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ORIGINAL ARTICLE

Relationship between Age of Cochlear Implantation with Written Language Skills in Children

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Objective: In this study, written language skills of deaf children as a function of age at implantation was examined and results were compared to normal hearing peers.

Subjects and Methods: Thirty five children fitted with cochlear implants, aged between 6 and 11 years, were evaluated in terms of their written language abilities and were compared with results those of 35 age- matched normal hearing children.

The children with cochlear implants were analyzed in two groups according to their age at implantation; under 4 years and at/over 4 years old. A Written Expression Skills Assessment Form was used to evaluate the written language skills of the two group of implanted children with those of normal hearing peers. Five different feautures of written expression points were scored and analysed, yielding composite score for written expression skills.

Results: The results revealed significantly different language skill composite scores of children who underwent cochlear implantation before and after the age of four. The children who were implanted before the age of four years had significantly higher scores compared to children implanted after four years of age. Moreover, scores obtained from group of children implanted before four years were similar to scores by the normal hearing group. The most difficult skill for the implanted group before the age of four years was in assisting keytone. Expression formation and productiveness was most difficult for children implanted after the age of four years. The findings indicate that children implanted at a relatively late age (i.e. after the age of four years) entered primary school later than their peers implanted at a younger age demonstrated lower academic skills, and have continued in special education.

Conclusion: These findings highlighted the importance of cochlear implantation during the critical period of language development. It is known that written language competency facilitates academic achivement and career choice. Written language skills should be assessed at regular test intervals, and training programs should promote development of written language skills.

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Introduction

Early identification of hearing loss and appropriate intervention and fitting hearing aids and/or cochlear implants, have been shown to advance language development in children with hearing loss [1,2]. Despite this remarkable finding, development of communication skills may vary widely in this population, with written communications skill being one of the most difficult ability [3].

During the act of writing, children use formal and syntax form of language for representing their own thoughts. For children with hearing loss, who may not have have acquired fluent speech and language, written language skill is considered to be one of the the most difficult communication skills, compared to the children with normal hearing [3].

In evaluation of written language skill of children with hearing loss, narrative samples have typically been

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collected using simple or sequential event cards. When using narrative assesment, word vocabulary, phrase form, orthographic rules, content of writing, and organization of thoughts become important element in the analysis [4,5,6,7,8].

Children have been shown to use three basic strategies in their written samples when responding to simple picture. The first strategy is to describe the exact Picture using simple expression of thought. The second strategy is to incorporate personel experiences that are evoked by the picture. The third strategy requires the child to personalize the picture in crafting their written narrative [9]. Yoshinaga-Itanao [9] describes as "good narratives" if the narrative is in third strategy and depending on self studies, she emphasizes that children with hearing loss can develope a narrative in third strategy.

Results from a number of studies show that children with hearing loss use simple and short sentences with limited vocabulary and repetition of a word and a sentence [4,8,10,11]. Concerning knowledge of ortographic rules, children with hearing loss acquire these rules at slow rate and generally they produce errors in punctuations, capitalization and use of adjuncts [10,11,12]. Children with hearing loss are deficient in writing an introduction, body and conclusion paragraphs or in logical sequencies of events [4,7,12].

Written expression skills in children with hearing loss is a highly complex skill, and to our knowledge there have been limited studies on written language skills of pediatric cochlear implant users.

Tomblin et al.[8] reported, a strong relationship between the language and literacy for pediatric cochlear implant users. Robbins and Bollard emphasized the important role that early implantation plays an important role in the development of language and vocabulary [13]. Niparko et al. reported that younger age at implantation was associated with significantly steeper rate increases in comprehension and in expression [14]. According to Pisoni et al., children implanted at an early age if enrolled in auditory rehabilitation program may demonstrate higher language outcomes when compared to children with severe hearing loss using hearing aids [15]. Results from other clinical studies have shown that cochlear implantation between ages 1 to 4 years, facilitates language development [16,17].

The purpose of this study is to explore the relationship between written language abilities and the age of cochlear implantation to better understand whether early implantation promotes expressive written language skills at later age in pediatric cochlear implant users.

