Predictive Factors of Language Development in Persian-speaking Children Using Cochlear Implants: A Pilot Study

Mohammad Majid Oryadi-Zanjani¹,², PhD; Tahereh Mohammadi³, BSc; Zahra Mohammadi⁴, BSc; Maryam Vahab¹,²*, MSc

¹Department of Speech Therapy, School of Rehabilitation Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
²Rehabilitation Sciences Research Center, Shiraz University of Medical Sciences, Shiraz, Iran
³Department of Speech-Language Pathology, Research Assistant, Northwestern University, Evanston, USA
⁴Department of Speech-Language Pathology, Shiraz University of Medical Sciences, Shiraz, Iran

ABSTRACT

Background: This study aimed to investigate some child- and environment-dependent factors in a retrospective method to find a prediction model for the spoken language development of children with hearing loss (HL) after cochlear implantation (CI).

Methods: The research reported here was conducted as a cross-sectional pilot study. The sample size was 18 Persian 5-to-7-year-old children with HL using CI (6 girls and 12 boys) who were recruited via consecutive sampling methods from Soroush Rehabilitation Center in Shiraz, Iran. The studied independent variables were categorized into child-related variables and parental variables. At the first step, the participants were divided into two groups, good language ability, and poor language ability, based on the results of Sentence Repetition Test (SRT). The correlation between the independent variables and SRT scores of the groups were compared in two stages.

Results: Regarding the development of spoken language in two groups of Persian-speaking preschool children using the cochlear implants with good and poor language development, IQ, duration of watching TV, duration of playing with the father, education status of the mother, education status of father, and economic status of the family had a significant correlation with language development of these children.

Conclusion: According to this study’s findings, the child’s IQ, the duration of watching TV during the day, the duration of playing with the father during the day, the level of education of the mother, the level of education of the father, and the economic level of the family may be considered the predictive factors in the language development of cochlear implant children during the preschool years.

Introduction

Indeed, many studies showed that depriving auditory input, at any degree, cannot only impede auditory perception, but also affect the development of the peripheral and central auditory pathways. Therefore, because of an altered auditory input, speech and oral language development can be limited, which will affect oral communication skills and social participation [1]. Besides, cochlear implantation (CI) positively affects children’s verbal communication, generally, and receptive and expressive language development, specifically [2-4]. However, language and speech outcomes in children using CI have a wide variation [5, 6]. Although cochlear implantation is effective for profound hearing-impaired children, it may not be effective for all
children using this device. Some children experience a great deal of environmental stimuli after cochlear implantation; however, some of them would usually not achieve the appropriate language and speech skills [5]. Despite significant individual differences and variations in the battery of speech and language outcome measures [7-9], other various findings were consistently reported in the literature on the cochlear implants in children [10].

Age at cochlear implantation affects all the functional indicators. Hence, in the spectrum of outcome indicators, the children implanted at an early age (under three years old) would function superior abilities than those implanted at an older age (over six years old). Besides, the duration of hearing loss or the duration of deafness is related to outcome and productivity. Furthermore, children who have been deaf for a shorter period before implantation would depict greater performance in the battery of speech and language outcome measures than those who have been deaf for a long period [11]. Therefore, both of these findings indicate the role of the sensitive periods of sensory, perceptual, and language development and emphasize the close relationship between neural and behavioral development, especially auditory, speech, and language development. The effect of sensory experience, primary language, and post-implant language processing activities on individual performance were shown on a range of outcome measures [7, 12].

Early implantation for deaf or hard of hearing children may take advantage of neuronal flexibility in the critical periods of auditory-based learning [13]. Therefore, children implanted after 24 months are much less likely to use oral communication exclusively, especially those with complex medical history or additional conditions associated with language delay [14].

Until recently, therapists and researchers have not been able to find authentic prognosticators of the outcome and success prior to implantation. Evidence strongly suggests that fundamental sensory and perceptual abilities essential for speech and language would emerge after implantation. In usual, the performance of all children using cochlear implants improves over time [10]. However, a number of studies were conducted on predictive factors of spoken language development in children using CI so far such as (I) intelligence quotient (IQ) [15]; (II) programming and auditory monitoring abilities [16]; (III) early intervention [17-19]; (IV) the duration of educational and rehabilitative intervention [3, 6, 15]; (V) family income [20]; (VI) parental socioeconomic status [15]; (VII) parental education [20]; (VIII) parenting style [20]; (IX) family engagement and participation in intervention [21, 22]; and (X) the quantity and quality of parental linguistic input [23].

