years)	Number of patients	Percentage
≤3.0	32	40.0
>3.0	48	60.0
Mean±SD	3.5	±1.1
Range (min-max)	1.5	-5.0

Five cases were not improved due to 2 cases autism spectrum disorder and 3 cases attention deficit hyperactivity disorder. Mean CAP was found 1.87±0.34 at 3 month, 3.65±0.92 at 6 month and 4.93±0.94 at 12 month. Mean CAP- at 6 month, 12 month and 24 months were statistically significant ($p<0.05$) compare with at 3 month.

Table 2: Categories auditory performance at different follow up.

Categories auditory performance	Mean±SD	Range (min-max)	P value
At 3 month	1.87±0.34	0.0-2.0	
At 6 month	3.65±0.92	1.0-5.0	0.001[s]
At 12 month	4.93±0.94	2.0-7.0	0.001[s]
At 24 month	5.69±0.89	3.0-8.0	<0.001[s]

s=significant, P value reached from paired t-test

Five cases were not improved due to 2 cases autism spectrum disorder and 3 cases attention deficit hyperactivity disorder. Mean SIR was found 0.94±0.25 at 3 month, 1.94±0.56 at 6 month, 3.66±0.59 at 12 month and 4.87±0.26 at 24 month. Mean SIR- at 6 month, 12 month and 24 months were statistically significant ($p<0.05$) in comparison with at 3 month.

At 6 month, mean CAP was found 4.06±0.91in age ≤3 years and 3.19±0.94 in age >3 years. At 12 month, mean CAP was found 5.47±0.84 in age ≤3 years and 4.40±1.05 in age >3 years. At 24 months CAP was found 6.12±0.76 in age ≤3 and 5.26±1.03 in age >3 years. Which were statistically significant (p<0.05) between two groups.

Table 3: Speech intelligence rating at different follow up.

Speech intelligence rating	Mean±SD	Range (min-max)	P value
At 3 month	0.94±0.25	0.0-1.0	
At 6 month	1.94±0.56	1.0-3.0	0.001[s]
At 12 month	3.66±0.59	1.0-4.0	0.001[s]
At 24 months	4.87±0.26	2.0-5.0	0.001[s]

s=significant, P value reached from paired t-test

Table 4: Association between categories auditory performance with age group.

Categori-es auditory perform-ance	Age ≤3.0 years (n=32)	Age >3.0 years (n=48)	P value
	Mean±SD	Mean±SD	
At 3 months	1.91±0.30	1.83±0.38	0.360[ns]
At 6 months	4.06±0.91	3.19±0.94	0.001[s]
At 12 months	5.47±0.84	4.40±1.05	0.001[s]
At 24 months	6.12±0.76	5.26±1.03	0.0001

s=significant, ns=not significant, P value reached from unpaired t-test

At 6 month, mean SIR was found 2.16±0.63 in age ≤3 years and 1.73±0.49 in age >3 years. At 12 month, mean SIR was found 4.15±0.67 in age ≤3 years and 3.17±0.52 in age >3 years. At 24 month mean SIR was found 4.86±0.54 in age ≤3 years and 3.79±0.57 in age >3 years which were statistically significant (p<0.05) between two groups.

Table 5: Association between speech intelligence rating with age group.

Speech intelligence rating	Age ≤3.0 years (n=32)	Age >3.0 years (n=48)	P value
	Mean±SD	Mean±SD	
At 3 months	0.94±0.25	0.88±0.33	0.368[ns]
At 6 months	2.16±0.63	1.73±0.49	0.001[s]
At 12 months	4.15±0.67	3.17±0.52	0.003[s]
AT 24 months	4.86±0.54	3.79±0.57	<0.001

s=significant, ns=not significant, P value reached from unpaired t-test

DISCUSSION

In this study carried out the Department of ENT and Head-Neck Surgery, Combined Military Hospital, Dhaka our results showed that the auditory performance and speech intelligibility of trained children in the rehabilitation centres was almost the same as those of untrained children with early implantation. After implantation, the CAP and SIR scores of both groups increased with increasing time of implant use during the follow-up period, and at each time point, the mean scores of the two groups were comparable.

In this study observed that the mean age was found 3.5±1.1 years with range from 1.5 to 5.0 years. In study of Gupta reported in his study out of these 30 children, 14 children were less than 30 months of age and 16 above 30 months at the time of implantation; the youngest child was 11 months of age and oldest was 56 months.[11] The mean age at implantation was 35.1 months. Gabr and Hassaan study also observed their mean age was 4.4±1.98 years.[12] Martineset al reported their study mean age was found 7.14±4.46 months.[13]