Materials and Methods

Approval was obtained by the Ethic Committee and informed consents were signed by the children and their parents. The experimental group included 18 girls and 17 boys who were fitted with cochlear implants. The control group consisted of 18 girls and 18 boys with normal hearing. The children with implants were divided into two groups according to their age atimplantation (i.e. younger or older than 4 years of age).

The common inclusion criteria for both groups were as follows:

- Educational placement in grades 4, 5, 6, 7, or 8.
- Cognitive abilities within normal limits with no learning deficits, as determined by reading and writing skills assessed by their schools.
- Did not have any psychological problems.
- Parents and children are willing to participate.

In addition the children with cochlear implants,

- Were unilateral cochlear implant users.
- Did not have any additional disability.
- Were not deafened by meningitis.
- Must have been using a cochlear implant regularly

for at least one year.

- The child has been enrolled in Auditory Verbal Therapy for a minimum of one year.

Study Group

Children with cochlear implants were selected at random from the students enrolled in the Auditory-Verbal Therapy and Family Counseling Program at Hacettepe University in the Educational Audiology Unit. They were placed in the following two groups based on age at implantation:

Group I: 17 children who underwent cochlear implantation before the age of four years.,

Group II: 18 children who underwent cochlear implantation after the age of four years.

Control Group

The control group included 35 children with normal hearing representing a wide range in terms of socio-economic status. The children were attending various schools in Ankara.

The demographic information defining the two samples is shown in Table 1.

The audiological information of cochlear implant groups (Group I and Group II) is shown in Table 2.

Assessment Measures

A Written Expression Skills Assessment Form was used to evaluate the written language skills of the participants. Written Expression Assesment Form is formed from four section including title, expression organisation, expression productiveness and ortographic rules. Each section was graded with its including attitudes. Written Expression Assesment Form totals 100 points: 3 for title, 51 for expression organisation, 24 for expression content and 22 for orthographic rules [4].

Practice preceded testing, presenting to the child a picture of traffic. The Picture not include a written tip have a main event with other seconder events. After practice, a piece of paper with no lines was given to the child who was asked to perform a provide written narrative about a scenerio that was discussed. No feedback was provided and there was no time limit. Written narritives required 15 to 30 minutes minute to complete to the task. The written narratives were analzed and interpreted according to the following scores.

0-20 points	Exigious Writing
21-40 points	Inconsiderable Writing
41-60 points	Partially Writing
61-80 points	Well Writing
81-100 points	Excellent Writing

Data analysis

Data were analysed using Statical Package for Social Sciences (SPSS 15.0).

Table 1. The Demographic Information of Study and Control Groups

	Gender		Preschoole education		Initiation age of primary school		Continuing of Special Education		Class of attending				
	Girl	Boy	Yes	No	On time	One year later	Continuing	Not continuing	4th grade	5th grade	6th grade	7th grade	8th grade
Group I	10	7	17	0	16	1	6	11	4	4	3	3	3
	58.8 %	41.2%	100%		5.8%	94.2%	35.3%	65.7%	23.5%	23.5%	17.6%	17.6%	17.6%
Group II	8	10	16	2	6	12	10	8	3	4	3	5	3
	44.4%	55.6%	88.9%	11.2%	33.3%	66.7%	55.6%	44.4%	16.7%	22.2%	16.7%	27.8%	16.7%
CG	19	16	27	8	35	0			7	8	6	8	6
	54.3	45.7%	77.1%	22.9%	100%				20.0%	22.9%	17.1%	22.9%	17.1%

P<0.05

Table 2. The Audiologic Parameters in Months for the Cochlear Implantation Groups I and II

