

# Prelingually deafened children's performance with cochlear implant

Masako Notoya Makoto Ito\* Mitsuru Furukawa\*

## ABSTRACT

Cochlear implantations have been shown to improve speech perception and production skills in Western children. However, there is a little data on perception and language development children with implantations in Japan. We report two Japanese pre-lingual children who received the nucleus 22-channel implant. They were trained by Kanazawa Method. Results indicate an overall improvement in the perception of speech sounds. Their vowel discrimination score reached 100% in 6-8 months, the consonants discrimination score was 50-70% using hearing alone by 60 months. We suggest that the use of early sign and written language instruction combined with oral communication has little effect on the rate of post-operative progress.

## KEY WORDS

cochlear implant, children, speech perception, Follow-up study

### Introduction

Cochlear implants have been used with profoundly hearing-impaired children since 1980 in Australia and have gained widespread acceptance for use with this population<sup>1)</sup>. In a recent study, the speech perception and production performance of congenitally and prelingually deafened children who received the cochlear implants was investigated and showed significant improvement. Staller et al<sup>2)</sup> studied duration of deafness and found that it was a significantly predictive factor of postoperative performance of children. However, there are a few published reports in Japan on the performance of children with cochlear implants because the devices have been available for relatively short period of time for the pediatric population. In this paper, we report two children who were implanted with the nucleus 22 channel prosthesis. The purpose of this study was to investigate the clinical course of deaf children and the effect of sign and written language on the speech perception abilities and oral lan-

guage development of children who use cochlear implant.

### Subjects

Two children received the nucleus multi-channel cochlear implant who had operation in Kanazawa university hospital. Case 1 is a congenital hearing loss, that was identified at 12 months of age. With a conventional powerful hearing aid, she demonstrated a response at about 70dB HL to 500 Hz-2kHz warble tones in the sound field (fig. 1). She could discriminate words from a closed set by hearing alone using the hearing aid. Her vowel discrimination was 10% and consonant discrimination was poor preoperatively. She used the Nucleus 22 in the common ground stimulation modes with 20 electrodes in the map that was implanted when she was 6 years 9 months of age. Case 2 was pre-lingually deafened due to meningitis when she was 1 year 2 months old. The preoperative pure-tone threshold levels are in Fig. 1. For 2

Dept. of Occupational Therapy, School of Health Science, Faculty of Medicine, Kanazawa Univ. Kodatsuno 5-11-80, Kanazawa City, Ishikawa, 920-0942 Japan

