International Journal of Pediatric Otorhinolaryngology 89 (2016) 1–5

Contents lists available at ScienceDirect

International Journal of Pediatric Otorhinolaryngology

journal homepage: http://www.ijporlonline.com/

Reading skills in Persian deaf children with cochlear implants and hearing aids

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ARTICLE INFO

Article history:
Received 15 March 2016
Received in revised form
6 July 2016
Accepted 8 July 2016
Available online 22 July 2016

Keywords:
Deaf
Hearing aid
Cochlear implant
Reading
Students

ABSTRACT

Objectives: Reading skills are necessary for educational development in children. Many studies have shown that children with hearing loss often experience delays in reading. This study aimed to examine reading skills of Persian deaf children with cochlear implant and hearing aid and compare them with normal hearing counterparts.
Method: The sample consisted of 72 s and third grade Persian-speaking children aged 8–12 years. They were divided into three equal groups including 24 children with cochlear implant (CI), 24 children with hearing aid (HA), and 24 children with normal hearing (NH). Reading performance of participants was evaluated by the "Nama" reading test. "Nama" provides normative data for hearing and deaf children and consists of 10 subtests and the sum of the scores is regarded as reading performance score.
Results: Results of ANOVA on reading test showed that NH children had significantly better reading performance than deaf children with CI and HA in both grades ($P < 0.001$). Post-hoc analysis, using Tukey test, indicated that there was no significant difference between HA and CI groups in terms of non-word reading, word reading, and word comprehension skills (respectively, $P = 0.976$, $P = 0.988$, $P = 0.998$).
Conclusion: Considering the findings, cochlear implantation is not significantly more effective than hearing aid for improvement of reading abilities. It is clear that even with considerable advances in hearing aid technology, many deaf children continue to find literacy a challenging struggle.

Acquisition of reading skills is necessary for children's educational and vocational development. Many studies have shown that children with hearing loss who use conventional hearing aids often experience delays in different aspects of reading, especially in reading comprehension [1–3]. The gap between deaf children and hearing peers tends to widen with age and, consequently, difficulties become more apparent as children progress through school. For instance, a comparable cohort of 14-year-old deaf children showed a reading delay of over 4 years on average. In this study two groups of deaf children, aged 8 and 14 years, were presented with a number of tasks designed to assess their reliance on phonological coding. Also results showed that deaf children place little reliance on phonological coding [4].

Two key components, i.e. knowledge of spoken and phonological awareness, have been found to underpin development of literacy among hearing children [5]. Similarly, those components have been shown to be important predictors of deaf children's literacy, although there are some notable differences. In some studies on complementary roles of phonological awareness and vocabulary, it was shown that phonological awareness was the strongest predictor of single word reading ability, whereas vocabulary knowledge was the strongest predictor of written sentence comprehension [6].

Technological developments in hearing aids over the last two decades have held out the prospect of increased access to speech for deaf children. Chief among the innovations that have taken place is the provision of cochlear implants [7]. Increased access to sound would promote knowledge of oral language and provide a direct route to phonological awareness. This would, in turn, be expected to have an impact on literacy [8].

There are some evidence of beneficial and facilitating effects of cochlear implantation on language comprehension and production

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http://dx.doi.org/10.1016/j.ijporl.2016.07.010
0165-5876/

in children with severe and profound hearing loss [6,9,10]. However, in contrast to the findings about spoken language development, evidence concerning the impact on reading and writing has been inconsistent [7,8]. Critical analysis of empirical studies with regard to reading achievement suggests that the lack of consistent findings might be the result of frequent failures to control potentially confounding variables such as age of implantation, language skills prior to implantation, reading ability prior to implantation, and consistency of implant use [11]. A cochlear implant is a surgically-implanted electronic device that provides a sense of sound to a person who is profoundly deaf or severely hard of hearing [12]. Cochlear implants bypass damaged hair cells and convert speech and environmental sounds into electrical signals and then send these signals to auditory nerve [13]. In fact, cochlear implantation leads to developments in oral language, auditory memory, and phonological awareness skills that are necessary for development of reading skills [7].

Previous research findings about comparison of reading skills between deaf children with cochlear implant and hearing aid have been inconsistent and contradictory. Some studies have compared literacy attainment in deaf children with cochlear implants (CI) and their peers with hearing aids (HA). Those with cochlear implants scored comparatively higher in reading and writing skills than peers with hearing aids [14,15]. Also, studies have found children with implants to be delayed when compared with hearing children [16]. In a study, Harris et al. compared reading and spelling abilities of deaf adolescents with cochlear implants (a group had been implanted before 42 months and another group later) and hearing aids. Results revealed that mean reading age was several years below chronological age for all 3 groups. However, participants in the hearing aid group performed better. Interestingly, reading levels were not predicted by age at diagnosis or degree of hearing loss, but there was a relationship between reading level and presence of phonetic errors in spelling. There were also differences in educational settings, with majority of children in the hearing aid group attending a school for the deaf, and relatively more of the children with cochlear implants attending a unit or mainstream setting.

