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CASE REPORT

Development of Auditory and Speech Language Performance Following Bimodal Cochlear Implantation in a Pre-lingual Late Implantee: A Case Report

Shashank Vashist[1], Meenakshi Chabbra[2]

[1]Manipal Hospital, Gurgaon, Haryana, India
[2]Vision Institute of Advanced Studies, Rohini, Delhi, India

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ABSTRACT

Objective - To describe the performance in terms of auditory and speech-language development in a late implanted patient with bimodal cochlear implantation.

Study Design - Prospective Case study.

Subject – A girl with congenital bilateral sensorineural hearing loss with speech and language delay having left ear profound SNHL and right ear severe to profound SNHL.

Intervention – Unilateral cochlear implant with neubio BOLD CI system done at the age of 15 years following auditory verbal therapy.

Main Outcome Measures – "Meaningful auditory integration scale (MAIS)", "Revised categories of auditory performance (Revised CAP)", "Speech intelligibility rating (SIR)", "Child using hearing devices QOL (cuHDQOL)", 3D- language acquisition test (3D- LAT), "Parent evaluation aural/oral performance of children (PEACH)" and "Teacher evaluation aural/oral performance of children (TEACH)" is used to assess the outcomes of the cochlear implantation.

Results – "Revised CAP," "SIR," "MAIS," "cuHDQOL," "3D-LAT", "PEACH," and "TEACH" scores showed improvement in the implanted teenager over time.

Conclusion - The findings represent the evidence for better outcomes of late cochlear implanted patients with bimodal stimulation. It may also provide convincing results about the benefits with the use of Neubio BOLD Cochlear Implant system with a contralateral hearing aid.

Keywords: 3D language acquisition test, Bimodal stimulation, Categories of auditory perception, Child using hearing devices quality of life, Cochlear implant, Late implantee, Meaningful auditory integration scale, Parent evaluation aural/oral performance of children and teacher evaluation aural/oral performance of children, Speech intelligibility rating.

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INTRODUCTION

Children who receive early cochlear implants develop auditory and linguistic skills at par with their hearing companions.[1] Cochlear implantation (CI) is a proven and effective treatment for children with severe to profound sensorineural hearing loss.[2] Less information is given about bilateral cochlear implantation, other than in cases such as deaf-blind patients and in cases of deafness post meningitis, where there is a risk of cochlear ossification.[3] Astonishingly, stimulation of the other ear is not suggested to unilaterally implant recipients in standard clinical practice.[3] Not stimulating with a hearing aid on the other side may be because of child rejecting it given the limited considerable benefits in comparison to the implanted side or considers it unnecessary after cochlear implant surgery; eventually, the less availability of scientific corroboration about the effective benefit of bimodal stimulation. This leads to the perception that unilateral CI is sufficient for appropriate perceptual- speech and language skills development. It's been established that binaural hearing facilitates the localization of sound and speech discrimination in noisy surroundings.[4]

*Author for Correspondence: shankvdoc@hotmail.com

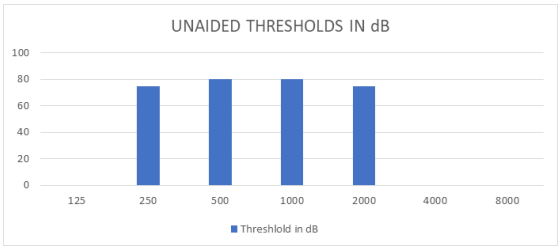

Figure 1: Unaided Thresholds in dB.

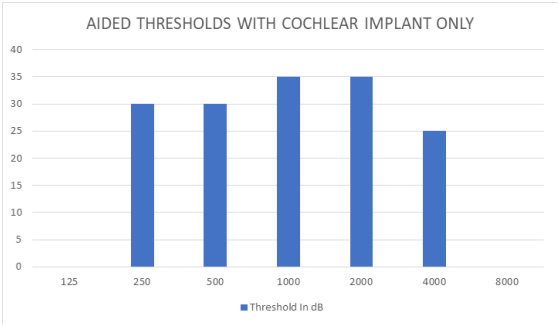

Figure 2: Aided Thresholds with cochlear implant only.

In agreement with these findings, goal should be to facilitate binaural hearing. "Bimodal stimulation improves the auditory-perceptual abilities of adults with usable residual hearing in the non-implanted ear"[5] The current study may be a salient allusion for the treatment of late unilaterally implanted pre-lingual children with bimodal stimulation. Also, the foundation is to explore the possible advantage of the binaural development of acoustic matrix to attain adequate perceptual and communication skills in pre-lingual children.