\* Takaramachi 13-1, Kanazawa City, Ishikawa, 920-0934, Japan

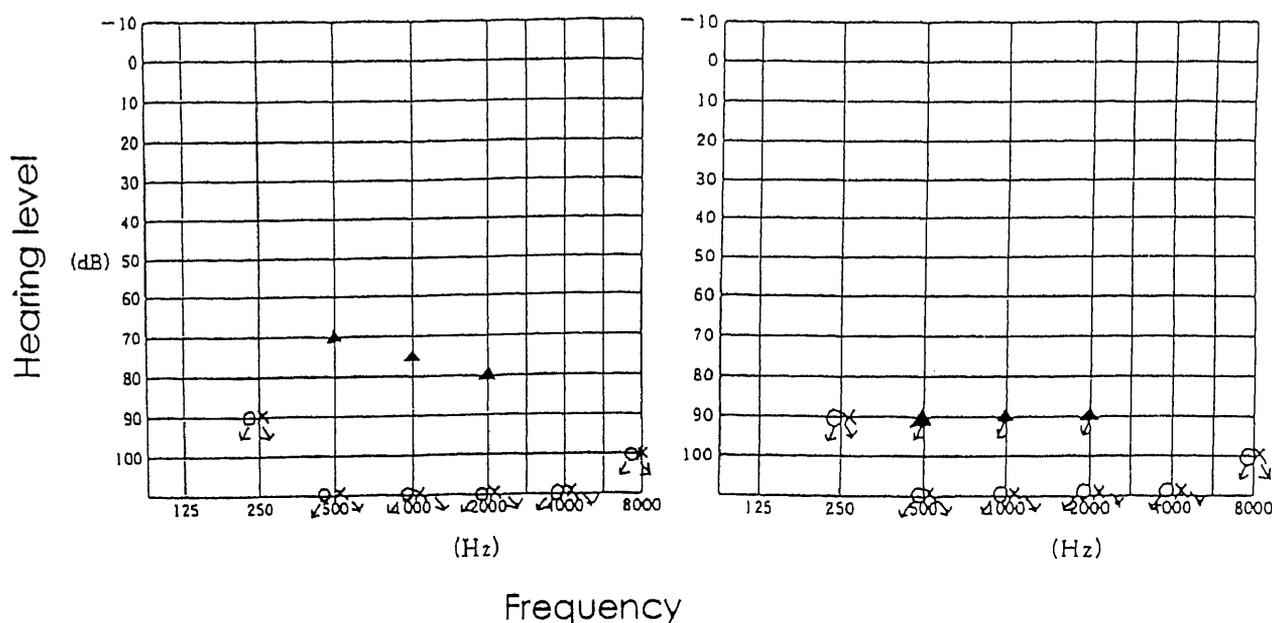


Fig. 1. Preoperative threshold and hearing aided threshold for subjects  
 Left is case 1 ; right is case 2  
 ○ ×, scale out

years she used hearing aids and received training in our clinic, but the preoperative aided threshold was not received. She received the Nucleus 22 multi-channel cochlear implant at the age of 3 years 5 months. She had a full insertion of the electrode array of the nucleus device. They have used the SPEAK coding strategy.

Prior to implantation, both children used sign and oral language together. Our clinical approach to teaching children with hearing impairment at an early phase is Kanazawa method (Suzuki, et al.<sup>3)</sup>; Notoya, et al.<sup>4)</sup> which consists of reception and production training through sign communication as well as auditory, lip reading, and written-language training. The children were given language training in our clinic; they were also trained at home by their mothers. Also the techniques for developing written, sign, and listening skills were demonstrated by us to the children's mothers at our clinic every two weeks. In addition to these individual training sessions, we had a two-hour group session with both children and their mothers once every two weeks in order to monitor the progress of home training and to provide auditory training. Prior to implantation, their communication mode was sign and oral language. Particularly case 2 was very good at sign language.

## Clinical course

### Auditory perception ability

#### (1) vowel discrimination test

The vowel discrimination test requires identification of the five Japanese vowels (/a/, /i/, /u/, /e/, /o/). Fig. 2 presents long-term follow up data on our cases. At the first post-implant interval (i.e., 3 months) their scores were close to zero, but a dramatic improvement in scores occurred at 6 months in case 1, and 12 months in case 2. Their vowel discrimination scores in both cases reached 100%.

#### (2) consonants discrimination test

The consonant discrimination test is more difficult than the vowel discrimination test because this test requires discrimination of 14 written words (/apa/, /aba/, /ata/, /ada/, /asa/, /aza/, /aka/, /aga/, /aya/, /awa/, /ara/, /ama/, /ana/, /aha/). Subjects were tested on consonant discrimination by auditory alone. They demonstrated a gradual improvement over time in this test. After 60 months postoperatively, consonants discrimination in case 1 reached 52%, case 2 reached 68% after 60 months (Fig. 3)

#### (3) closed-set word identification

This test consists of 50 picture cards. Children

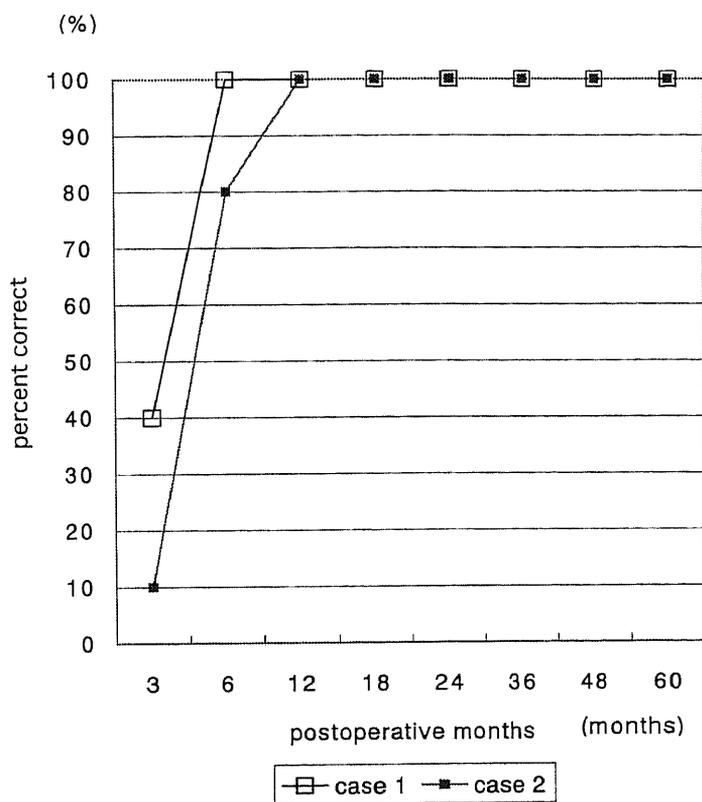


Fig. 2. Mean scores for subjects with cochlear implant on test assessing vowel discrimination using closed-set with acoustic only condition.

