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# A COMPARATIVE STUDY OF HEARING AND SPEECH OUTCOME IN PATIENTS AFTER UNILATERAL COCHLEAR IMPLANT AND BIMODAL HEARING.

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## ABSTRACT

A comparative study of hearing and speech outcome in patients after unilateral cochlear implant and bimodal hearing.
Objective : Objective of the study was to evaluate early hearing and speech outcomes of Cochlear Implant in patients with bimodal stimulation ( patients who use Cochlear Implant in one ear & hearing aid in the other) and compare it with the patients using Cochlear Implant only .
Method : Study was conducted in Department of ENT , Civil Hospital , Ahmedabad . We studied & evaluated early outcome of Cochlear Implant in 25 patients of 1-5 years age group, who used Bimodal stimulation & compared It with 25 patients who used CI only. Study was carried out over period of 2 years & Hearing & Speech Ability was recorded on Category of Auditory Performance(CAP) Scale & Speech Intelligibility Rating(SIR) Scale at the intervals of 6 months . Result :. Patients who used bimodal stimulation showed better scores on Category of Auditory Performance Scale(CAP) & Speech Intelligibility Rating (SIR) compared to the patients who did not use bimodal stimulation.
Conclusion : Patients with bimodal stimulation showed better auditory & verbal responses compared to patients who did not receive bimodal stimulations. So use of bimodal stimulation should be recommended.

## KEYWORDS:

Cochlear Implant ; bimodal stimulation ; hearing aid ; unilateral hearing

### Introduction

The provision of binaural hearing to people who have bilateral hearing impairment is important because binaural hearing provides better speech perception and sound localization over monaural hearing. Furthermore, auditory stimulation to both ears prevents neural degeneration that is associated with auditory deprivation.

For people who have profound deafness in both ears, binaural hearing can be provided only with bilateral implantation. For people who receive a cochlear implant in one ear and who have residual hearing in the nonimplanted ear, binaural hearing can be achieved by either bilateral implantation or by the use of a cochlear implant with a hearing aid in opposite ears (binaural/bimodal stimulation).

This study addresses the question of whether bimodal stimulation (Cochlear Implant in one ear & Hearing aid) offers greater advantages to recipients of unilateral cochlear implants.

### Rationale for Providing Binaural Hearing

**Localisation :** A person who receives auditory stimulation in only one ear may be able to tell whether a sound comes from the right or left side (side discrimination) by knowing that the louder sounds are more likely to come from the aided/implanted side. To perceive the location and direction of sounds, however, it is necessary to make use of interaural time and level differences.

**Speech Perception :** Listening with two ears is better than one in understanding speech in a noisy environment. The binaural benefit is thought to arise from a combination of head diffraction, binaural redundancy, and binaural squelch effects.

**Sound Quality and Music Perception :** Sound quality relates to the perceived effects of variations in the frequency spectrum and the amplitude envelopes over time. Subjective judgments of the quality and pleasantness of sounds and recognition of melodies by implant users are generally poor. This is possibly because limited pitch and spectral details of sounds are delivered to the users. In most implant sound processors, the short-term spectral shapes of acoustic signals are estimated using a Binaural-Bimodal Fitting or Bilateral Implantation of bandpass filters (eg, 22 frequency bands are available to span the range from about 100 to 10 000 Hz in the Nucleus system). Because the acoustic features of complex sounds are much more degraded in electrical than in acoustic stimulation, combining acoustic hearing with electric hearing would be expected to improve sound quality and enhance music perception for users of cochlear implants in general.

### Objectives

Objective of the study was to evaluate early hearing and speech outcomes of Cochlear Implant in patients with bimodal stimulation ( patients who use Cochlear Implant in one ear & hearing aid in the other) and compare it with the patients using Cochlear Implant in one ear only.

### Methods

This was a case control study carried out over period of 3 years , from July 2013 to June 2016 at Tertiary care institute. Written & informed consent was taken from the guardians of all the children. Approval of ethical committee was taken before commencing the study. In this study , group A comprised of 25 patients, having bilateral severe to profound hearing loss, in age group 1-5 years , who underwent Cochlear Implant Surgery in one ear & used BTE Digital Hearing Aid in another ear in post-operative period . Group B comprised of 25 patients, having bilateral severe to profound hearing loss, in age group 1-5 years , who underwent Cochlear Implant Surgery in one ear & did not use Hearing Aid in another ear in post-operative period . Pre-operatively, these children received complete medical examinations at

Civil Hospital, Ahmedabad, including related consultations in audiology, pediatrics, neurology, medical genetics, otolaryngology, psychology, speech pathology, and radiology. All the patients inn both groups had normal physical & mental development & normal radiological findings of brain.

All the 50 patients underwent cochlear implant surgery. After placement of the internal cochlear implant devices, intraoperatively we measured electrode impedances, visually detected electrical stapedius reflexes (VESR) and auditory response telemetry (NRT/ART). These intraoperative objective measures were used to help program the speech processor for each child. Postoperatively, each child has had regular follow-up to assure complete healing of the surgical incision, to assess their general medical conditions, and for speech processor programming. Their hearing and communication skills have been assessed on a regular basis on Categories of Auditory Performance (CAP) score & Speech Intelligibility Rating (SIR) score Postoperatively, we have also repeated electrode impedance measurements, NRT measurements, otoacoustic emissions, and electrical auditory brainstem responses (EABR). We now follow-up information of the children ranging from 6 months to 2 years. This assessment was done after 6 months , 12 months , 18 months , 24 months after surgery.