In this study the mean CAP was found 1.87±0.34 at 3 month, 3.65±0.92 at 6 month and 4.93±0.94 at 12 month. Mean CAP- at 6 month, 12 month and 24 months were statistically significant (p<0.05) compare with at 3 month. Five cases were not improved due to 2 cases autism spectrum disorder and 3 cases attention deficit hyperactivity disorder. Shakrawalet al the postoperative mean CAP scores in both the groups were statistically significant at 3, 6 and 12 months.[14] The postoperative scores at 3, 6 and 12 months were 2.46±0.56, 5.43±0.77, and 7.95±1.86 respectively. Devesahayamet al reported the implantees were grouped according to cross-over and post lingual group.[15] Pre-implantation mean CAP score was 0 for both groups. At 24 months post implant, 96.4% of our implantees were able to understand common phrases without lip reading (CAP score 5 and above) irrespective of age of implant. Twenty-two implantees (39.3%) were able to use the telephone with a known listener. The CAP score for both groups (overall) showed significant improvement with 78.6% achieved CAP score of 6 and above at 24 months after implantation (p<0.001). This method of measuring functional outcome have been widely used world-wide as there is good inter-observer reliability and can be used across wide age groups.[16] The CAP score showed marked improvement at the first six months post implantation with continued improvement in subsequent months. Similar to other studies conducted on post-lingual patients, the marked improvement occurs especially during the first six months after implantation.[17] Post lingual patients are also considered better candidates for implantation because more activation of auditory associated brain activity happens in post lingual patients as shown in the study conducted by Nahla et al and Martines et al CAP and SIR before cochlear implantation and 3, 6 and 12 months post switch-on respectively; it is clearly evidenced as speech perception and speech intelligibility

performances improved progressively after implantation.[13,18] Specifically, with a CAP average score of 3.25±1 and amedian value of 3 at 12 months post implantation, our outcomes are in line with those of Govaerts et al in fact he found also that children implanted before the age of 2 years, compared with their normal hearing peers, showed similar CAP values just at three months post implantation.[19]

In current study observed that the mean SIR was found 0.94±0.25 at 3 month, 1.94±0.56 at 6 month, 3.66±0.59 at 12 month and 4.87±0.26 at 24 month. Mean SIR- at 6 month, 12 month and 24 months were statistically significant ($p<0.05$) in comparison with at 3 month. Five cases were not improved due to 2 cases autism spectrum disorder and 3 cases attention deficit hyperactivity disorder. Shakrawalet al reported in the postoperative scores at 3, 6 and 12 months were 1.67±0.75, 2.48±0.96, and 4.08±0.862 respectively in 1-4 years of age children.[14] In study of Gupta found SIR scores at 6 months were calculated and studied for various factors using the Chi square test.[11] The p value was found to be significant for age at implantation, duration of auditory deprivation, and residual hearing.

In this study, at 6 month, mean CAP was found 4.06±0.91in age ≤3 years and 3.19±0.94 in age >3 years. At 12 month, mean CAP was found 5.47±0.84 in age ≤3 years and 4.40±1.05 in age >3 years. At 24 months CAP was found 6.12±0.76 in age ≤3 and 5.26±1.03 in age >3 years. Which were statistically significant ($p<0.05$) between two groups. In Gupta study reported that the P value for CAP at 12 months was also found to be significant for age at implantation, duration of auditory deprivation, and residual hearing.[11] The odds ratio calculated for these factors were 5.78, 17.14, and 7.71 respectively. Shakrawal et al reported that the scores when compared in both the groups revealed that the results were comparable and significant after 12 months of follow up while the scores were not significant after 3 and 6 months.[14] The CAP score 1-4 years of children were 2.459±0.557, 5.432±0.765 and 7.95±1.84 post-operative follow up at 3 months, 6 months and 12 months respectively. That was support to our observation.

In present study observed at 6 month, mean SIR was found 2.16±0.63 in age ≤3 years and 1.73±0.49 in age >3 years. At 12 month, mean SIR was found 4.15±0.67 in age ≤3 years and 3.17±0.52 in age >3 years. At 24 month mean SIR was found 4.86±0.54 in age ≤3 years and 3.79±0.57 in age >3 years. Which were statistically significant ($p<0.05$) between two groups. Shakrawal et al compared in the postoperative mean SIR scores both the groups; the results were comparable but not significant after 3 and 6 months while the results were significant after 12 months.[14] O'Donoghueet al reported age at implantation was a significant covariate ($p=0.01$) and mode of communication was a significant between-individuals factor ($p=0.04$).[20] Young age at intervention and oral communication mode are the most important known determinants of later speech perception in young children after cochlear implantation. O'Donoghue et al congenitally and prelingually deaf children who receive cochlear implants before the age of 7 years have significant closed-set speech perception abilities develop in <3 years after implantation.[21]

Limitations

The limitation was that the sample size was small, so the result can't be generalised.

CONCLUSION

Cochlear implant surgery is a safe surgical procedure with good surgical and functional outcomes. Children with congenital deafness who underwent implantation before the age 3 years appeared to benefit from the implant. The majority of implantees have significantly gained auditory improvement as shown by the CAP scores. Post lingual and cross-over implantees require a shorter duration of rehabilitation period and marked improvement of speech intelligence rating, auditory performance, speech intelligence rating is seen in six months. In this study observed to the importance of early implantation are significantly increased better outcome.

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