JMS 2021;4(1):118-125
UDC:616.282.1-76:159.946.3

ASSESSMENT OF SPEECH DEVELOPMENT IN SUBJECTS WITH PRELINGUAL HEARING IMPAIRMENT PRIOR TO OR AFTER COCHLEAR IMPLANTATION

Vesna Lazarovska
Hearing, Speech and Voice Rehabilitation Center, Skopje
Faculty of Medicine, Ss. Cyril and Methodius University in Skopje, R. North Macedonia

Abstract

Hearing is one of the most important features that every human being possesses, one of the five senses along with sight, smell, taste, and touch.

This function is accomplished owing to the complex mechanism of the sensory organ for hearing, the ear, and its coordination with the nervous system.

The impairment of the cochlear normal function, impairment of the transduction of the mechanical acoustic signal in the synaptic activity of the auditory nerve leads to disorders of the complex ear mechanism.

The aim of this study was to evaluate the speech development, that is, to assess the speech-voice development by using the Test for recognition of simple questions in the period of 6, 12 and 24 months.

The results of the test for development of hearing perception showed progression during the examined period.

Subjects in whom cochlear implant was placed in the younger age showed better results at the Test for recognition of simple questions and they recognized the meaning of a larger number of questions.

This was statistically confirmed with calculated correlations between the age when the intervention was realized and the number of perceived simple questions at 6, 12 and 24 months post-implantation. All three correlations were negative and statistically significant.

***Keywords*:** impaired hearing, cochlear implant, hearing perception, speech development

Introduction

Cochlear implant is a kind of artificial ear that conveys auditory information via the central nervous pathways by electrical stimulation of the auditory nerve fibers.

The development of cochlear implants started with the research done by Djourno and Euries. For the first time in 1982 the first implant system was clinically used [1-6].

Over the last fifteen years more than thirty different cochlear implants have been developed [7-10].

By the improvement and advancement of the design and site of electrode implantation a better contact of the electrodes with the inner wall of scala tympani has been enabled, thus reducing the stimulus threshold and increasing the dynamic range and selectivity to the relevant stimulus [11-16].

A large number of studies have been conducted and they analyzed the correlation between the hearing and speech.

Dialectical relationship between the hearing and speech is known, but the importance of the hearing has to be emphasized since it preconditions the speech.

The improvement of implants and especially the strategy for speech encoding has enabled a wide range in selection of candidates for cochlear implantation [17].

Material and Methods

For accomplishing the set aim a retrospective-prospective study was conducted comprising 31 subjects with prelingual sensorineural hearing loss/impairment.

In the beginning binaural behind-the-ear hearing amplifiers were applied to all included study participants; they were tested and the benefit from the hearing aids was determined. Later, cochlear implantation was made in all participants and the results were analyzed.

The study was realized at the Hearing, Speech and Voice Rehabilitation Center in Skopje and the University Clinic for Ear, Nose and Throat in Skopje. The subjects/participants were followed in a period of 6, 12 and 24 months.

The following aims were set:

1. To determine the dynamics of speech development in subjects with prelingual hearing impairment (with behind-the-ear hearing amplifier);
2. To determine the dynamics of the speech development in the same subjects (with cochlear implant)**;**
3. To make a comparative analysis of the dynamics of speech development with behind-the-ear hearing amplifier and with a cochlear implant. For determination of the significance in difference of the analyzed tests among subjects prior to and after the implantation of the hearing amplifier and implantation of cochlear implant as well as among subjects with inserted cochlear implant 6, 12 and 24 months following implantation, non-parametric tests for two or more independent samples were used (McNemar test and Cochran's Q test);
4. To determine the benefit of using the behind-the-ear hearing amplifiers and the benefit of cochlear implants;
5. To determine the dynamics of the development of speech perception within the period of 6, 12 and 24 months.

Results and Discussion

Table 1, Figures 1a, 2b, 1c illustrate the distribution of subjects with regards to their ability to imitate questions such as *What is your name?, What color are your shoes?* and *Where is your hearing aid?* at 6, 12 and 24 months after cochlear implantation.

Cochran's Q test confirmed a significant difference in the ability of subjects to imitate these three questions in the two-year period of using the cochlear aid, which was due to a positive test obtained in a significantly larger number of subjects after 12 and especially after 24 months.

Tested differences in the time intervals with the McNemar's test were not confirmed as significant, except the difference in the ability to imitate the question *Where is your hearing aid?* in the 12/24-month period.