In conclusion, this study aimed to investigate some predictive factors in a retrospective method to find a prediction model for the spoken language development of children with hearing loss (HL) after CI. Furthermore, in addition to a number of variables which were considered in the earlier studies (IQ, the age of implantation, the duration of CI using, the economic status of the family, the number of children in the family, level of mother’s and father’s education), some other factors, which have not been studied so far, were included such as birth order, the age of HL detection, the age of hearing aids fitting, rehabilitation program onset age, the time of rehabilitation services pre/post of CI, the number of rehabilitation program days weekly, the duration of watching TV daily, the duration of computer games daily, maternal depression, the duration of reading book for child daily, the duration of mother-child play daily, the duration of father-child play daily, mother’s working hour per day, and father’s working hour per day. Therefore, this study aimed to investigate the correlation between these factors and language development in Persian-speaking children using cochlear implants.

Methods

This cross-sectional study was conducted as a pilot study. The research protocol was approved by the Ethics Committee of Shiraz University of Medical Sciences, Shiraz, Iran (IR.SUMS.REC.1394.S261), and informed consent was obtained from the parents of each child participating in the study. The sample size was 18 Persian 5-to-7-year-old children with HL using CI (6 girls and 12 boys) who were recruited via consecutive sampling methods from Soroush Rehabilitation Center in Shiraz, Iran. The inclusion criteria were chronological age, bilateral severe-to-profound, congenitally sensory-neural hearing loss, cochlear implantation before 3 years old, using oral language as a communication method pre- and post-implantation, receiving similar education, and rehabilitation services and no other disabilities.

The assessment tool was the Sentence Repetition Test (SRT), which is a highly valid and reliable test for the measurement of grammatical development in Persian-language children. Content Validity Index (CVI), the Interclass Correlation Coefficient, and the standard error measurement for the test were reported 80% and 7.45, respectively. SRT includes 41 sentences with different lengths and complexities [24]. At the first step, the participants were divided into two groups, good language ability and poor language ability, based on the SRT scores providing in the results section (Table 1).

The studied independent variables were categorized into child-related variables and parental variables. Moreover, the variables related to children included birth order, IQ, the age of HL detection, the age of hearing aids fitting, age of implantation, the duration of CI using, rehabilitation program onset age, the time of rehabilitation services pre/post of CI, the number of rehabilitation program days weekly, the duration of watching TV daily, and the duration of computer games daily.

Thus, the independent variables related to the parents included the economic status of the family, the number of children in the family, maternal depression, the duration of reading book for child daily, the duration of mother-child play daily, the duration of father-child play daily, the level of mother’s education, the level of father’s education, the duration of the mother’s employment daily, and the duration of the father’s employment daily.

At the second step, except for the variables of IQ and maternal depression, other variables were determined...
using the available information in children’s records. At the third step, the children’s IQ and the mother’s depression were assessed by an expert psychologist. To measure the children’s IQ, the Persian version of the Wechsler Intelligence Scale for children was used [25]. Persian version of the Beck depression questionnaire was used to determine the presence or absence of depression in mothers [26]. Finally, the correlation between the independent variables and the groups’ SRT scores was compared in two stages. In the first stage, all the variables were compared between the two groups by Mann–Whitney U test and the chi-squared test. In the second stage, according to the first stage results, just the significantly different variables were analyzed by the Stepwise method of Linear Regression.

**Results**

There was a significant difference among the SRT scores of the two groups (Table 1). There was, however, no significant difference between the two groups in the aspect of age, gender, distribution, and severity of HL (Table 1).

The mean and the standard deviation of continuous independent variables are shown in Tables 2 and 3. They include IQ, the age of HL detection, the age of hearing aids fitting, the age of implantation, the duration of CI using, rehabilitation program onset age, maternal depression, the duration of watching TV daily, the duration of computer games daily, the duration of reading book daily, the duration of mother’s playing with a child daily, the duration of father’s playing with a child daily, the level of mother’s education, the level of father’s education, and the duration of the mother’s employment daily, and the duration of the father’s employment daily.

