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Review Article

Reading Skills in Preschool and School-aged Children with Unilateral Cochlear Implants in Iran: A Narrative Review

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ABSTRACT

Background: The acquisition of reading skills is one the most important challenges a cochlear implanted child faces in his/her life. Although cochlear implants can improve speech, language, and reading skills, some children continue to experience reading difficulties. Some studies have reviewed the reading skills in English-speaking children with cochlear implants; however, language and cultural discrepancies may result in diverse aural rehabilitation programs and varying effects of factors on reading in these children. The aim of the present study is to review evidence regarding reading skills, including phonological awareness, reading comprehension, vocabulary, and story retelling in preschool and school-aged children with unilateral cochlear implants in Iran.
Results: Overall, the findings of studies in this area suggest that Persian-speaking preschool and school-aged children with unilateral cochlear implants show worse reading performance compared with their normal hearing peers.
Conclusion: Impaired reading skills in children with cochlear implants necessitates the identification of reading problems and targeted aural rehabilitation programs to improve reading skills in these children. Future studies over longer periods are necessary in order to determine the reading developmental trajectory of children with cochlear implants in Iran. In addition, investigating the precise role of underpinning abilities such as language and hearing skills in reading development can help children with cochlear implants achieve age-appropriate reading skills.

Introduction

Sensorineural hearing loss (SNHL) is one of the most common sensory deficits in children [1]. In children with severe to profound SNHL, damage to cochlear hair cells or the auditory nerve in early childhood interferes with the normal development of the auditory system and prevents the development of auditory-related skills such as language, speech, and literacy [2]. Cochlear implant (CI) is a medical instrument that completely or partially replaces the sensory cells in the cochlea through the implantation of an electrode inside the inner ear, and it restores the sense of hearing for people with severe to profound SNHL through electrical stimulation of the auditory nerve [3-5]. The use of CIs and subsequent aural rehabilitation facilitates the development of cognitive skills and language abilities related to reading comprehension, such as richer vocabulary and longer short-term memory in children with hearing loss [6, 7]. Skillful reading is guaranteed when these skills are developed [8]. While CIs lead to improved language and speech and ultimately reading skills, children with them

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still fall behind normal-hearing ones. Moreover, there is a lot of variability in the ability to read among pediatric CI users. The ability to acquire reading skills is one of the challenges facing cochlear implanted children despite technological advances [9-12].

Literacy means the ability to understand and evaluate, be present in society, achieve goals, and develop knowledge [13]. The most important benefit of literacy is the creation and maintenance of self-confidence and self-reliance in individuals, and it increases the active presence of individuals in society by allowing them to gain political and legal awareness of their rights [14, 15]. The development of literacy includes the development of reading, one of the main components of literacy and a critical element in academic success. Among academic skills, perhaps none is more important than the ability to read [16]. This ability includes the sub-skills of oral language comprehension, reading comprehension, decoding, phonological awareness, letter knowledge, syntax and semantics, vocabulary knowledge, concept about print, text knowledge, and story retelling [17]. As studies have demonstrated, children with CI can access oral language, which brings higher levels of speech comprehension as well as better vocabulary skills [18]. Although CI children need less educational support than their deaf peers [19], they still perform more poorly academically than normal-hearing peers, because they have less access to phonological information [20]. It is well known that the characteristics of CI-transmitted signals are limited, such that they affect sensitivity to phonological structures. Therefore, CIs are not able to retain all acoustic details contained in speech signals [16]. It seems that the difficulty children with CIs face in developing phonological awareness of oral language is one of the effective factors in reducing the ability to acquire reading skills, which may even lead to CI children dropping out of school [21].

