Delayed prelingual cochlear implantation in childhood and puberty

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ABSTRACT

Objective: To evaluate the results of delayed cochlear impantion performed in childhood and puberty in the light of speech language pathology assessments.

Methods: Totally 49 children with prelingual profound hearing loss were included in the study. All children received a cochlear implant between the ages of 5 and 19 years (Group 1 aged between 5 and 9 years, group 2 aged between 10 and 14 years, group 3 aged between and 15 and 19 years). The MAIS, MUSS and PLS-4 scores of children were evaluated one month before, and one year and two years after the operation.

The descriptive statistics included several independent variables; age of implantation; gender; trade name of the implant; preoperative duration of hearing aid use; preoperative special education, family support and additional handicap. These variables were categorical variables. We used repeated measures analysis of variance to test improvements in MAIS, MUSS and PLS scores, and whether this improvement depend on the independent variables. In addition, we also tested the interaction between time and the independent variables.

Results: The preoperative MAIS, MUSS and language scores were significantly higher in older children compared to younger children ($p < 0.01$). After two years these scores were similar between the all age groups ($p > 0.4$). There was a significant age and time interaction ($p = 0.005$). That is, improvement continued in all age groups in a parallel way and group 2 reached to the level of group 1 after two years. However, group 3 almost reached to a plateau level after two years. The family support was associated with the MAIS, MUSS and language scores of the patients ($p = 0.01$), and there was a family support-time interaction ($p < 0.0001$). In group 1 and 2, the way of communication shifted from total communication (lip reading, sign language, auditory) to auditory-verbal communication in a significant number of the patients ($p < 0.01$). However, that change in the way of communication was not statistically significant in group 3 ($p > 0.05$).

Conclusion: The decision of delayed cochlear implantation in children can be made in the light of following parameters. A good family support is most important. The patients must be wearing hearing aids regularly since early childhood, and preferably use the auditory verbal communication. Evaluation of the patient with MAIS, MUSS and PLS is important to understand the level of receptive and expressive communication level.

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1. Introduction

Many individual and environmental factors influence the outcome of cochlear implantation. Good residual hearing is considered to be an important factor for implantation results in patients with postlingual deafness [1–3]. However, age at implantation and duration of deafness has the most significant impact on the postimplant outcome measures.

No definite evidence currently exists concerning the true benefit of cochlear implantation in adolescents or adults with prelingual deafness. Prelingually deaf adults will hardly achieve open-set speech recognition after cochlear implantation [4,5]. However, prelingually deaf patients implanted after puberty may have limited benefits and some achieve open-set speech recognition [6–10]. Some open set word recognition can be achieved if implantation is performed after 5 years of age [11,12]. The improvement in speech perception abilities after cochlear

implantation is related to sensitive period or central nervous system plasticity [13–16].

Hearing-impaired patients participate actively in society using auditory verbal communication with the help of hearing aids. Thus, educational environments and communication modes should be considered as critical factors for planning cochlear implantation [3]. The speech language pathology generally uses MAIS (Meaningful Auditory Integration Scale), MUSS (Meaningful Use of Speech Scale) and PLS-4 (Preschool language scale) tests to assess the patients, and in turn determine about their candidacy for implantation. The MAIS and MUSS tests allow the examiner to evaluate a child's skills in meaningful, real-world situation. The MAIS gathers auditory behavioral information, whereas the MUSS investigates speech production behaviors on the basis of parent report and clinical observation. PLS-4 is a standardized test of auditory comprehension and expressive communication for infants and toddlers. The auditory comprehension subscale assesses basic vocabulary, concepts and grammatical markers in preschool and higher-level abilities such as complex sentences, making comparisons and inferences, etc. in older children. This test also includes an articulation screener and a language sample checklist. In this study we aimed to evaluate the results of delayed cochlear impantion performed in childhood and puberty in the light of speech language pathology assessments.

