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Long-Term Effects of Cochlear Implant on the Pragmatic Skills and Speech Intelligibility in Persian-Speaking Children

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Abstract

Background

Pragmatic skills of language are important for everyday life interactions. It has been proven that cochlear implantation age should be considered, as an important predictor of language skills in children with cochlear implantation (CI), but information about the benefits of early cochlear implantation on pragmatic language development in these children are very few. Thus, this study intends to compare pragmatic skills as well as speech intelligibility in prelingual deaf children who received cochlear implants before the age of 6 years and those who received cochlear implants after the age of 6 years with an 8-year follow-up.

Materials and Methods: This Retrospective 8-year longitudinal study was conducted in a cochlear implant center in the city of Tehran, Iran, in 2021. Forty-five children were included in two groups: early cochlear implant (n = 17), and early cochlear implant (n = 28). The Persian version of the children's communication checklist (CCC) was used to assess the participants 'pragmatic skills and the Persian version of the Intelligibility Context Scale (ICS) was used to assess the participants' speech intelligibility.

Results: The two study groups did not show a significant difference in terms of pragmatic scores ($P>0.05$) but had a significant difference in terms of ISC scores ($P<0.001$). Speech intelligibility had a significant negative relationship with the age of cochlear implantation ($r = -0.5$, $P<0.001$) but had no significant correlation with pragmatic skills ($P>0.05$).

Conclusion

The long-term results of early and late cochlear implants were similar in terms of the development of pragmatic skills but very different in terms of speech intelligibility. The age of cochlear implantation had no effect on the pragmatic of language.

Key Words: Cochlear Implant, Language, Pragmatic, Intelligibility, Hearing Impairment, Speech.

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1- INTRODUCTION

The prevalence of hearing loss in Isfahan is about 4.8 per 1000 newborns (1). And in general in Iran, out of every 1000 babies, about three babies are born with profoundly hearing loss (2). Cochlear implantations became a successful medical intervention and routinely perform in both children and adults with severe to profound hearing-impaired (3, 4). The bulk of existing research suggests that cochlear implants (CI) can be effective in improving deaf children's communication (2, 5-7). Pragmatics is one of the most important aspects of communication and one of the three main aspects of language (8). Communication in social interactions is part of the pragmatics of language (9).

Pragmatic skills are important for everyday life interactions (10). Pragmatic skills refer to the proper use of language to create interaction and convey meaning in various conversational contexts, such as continuing a topic in a conversation, taking turns, asking questions, or adding information (10, 11). Pragmatic language ability is also associated with cognitive skills and success in general education for CI children (12). Children implanted at younger ages showed better communication skills (5, 13), and Intelligent speech (3, 14) than those implanted after a long period of deafness. Despite this remarkable result, the development of communication and pragmatic skills may be very different in this population (15, 16).

Recently, many studies have been conducted on the pragmatic skills of people with cochlear implants, which shows its importance (12, 16-19). However, most of these studies have compared the pragmatic skills of CI children with hearing children (12, 18), and so far very few studies have compared the pragmatic abilities of early and late implanted children. Also, it seems that there is no study that compares all communication components between early and late cochlear implant children. Therefore, this study compares pragmatic language skills and speech intelligibility of Persian-speaking children with early and late cochlear implants with 8-year follow-up.

2- MATERIALS AND METHODS

2-1. Study design

A retrospective, 8-year longitudinal case–control study was performed in 2021 to compare pragmatic skills and speech intelligibility in prelingual deaf children who received cochlear implants before the age of 6 years and those who received cochlear implants after the age of 6 years in Tehran, Iran. Follow-up data was compiled in April 2021 and is reported in this article resulting in a mean follow-up period of 8.7 years (range 4.16–12.9) in this study. The Medcalc software was used to determine the sample size. According to a similar study (7), the sample size for each group of 21 people was calculated. Therefore, considering the possibility of drop in sampling, we sampled a total of 45 children.