AIMS AND OBJECTIVES

This present study aims at documenting the experience of bimodal cochlear implant stimulation with regards to speech and language performance, "auditory perception", "speech intelligibility" rating using the qualitative technique, "Parent evaluation aural/Oral performance of children," and "Teacher evaluation aural/Oral performance of children" and also "Quality of life-related to hearing after cochlear implantation" in a late implanted teenager.

METHODS

A female patient was enrolled and underwent CI at the age of 15 years. in the left ear. The Neubio BOLD 22 implant with 12 electrodes was implanted. The teenager was diagnosed with profound sensorineural hearing loss in the left ear, higher than 90 dB, severe to profound loss in the right ear. The teenager had bilateral no middle ear pathology and intact VIII cranial nerve. The patient has been using strong power BTE hearing aid in the right ear since 3 months before the implant. The patient had no psychomedical disagreement and was encouraged for rehabilitation after implantation. Considering the child's age, the family's expectations were set reasonably and a detailed discussion on the complexity and challenges

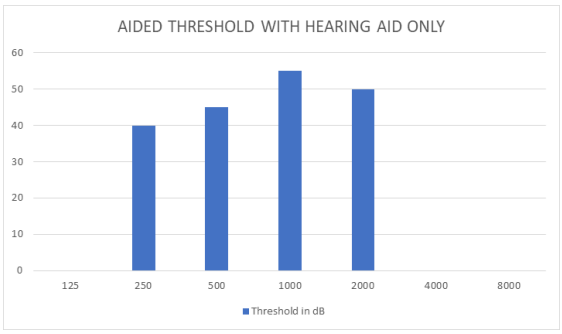

Figure 3: Aided Thresholds with hearing aid only.

of oral communication after CI was held prior to the surgery along with an informed consent. The patient enrolled had a strong desire for improved hearing and lifestyle and opted to go ahead with the surgery. The patient underwent free field audiometry. The stimulus used was warble tone without any aid, with a hearing aid only and with cochlear implant only after 6 months of using the sound processor. Their scores are given below in the Figures 1-3, respectively. The pre-implant status of hearing, speech and language were obtained. The teenager's speech before the implant was evaluated was pre-recognizable words and used iconic gestures for communication. The teenager's receptive and expressive language age before the implant was evaluated to be 9 to 11 months. The 9 to 11 months of receptive language age depicts that the teenager comprehends simple commands, whereas 9 to 11 months of expressive language age depicts that she expresses herself through pointing with few words when asked for the desired things. The cognitive age of the child was evaluated to be 12 to 14 months showed pretending to verbalize words to particular objects, performing structured dance movements etc. Data were obtained by reviewing the patient record and from the verbal habilitation professional. Child attended 2 sessions a week with an approximate length of a session being an hour with the therapist.[6] Revised CAP; [7]SIR and [8]MAIS scores at pre-switch on, 3 and 6 months were documented as per the internationally standardized St. Gabriel's curriculum. Also, the[9] cuHDQOL; 3D- Language Acquisition Test;[10] Parent evaluation aural/Oral performance of children and[11] Teacher evaluation aural/Oral performance of children scores were

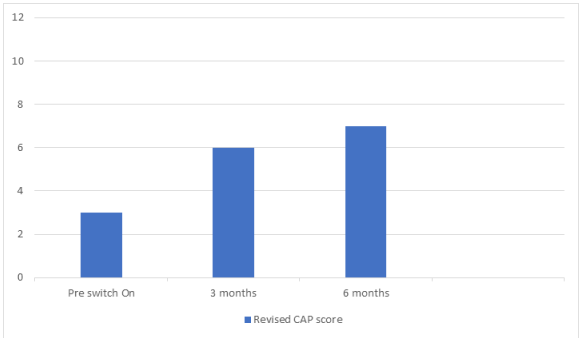

Figure 4: Scores of Revised CAP

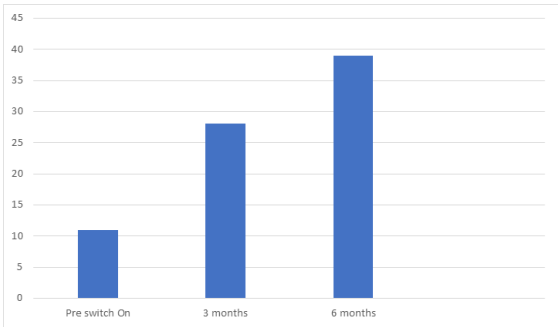

Figure 5: Scores of MAIS.

obtained at the 6 months of the switch on to assess language performance, quality of life of the patient related to hearing after cochlear implantation. A structured interview was conducted to gather information and was recorded for future reference. The interview was then analyzed using qualitative measures.

The Figure 1 shows the free field audiometry unaided thresholds in dB. The frequencies arranged on X- axis from 125 to 8 khz. The child had no response on 4 khz on 100 dB warble tone given in the free field.

