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## Original Research Article

## Effect of age on outcome of auditory verbal therapy in cochlear implantation

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## ABSTRACT

**Objective:** 1. To assess the outcome of auditory verbal therapy in prelingually deaf children who underwent cochlear implantation. 2. To assess the effect of age at cochlear implantation on language development outcomes.

**Materials and Methods:** 40 post cochlear implantation patients implanted at P.D.U. medical college and hospital, Rajkot receiving auditory verbal therapy at regular intervals were studied for hearing and speech development. The children were divided into 2 groups- <4 years and 4-7 years of age at the time of implantation. All children were assessed by revised Categories of Auditory Performance (CAP) and Speech Intelligibility Rating (SIR) at 6 months of auditory verbal therapy.

**Results:** Among the 40 patients, 18 were below 4 years of age and 22 children were above 4 years of age; 28 male and 12 female children were present. The average CAP scores in the <4 years group was 4.7 and the in 4-7 years group was 3.72. The average SIR scores in the <4 years group was 3.45 and the in 4-7 years group was 2.54. These observations were found to be statistically significant.

**Conclusion:** Statistically significant benefits are seen in hearing and speech abilities as well as in quality of life. Earlier the age of the child at time of implantation, better is the auditory and speech outcome. Only implantation will not suffice, but adequate and timely post implantation hearing and speech training can help patients make greatest use of their cochlear implantation.

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## 1. Introduction

Cochlear implantation brings hope for patients having profound hearing loss. Auditory nerve excitation by electrical stimulation results in poor resolution of information of verbal stimulation. Only implantation will not suffice but adequate and timely post implantation Auditory Verbal Therapy can help patients make greatest use of their cochlear implantation. The rehabilitation programme includes structured set of exercises designed to help the patient understand and recognize the sound signal. It begins with simply detecting the sound then distinguishing different sounds and thence to recognize spoken words.

The first 3 years in a child's life are critical for acquiring information about the world, communicating with the family and developing a cognitive and linguistic foundation. Children deprived of language input in early life are at risk of poor academic performance later in childhood resulting in socio-emotional and behavioral problems. Thus speech is the most efficient means of communication within families and local community.<sup>1</sup> The existence of a critical period for language development during first five years of life is well established. Providing auditory stimulation during this period is critical.<sup>2</sup> Speech intelligibility refers to the amount by which a speaker's message is recognized by the listener. When impaired it impacts communication. Adequate development of speech intelligibility is important for –integration into society, quality of life, access to mainstream education, psychosocial and professional development. A cochlear implant is a prosthetic device

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which replaces the transducer function of damaged hair cells and provides electrical stimulation enabling meaningful activation of auditory cortex.<sup>2</sup> Children implanted early who do not have other significant developmental disabilities and when coupled with intensive post implantation speech language therapy, may acquire age appropriate speech, language, developmental and social skills. A team approach coordinated by ENT consultant, cochlear implant coordinator, speech language pathologist, audiologist and counselor is essential for language development. There are many therapies available to address learning and communication for children with hearing impairment- Auditory verbal therapy, sign language, cued speech, total communication, simultaneous communication, verbo-tonal or guberina method and natural auditory oral approach. Auditory verbal therapy is a parent centered approach that encourages the use of naturalistic conversation and use of spoken language to communicate.<sup>3</sup> Auditory verbal therapists are trained to provide therapy sessions, train parents and manage educational services. The ultimate goal is to develop hearing as an active sense so that listening becomes an integral part of the child's development. Total language development consists of comprehension, verbal reasoning, narrative ability and spontaneous language production.<sup>4</sup>

## 2. Materials and Methods

This is a prospective study carried out in 40 bilaterally deaf children of age group 2-7 years of both genders with no benefit with hearing aid who underwent cochlear implantation surgery and receiving auditory verbal therapy at regular intervals at the department of otorhinolaryngology, P.D.U. medical college and hospital, Rajkot.

### 2.1. Inclusion criteria

All bilaterally deaf children of age group 2-7 years with no benefit with hearing aid no other known conditions that interfere with speech/language development, no known problems with the cochlear implant lasting over 30 days and completed 6 months of AVT.

### 2.2. Exclusion criteria

1. Children with neurological defects
2. Children with anatomic defects of the middle ear, inner ear, eighth nerve.
3. Children with less than 6 months of AVT

The children were assessed by revised Categories of Auditory Performance (CAP) score described by The Shepherd centre based on Nottingham CI program, 1995.<sup>5</sup> Speech intelligibility and quality was assessed by Speech Intelligibility Rating (SIR) of O'Donoghue et al.<sup>6</sup> The aim

of the study is to examine the effects of age, duration and type of early auditory experience on spoken language competence. Patients are assessed by number of levels of development of speech and listening skills:

**Table 1:** revised Categories of Auditory Performance (CAP) score: The Shepherd centre based on Nottingham CI program, 1995<sup>5</sup>