2-2. Participants

Forty-five children, 28 with late CI and 17 with early CI, with the mean age of 15.6 (year) in children with late CI and 7.16 in children with early CI were recruited in the current study. The control group included 17 children with early CI, who were implanted before 6 years of age. The experimental group included 28 children with late CI, who performed their implantation after 6 years of age. All participants were conveniently selected and enrolled in this study. All of these individuals were received cochlear implantation unilaterally in a cochlear implant center in one of Tehran's hospitals from 2008 to 2013. All participants were Persian-speaking monolingual individuals whose oral-motor system was normal

based on a speech and language pathologist (SLP) examination. Also, according to the examination of the SLP, none of the participants had additional disabilities that may affect the quality of communication, such as mental retardation, physical problems, or vision problems. This SLP with a master's degree had 6 years of experience in speech and language therapy for deaf children. We used as inclusion criteria patients with prelingual deafness, and with at least 4 years of experience using cochlear implants. Another inclusion criterion was having a typical hearing in the parents of the participants. Most participants used oral language as their main method of communication. In fact, 11 (39%) of the experimental group participants used sign language along with oral communication and were also highly dependent on lip-reading. One (6%) in the control group and seven (25%) in the experimental group attended in deaf schools, and the rest of the participants (82%) were mainstreamed.

2-3. Measures

In this study, the Children's Communication Checklist (CCC) (11) was used to assess communication and pragmatic skills. The CCC provides an objective assessment of communication difficulties and pragmatic deficits in children aged 5 to 17 years and is completed by parents (11). The CCC measures various aspects of communication disorders. This questionnaire mainly includes pragmatic skills that are necessary for social interactions (11, 20).

The CCC with a validity of 0.75-0.84 based on Cronbach's alpha was adapted to Persian language in Monolingual children (20). The CCC with a validity of 0.75-0.84 based on Cronbach's alpha was adapted to Persian in Persian speaking children (20). The CCC has 70 items divided to 9 subscales including A) speech, B) syntax, C) inappropriate initiation, D) coherence, E) stereotyped language, F) use of context, G) rapport, H) social relationships, and I) interests. Also, the sum of the scores of the subscales of inappropriate initiation, coherence, stereotyped language, use of contexts, and rapport (subscales C to G) shows the score of the pragmatic composite score (PCS) (11). In addition, the Intelligibility Context Scale (ICS) assessed the Intelligibility of speech of all participants. The ICS is the first screening tool to determine the intelligibility of speech (21). This tool assesses parents' understanding of their child's speech clarity when talking to different people in real situations (21). The ICS was adapted to Persian with internal consistency and test-retest values of 0.89 and 0.82 in Persian-speaking children, respectively (22). This tool is also completed by parents.

2-4. Procedure

According to the medical records, patients who met the inclusion criteria were identified and their parents were invited to participate in this study. The purpose of the study was explained to the parents of each participant individually, and if they wished to participate in the study, after obtaining written consent, they were asked to complete the CCC and the ICS. The researcher taught parents how to respond to the CCC and the ICS. The parents of all participants completed these two checklists in the waiting room of the cochlear implant center in the presence of the SLP.

2-5. Ethical consideration

The Ethical Committee of Baqiyatallah University of Medical Sciences (Code No. IR.BUMS.REC.1399.429) has approved this study.

2-6. Data analysis

These data were analyzed via SPSS software version 22. Descriptive methods (mean score and standard deviation, etc.) were used to determine the performance of

each group of participants in these tests, and inferential statistical analysis was used to compare the mean score between the groups. Data distribution based on the Kolmogorov-Smirnov test and Q-Q plots were not normal, so nonparametric techniques were used to analyze the data, for example, or Mann-Whitney U test and Spearman. In this study, P <0.05 was considered statistically significant.

3- RESULTS

3-1. Patient characteristics

The demographic information of the participants is shown in **Table.1**. Of the 45 participants recruited, 22 (48.9%) were males, and 23 (51.1%) were females. The mean age of cochlear implantation in the control and experimental group participants was 3.78±1.5 and 13.56±5 years, respectively (*P* <0.001). Also, the mean age of participants at the time of this study in the control and experimental group participants was 12.54±1.53 and 22.35±5.02 years, respectively (*P* <0.001). Participants in the two groups did not differ significantly in terms of years of follow-up, gender, and hearing aid use (*P*>0.05) (**Table.1**).

Table-1: Demographic information of all participants (n=45).