2. Methods

Totally 49 children with congenital prelingual profound hearing loss were included in the study. All patients had an experience of hearing aid use prior to unilateral cochlear implantation, and received auditory verbal therapy. All children received a cochlear implant (CI) between the ages of 5 and 19 years. Cochlear, Advanced Bionics and Medel CIs were used in 28, 5 and 26 patients, respectively. None of them had inner ear malformation, and full insertion of the CI was performed. The patients were divided into three groups depending on their implantation age. Group 1 children were implanted between 5 and 9 years of age, and group 2 and 3 children were implanted between 10 and 14 and 15 to 19 years of age, respectively. There were 36, 9 and 4 children in group 1, 2 and 3, respectively. MAIS, MUSS and PLS-4 (language) scores of children were evaluated one month before, and one year and two years after the operation. The patients in group 3 were also evaluated using speech tests.

2.1. Statistical analyses

We used SAS version 9.1 to analyze the data. The descriptive statistics included several independent variables; age of implantation; gender; trade name of the implant; preoperative duration of hearing aid use; preoperative special education, family support and additional handicap (attention deficit or hyperactivity disorders). Family support was made as described by Moeller. Scorere assigned as follows: 1 = limited participation; 2 = below average participation; 3 = average participation; 4 = good participation; and 5 = ideal participation [17]. These variables were categorical variables. The outcome variables in the study were: MAIS, MUSS and PLS4 language scores before and after implantation. We used repeated measures analysis of variance (ANOVA) to test the following hypotheses (within-subject main effect):

1) Did MAIS scores measure after the implant improved, compared to MAIS scores before the implant?/Or does the implant improve the patient's MAIS scores?
2) Did MUSS scores measure after the implant improved, compared to MUSS scores before the implant?/Or does the implant improve the patient's MUSS scores?
3) Did the language scores measured after the implant improved, compared before the implant?/Or does the implant improve the patients' language.

Table 1
Univariate repeated measures means of MAIS, MUSS and Language by socio-demographics of patients with implant.

Socio-demographics	MAIS			MUSS			Language	
	Preop Mean	Postop 1st yr Mean	Postop 2nd yr Mean	Preop Mean	Postop 1st yr Mean	Postop 2nd yr Mean	Preop Mean	Postop 2nd yr Mean
Age groups								
5–9 years	9.5	28.8	35.5	8.4	18.8	26.8	21.0	38.3
10–14 years	13.4	31.4	37.2	12.2	21.9	29.6	25.8	44.1
15–19 years	16.0	26.8	30.3	23.0	27.8	30.8	41.5	46.0
Gender								
Males	9.8	30.2	36.9	10.6	20.1	28.1	25.3	42.5
Females	11.3	28.5	34.5	10.2	20.1	27.4	22.5	38.5
Family support								
<5	11.1	27.9	34.3	10.1	18.5	25.0	23.5	35.2
≥5	9.9	32.1	38.0	10.8	23.9	34.1	23.6	51.9
Preop hearina aid use (years)								
1–4	8.8	28.6	35.3	7.1	17.4	25.5	20.1	36.0
5–8	12.0	29.7	36.7	12.6	23.2	30.9	23.7	46.0
9–12	13.8	29.9	34.9	13.5	22.3	29.4	26.5	42.8
12+	17.3	30.3	33.0	24.3	29.0	31.3	46.7	50.3
Preop education								
Preschool	10.2	31.0	34.6	6.8	17.2	26.4	18.8	39.6
Elementry	9.3	27.9	35.4	7.9	18.0	25.6	21.4	36.1
Middle	11.9	32.1	38.1	12.6	23.4	31.6	20.7	45.1
High	13.9	29.0	33.7	15.2	23.3	29.8	31.2	44.9
Post-Secondary	18.0	32.0	35.0	32.0	37.0	40.0	56.0	68.0
Trade Name								
Nucleus	11.3	29.1	35.7	12.6	22.1	28.3	27.5	45.8
Clarion	8.0	28.0	35.4	6.6	16.0	24.0	14.4	35.8
Medel	10.9	29.3	35.2	9.4	19.5	27.8	22.5	36.8
Additional handicap								
Absent	12.4	31.8	36.6	12.3	22.5	30.1	26.2	45.8
Present	8.0	24.4	33.2	6.8	15.9	23.3	18.9	29.9
Overall Means	10.8	29.1	35.4	10.3	20.1	27.6	23.5	40.0