The Journal of International Advanced Otology

J Int Adv Otol 2015; 11(2): 110-3 • DOI: 10.5152/iao.2015.915

Original Article

Recent Rehabilitation Experience with Pediatric ABI Users

Esra Yücel, Filiz Aslan, Hilal Burcu Özkan, Levent Sennaroğlu

Department of Audiology, Hacettepe University, Ankara, Turkey (EY, FA)
Otolaryngology Audiology and Speech Pathology Unit, Hacettepe University Faculty of Medicine, Ankara, Turkey (HBÖ)
Department of Otolaryngology, Hacettepe University Faculty of Medicine, Ankara, Turkey (LS)

OBJECTIVE: The aim of this study is to describe the rehabilitative outcomes of pediatric auditory brainstem implant (ABI) users in the Department of Otolaryngology in the Hacettepe University. It was a retrospective study, and all patients' files were reviewed.

MATERIALS and METHODS: The data was collected from 41 children who were fitted with ABI between 2005 and 2013. Inclusion criteria for children in our study are profound, congenital bilateral sensory-neural hearing loss with anomalies (such as cochlear, labyrinthine, and cochlear nerve aplasia) and more than one year of auditory experience with ABI. Post-meningitis patients and neurofibromatosis type 2 (NF2) patients were excluded. Auditory perception was evaluated using the Meaningful Auditory Integration Scale (MAIS), Functioning after Pediatric Cochlear Implantation (FAPCI) instrument, Categories of Auditory Performance (CAP), and Children's Auditory Perception Skills Test in Turkish (CIAT). Speech intelligibility was categorized with speech intelligibility rating (SIR), and language development was assessed using the Test of Early Language Development-Third Edition (TELD-3) and Manchester Spoken Language Development Scale (MSLD).

RESULTS: All patients gained basic audiological functions and were able to recognize and discriminate sounds by the third month of ABI surgery. According to the duration of ABI use and learning skills, patients revealed development from word identification to sentence recognition level in a wide spectrum.

CONCLUSION: Preliminary results indicate that all children have gained basic auditory perception skills. On the other hand, language and speech development data were varying among children. Additional handicaps seemed to slow down progression. Secondary improvement was seen at psychosocial areas with respect to behavioral and social adjustment as well as eagerness to start communication.

KEYWORDS: Auditory brainstem implant, rehabilitation, children

INTRODUCTION

Auditory brainstem implant (ABI) provides a better option for children who have labyrinthine, cochlear aplasia, and/or cochlear nerve aplasia [1]. In 2001, Colletti et al. [2] reported the first pediatric ABI patient's results that involve environmental sound awareness and speech detection skills. At present, more clinics in Europe and USA have implemented ABI and have enhanced their rehabilitation procedures. In the literature, there is a wide range of researches regarding auditory and language performance of pediatric cochlear implanted (CI) patients. However, we have limited information regarding ABI outcomes as the number of pediatric ABI users is limited.

In our study, we aimed to describe auditory perception and language development skills of pediatric ABI patients from the Department of Otolaryngology in the Hacettepe University.

MATERIALS and METHODS

Forty-one children who have ABI between 2005 and 2013 were recruited into our study. Inclusion criteria for children in our study are profound, congenital bilateral sensory-neural hearing loss and more than one year of auditory experience with ABI. Post-meningitis patients and neurofibromatosis type 2 (NF2) patients were excluded. According to the inclusion criteria, five children were excluded, and all evaluations were conducted for 36 of 41 children. Approval from the Hacettepe University Non-interventional Clinical Researches Ethics Board was also obtained [no: GO 14/516], and they signed the approval form of all patients.

Twenty-six of the 36 children in the study were females, and all children were aged between 36 and 147 months (mean age, 76 months). All children use their implants regularly on a daily basis, and 12 of 36 children have special needs (Table1).

This study was presented at the 12th Congress of the European Federation of Audiology Societies, 27-30 May, 2015, İstanbul, Turkey.