Category	Criteria
Level 0	Unaware of environmental sounds
Level 1	Detects some environmental sounds
Level 2	Responds to some speech sounds
Level 3	Can identify some environmental sounds
Level 4	Understands some spoken words with additional performatives e.g. 'where is the duck that says quack quack', 'give me the car brmm'
Level 5	Understands common phrases e.g. pick it up; it's bath time
Level 6	Understands some spoken words without performatives e.g. give me the duck'/ 'go get the car'
Level 7	Responds appropriately to simple questions e.g. what is it?
Level 8	Understands conversations with familiar speakers
Level 9	Understands conversations with unfamiliar speakers
Level 10	Follows recorded stories
Level 11	Uses the telephone with familiar speakers
Level 12	Uses the telephone with unfamiliar speakers

**Table 2:** Speech Intelligibility Rating (SIR): O'Donoghue et al<sup>6</sup>

Category	Criteria
5	Connected speech is intelligible to all listeners. Child is understood easily in everyday contexts
4	Connected speech is intelligible to a listener who has little experience of a deaf person's speech.
3	Connected speech is intelligible to a listener who concentrates and lip reads.
2	Connected speech is unintelligible. Intelligible speech is developing in single words when context and lip reading clues are available.
1	Connected speech is unintelligible. Pre-recognizable words in spoken language; primary mode of communication may be manual.

## 3. Result and Discussion

40 children who underwent cochlear implantation were divided in two groups based on age at implantation- <4 years and 4-7 years. 18(45%) children belonged to less than 4 years group and 22(55%) children belonged to 4-7 years age group. Out of 40 children, 12(30%) were female and

**Table 3:** Age and sex distribution

Sex	<4 years	4-7 years	Total
Male	14	14	28
Female	4	8	12
Total	18	22	40

**Table 4:** Revised CAP score and SIR score before and after implant.

	<4 years			4-7 years		
	Before implant	1 month	6 months	Before implant	1 month	6 months
Average CAP score	0	1.3	4.7	0	1.27	3.72
Average SIR score	1	1	3.78	1	1	2.54

28(70%) were male.

Before cochlear implantation, CAP score was category 0 and SIR score was category 1 in all patients.

CAP score and SIR score was evaluated in all patients after 1 month. Average CAP score was 1.3 in <4years age group and 1.27 in 4-7 years age group. SIR score was 1 in all children.

There was an improvement in all patients at 6 months after implantation. Average CAP score in children implanted below 4 years was 4.7 whereas in case of age group 4-7 age group, average CAP score was 3.72. So on an average child implanted before 4 years is able to understand common phrases while child implanted after 4 years is able to understand some spoken words.

On calculating t value,  $t_{(calculated)}-3.33 > t_{(critical)}2.02$ . This states that the results are statistically significant.

**Table 5:** RevisedCAP score and SIR score at 6 months according to sex distribution.

	Female	Male
Average CAP score	4.16	4.17
Average SIR score	3	2.92

On comparing the scores based on gender groups, average CAP scores in males was 4.17 and females was 4.16; the average SIR score was 2.92 in males and 3 in female. The difference was found to be of no significance.

In our study, average CAP score in children implanted below 4 years was 4.7 whereas in case of age group 4-7 age group, average CAP score was 3.72 at 6months after implantation. The average SIR score was 3.78 in <4 years age group and 2.54 in 4-7 years age group.

In the study done by V. Saravanan<sup>7</sup> he compared CAP and SIR scores between age group <3 years and 3-6 years at 1 year after implantation. The mean CAP score was 5.17 in age group <3 years and 3.62 in age group 3-6 years. The mean SIR score was 4.04 in age group <3 years and 2.23 in age group 3-6 years at 1 year after implantation.

In the study done by Yang et al<sup>8</sup> CAP and SIR scores among 3 age groups were compared; 1.3-2.9 years, 3-4.9

years and 5-7.9 years. The study showed that the scores were significantly higher in age group 1.3- 2.9 years as compared to other two groups.

Nikolopoulos et al<sup>9</sup> studied 133 children and showed acceptable results in children implanted before 8 years of age. Better results were seen in patients implanted before the age of 4 years as compared to those after the age of 4 years.

Govaerts et al.<sup>10</sup> analyzed a retrospective cross sectional study of 70 cochlear implant children and demonstrated that children implanted after the age of 4 years CAP scores rarely reached normal while children implanted at 2-4 years normal CAP scores were achieved.

Similar studies were carried out by Tajudeen et al and Fang et al; both the studies showed that before 3 years of age had significantly better CAP and SIR scores as compared to children >3 years.

Thus it can be concluded by the study that irreversible changes occurring in auditory system with prolonged auditory deprivation becomes a hindrance for normal language development. Therefore cochlear implantation should be performed as early as possible.

#### 4. Conclusion

Cochlear implantation along with Auditory Verbal Therapy provides satisfactory hearing and speech abilities to congenitally deaf children. Auditory verbal therapy teaches young children to listen and communicate without depending on lip reading and sign language. Earlier cochlear implantation dramatically affects the amount of spoken language development.<sup>3</sup> Children should be screened for hearing impairment to diagnose severe to profound hearing loss as early as possible and intervention provided at the earliest for best outcome. Regular follow up and active participation by parents is necessary to maximize the benefits.

## 5. Limitations

1. Comparatively small sample size
2. Lack of long term follow up

## 6. Conflicts of Interest

All contributing authors declare no conflicts of interest.

## 7. Source of Funding

None.

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