There is a growing interest in considering implantation for children, even for those with residual hearing. In fact, it has been our personal observation that teachers of the deaf, speech-language pathologists, and specialists are referring more children for implant evaluation who have substantial aided residual hearing. These professionals observe that a proportion of such children do not progress with their HAs at the same rate as children with implants do. Parents of such children also are asking CI professionals to consider implantation, despite being informed of potential risks of further damage to inner ear structures incurred by implantation [17].

Investigators in CI centers also have begun to explore performance outcomes in children with aided residual hearing as an indirect means of evaluating CI efficacy [18]. Results generally have indicated that the best performing implant users are attaining scores equivalent to children with losses ranging from 70 to 80 dB HL. On the basis of these findings, a more in-depth investigation to compare reading abilities of children with hearing loss who use conventional amplification with abilities of children with CI seems important. Findings from such investigation may provide a useful guideline to determine whether a child with aided residual hearing can benefit from a CI, or even whether candidacy for an implant can generally be expanded to include children with substantial aided residual hearing.

There are quite a few research on reading skills in Persian deaf children with cochlear implant and hearing aid. In a previous study in Iran, Weisi et al. focused exclusively on children with a cochlear implant and did not compare outcomes with those of deaf peers who used conventional hearing aids. However, there have been considerable technological advances in hearing aids recently [19] and many children in the Iran are now using digital aids that are expected to give them better access to speech [20]. Now researchers, therefore, think it might be legitimate to ask whether children with a cochlear implant have higher literacy levels than peers who rely on hearing aids in Iran.

Accordingly and considering insufficient studies in this area, the objectives of this article was to examine and compare the reading skills of second and third grade Persian deaf children (with CI or HA) with those of normal hearing (NH), and to determine whether cochlear implantation may have significant effect on educational skills in deaf children. In fact, the study compared three groups of children (two deaf groups and one normal group) who were similar in age, nonverbal IQ, and levels of education. Two deaf groups differed in the type of aid that they were using (one group used hearing aids and another group used a cochlear implant). The second goal of this study was to assess and compare reading skills of subjects based on their educational level. The study, using standardized tests, assessed reading of nonwords, single words, and text comprehension. Authors hope that findings of this study can help health and education professionals scale up early interventional programs for deaf children.

1. Methods

The sample consisted of 72 s and third grade Persian-speaking children aged 7.8–9.4 years old. The participants were selected from elementary ordinary schools in Hamadan, Iran. Participants were divided into three groups; Group 1 consisted of 24 children (16 males and 8 females) who had unilateral cochlear implants (received the Cochlear™ Nucleus® cochlear implant). Prior to implantation, they all had been classified as profoundly deaf (losses in excess of 91 dB in the better ear). They showed improvement after implantation in the thresholds of speech frequency by 30–65 dB. The age of cochlear implantation was when they were 2 years old.

Group 2 consisted of 24 age and gender matched severely to profoundly ($71–91^{+}$) deaf children with conventional amplifying hearing aids which they used in class. Children who had used hearing aids demonstrated a 35- to 70-dB advantage particularly at frequencies >2 kHz. Both of deaf groups were attending mainstream (oral-only) schools and had never been instructed in sign language.

These two groups received individual speech training sessions with a qualified speech pathologist once per week at their schools on average. Also, they had received aural rehabilitation before entering school. As deaf children (the HA or CI users) were learning in public school, they didn't receive any therapy for literacy improvement. The inclusion criteria for deaf children were that the onset of deafness must be below the age of three and had an unaided hearing loss at least 71 in the better ear and no additional neuromuscular, visual or cognitive problems.

Group 3 consisted of 24 age and gender-matched normally hearing children whose first language was Persian and had no significant developmental disabilities according to teachers' reports. Normal hearing and deaf children were classmates and their intelligence quotients were assessed by a psychologist before school entrance and all had an IQ in the normal range. Psychologists used Persian version of Wechsler Intelligence Scale for Children-revised (WISC-R) to assess the intelligence quotient [21]. An oral mechanism exam was also conducted by the researchers to exclude cases with neuromuscular disabilities. Neuromuscular disability may effect of reading speed.

The study was approved by Ethics Committee of Hamadan