Corresponding Address:
Filiz Aslan, E-mail: filizasl@gmail.com
Submitted: 29.01.2015 **Accepted:** 22.06.2015 **Available Online Date:** 09.07.2015

Table 1. Number of children with special needs in the study

Special needs	Number
ADHD*	5
Global Developmental Delay	4
Pervasive Developmental Disorder	1

*Attention deficit and hyperactivity disorder

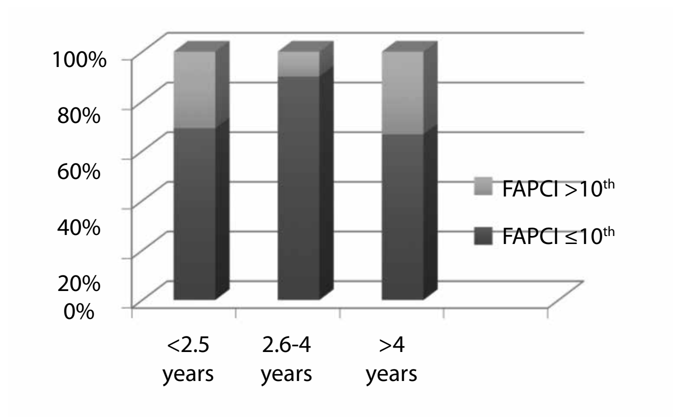

Figure 1. FAPCI scores according to ABI use

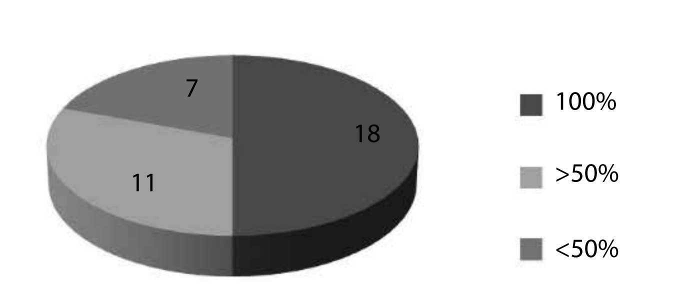

Figure 2. Closed-set pattern perception scores

Their educational settings are varied due to their age and developmental stage. All children integrated individualized education program (IED), eight of them also attended the school of hard of hearing that is based on total communication, and 17 of 36 children had mainstream education.

To evaluate auditory perception, we aimed to determine functional auditory perception skills in the everyday life of children. Functioning after Pediatric Cochlear Implantation (FAPCI) instrument was used for evaluating the real-world verbal communication [3]. It has 23 items and the auditory development curve of normally hearing children. Also, CAP was used as an index that comprises eight performance categories arranged in the order of increasing difficulties [4]. The scores are changing between 0, "displays no awareness of environmental sounds," to 7 "can use the telephone with a familiar speaker." In addition, comprehensive test battery Children's Auditory Perception Skills Test in Turkish (CIAT) was applied that includes the detection of sound subtests, perception of supra-segmental subtests, speech identification subtests, and open-set sentence recognition subtests [5]. The tests were conducted with regard to the chronological age and duration of ABI use.

Language development skills were assessed using the Test of Early Language Development-Third Edition (TELD-3), and the test provides us with receptive and expressive language performances of children [6]. Auditory spoken language development was categorized with MSLDS and focused on charting their progress over time [7]. Also, we evaluated the speech intelligibility of children with speech intelligibility rating (SIR) [8]. It has five performance categories ranging from "pre-recognizable words in spoken language" to "connected speech are intelligible to all listeners."

The basic features of the data of the study were described by SPSS [SPSS Inc., Released 2007; SPSS for Windows, Version 16.0; Chicago, IL, USA]. Because of the limited number of patients and data, only descriptive analyses were presented.

RESULTS

Auditory Perception Outcomes

FAPCI and Duration of ABI Use

Prior to ABI, these children heard limited sounds or no sound; from this view, their everyday auditory functionality scores were compared with the duration of ABI use. They were separated in three groups according to ABI use, and results indicated that in the first 2.5 years and after 4 years, auditory functionality scores improved more than those between 2.5 and 4 years did. However, as expected, their scores were poorer than those of normally hearing children (Figure 1).

CAP Scores

In CAP, there are eight categories for rating children's auditory perception abilities. Eighteen of 36 children's scores were 5; only six of them reached scores of 6 and higher. A score of 5 indicates the ability to discriminate at least two speech sounds; a score of 8 indicates the ability to talk with a familiar speaker on the phone. Only one of them completed the CAP test successfully.

CIAT Outcomes

Thirty-six of the children detected environmental sounds as well as detected and recognized the Ling-6 sounds. All children used their ABI regularly on a daily basis.

Closed-set auditory perception tests were performed in pattern perception subtest and in word identification subtest. Eighteen of 36 children distinguished all words, 11 children distinguished more than half of the words, and seven of them distinguished less than half of the words. Nineteen children had an appropriate developmental stage according to chronological age and auditory perception level. Fourteen of 19 ABI users identified all stimulus words, three of them had scores between 50% and 79%, and the others had scores of 25% (Figure 2).