	Groups	Mean	SS	Min	Max
Age at time of cochlear implantation	Group I	35.0000	11.89538	13.000	48.000
	Group II	89.2778	19.97294	60.000	120.000
Duration of cochlear implantation usage	Group I	101.5294	14.07177	78.000	129.000
	Group II	62.2778	24.95597	16.000	108.000
Duration of hearing aid use	Group I	17.6000	8.13985	4.00	30.00
	Group II	60.6667	23.15167	24.00	98.00
Age at identification of Hearing loss	Group I	8.9412	4.27888	2.00	18.00
	Group II	17.8333	12.17640	2.00	48.00
Diagnosing the Hearing Loss	Group I	11.7059	5.44018	4.00	24.00
	Group II	20.2778	12.02842	6.00	48.00
Age at hearing aid fitting	Group I	13.4118	4.47296	8.00	24.00
	Group II	24.8889	13.19487	9.00	48.00

For ordinal data, descriptive statistics were conducted for calculating means, standard deviations, minimum and maximum values. For nonparametric variables, number and percent values were examined.

Kolmogorof-Smirnov test was used to check the distribution of numeric values and Fisher's exact chi-square test was used in qualitative data for group comparison. For both of these tests, statistical significance level was set to $p<0.05$.

Results

Results indicated that there was no significant difference in gender (p:0.637), in preschool education (p:0.081) and in grade parameters (p:1.000).

Between the three groups, significant statistical difference were found in initiation age to primary school (p:0.001) and in special education (p:0.001).

Group I implanted before the age of four and Group II implanted after the age of four were compared in terms of audiological information. They differed significantly as a function of age at cochlear implantation (p:0.001), the duration of cochlear implantation use (p: 0.001), the duration of hearing aid usage (p:0.001), age when hearing loss was suspected (p:0.018) and when the hearing loss was diagnosed (p:0011).

Results on the written expression test for the variable age at cochlear implantation.

As statistically significant effect was found for age at implantation for three groups (Group I, Group II and Control Group) based on the total points score of the the written expression test ($p<0.005$). (Table 3) Tukey Post Hoc Testing was conducted to test simple effects between groups and significant statistical difference were found in total point ($p<0.005$) (Table 4).

According to the total points, it was found in Group I, 3 children had partial writing skills, 9 children had good skills, and 5 children had excellent skills, For Group II 18 children had exigious, 8 children had inconsiderable skills and 9 children had partially skils. In the Control Group, 1 person had partial writing skills, 11 children had good skills and 23 children had excellent skills (Figure 1).

The Results of sub features of Written Expression

Significant statistical difference was confirmed in the sub-features of written expression skills including expression organisation, expression productiveness and ortographic rules between three groups. There was no significant difference in the title feature.

Kruskal Wallis multiple comparisons indicated significant differences between Group I and II, Group II and CG. However, there was no significant difference between Group II and CG (Table 5).

In three sub-features of written expression, Group I's mean point was significantly higher than Group II's mean point and similar to CG's mean point (Table 6).

Discussion

In this study, we evaluated the written expression skills of two groups of children implanted either before or after 4 years of age and compared their results to control group of normal hearing. The majority of children (52,9%) implanted before the age of 4 years achieved scores between 61-80. In contrast the

