



Cochlear implant – speech and language development in deaf and hard of hearing children following implantation

Kohlearni implantat – razvoj govora i jezika kod gluve i nagluve dece posle implantacije

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Abstract

Background/Aim. Almost 200 cochlear implantations were done in the four centers (two in Belgrade, per one in Novi Sad and Niš) in Serbia from 2002 to 2009. Less than 10% of implantees were postlingually deaf adults. The vast majority, i.e. 90% were pre- and perilingually profoundly deaf children. The aim of this study was to assess the influence of improved auditory perception due to cochlear implantation on comprehension of abstract words in children as compared with hearing impaired children with conventional hearing aids and normal hearing children. **Methods.** Thirty children were enrolled in this study: 20 hearing impaired and 10 normal hearing. The vocabulary test was used. **Results.** The overall results for the whole test (100 words) showed a significant difference in favor of the normal hearing as compared with hearing impaired children. The normal hearing children successfully described or defined 77.93% of a total of 100 words. Success rate for the cochlear implanted children was 26.87% and for the hearing impaired children with conventional hearing aids 20.32%. **Conclusion.** Testing for abstract words showed a statistically significant difference between the cochlear implanted and the hearing impaired children with hearing aids (Mann-Whitney *U*-test, $p = 0.019$) implying considerable advantage of cochlear implants over hearing aids regarding successful speech development in prelingually deaf children.

Key words:

cochlear implants; deafness; hearing loss; language tests; cochlear implantation; child; child preschool.

Apstrakt

Uvod/Cilj. U periodu od 2002. do 2009. godine u Srbiji je urađeno oko 200 kohlearnih implantacija u četiri klinička centra (Beograd – KC Srbije i KBC Zvezdara, Novi Sad, Niš). Oko 10% bile su odrasle osobe sa razvijenim govorom, a oko 90% deca i to u prelingvalnoj, perilingvalnoj i ranoj postlingvalnoj fazi. Cilj ovog istraživanja bio je da se ispita u kojoj meri poboljšanje auditivne percepcije govora pomoću kohlearnog implanta utiče na razvoj razumevanja apstraktnih pojmova kod gluve i nagluve dece u odnosu na decu sa konvencionalnim slušnim aparatima i čujuću decu. **Metode.** Istraživanje je urađeno na uzorku od 30 dece: 20 gluve i nagluve i 10 čujuće. Instrument je bio test rečnik. **Rezultati.** Računajući sve pojmove (100 reči) rezultati pokazuju i dalje značajnu razliku između čujuće i gluve dece. Deca koja čuju imenovala su, opisala ili definisala svih 100 reči sa 77,93% uspešnosti. Deca sa kohlearnim implantima postigla su 26,87%, a deca sa konvencionalnim slušnim aparatima 20,32% uspešnosti na svim pojmovima. **Zaključak.** Ispitivanje razlike u poznavanju apstraktnih pojmova pokazalo je statistički značajnu razliku (Mann-Whitney *U*-test, $p = 0.019$) između dece sa kohlearnim implantima i dece sa konvencionalnim slušnim aparatima, ukazujući na to da kohlearni implant ima značajnu prednost u odnosu na konvencionalne slušne aparate u povećanju uspešnosti razvoja govora kod gluve i veoma teško nagluve dece.

Ključne reči:

kohlea, implantat; gluvoća; sluh, gubitak; jezici, testovi; kohlearna implantacija; deca; deca, predškolska.

Introduction

More than 200 cochlear implantations were performed from 2002 to 2009 in Serbia (four cochlear implant centers – Clinical Center of Serbia and Clinical Hospital Center

“Zvezdara” in Belgrade, Clinical Center of Vojvodina in Novi Sad and Clinical Center Niš). Less than 10% of patients were postlingually deaf adults while more than 90% were children with prelingual, perilingual or early postlingual deafness. Auditory deprivation and lacking of speech stimuli

leads to severe consequences in speech and language development. If early intervention during „critical period“ for speech development is missed stigma of the deaf will remain permanently and a person will be handicapped¹⁻³. Stigma of the deaf is characterized by poor speech comprehension and language communication. Cochlear implantation tends to improve auditory perception in severely to profoundly deaf children. Auditory skills of hearing impaired children are specific and variable due to different etiologic factors⁴. Listening progress improves communication capacity and overall quality of life of hearing impaired children. Numerous studies have shown considerable progress following cochlear implantation⁵. Communication skills could be severely affected by poor speech perception in case of prelingual or perilingual hearing loss^{6, 7}. Studies regarding short-term auditory memory for short words have shown a rapid increase in cochlear implanted children shortly after the implantation⁸. Auditory perception is not the only variable inducing speech and language development⁷⁻⁹. A whole lot of factors such as intelligence, rehabilitation, education, social and psychological issues could affect speech and language of hearing impaired children. Severe to profound deafness affects not only listening and speech but changes the whole deaf personality¹⁰.