Early in the 2000s, Iran implemented hearing screening and early intervention programs, and as a result, a large number of children with severe to profound hearing loss now undergo surgery at various CI centers and receive aural rehabilitation programs. CIs significantly affect the reading development of SNHL children, improving the quality of life and ensuring their active participation in society along with their normal-hearing peers. Many studies have investigated the reading status of English-speaking cochlear implanted children [5, 8, 10, 22]. Although CI rehabilitation programs have a set of general principles and rules, linguistic and cultural differences in different countries lead to changes and differences in rehabilitation programs. Moreover, depending on the social conditions, variables related to children's hearing, such as age at implantation and the daily duration of device use, may differ, thus affecting the reading results of these children in different ways. The aim of the present narrative review is to examine reading skills studies in preschool and primary school-aged children with unilateral CI in Iran. As more attention has been paid to phonological awareness, reading comprehension, vocabulary knowledge, and story retelling in domestic studies, the present study has also investigated these four reading sub-skills in the mentioned group of children with the goals of identifying gaps in research on Persian-speaking cochlear implanted children, discovering reading problems in these children, and providing solutions to solve existing problems so as to take an effective step toward improving reading skills among SNHL children with CIs.

Reading Skills in Children with CI

Reading skills are usually developed at an early school age [10] and depend on the learner's phonological awareness [23]. Segmentation, deletion, and rhyme are the most important phonological awareness skills required to start reading [24]. However, reading at higher levels involves vocabulary and language knowledge [25]. In fact, reading is a second language based on oral language [26]. CIs lead to improvements in oral language, auditory memory, and phonological awareness skills that are essential for reading improvement [20, 27, 28]. Early experiences and greater oral access in cochlear implanted children lead to a better reading ability than in non-implanted children with hearing loss [29]. However, even with the use of CIs, their performance is lower than that of their normal-hearing peers [4]. Research has shown that early success in the reading skills of cochlear implanted children is not preserved over time, perhaps because reading instruction in these children stops in the fourth grade, and they are expected to learn through reading; however, findings show the lack of a clear structure and the need for more vocabulary in textbooks for higher grades [30]. Language skills, phonological representation, and phonological processing skills are of significant importance in the development of reading skills of cochlear implanted children [31, 32]. Progress in vocabulary, rhyme awareness, and speech reading have positive effects on the reading ability of these children [33]. Geers et al. believe that nonverbal intelligence accounts for a significant proportion of errors in speech comprehension, speech production, oral language, and reading after other demographic and auditory factors such as age at implantation or duration of prosthesis use [34].

Previous domestic studies often utilized the Nama test when examining reading performance. This test includes sub-tests of word reading, non-word reading, word chain, rhyme recognition, picture naming, text comprehension, word comprehension, phoneme deletion, letter fluency, and category fluency [35]. A number of studies have indicated poor reading skills in Persian-speaking cochlear implanted children compared to their normal-hearing peers [20, 36, 37]. According to Weisi et al., richer vocabulary, greater phonological skills, wider mental word representation, better language and speech skills, more effective verbal comprehension, and better integration of auditory inputs with visual inputs lead to better reading skills in normal hearing children compared to CI users [20]. Moreover, as education levels increase, the above-named skills improve in normal-hearing children, yet cochlear implanted children do not show progress in these skills in the third grade of primary school compared to the second grade, which in turn leads to more differences in the reading ability of the two

groups at higher levels [20, 36]. However, Motasaddi-Zarandy et al. found good to excellent academic performance in Persian literature (including word and text reading) in most cochlear implanted children. The age at implantation and the duration of prosthesis use are two key factors in the development of reading ability in these children. Motasaddi-Zarandy et al. further found higher-than-average reading performance in children implanted under 4 years of age [38]. children implanted at age of three and above, Rezaei et al. studied children implanted at the age of three years and above and found no relationship between age at implantation and reading skills at 8 or 9 years of age [36]. Therefore, implantation under the age of three years is clearly effective and accompanied by remarkable progress in reading skills. Further studies are needed to more accurately identify other factors affecting the development of reading skills in Persian-speaking cochlear implanted children.

1. Phonological Awareness in Children with CI

Phonological awareness is the skill of discovering and manipulating spoken language units such as syllables and words in a wide range [39-41]. The ability to read a word requires knowledge of the phonological structure of the language. To read a new word, children use their knowledge of letters and sounds to match a phoneme to its spoken form and then combine phonemes to read the whole word [42]. The three most important basic skills of phonological awareness include rhyme awareness, phoneme awareness, and intersyllabic awareness. They are investigated in the form of phoneme awareness tasks, usually including alliteration recognition, rhyme recognition, syllable segmentation, phoneme segmentation, phoneme blending, and recognition of words with the same initial or final phoneme, naming and deleting the initial, middle, or final phoneme [41, 43]. James et al. as well as Sterne and Goswami have shown that the development of phonological awareness skills in hearing-impaired children follows a similar sequence as that of normal-hearing children [44-46]. Children with CI show poorer phonological awareness skills, especially at the phoneme level, than their normal-hearing peers because of their more limited access to certain vocal structures in speech message [16]. For example, normal-hearing children acquire phoneme-blending skills at the age of 10, while cochlear implanted children still do not fully acquire this skill until adolescence and middle school [47, 48].