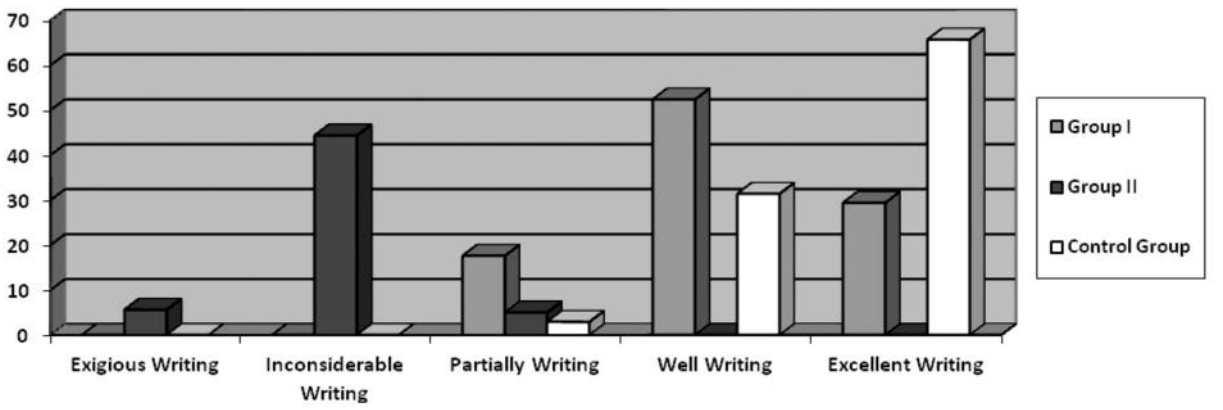

Figure 1. Results of Written Scores for Three Groups

Table 3. Mean, Standard deviation, minimum and maximum values of total points of three groups

Total points (100p) N=70		$\bar{X}$	SS	Min(p)	Max(p)	E(269)	P
Group I	(n=17)	73.59	14.731	50	99		
Group II	(n=18)	37.22	11.332	17	56		
CG	(n=35)	83.11	9.612	77	99	97.137	0.001*

Table 4. Tukey post hoc results for the three groups

TOTAL POINTS (100p)	GROUPS	Grup I	Grup II	KG
	Grup I		0.001*	0.018*
	Grup II	0.001*		0.001*
	KG	0.018*	0.001*	

Table 5. Comparision Through Groups with Kruskal Wallis

	GROUPS	Group I	Group II	CG
Expression Organisation	Group I		0.000265*	0.170051
	Group II	0.000265*		0.000001*
	CG	0.170051	0.000001*	
Expression Productiveness	Group I		0.000134*	0.297433
	Group II	0.000134*		0.000001*
	CG	0.297433	0.000001*	
Ortographic Rules	Group I		0.003606*	0.284363
	Group II	0,003606*		0,000001*
	CG	0,284363	0,000001*	

Table 6. The points of minimum, maximum, mean and standard deviation of written expression features

	Groups (N=70)		$\bar{X}$	S D	Min (p)	Max (p)
Expression Organisation (51 p)	Group I	(n=17)	33.53	9.540	20	51
	Group II	(n=18)	14.06	5.263	5	21
	CG	(n=35)	40.03	7.242	25	51
Expression Productiviness (24 p)	Group I	(n=17)	19.71	3.368	14	24
	Group II	(n=18)	9.61	3.090	3	15
	KG	(n=35)	21.74	1.686	16	24
Ortographic Rules (22 p)	Group I	(n=17)	16,94	3,418	9	22
	Group II	(n=18)	11,39	3,346	4	19
	KG	(n=35)	18,46	2,904	8	22

majority of children (44,4%) implanted after the age of 4 years obtained scores between 21-40. Most of the children in the control group (65.7%) scored between 81-100. These findings indicated that the majority of children implanted before age 4 years demonstrated more advanced written skills than most of the children implanted after the age 4 years but lower than the performance to children with normal hearing.

Composing a story and writing a narrative are typically initiated in the fourth grade of primary school. Previous studies have demonstated that children with hearing loss achieved the skills similar to those of normal hearing children but the rate of mastery can be much slower [4]. In our study, children with cochlear implants were able to write a story and use narrative by the beginning of the fourth grade of primary school.

When examing the findings specific to expression organisation including writing introduction, body and conclusion paragraphs, significant difference was detected between early and later implanted groups. Although significant differences were not found between the early implanted group and the normal hearing group, the highest scores obtained from the control group was in expresion organisation. Thus, although the later implanted group could initiate writing a story, they had difficulty with body and conclusion paragraphs. In previous studies it seemed insufficiencies in expression of keynote, defining the keynote with samples, detailing the events and defining with logically [12, 18]. In our study, paralel findings were reported in the later implanted group.

When examining expression productiveness scores they were significantly lower for the later implanted group compared to scores for the earlier implanted group. The later implanted group were deficient in their writing skills in terms of word order, word meaning, and synonoms. This finding is an agreement with other studies showing that children with hearing loss are deficient in word vocabulary knowledge, repetition of a word and in forming complete sentences [11,19].