The aim of the study was to assess the impact of improved auditory perception on speech and language development in cochlear implanted children. Abstract words are hard to understand and acquire for severely to profoundly deaf children. Therefore, we decided to evaluate communication outcome in deaf children with cochlear implants and hearing aids in comparison with their hearing peers.

Methods

The overall sample in the study consisted of 30 children aged 4 to 7 years, divided into three groups: E1 – 10 deaf children with cochlear implants, E2 – 10 deaf children with

hearing aids and C – 10 hearing children of the same age. All of the deaf children in this study had a severe to profound congenital hearing loss. They were enrolled in speech and hearing rehabilitation in Audiology Rehabilitation Department of Institute for ENT&HNS of Clinical Center of Serbia, Belgrade.

There is a lack of valid instruments for speech and language evaluation in children. „Vocabulary test“¹ is an instrument for language evaluation in children aged 3–7 years. It has 100 items divided into five groups of 20 words each, according to age, for 3-, 4-, 5-, 6- and 7-year old children. The test for 3-year-old children has 9 common and 1 abstract word. The number of abstract words gradually rises so that the test for 7-year-old children consists of 5 common and 15 abstract words. It represents vocabulary and understanding abstract words, such as death, life, punishment, satisfaction, etc. The test results were evaluated as follows: absent (0), recognizes the word (1), describes the word (2) and defines the word (3).

The data were statistically analysed and displayed in tables and graphs. Mann-Whitney-*U*-test for small independent samples was used.

Results

Table 1 shows overall results of the vocabulary test for all three groups. The hearing children had much better achievements than hearing impaired children in both E1 and E2 groups. We would like to point out superior results of cochlear implanted children as compared to children with hearing aids.

Table 2 shows the list of the least recognized words for all three groups. The hearing children did not recognize the word *purpose*, except one kid. The list of the abstract words that were not recognized by cochlear implanted children consisted of 25 items, whereas the list of words that the children with hearing aids did not recognize was considerably longer (36 items).

Table 1

Overall results of the vocabulary test

Group	All words				Abstract words			
	AS	%	+	-	AS	%	+	-
Control (C)	2.33	77.93	2.76	1.34	2.07	69.01	2.59	0.68
E1	0.80	26.87	1.18	0.16	0.32	10.57	0.62	0.06
E2	0.60	20.32	0.95	0.17	0.11	3.69	0.32	0

C – hearing children; E1 – cochlear implanted children; E2 – children with hearing aids; AS – average score; (+) – best score in the group; (-) – worst score in the group

Table 2

The least recognized abstract words

Group	Abstract words	Points
Control (C)	purpose	3
E1	compassion, belief, purpose, respect, defeat, choice, progress, crime, construction, trust, need, truth, punishment, knowledge, success, hope, fortune, courage, battle, future, peace, strength, satisfaction, work, freedom	0
E2	life, story, work, happiness, friend, death, satisfaction, strength, peace, laughter, pain, future, battle, courage, fortune, hope, success, wedding, knowledge, punishment, truth, Wednesday, need, trust, construction, crime, progress, choice, guilt, defeat, respect, purpose, husband, poison, belief, compassion	0

C – hearing children; E1 – cochlear implanted children; E2 – children with hearing aids

Table 3 shows a comparison of the overall results for all three groups of the children. The overall achievement of cochlear implanted children (E1) was superior to the results of the children with hearing aids (E2) but the difference was not statistically significant.

Table 4 shows a comparison of the results for abstract words for all three groups. Ability to describe and define abstract words was highest in rehabilitation of congenitally deaf children. The superior achievement of the children with cochlear implants regarding abstract words understanding is clearly emphasized in Table 4.

laughter, pain, future, battle, courage, fortune, hope, success, wedding, knowledge, punishment, truth Wednesday, need, trust, construction, crime, progress, choice, guilt, defeat, respect, purpose, husband, poison, belief, compassion) (Table 2).