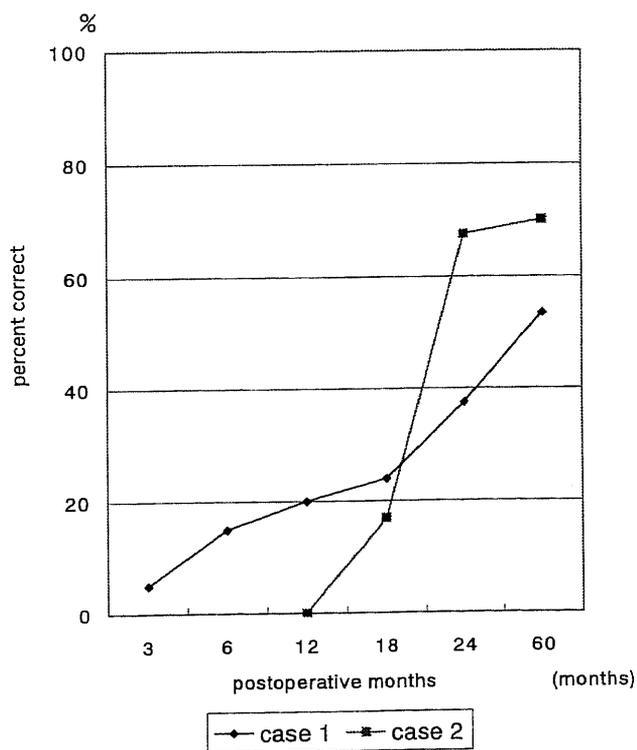


Fig. 3. Mean scores for subjects with cochlear implant on test assessing consonants discrimination using closed-set with acoustic only condition.

Table 1. Closed-set word Identification scores in two cases

|        | Age            | hearing alone | hearing + lip reading |
|--------|----------------|---------------|-----------------------|
| case 1 | 9years 4months | 65%           | 96%                   |
| case 2 | 5years4months  | 100%          | 100%                  |

%,correct responses

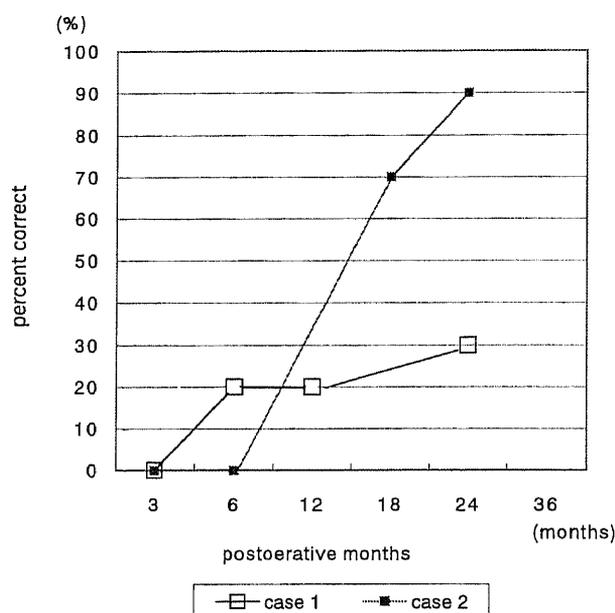


Fig. 4. Mean scores for subjects with cochlear implant on test assessing recognition of words using closed-set with acoustic only condition.

identify one from five alternative picture cards in hearing alone or by hearing plus lip reading. When case 1 was 9 years 4 months, at the 29 months post-implant, her score was 65 % by hearing alone and 96% by hearing plus lip-reading. When case 2 was 5 years 4 months, at the 23 months post-implant , both scores had reached 100% (Table 1).

#### (4) open-set word recognition

We select 20 words that typically would be within the vocabulary of most young children. For open-set speech recognition tasks, using an auditory-only format. Pre-operatively, their scores were zero on open-set recognition. Post-operative results at the 12,18,24 months test intervals is shown in Fig.4. Their

performance reached 30% in case 1, 90% in case 2. They use oral language as their primary mode of communication and at the regular schools. Case 2 can understand daily conversation by auditory alone.