Open-set Sentence Recognition Outcomes

At the time of assessment, 12 children had improved sentence recognition, and their scores were more than 50%. Also, three of them started to use telephone in basic conversations.

Language and Speech Intelligibility Development Outcomes

Language development was evaluated in two subtests: receptive language development and expressive language development. Al-

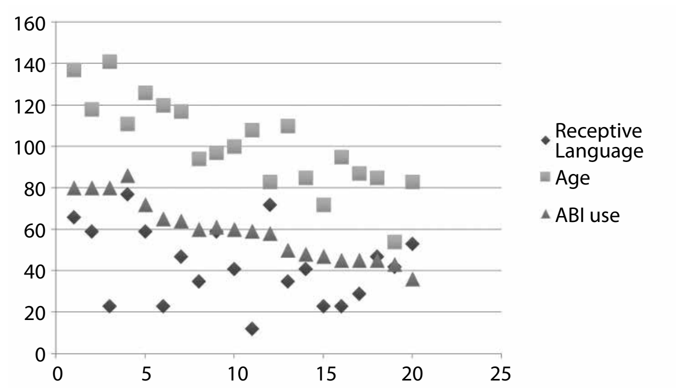

Figure 3. Receptive language development of children

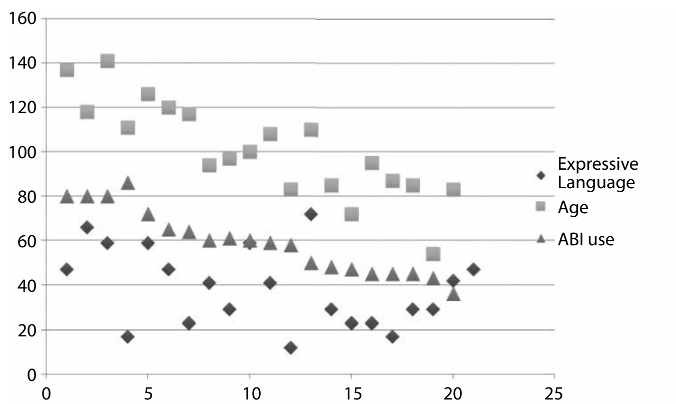

Figure 4. Expressive language development of children

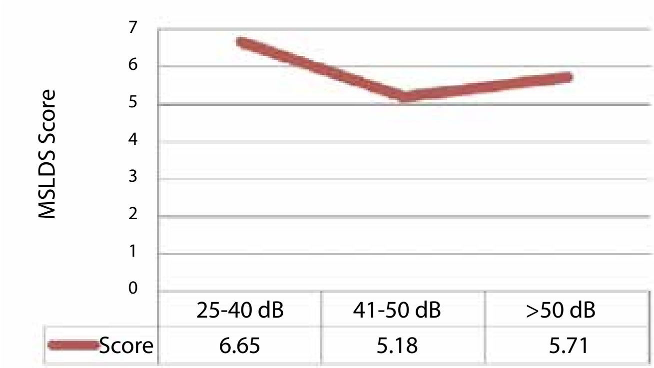

Figure 5. MSLDS Scores of ABI Users according to hearing thresholds

though our clinic has an increasing number of pediatric patients, our sample remained small for advanced statistical comparison. In this study, language scores were reported for comparing receptive language development with the duration of ABI use and chronological age; same data was prepared with regard to expressive language.

Results indicate that duration of ABI is significant than chronological age for both receptive and expressive language development. When a child becomes older, the gap between chronological age and language development scores become wider. Also, although there is no statistical significance, the gap between language scores and duration of ABI use is increasing due to clinical experience (Figures 3 and 4).

Another language development scale was MSLDS. The scale does not provide us age equivalent scores, but it categorized the spoken language development into six levels. In addition, the results of MSLDS were compared with hearing thresholds. In figure 5, it is seen that children whose hearing thresholds were between 25 and 40 dB have better language scores than others.

Finally, speech intelligibility skills were assessed by SIR as well as compared with hearing thresholds. Most of the children performed poorly based on SIR assessment, and their speech intelligibility was not good. On comparing SIR scores with hearing thresholds, better hearing thresholds indicated more clear speech.

DISCUSSION

ABI has been implemented from the early 90s in pediatric patients [2, 9]. First, auditory sensation was achieved in NF2 patients; at present, cochlear malformations and cochlear nerve aplasia are more common indications in the pediatric group [10]. In this study, we also excluded pediatric patients who had severe ossification after meningitis. Only non-tumor patients with cochlear anomalies and cochlear nerve deficiencies were included.