There was no significant difference among the groups in some factors, including the age of HL detection (P>0.05), age of hearing aids fitting (P>0.05), age of cochlear implantation (P>0.05), the duration of CI using (P>0.05), rehabilitation program onset age (P>0.05), the number of rehabilitation program days weekly (P>0.05), birth order (P>0.05), the number of children in the family (P>0.05), depression of mother (P>0.05), duration of mother’s playing with a child (P>0.05), duration of a computer game (P>0.05), the duration of the reading book (P>0.05), working status of the mother outside home (P>0.05), and no working time of father outside home (P>0.05).

Whereas, a significant difference was found between the groups in terms of IQ (P<0.05), the duration of watching TV (P<0.05), the duration of father’s playing with a child (P<0.05), the level of mother’s education (P<0.05), educational status of the father (P<0.05), and...
Predictive factors of language development in Persian-speaking children using cochlear implants

Discussion

Regarding the development of spoken language in two groups of Persian-speaking preschool children using cochlear implants with good and poor language development, IQ, duration of watching TV, duration of playing with the father, education status of the mother, education status of the father, and economic status of the family had a significant correlation with language development of these children. In other words, the acquisition of speech and language skills may be predicted by addressing the investigated factors in this study. There was no significant difference between the two groups of children using cochlear implants with good and poor language development due to the remaining variables. It can be said that the effect of these variables was controlled in the study. In other words, the two groups studied were similar in terms of these variables.

The result of this study was in accordance with a study conducted by Wijayanti et al., who stated that there was a strong relationship between parenting style, family income, and maternal education with the development of speech and language in children [20]. If these variables were good and in accordance with the needs of children, the development of speech and language would also be good. On the contrary, if the parenting style was not good enough and not according to the needs of children, then the development of speech and language of the children would also be poor. This finding is also consistent with a study carried out by Bingham et al. [27] reporting that parenting contributes directly to the academic skills as well as the language development of the children. Besides, parental language input has an influence on a child’s language development. In a systematic review and meta-analysis study, Holzinger et al.’s findings emphasized strong positive correlation between parental linguistic input during the first years after cochlear implantation and later child language outcomes [23]. Therefore, our findings show that parental interventions can be very effective in developing children’s speech.

The results obtained from this study regarding the IQ, parental education level, and family economic level are consistent with the results of Piccolo et al. and Duncan et al. [28]. The socio-economic status of families directly influences the level of parental time and parenting style investments, as well as the productivity of the investment process and IQ [28]. There are strong relationships between IQ and language outcomes as well as between language skills and speech perception ability [29]. A comprehensive review over seventy-eight studies addressed the importance of father playing with children, and it highlighted that fathers’ playtime has unique features that is distinguished from a maternal playtime as well as overlaps [30]. According to previous findings, the more time a child spends playing and interacting with their parents, the better his/her spoken language development will be expected [20, 27]. Therefore,

Table 4: The frequency distribution of the discrete variables

<table>
<thead>
<tr>
<th>Groups</th>
<th>N*</th>
<th>Birth order</th>
<th>Numbers of children</th>
<th>Rehabilitation program onset age</th>
<th>Rehabilitation program onset time</th>
<th>Numbers of rehabilitation program days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1st 2nd 3rd 4th 5th</td>
<td></td>
<td>1 2 3 4 5</td>
<td>1st 2nd 3rd 4th 5th</td>
<td>Pre-CI Post-CI</td>
</tr>
<tr>
<td>Children with good language abilities</td>
<td>8</td>
<td>5 1 1 0 1</td>
<td>4 2 0 1 0 1 7 0 0 0</td>
<td>7 1</td>
<td>7 1</td>
<td></td>
</tr>
<tr>
<td>Children with poor language abilities</td>
<td>10</td>
<td>5 3 1 1 0</td>
<td>3 5 1 1 0 0 3 2 4 1</td>
<td>8 2</td>
<td>8 2</td>
<td></td>
</tr>
</tbody>
</table>