Phonological awareness studies on Persian-speaking cochlear implanted children have shown lower than normal performance in all tasks [41, 43, 49]. According to Safaeian Titkanlou et al., auditory deprivation and experiences, speech comprehension, speech production skills, and the development of vocabulary are all factors that can play a role in the occurrence of impaired phonological awareness in children with cochlear implants [43]. Soleymani et al. attributed the phonological awareness problems of preschool cochlear implanted children to their language limitations and explained that pre-implant hearing impairment delays the development of language skills that underpin phonological knowledge skills [41]. Although children who receive their CI early show some degree of delay in learning phonological awareness skills [43], nevertheless, children receiving their CI at a younger age still perform better, because they progress faster. Unlike reading skills, phonological awareness skills in cochlear implanted children showed a significant improvement with increasing child age, while this improvement was not observed in normal-hearing children [50]. Rastegarianzadeh et al. showed a difference between 5- and 7-year-old children in terms of phonological awareness skills, and Weisi et al. demonstrated a difference between 8- and 9-year-old children in terms of reading skills. This may indicate that the auditory, language, and other related skills (e.g., reading skills) improve more rapidly in children with early cochlear implantation, but such improvement slows down over time. As in other studies, the current research noted a marked increase in the difference in reading performance between implanted and normal children over time [10, 51-53]. Reading growth can be improved through rehabilitation with a special focus on the necessary skills.

2. Reading Comprehension in Children with CI

Reading comprehension is based on linguistic knowledge and awareness of the relationship between the spoken and written forms of language [54]. According to Hoover and Gough's simple view of reading, reading comprehension is the product of language decoding and comprehension [55]. According to this model, improving speech comprehension skills affects the reading comprehension skills of cochlear implanted children in three ways, namely decoding, spoken language, and visual word recognition [56]. Vermeulen et al. showed that the reading comprehension performance of children with CI was better than their deaf non-implanted peers, but it was slower than that of their normal-hearing peers. The authors emphasized the importance of language comprehension ability over visual word recognition skills in the reading comprehension scores of these children [56]. López-Higes et al. found that key skills for developing reading comprehension are related to grammar comprehension, allowing the integration of information across linguistic units such as words, phrases, and sentences. This delay in acquisition of syntactic morphological patterns occurs first in oral comprehension and subsequently in reading comprehension [57].

Persian-speaking cochlear implanted children score lower in reading comprehension than normal-hearing children [32, 54, 58]. Two studies reported no difference between the two groups of children with hearing aids and CI in terms of reading comprehension skills [37, 54]. Reading comprehension depends on factors such as word recognition, oral language comprehension, vocabulary, grammar knowledge, word combination and semantic interpretation of sentence, and text structures [37]. Rezaei et al. reported that vocabulary and language skills play a role in reading comprehension in Persian. Deaf children have significant difficulties in reading comprehension due to their incomplete knowledge of the Persian language and their poor vocabulary knowledge

[36]. Pooresmaeil et al. pointed to the important, obvious relationship between syntax comprehension and reading comprehension and stated that better comprehension of complex syntactic structures leads to better reading comprehension in cochlear implanted children [32].

3. Vocabulary in Children with CI

Children with a wider vocabulary achieve better results in reading, language, and cognitive skills [40]. Advanced vocabulary knowledge increases one's chances of getting a better job and achieving better educational outcomes in normal-hearing children [54]. Vocabulary is also very important in the reading comprehension performance of cochlear implanted children [36, 37]. Harris et al. considered vocabulary and speech reading ability to be the strongest long-term predictors of reading performance in these children [51].