Variables	Category	Experimental Group, (n=28)			Control Group, (n=17)			P-value
		Min	Max	Mean ± SD	Min	Max	Mean ± SD	
Chronological age* (year)	-	13.83	33	22.35±5.02	10.75	15.66	12.54±1.53	<0.001
Age of CI* (year)	-	6.83	25.33	13.56±5.02	1	5.95	3.74±1.54	<0.001
Years of follow up (year)	-	4.16	12.57	8.72±2.14	5.83	12.9	8.71±1.7	.631
Auditory training sessions after CI* (number)	-	0	30	25±9.62	30	30	30	<0.05
Speech therapy sessions after CI* (n)	-	0	70	55.35±24.86	70	70	70	<0.05
Gender	Male	14 (50%)			8 (47%)			.85
	Female	14 (50%)			9 (53%)			
Use hearing aids after CI	Yes	3 (11%)			1 (6%)			.585
	No	25 (89%)			16 (94%)			

* *P*- value is significant at level of 0.05 based on Mann-Whitney U test or Chi-square as appropriate, CI: Cochlear Implantation, SD: Standard Deviation.

3-2. Pragmatic and Intelligibility outcomes

Table.2 illustrates the mean of the ICS and CCC scores for the two groups. The mean scores of speech and syntax (subscales A and B of the CCC), as well as the mean score of the ICS, were significantly different between the two groups (*P* <0.05). However, there were no significant differences for the PCS and other CCC subscales between the two groups (*P*>0.05). Based on the mean scores, the children in the control group scored better than the experimental group in all subscales of the CCC except three (F, G, and H subscales) and also in the ICS scale.

Table-2: The CCC and ICS scores and comparison of experimental and control groups (n=45).

Measures	Experimental Group (n=28)	Control Group (n=17)	P-value
A: Speech* (M±SD)	27.25±4.73	30.64±4.24	<0.05
B: Syntax* (M±SD)	26.32±2.05	28.05±2.19	<0.05
C: Inappropriate initiation (M±SD)	21.42±2.94	21.47±2.91	.981
D: Coherence (M±SD)	29.03±2.72	30.05±1.47	.378
E: Stereotyped language (M±SD)	17.82±3.15	18.05±3.47	.696
F: Use of context (M±SD)	21.96±2.44	21.64±3.27	.954
G: Rapport (M±SD)	27.46±2.56	27.11±2.59	.67
H: Social relationships (M±SD)	25.78±2.4	25.23±3.43	.991
I: Interests* (M±SD)	26.5±1.87	28.23±1.88	<0.05
Pragmatic composite score (M±SD)	117.71±9	118.35±10.9	.639
ICS* (M±SD)	3.94±0.57	4.69±0.37	<0.001

**P*-value is significant at <0.05, CI: Cochlear Implantation, M: Mean, SD: Standard Deviation, ICS: Intelligibility Context Scale, CCC: Children's communication checklist.

3-3. Relationship between variables

Considering all participants in this study, speech intelligibility score had a significant negative correlation only with the children's chronological age and age of CI (*P* <0.001). The experience of using the CI (years of follow-up) had a significant positive correlation only with the pragmatic composite score (PCS) (**Table.3**).

Table-3: Spearman correlation between the pragmatic composite score (PCS), and the Intelligibility Context Scale (ICS) and the demographic data of the participated patients (n=45).

Spearman Correlation	Chronological age		Age of CI		Auditory training after CI		Speech therapy after CI		Years of follow up	
	r	*P*- value	*r*	*P*- value	*r*	*P* -value	*r*	*P*- value	*r*	*P*- value
PCS	-0.05	0.74	-0.12	0.420	0.01	0.918	0.01	0.918	0.30*	0.042
ICS	-0.47*	0.001	-0.50*	0.001	0.05	0.761	0.05	0.761	0.01	0.930

**P*-value is significant at <0.001, CI: Cochlear Implantation, PCS: pragmatic composite score, ICS: Intelligibility Context Scale.

4- DISCUSSION

The present study compared the results of an 8-year follow-up of communication skills, speech intelligibility, and pragmatic development of Persian-speaking children with prelingual deafness who underwent cochlear implantation before the age of 6 years and after the age of 6 years. The results highlighted that children with late cochlear implants did not show poorer performance in communication and pragmatic skills than children with early cochlear implants. However, there is a significant difference in speech and syntax between early and late cochlear implant children. Also, in terms of speech intelligibility, these two groups were

significantly different. These findings suggest that hearing-impaired children who receive late cochlear implants have acceptable communication and pragmatic skills despite their low speech intelligibility (Table 2). This is in line with the results of several previous studies, in which deaf participants can use a wide range of pragmatic skills (10, 16, 18). The participants with late cochlear implants also appear to use a range of pragmatic skills, such as the initiation of talking, coherence, the stereotyped language, the rapport, and the use of context, almost as much as early cochlear implanted children (Table.2). Our results are consistent with previous studies showing that children with early cochlear implants perform almost similarly to children with late cochlear implants in terms of pragmatic language skills (19).