* N=number

Table 5: The frequency distribution of the discrete variables

<table>
<thead>
<tr>
<th>Groups</th>
<th>N*</th>
<th>Economic status of family</th>
<th>Educational status of mother</th>
<th>Educational status of father</th>
<th>Working status of mother outside home</th>
<th>Working time of father outside home</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Poor Moderate Good Illiterate</td>
<td>Under diploma Upper diploma</td>
<td>Illiterate</td>
<td>Under diploma Upper diploma</td>
<td>No Yes 4 hours daily 8 hours daily More than 8 hours daily</td>
</tr>
<tr>
<td>Children with good language abilities</td>
<td>8</td>
<td>0 5 3 0 1 7 0 3 4 7 1 0 3 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Children with poor language abilities</td>
<td>10</td>
<td>4 6 0 1 9 0 0 10 0 10 0 1 3 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* N=number

the economic status of the family (P<0.05). Moreover, a significant correlation was observed between SRT scores and IQ (B=4.163, SD=1.763, P=0.032). In other words, it can be predicted that by increasing each unit of IQ, the SRT scores of the children using CI will increase 4.163 units.
regarding the duration of watching TV and duration of the father playing with the child during the day, it can be explained that the more time the child spends watching TV, the less time he spends interacting and playing actively.

In general, when we look at these six factors together, we find that these variables operate in an interactive framework with each other. This means that the higher the child’s intelligence, the better his interaction with parents and others around him/her. On the other hand, the higher economic and educational level of the parents can guarantee that the parents have more time and patience to interact and play with their child. As a result, a child who spends more time with his or her parents will spend less time watching television.

The ineffectiveness of the other variables studied does not mean that these variables are not important. Rather, it simply means that since the two groups were not significantly different in these variables, the effect of these variables in this study was naturally controlled. The small sample size of the children studied was the only significant limitation in this study. Conducting studies with greater sample sizes and controlling other variables can be effective in obtaining results that are more accurate. Among the issues that should be addressed in future studies is the extent, or burden of the impact of each factor in predicting the rate of development of oral language skills in children with the implant. It is also recommended to perform similar studies on children with hearing aid. Therefore, in future studies, we hope to find a relationship between these variables and oral language development in children using hearing aids and to compare this study’s findings.

Conclusion

According to this study’s findings, the child’s IQ, the duration of watching TV during the day, the duration of playing with the father during the day, the level of education of the mother, the level of education of the father, and the economic level of the family may be considered as predictive factors in the language development of cochlear implant children during the preschool years.

Acknowledgement

The authors would like to thank Z. Zandi for her cooperation in collecting the data, Dr. Z. Bagheri for her careful statistical advice, and Dr. L. Khojasteh for the framework with each other. This means that the higher the child’s intelligence, the better his interaction with parents and others around him/her. On the other hand, the higher economic and educational level of the parents can guarantee that the parents have more time and patience to interact and play with their child. As a result, a child who spends more time with his or her parents will spend less time watching television.

The ineffectiveness of the other variables studied does not mean that these variables are not important. Rather, it simply means that since the two groups were not significantly different in these variables, the effect of these variables in this study was naturally controlled. The small sample size of the children studied was the only significant limitation in this study. Conducting studies with greater sample sizes and controlling other variables can be effective in obtaining results that are more accurate. Among the issues that should be addressed in future studies is the extent, or burden of the impact of each factor in predicting the rate of development of oral language skills in children with the implant. It is also recommended to perform similar studies on children with hearing aid. Therefore, in future studies, we hope to find a relationship between these variables and oral language development in children using hearing aids and to compare this study’s findings.

Conclusion

According to this study’s findings, the child’s IQ, the duration of watching TV during the day, the duration of playing with the father during the day, the level of education of the mother, the level of education of the father, and the economic level of the family may be considered as predictive factors in the language development of cochlear implant children during the preschool years.

Acknowledgement

The authors would like to thank Z. Zandi for her cooperation in collecting the data, Dr. Z. Bagheri for her careful statistical advice, and Dr. L. Khojasteh for the language editing of the manuscript. Special thanks are expressed to the families and children who participated in the research.

Conflict of Interest: None declared.

References

2. Eisenberg LS. The Impact of Hearing Loss on Childhood Development and Family Constellation. Volta Review.