Results of studies on Persian language cochlear implanted children showed a poorer vocabulary in these children than in normal-hearing children [54, 59]. For example, in a study of fourth-grade Persian-speaking children, which included normal-hearing children, cochlear implanted children, and children with hearing aids, Gholamiyan Arefi et al. found that normal-hearing children had a richer vocabulary than cochlear implanted children. However, no significant difference was observed between the children with hearing aids and those with CI in terms of their vocabulary [54]. In addition, Rahimi et al. reported poorer performance in receptive and expressive vocabulary in cochlear implanted children aged 5 to 8 years. These children had a better receptive than expressive vocabulary [59]. One study showed an evident relationship between grammar and vocabulary in Persian-speaking cochlear implanted children aged 6 to 8 years, such that grammar exercises improved the vocabulary of these children [60].

4. Story Retelling in Children with CI

Story retelling means that children often retell stories and explain a series of events in everyday conversations, which is regarded as an important strategy to promote vocabulary learning in children; because it provides numerous opportunities to learn new words through rich linguistic interactions and conversations in familiar contexts [61, 62]. CI under the first year of age leads to faster-than-usual development of story retelling skills in hearing-impaired children, such that cochlear implanted children can reach near-normal hearing levels [63]. Overall, however, these children continue to lag behind their normal-hearing peers in this skill [64-66]. The utterances of cochlear implanted children are similar to those of normal-hearing peers; however, the quality of utterances is clearly not normal, as cochlear implanted children show a lower number of subordinate clauses, a shorter average utterance, and a higher percentage of incorrect utterances [64].

There is a clear relationship between story retelling skills and reading comprehension in Persian-speaking cochlear implanted children, i.e. better story retelling ability ensures better reading comprehension [58]. The two sub-skills of macrostructure (including topic maintenance, main information and sequencing) and microstructure (including referencing, conjunctive cohesion, syntax complexity, and mean length of utterances) are investigated in the Persian story retelling test [67]. In a study of 7-year-old Persian-speaking children, Jarollahi et al. compared the performance of story retelling criteria by first graders between children with CI and/or hearing aids and normal-hearing children. They found that in general, hearing-impaired children experience many problems with macro- and micro-story retelling structures. These children show less topic maintenance, and their oral language lacks enough information to be fully understood by the listener. In addition, hearing-impaired children express story events in a less logical order compared to normal-hearing children. The authors stated that limited familiarity with language structures and limited vocabulary reduce these children's ability to engage in conversation [68]. Jalalipour et al. showed a delay in the development of story retelling skills in cochlear implanted second graders compared to their normal-hearing peers [58]. In a study by RezaeiRad et al., children with CI obtained lower scores than normal hearing children in the subtests related to contextual and semantic quality of the utterance [69]. Cued speech can improve the skill of story retelling in macrostructure and two components of microstructure including referencing and mean length of utterances [70]. Furthermore, a creative drama-based rehabilitation program can be useful in enhancing the story retelling skills of Persian-speaking cochlear implanted children by creating situations that motivate them to state sentences with complete and correct language structures [71].

Conclusion

According to the results of previous studies in Iran, Persian-speaking cochlear implanted children still have difficulty and lag behind their normal-hearing peers in terms of reading ability and its basic skills such as phonological awareness, reading comprehension, vocabulary knowledge, and story retelling, despite advances in auditory, language, and speech skills after receiving prostheses and rehabilitation programs. In addition, most studies reported no difference in reading performance between cochlear implanted children and hearing aid users with severe to profound hearing loss. The results necessitate the identification of reading problems in these children and the implementation of targeted auditory and speech rehabilitation programs to improve their reading skills. It seems that the development of reading skills in children with CI slows down over time, which in turn creates a greater gap between them and their normal-hearing peers. Considering the importance of reading in a child's professional and social future, it is necessary to design further long-term studies over longer periods to identify the extent and trajectory of reading development in cochlear implanted children in Iran. Many studies have pointed to the important role of the age of implantation in the development of reading skills, such that the younger the age at implantation is, the better the reading results will be. However, the exact

role of other factors and foundational reading skills such as language and auditory skills has been investigated in but few studies. After investigating and determining the role of each of these factors, programs and exercises can be designed with a special focus on the most effective underlying reading skill. Such interventions may be efficacious in improving the reading development in children with CI and bring their performance closer to a normal level.

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