This may be because children with hearing impairments can develop pragmatic skills despite language delays during language development (12, 18). Also, some studies have shown that most patients with CI have a continuous improvement in most of their language skills in the first 4 years after cochlear implantation, so that after 4 years, they did not show a significant difference with their hearing counterparts (23). A positive correlation between years of follow-up and pragmatic skills (Table.3) has also been confirmed in previous studies (12, 18). Because we do not have a normal hearing group to compare, we cannot compare the results of these children with the normal group. However, some studies have shown that pragmatic skills in children with cochlear implants are not significantly different from children with normal hearing (12, 18). Given that in the present study no relationship was found between pragmatic scores and cochlear implantation age (Table.3), it can be argued that cochlear implantation age has no effect on the development of pragmatic skills, which confirms the findings of previous studies (19). Given this, it can be argued that children with cochlear implants can sooner or later improve their pragmatic skills to the group with normal hearing. Therefore, cochlear implantation can be effective in strengthening pragmatic skills even at older ages. However, this contradicts the results of some studies that believe that the development of pragmatic skills is sensitive to the age of cochlear implants (24). In this study, as well as the study by Rezaei et al. (18), used parental rating to assess pragmatic skills, while in other studies, the child's pragmatic skills were scored by a clinician through a questionnaire, conversation, or story retelling (9, 10, 17, 19). Some believe that most parents tend to overestimate their child's abilities (12). But, various studies have shown that parental scoring is valid and can be used by parents to assess a child's speech and language skills (21, 22).

However, the use of different tools to assess pragmatic language skills as well as different age groups makes it difficult to compare the results of these studies. The present study also found that children who received cochlear implants early had better speech and syntax skills than those who received cochlear implants later (Table.2), which confirms the findings of previous studies (25, 26). This suggests that speech development and the development of well-constructed sentences occur at an early age and are not as compensable as other communication skills over time and language rehabilitation therapy. This is agreeing with the results of most studies that believe that the development of speech and syntax skills is sensitive to the age of cochlear implants (5, 6, 24, 27). Therefore, it seems that one of the long-term results of early cochlear implant versus late cochlear implant is better development of speech and syntax skills. The results of this study showed that the intelligibility context scale (ICS) in participants with late

CI and early CI was significantly different (Table.2), which agrees with the results of previous studies (3, 14, 28). On the other hand, the significant negative relationship between the ICS score and the age of CI (Table.2) indicates that the age of CI is a very important factor in determining future speech intelligibility, which has been reported in all previous studies (14, 18, 29). That is, as a child's cochlear implant age decreases, that child is more likely to have a more intelligent speech in the future. Since this tool is rated by parents and has not yet been used to assess the speech intelligibility of children with cochlear implants, it is best to be careful in interpreting and generalizing the results.

However, considering that the results of the Speech subscale of the CCC were significantly different in the two groups studied (Table.2) and this is consistent with the ICS results in these two groups, it can be concluded that ICS has simultaneous validity and its results for Preliminary assessment of speech intelligibility of cochlear implanted children is also reliable. Therefore, it seems that another long-term result of early cochlear implantation versus late cochlear implantation is the better development of speech intelligibility.

The present study had several limitations: First, the pragmatic skills and speech intelligibility of these participants were not assessed prior to implantation. Second, we did not have a normal hearing group to compare these skills. Third, participants' use of cochlear implants during the day was not considered. Fourth, the sample size was limited and the design was cross-sectional, and finally, only parent rating was used to assess these skills. Therefore, further studies should longitudinally evaluate the effect of late and early cochlear implants on pragmatic language skills of children with CI. Increasing knowledge in this area helps to develop the necessary intervention programs to improve pragmatic language skills in children with cochlear implants.

5- CONCLUSION

The long-term results of early and late cochlear implantation were no different in terms of the development of most communication skills, especially pragmatic language, but they were very different in terms of intelligibility of speech. The age of cochlear implantation had no impact on the pragmatic of language. Although no differences were observed in pragmatic language skills, better development of speech and syntax skills, as well as greater intelligibility of speech, are the long-term results of early cochlear implant versus late cochlear implant. These results are useful for accurate planning of rehabilitation of these children before and after cochlear implantation and should be considered.

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7- CONFLICT OF INTEREST: None.

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