#### Discussion

The purpose of this study was to investigate the perception abilities of two Japanese deaf children with cochlear implants and the effects of early sign and written-communication instruction on the speech development of pre-lingually deafened children using cochlear implants. Results reveal a continuous improvement of auditory perception skills in two children who have had implants for 60 months. The data clearly indicate that Japanese congenitally and pre-

linguistic deaf children do obtain a significant benefit from cochlear implantation. Moreover, they use sign, oral and written language modes. These results are in agreement with previously published reports<sup>5,1</sup>. Walzman et al<sup>6,1</sup> revealed that the good performance in congenitally and pre-linguistic deaf children does not appear to plateau within a 2-year period. Accordingly, our cases should continue to acquire language and increase their oral vocabularies.

Results have revealed a continuous improvement of auditory perceptual skills in children with implants for 2 years or more. In about 2 years, our case 2 began to use oral language without sign language and lip reading as her primary mode of communication, and attends regular school. Since her perceptual and linguistic abilities are highly developed by 6 age in normally hearing children, we hypothesized that the deaf child, if given greater access to auditory input earlier, by receiving a cochlear implant before the age 4 years, could achieve a higher level of performance, and obtain increased benefit sooner.

The data by Walzman et al clearly indicate that congenitally and pre-linguistic non-congenitally deaf children do obtain significant benefit from cochlear implantation. In addition, preliminary review of the data appears to suggest that the primary preoperative mode of communication has an effect on the rate of progress postoperatively, i.e., children who used sign language progress at a slower post-implantation pace. Data reported by Miyamoto et al<sup>7,1</sup> reveal prelingually deafened children with implants who used oral communication obtained significantly higher scores on only 2 of the 13 speech perception measures compared to children who used total communication. This suggests that communication mode does not account for large differences in speech perception performance among pre-lingually deafened children with multi-channel cochlear implants.

When our cases' linguistic ability was evaluated at 30-36 months after implantation, oral-communication ability in case 2 was almost equivalent to that of hearing peers, while comprehension of written language communication was greater. This suggests that

early presentation of sign and written language may not adversely influence oral-language development.

Factors that may influence the rate of postoperative progress also need to be studied. Base on the results of this investigation, the authors concluded that implantation for young deaf children is beneficial to the development of auditory perceptual skills, even when they have used sign language before.

### **Conclusion**

We report two children with congenitally and acquired deafness who received a nucleus 22 channel implant at 6 years 9 months and 3 years 5 months. Though they used predominantly signing, lip reading, and written language before the operation, their auditory perception and production has made good progress. Articulation and speech intonation also improved. Moreover the prelingually deaf case 2 has better speech recognition. We suggest that the use of early sign and written language instruction combined with oral communication have little effect on the rate of post-operative progress.

### **References**

- 1) Iwao Honjyo : Cochlear Implant (Japanese), 1-4, Nakayama Bookstore, Tokyo, 1994.
- 2) Staller, S.J., Beiter, a.L., and Brimacombe, J.A. : Pediatric performance with the nucleus 22-channel cochlear implant system. *Am. J. Otol.*, 12 : 126-136, 1991.
- 3) Suzuki, S., Notoya, M. : Teaching written language to deaf infants and preschoolers. *Topic in Early Childhood Special Education*. 3 : 10-16, 1984.
- 4) Notoya M., Suzuki S., and Furukawa, M. : Effects of early manual instruction on the oral-language development of two deaf children. *Am. Ann. Deaf*, 139 : 348-351, 1993.
- 5) Gantz, B.J., Tyler, R.S., Woodworth, G.G. : Results of multichannel cochlear implants in congenital and acquired prelingual deafness in children : five-year follow-up. *Am. J. Otol.* 15 : 1-7, 1994 (suppl 12).
- 6) Walzman, S.B., Cohen, N. L., Shapiro, W.H. : Use of multi-channel cochlear implant in the congenitally and prelingually deaf population. *Laryngoscope*, 102 : 395-399, 1992.
- 7) Miyamoto, R.T., Osberger, m.j., Robbins, A.M. : Prelingually deafened children's performance with the nucleus multi-channel cochlear implant. *Am. J. Otol.*, 14 : 437-445, 1993.

## 言語習得前高度聴覚障害幼児例の人工内耳装用経過

能登谷晶子, 伊藤 真人, 古川 俣

### 要 旨

先天聾と後天聾の各1例に6歳9カ月時と、3歳5カ月時にヌクレウス22人工内耳埋込み術を行い、その経過を報告した。術前2症例は手話や読話、文字言語を主として使用していたが、術後の聴覚受信や発話は良好であった。構音や発話のイントネーションも改善した。後天聾例において、より音声受信が良好であった。音声言語に加えて、手話や文字言語を併用した言語訓練を受けていても、人工内耳後の音声受信の経過には影響を及ぼさないのではないかと示唆された。