The Figure 2 shows the free field audiometry aided thresholds in dB after 6 months of Cochlear Implantation in the left ear. The frequencies arranged on X-axis from 125 to 8 khz.

The Figure 3 shows the free field audiometry aided thresholds in dB after 6 months of using hearing aid in right ear. The frequencies arranged on X-axis from 125 to 8 khz.

RESULTS

The findings and medical case files were combined to find emergent themes. The frequently emerged themes included:

- Auditory perception
- Experience with the implant
- Speech intelligibility of the patients concerning the current situation
- 3D-language acquisition test
- "Parent evaluation aural/Oral performance of children score"
- "Teacher evaluation aural/Oral performance of children score"

Revised CAP Score

The Figure 4 shows the scores of Revised CAP taken at the various stages i.e., pre-switch ON, 3 to 6 months after the switch on of the device. The revised category of auditory perception increased from level 3 to 7, showing the teenager responds appropriately to simple questions.

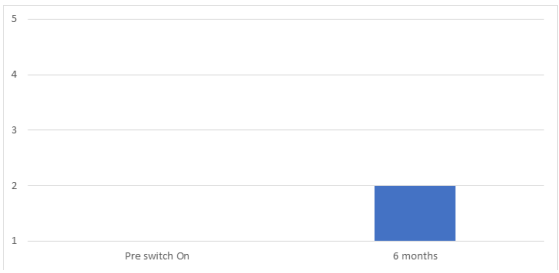

Figure 6: Scores of SIR.

MAIS Score

The Figure 5 shows the scores of MAIS taken at the various stages i.e., pre-switch ON, 3 to 6 months after the switch on of the device. The meaningful auditory integration scale increased from a score of 11 to 39 on the scale that shows the teenager spontaneously associates "vocal tone (anger, excitement, anxiety) with its meaning based on hearing alone as well as knowing the difference between speech and nonspeech stimuli with listening alone" after 6 months of cochlear implantation.

SIR Score

Figure 6 shows the scores of SIR taken at the various stages i.e., pre-switch On, 6 months, after the device switch on. The speech intelligibility of the teenager increased from level 1 to 2 on the scale that shows the "Connected speech is unintelligible. Intelligible speech is developing in single words when context and lip-reading cues are available." The pre-switch on score is 1 that shows the teenager used "pre recognizable words in spoken language, her primary mode of every day communication may be manual."

CuHDQOL Score

The scores of cuHDQOL taken after 6 months of the switch-on and auditory rehabilitation is 67. As per the questionnaire, the score shows that the parents of the teenager believe that the cochlear implant device has improved communication between the child and the family members. They also believe that their teenage child will have greater educational opportunities and achievements with their cochlear implant device and that their child will be able to find employment and support themselves as an adult. They believe their teenage child will feel confident in the world, and also believe that the child will lead a happy and safe life.

3D Language Acquisition Test

The Figure 7 shows the scores of 3D Language acquisition test before the switch ON and post 6 months of switching on the device in three domains i.e., receptive language age, expressive language age and cognition. The receptive, expressive language age is 9 to 11 months and cognition is 12 to 14 months. The 9 to 11 months of receptive language age depicts that the teenager comprehends simple commands, whereas 9 to 11 months of expressive language age depicts that she expresses herself through pointing with few words when asked for the desired things. 12 to 14 months of cognition age shows pretending to verbalize words to particular objects, performing structured dance movements etc. There is an improvement seen post 6 months of switch ON in all three domains. The receptive and expressive language age is 18 to 20 months and cognition is greater than 33 to 36 months. The 18 to 20 months of receptive language age depicts that the teenager comprehends questions regarding action of agents in the pictures and questions concerning the habitual behaviour of named agents. Whereas

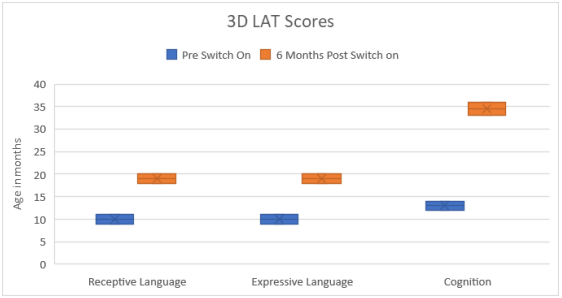

Figure 7: 3D LAT Score.

18 to 20 months of expressive language age depicts that the teenager expresses herself through few words naming the object, animals, eatables., describes event by naming the person involved along with few actions, makes appropriate animal/vehicle noise when asked, repeat words when asked, signifies disappearance of a person within 1–2-word utterances, asking questions e.g., 'where ball'? Uses more kinship terms and possession relationship e.g., Mummy's shoe etc. Cognition over 33 to 36 months shows the teenager knows about the usage of language, plans for upcoming event, knows about the concept of money etc.