The hearing children were superior to both experimental groups with cochlear implant (E1) and hearing aids (E2), in defining both common and abstract words. Such results were expected. Congenital or early acquired prelingual hearing loss interferes with speech and language development affecting phonological, semantic and

Table 3

Comparison of overall results			
Group	Average range	Mann-Whitney <i>U</i> -test	<i>p</i>
Control (C)	15.50		
E1	5.60	1.00	0.000*
C	15.50		
E2	5.50	0.00	0.000*
E1	12.35	31.50	0.165
E2	8.65		

C – hearing children; E1 – cochlear implanted children; E2 – children with hearing aids; *significant

Table 4

Comparison of the results for abstract words			
Group	Average range	Mann-Whitney <i>U</i> -test	<i>p</i>
Control (C)	15.50		
E1	5.50	0.00	0.000*
C	15.50		
E2	5.50	0.00	0.000*
E1	13.55	19.50	0.019*
E2	7.45		

C – hearing children; E1 – cochlear implanted children; E2 – children with hearing aids; *significant

Discussion

Analysis of the results revealed that regarding abstract words all of the children achieved best results for words *mother, love* and *friendship*. All of them found those words familiar and easy to define. Quantitative analysis showed that the deaf kids had a limited vocabulary and poor grammar, but nevertheless they understood the meaning (example, from the group E1 – S.P. “Mother – mom is mine, loves you, gives milk” and from the control group of hearing kids – N.M. “Mother – everyone has got a mother, that is the most important...”).

The hearing children from the control group described all of the words, yet they did not reach the maximal score of 141 (3 points for each word), but only 97 (69%). Among 47 abstract words the word *purpose* was the least recognized. Only one kid described it and got 3 points.

The cochlear implanted children (E1) did not recognize 25 out of 47 abstract words (*compassion, belief, purpose, respect, defeat, choice, progress, crime, construction, trust, need, truth, punishment, knowledge, success, hope, fortune, courage, battle, future, peace, strength, satisfaction, work, freedom*) while the children with hearing aids (E2) did not recognize 36 words (*life, story, work, happiness, friend, death, satisfaction, strength, peace,*

every other aspect of speech¹¹. Early intervention with hearing aids or cochlear implant could reduce the consequences of deprivation but never fully eliminate them so that backlog compared to the hearing peers is always obvious.

The difference in overall achievement for both children with cochlear implants and hearing aids is not statistically significant (Table 3).

It complies with findings of other authors that the deaf child development is influenced by multiple factors^{7,12}. Regardless of the type and quality of amplification some kids are better communicators than others. All of the children in both experimental groups (E1 and E2) were enrolled in continuous speech and hearing rehabilitation, so that their vocabulary was fairly developed and they were capable of solving these tasks. When it comes to abstract words there is a significant difference in hearing in cochlear implanted over children with hearing aids (Table 4). Cochlear implanted children were so far superior to deaf children with hearing aids regarding speech perception. They have much better auditory skills (detection, discrimination, identification and comprehension) and they perform better on the Ling 6-sound test, phonemes, logatomes, short words, polysyllables, sentences⁷. Congenitally deaf children develop speech perception and consistency in the first three

years following cochlear implantation. Children implanted before the age of 2 years could reach their hearing peers by the age of 6, if they are subjected to intensive speech and hearing rehabilitation¹³⁻¹⁵. Comparison of the results in this study with other authors findings was not possible, because of language differences. There are no available studies in Serbian language or similar languages like Croatian or Bosnian. Complete results for 100 words showed significant difference between hearing and deaf children (Tables 1 and 3). The overall success rate was 77.93% for the hearing children (C), 26.87% for the cochlear implanted (E1) and 20.32% for the deaf children with hearing aids (E2) (Table 1). The difference for abstract words was statistically significant (Mann-Whitney *U*-test, $p = 0.019$) between the groups E1 and E2 which suggest that cochlear implant significantly contributes to speech development in profoundly deaf children.

Conclusion

Cochlear implantation has statistically significant impact on speech and improves auditory skills and language development in the deaf children. There is an abstract words acquisition, with no statistically significant difference in vocabulary of the cochlear implanted and the deaf children with hearing aids, although the cochlear implanted children show better overall scores of the described and defined words.

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