All children used their ABI regularly on a daily basis, and similar to the findings in the literature, they were found to develop awareness toward environmental sounds and speech sounds after 1-month to 3-month intervals [11-14]. Functionality of auditory perception skills was mostly evaluated with MAIS/IT-MAIS in researches; however, in our research, FAPCI was conducted to determine auditory functioning and compared with normally hearing population. The results indicated an obvious delay; however, an interesting finding is that their performance changes with time. Better performance has been seen in 2–4 years of ABI use; however, further follow-up is still needed to conclude the study.

In the CAP scale, most of our patients had a score of 5, and the duration of ABI use is an important variable in this scale. Their CAP scores improved from 2 to 7 after the first year with time, but only few of them could reach scores of 7 and 8. These results are slightly better than those of the other studies [15, 16].

Auditory perception skills in speech sounds, close-set word detection, and word identification assessed with CIAT test battery. All of them detected speech sounds in various frequencies. After 1 year of follow-up, most of them developed word recognition skills in a close-set mode. Their word identification scores changed due to their chronological age, duration of ABI use, and cognitive development. Results of speech recognition skills are also similar to those of other studies [14, 16-19]. Open-set sentence recognition is improved in 12 of the children. These children scored more than 50%, and three children communicated via telephone. Sanna et al. [14] reported a 12-year-old girl with ossified cochlea who had improved open-set sentence recognition with lip-reading. Also, Colletti and Shannon [16] notified the results of 20 ABI users; according to their findings, 65% of the non-tumor patients had improved open-set speech perception skills.

Language development of ABI users in our study improved in correlation with the duration of ABI use. However, young ABI users' language development improves more rapidly, but older children's language development decreases with time. We assumed that in the later years, language development tasks will become harder, and catching up with these tasks would be difficult [20]. Language tests were performed in the auditory-verbal mode; in further studies, their scores could possibly be better with sign language. Because in a study by Eisenbergs et al. they used language test with sign language, and their patients had better scores [19].

On the other hand, speech production and intelligibility were the problematic areas. We need more data and time. In the ABI centers, all have limited number of patients. The articles also provide us with the longitudinal outcomes of the centers. In our study, the only disadvantage of speech improvement is speech intelligibility. Our assumption is that frequency resolution is poorer than cochlear implant, and speech intelligibility is affected. In the future, studies could be focused on speech production and intelligibility of patients.

As a result, early age of implantation and family support are important parameters for pediatric ABI users in rehabilitation process. Intensive intervention and follow-up of both audiological evaluation and rehabilitation are necessary.

Multidisciplinary approach is suggested in pre- and post-implantation evaluation and follow-up. Due to the heterogeneity of this group, evaluation and follow-up should be considered individually. Assessment, follow-up, and rehabilitative expectations should be different from those for CI. Children with special needs show slower progress than other ABI users.

On daily basis, auditory verbal communication is not sufficient, particularly in functional auditory development. Improving assistive methods and starting to teach sign language from the time of diagnosis are crucial. In the post-operative process, use of these methods as an additional assistance would support their self-confidence. Also, ABI users often use lip-reading; therefore, it can be used with auditory stimulation to enhance understanding conversations.

In our study's children, performance was better with regard to a close-set situation, but their vocabulary was weak; they struggled in attention and memory skills. Auditory training programs should have activities that support attention and memory. Additional handicaps are not the only reason for preparing comprehensive training program; all pediatric ABI users need programs that include activities in all developmental areas.

Speech intelligibility is their another weakness. Phonological development must be strengthened to improve their speech sound production.

Further developmental stages involve thinking and predicting words in sentences using clues in the context to maintain conversation; use of language-based visual clues would be a difficult skill to develop. Therefore, rehabilitation programs should be encouraged to improve these skills.

Finally, ABI is an effective approach for the improvement of real-life adaptation and for different types of communication.

Ethics Committee Approval: Ethics committee approval was received for this study from the Hacettepe University Non-interventional Clinical Researches Ethics Board (no: GO 14/516).