Parent Evaluation Aural/Oral Performance of Children

The Figure 8 shows scores of "Parent evaluation aural/oral performance of child (PEACH)" post 6 months post switch on through bimodal stimulation in quiet and noisy environments. PEACH consists of 13 questions out of which 11 questions are taken to assess the performance. Six questions assess the performance of oral/aural in quiet environment and 5 questions assess the performance in a noisy environment. The scoring is done in 0 to 4 Likert scale where 0 signifies – Never; 1 denotes- Seldom; 2 denotes- Sometimes; 3 denotes- Often; 4 denotes- Always. The raw score is calculated in percentage by dividing 24 for questions concerning quiet environments and dividing by 20 for questions concerning noisy environments. The overall score in percentage consists sum of 11 questions divided by 44. The graph above shows 87.5% in quiet environment, 60% in noisy environment and overall score shows 75%.

Teacher Evaluation Aural/Oral Performance of Children

Figure 9 shows scores of "Teacher evaluation aural/oral performance of child (TEACH)" post 6 months of cochlear implantation through bimodal stimulation in quiet and noisy

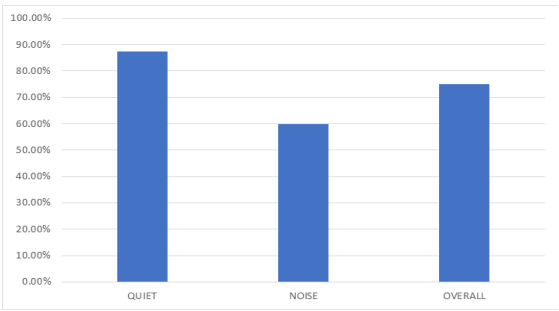

Figure 8: Scores of "Parent evaluation aural/oral performance of child (PEACH)

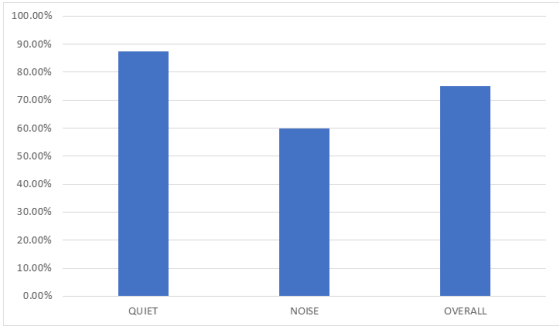

Figure 9: Scores of "Teacher evaluation aural/oral performance of child (TEACH)

environment. TEACH consists of 11 questions out of which 9 questions are taken to assess the performance. Five questions assess the performance of oral/aural in a quiet environment and 4 questions assess the performance in a noisy environment. The scoring is done in 0 to 4 Likert scale where 0 signifies – Never; 1 signifies- Seldom; 2 signifies- Sometimes; 3 signifies- Often; 4 signifies- Always. The raw score is calculated in percentage by dividing 20 for questions concerning quiet environments and dividing by 16 for questions concerning noisy environments. The overall score in percentage consists sum of 9 questions divided by 36. The graph above shows 85% in quiet environment, 68.75% in noisy environment and Overall score is 77.78%.

SUMMARY

This study indicated that the late implanted teenager who experienced sequential bimodal stimulation showed development in all seven domains, ameliorating the patient's quality of life. The intensive auditory verbal training aided in achieving requisite outcomes throughout their rehabilitation. Cochlear implantation implanted with Neubio's BOLD 22 with 12 electrodes CI system may have played an important role in auditory and speech development skills. The child's family acknowledged CI as a vital asset as a teenager was able to communicate and pay attention to her surroundings. The Revised CAP; SIR; MAIS were taken pre-switch ON, 3 months and 6 months post-switch ON of the device. The child's quality of life-related to hearing (cuHDQOL); Language performance on 3D Language acquisition test done post 6 months of the switch-on showed considerable improvement in the quality of life related to hearing and language age, respectively. The PEACH and TEACH administered 6 months post cochlear implantation considered the improvement in the oral/aural performance in the noise and the quiet environment.

CONCLUSION

This study showed prefatory data about the benefits arising from the Neubio BOLD unilateral cochlear implant with use of contralateral hearing aid, consisting of substantial development in auditory, speech and language skills. These findings showed the benefits of bimodal cochlear implantation in the late implanted teenager.

RECOMMENDATIONS

- The same study may be undertaken to correlate the findings in the noisy and quiet environment with a larger sample size with and without cochlear implant.
- The same study may be undertaken to assess the language of the child post 12 months to infer the findings of language development in the child with the same device.

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