It is known that children with hearing loss can improve the rules about writing ortography slower than the normal hearing children [10,12]. In orthography functions, statistical difference was shown in adjustment of paper usage and punction marks while there was no meaningful difference in readable of narrative and in capitalization.

In this study, the basic factors affected to the written expression skill of the child was age cochlear implantiation. But previous studuies showed that, many factors can effect the skill of written expression except cochlear implantiation age. In our study, it was thought that various factors can effect the writte expression skills and depending on this reason, the relationship of other factors were examined.

It is known that there is a relation between the written expression skill and class level. The study colared from Maxwell and friends, it was found written expression sufficiency increases according to class level [20]. This state can be exposed with improving of literary skills depeding on increased age and also with information and expectation supplied from education programmes. In our study, improvement of written expression skills was expected according to the increasing class level, but findings confirmed no sgnificant difference between the class level and written expression skill. This result may be explained by large number of students in the class. Despite of this, when we looked at our study, in both early and later implanted groups the lowest points were get from the younger students who were continuing 4th grade.

According to Joint Committee on Infant Hearing the most ideal time is first 6 months period after delivery in detection of hearing impairment [21]. In recent years studies showed that, early detected hearing impairments can reap lasting benefits from early interventions and this state supplies contributions for language development. In later years, these contributions effects social emotional development and academic and communication skills in positive [22,23]. Our study confirmed, the early implanted group's hearing impairment was noticed in 8.9 month average and hearing detection was defined in 11.7 month average, but later implanted group's hearing impairment was noticed in 17.8 month average and detection was defined in 20.2 month average.

It is known that, children who had received Auditory Verbal Therapy intervention could function effectively within the school and community environment. They achieve scores within the average range on measures of communication, self-perception and academic skills. [24, 25] Writing skill is one of the academic skills and we have chosen the children who achieved writing skill from this reason, the children who joined the

study had received at least 1 year of auditory verbal therapy.

In a study by El-Hakim et al. [26] duration of cochlear implant use was compared in two groups. Their findings showed that the cochlear implant users with longer duration had better performance in language development and also had a more extensive vocabulary. In our study, we also get similar results with this study. It was confirmed that, usage duration mean was 101.5 month in early in early implantiation group while in later implantion group it was 62.2 month as a mean. Depending on this results, early implantion group get higher performances in written language skill compared with later implantion group.

Geers et al. [27], informed the advanced degree hearing impairments have diffuculties in reading and writing skills. Reading and writing skills, however, matter in while initiating to the first grade of primary school. Until this period, absence of auditory stimulation in deaf children, may adversely affect the development. From this reason, the later implanted children who obtain auditory inputs later in time are expected to initiate school later than their peers. In our study, it was found that exception with one children, all early implanted children were initiated the primary school on time with their peers, but the later implanted children initiated one or two year later. In later implanted group continuing to the special education is expected according to the sufficiency of academic perfornance and also increasing of class level. In this study, it was confirmed that the 55.6 % of later implanted children admitted to the special education whereas only 35.3 % of early implanted group.

As a result, in this study, in terms written expression levels, the significant difference was found between early and later implanted groups. Findings showed that, later implanted group obtained lowest points and early implanted group get more closer points to the normal hearing group. This statement can be accounted by in sufficient auditory stimulation in most critical period between 0 and 2 years for language development. In the period of pre-implantation, early implantation group had some sort of auditory input using hearing aids. Although in this critical period, they were exposed to auditory deficieny in frequencies between 4000 and 8000 Hz contained dense speech stimuli. Just because of this, after cochler implantation they get sufficient stimuli in all speech frequencies but the exposed stimulus deficiencies caused the difference in normal hearing peers.

Written language skills of hearing impaired children and the relation between written language and reading comprehension skills should be re-evaluated by future studies in detailed in order to establish new rehabilitation aspects. Cochlear implantation applied in critical period of language development, matters not only for auditory and communication skills but also for improvement of written language skills, sufficiency of academic skills and pursue a career in future period of children's life.

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