## Result

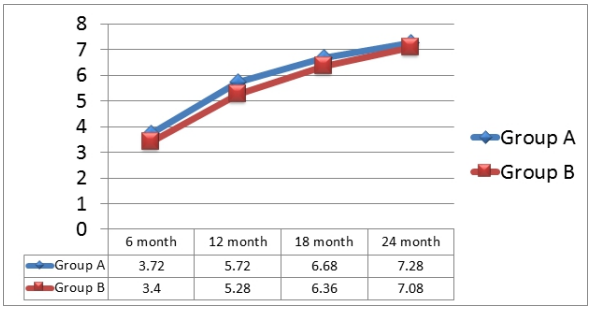
The 50 children implanted at Civil Hospital, Ahmedabad , have not had any postoperative medical or cochlear implant device complications. All of the children have shown significant improvements in their sound detection, speech perception abilities and communication skills. All of the children have shown evidence of good NRT/ART results. All showed evidence of good postoperative EABR results.

Auditory & verbal responses were assessed & scored on CAP & SIR scale at the intervals of 6 month, 12 month, 18 month & 24 months. They were as follows : Group6 month12 month18 month24 monthA3.725.726.687.28B3.45.286.367.08Independent t testThe *t*-value is 2.35907. The *p*-value is .011219. The result is significant at $p < .05$.The *t*-value is 3.39467. The *p*-value is .000693. The result is significant at $p < .05$.The *t*-value is 2.34216. The *p*-value is .011684. The result is significant at $p < .05$.

The *t*-value is 1.86772. The *p*-value is .033957. The result is significant at $p < .05$.

CAP [TSC Revised Version, based on Nottingham CI Program, 1995] Mean score and results of independent t test

| Group | 6 month | 12 month | 18 month | 24 month |
|---|---|---|---|---|
| A | 3.72 | 5.72 | 6.68 | 7.28 |
| B | 3.4 | 5.28 | 6.36 | 7.08 |
| Independent t test | The *t*-value is 2.35907. The *p*-value is .011219. The result is significant at $p < .05$. | The *t*-value is 3.39467. The *p*-value is .000693. The result is significant at $p < .05$. | The *t*-value is 2.34216. The *p*-value is .011684. The result is significant at $p < .05$. | The *t*-value is 1.86772. The *p*-value is .033957. The result is significant at $p < .05$. |




Speech intelligibility rating (O'donoghue et al 1999)

**Table 2** : CAP score in Group A (Bimodal) and Group B (Unilateral CI) over a period of time

| Group | 6 month | 12 month | 18 month | 24 month |
|---|---|---|---|---|
| 1 | 1.12 | 2.08 | 3 | 3.44 |
| 2 | 1 | 2 | 2.84 | 3.08 |
| Independent test | The t-value is 1.80907. The p-value is .038353. The result is significant at $p < .05$. | The t-value is 1.44463. The p-value is .077529. The result is not significant at $p < .05$. | The t-value is 2.13809. The p-value is .018814. The result is significant at $p < .05$. | The t-value is 3.11769. The p-value is .001539. The result is significant at $p < .05$. |

**Table 2 :** SIR score in Group 1 (Bimodal) and Group 2 (Unilateral CI) over a period of time

## Discussion

The evidence to date establishes that the use of bimodal hearing devices brings improvement over the use of a cochlear implant alone. Results across all studies attest to localization and speech perception advantages that can be attributed to a combination of head diffraction and redundancy for some listeners. In addition, bimodal hearing offers advantages in speech perception and music perception because of complementarity. The low-frequency residual acoustic hearing complements the high frequency electric hearing, which is especially beneficial for segregating voice sources, for perceiving voicing information in consonants, and for perception of sound quality and music. These benefits are consistent with research on people who combined acoustic with electric hearing in the same ear.(20-21)

An international consensus on bilateral bimodal stimulation(22) identified several advantages of bilateral cochlear implantation, including: (1) the better ear is always implanted, given that it is difficult to predict which ear will give the best speech understanding postoperatively; (2) allows bilateral cortical stimulation; and (3) restores binaural hearing.

It is unequivocal that stimulation should be provided to the unimplanted ear to achieve binaural hearing. The evidence demonstrates that binaural benefits for localization and speech perception can be obtained by many individuals using either bimodal stimulation or bilateral implantation. This is because of the combined effects of head diffraction, redundancy, squelch, and complementarity. The effect of complementarity is greater in the bimodal mode (CI + HA) than in the bilateral implant mode (CI + CI) because low frequency information provided by acoustic hearing complements high-frequency information provided by electric hearing. This is supported by evidence on voice segregation, consonant perception, and music perception. Further research is necessary to improve current technology and fitting strategies to support binaural hearing and to gain better understanding of factors affecting performance with binaural hearing devices.

**Conclusion :** Patients with bimodal stimulation showed better auditory & verbal responses compared to patients who did not receive bimodal stimulations. So use of bimodal stimulation should be recommended.

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