Informed Consent: Written informed consent has been obtained from all participants.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - E.Y.; Design - E.Y.; Supervision - L.S.; Materials - E.Y., F.A.; Data Collection and/or Processing - F.A., H.B.Ö.; Analysis and/or Interpretation - H.B.Ö.; Literature Review - F.A., H.B.Ö.; Writing - E.Y., F.A., H.B.Ö.; Critical Review - E.Y., F.A.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Sennaroglu L, Ziyal İ. Auditory brainstem implantation. Auris Nasus Larynx 2012; 39: 439-50. [CrossRef]
2. Colletti V, Fiorino F, Sacchetto L, Miorelli V, Carner M. Hearing habilitation with auditory brainstem implantation in two children with cochlear nerve aplasia. Int J Pediatr Otorhinolaryngol 2001; 60: 99-111. [CrossRef]
3. Clark JH, Aggarwal P, Wang NY, Robinson R, Niparko JK, Lin FR. Measuring communicative performance with the FAPCI instrument: Preliminary results from normal hearing and cochlear implanted children. Int J Pediatr Otorhinolaryngol 2011; 75: 549-53. [CrossRef]
4. Archbold S, Lutman ME, Nikolopoulos T. Categories of auditory performance: inter-user reliability. Brit J Audiol 1998; 32: 7-12. [CrossRef]
5. Yücel E, Sennaroglu G. Çocuklar İçin İşitsel Algı Testi. Advanced Bionics, 2011
6. Topbaş S, Güven OS. Reliability and validity results of the adaptation of TELD-3 for Turkish speaking children: Implications for language impairments. Oral Presentation, 12th Congress of the International Clinical Phonetics and Linguistics Association, Istanbul, Turkey, 2008.
7. Allen C, Nikolopoulos TP, Dyar D, O'Donoghue GM. Reliability of a rating scale for measuring speech intelligibility after pediatric cochlear implantation. Otol Neurotol 2001; 22: 631-3. [CrossRef]
8. Sennaroglu L, Sennaroglu G, Atay G. Auditory brainstem implantation in children. Curr Otorhinolaryngol Rep 2013; 1: 80-91. [CrossRef]
9. Colletti L. Beneficial auditory and cognitive effects of auditory brainstem implantation in children. Acta Oto Laryngol 2007; 127: 943-6. [CrossRef]
10. Atas A, Sennaroglu G, Sevinc S, Yucel E, Sennaroglu L, Ziyal I. Auditory brainstem implant in prelingually deaf children. Skull Base 2009; 19: A278. [CrossRef]
11. Sennaroglu L, Colletti V, Manrique M, Laszig R, Offeciers E, Saeed S, et al. Auditory brainstem implantation in children and non-neurofibromatosis type 2 patients: A consensus statement. Otol Neurotol 2011; 32: 187-91. [CrossRef]
12. Lenarz T, Moshrefi M, Matthies C, Frohne C, Lesinski-Schiedat A, Illg A, et al. Auditory brainstem implant: part I. auditory performance and its evolution over time. Otol Neurotol 2001; 22: 823-33. [CrossRef]
13. Sanna M, Kharis T, Guida M, Falcioni M. Auditory brainstem implant in a child with severely ossified cochlea. Laryngoscope 2006; 116: 1700-3. [CrossRef]
14. Lenarz M, Matthies C, Lesinski-Schiedat A, Frohne C, Rost U, Illg A, et al. Auditory brainstem implant part II: subjective assessment of functional outcome. Otol Neurotol 2002; 23: 694-7. [CrossRef]
15. Colletti V, Shannoon RV. Open set speech perception with auditory brainstem implant? Laryngoscope 2005; 115: 1-5. [CrossRef]
16. Colletti L, Zoccante L. Nonverbal cognitive abilities and auditory performance in children fitted with auditory brainstem implants: Preliminary report. Laryngoscope 2008; 118: 1443-8. [CrossRef]
17. Colletti V, Fiorino F, Carner M, Miorelli V, Guida M, Colletti V. Perceptual outcomes in children with auditory brainstem implants. International Congress Series 2004; 1273: 425-8. [CrossRef]
18. Eisenberg LS, Johnson KC, Martinez AS, DesJardin JL, Stika CJ, Dzubak D, et al. Comprehensive evaluation of a child with an auditory brainstem implant. Otol Neurotol 2008; 29: 251-7. [CrossRef]
19. Otto SR, Brackmann DE, Hitselberger W. Auditory brainstem implantation in 12 to 18 year-olds. Arch Otolaryngol Head Neck Surg 2004; 130: 656-9. [CrossRef]
20. Merkus P, Di Lella F, Di Trapani G, Pasanisi E, Beltrame MA, Zanetti D, et al. Indications and contraindications of auditory brainstem implants: systematic review and illustrative cases. Eur Arch Otorhinolaryngol 2014; 271: 3-13. [CrossRef]