Table 1. Test for recognition of simple questions

Imitate		**6 months**		**12 months**		**24 months**	
		number	%	number	%	number	%
What is your name?	Yes	13	41.9	27	87.0	29	93.5
	No	16	51.6	2	6.5	0	0
	No answer	2	6.5	2	6.5	2	6.5
CochranQ=28.5df=2 p=0.000001 6 / 12 / 24							
6/12 McNemar=12.07 df=1 p= 0.0005							
What color are your shoes?	Yes	0	0	8	25,8	19	61,3
	No	29	93.5	21	67.7	10	32.2
	No answer	2	6.5	2	6.5	2	6.5
CochranQ=28.74df=2 p=0.000001 6 / 12 / 24							
12/24 McNemar=9.1 df=1p= 0.0026							
Where is your hearing aid?	Yes	8	25.8	22	70.9	27	87.0
	No	21	67.7	7	22.6	2	6.5
	No answer	2	6.5	2	6.5	2	6.5
CochranQ=30.63 df=2 p=0.00000 6 / 12 / 24							
6/12 McNemar=5.3 df=1 p= 0.0769 6/24 McNemar=8.3 df=1 p= 0.0048 12/24 McNemar=3.2 df=1 p= 0.074							

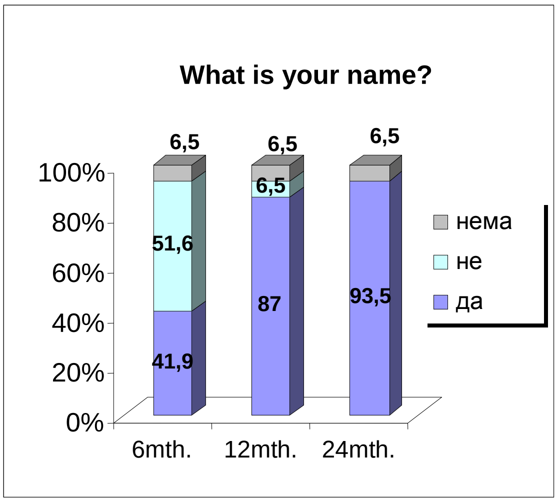

Figure 1a. Imitating the question
What is your name?

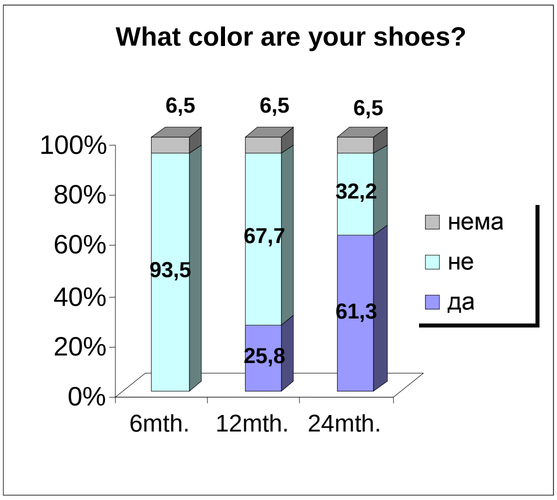

Figure 2b. Understanding the question
What colour are your shoes?

Figure 1c.

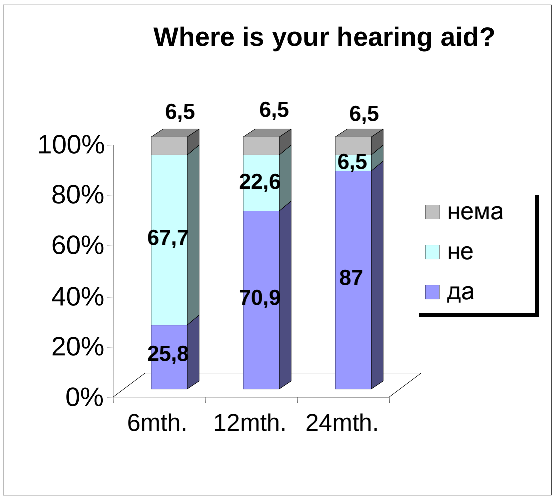

Figure 2c. Understanding the question Where is your hearing aid?

Table 2, Figuress 2a, 2b, 2c show the ability of subjects to understand the questions analyzed in Table 1. It is obvious that the smaller period since the implant insertion has passed, the poorer results are achieved.

For example, there were no subjects who understood the question *What color are your shoes* at 6 and 12 months following the implantation, whereas after 24 months only 2 subjects had that ability. These differences were statistically significant

Table 2. Test for recognition of simple questions

Understood		**6 months**		**12 months**		**24 months**	
		number	%	number	%	Number	%
What is your name?	Yes	6	19.3	19	61.3	26	83.8
	No	23	74.2	10	32.2	3	9.7
	No answer	2	6.5	2	6.5	2	6.5
CochranQ=30.9 df=2 p=0.00000 6 / 12 / 24							
6/12 McNemar=11.08 df=1 p= 0.00087 6/24 McNemar=18.05 df=1 p= 0.00002 12/24 McNemar=5.14 df=1 p= 0,023							
What color are your shoes?	Yes	0	0	0	0	2	6.5
	No	29	93.5	29	93.5	27	87.0
	No answer	2	6.5	2	6.5	2	6.5
CochranQ=4.0 df=2 p=0.13 6 / 12 / 24							
Where is your hearing aid?	Yes	0	0	8	25,8	12	38,7
	No	29	93.5	21	67.7	17	54.8
	No answer	2	6.5	2	6.5	2	6.5
CochranQ=17.23df=2 p=0.00018 6 / 12 / 24							
12/24 McNemar=1.5 df=1 p= 0.22							

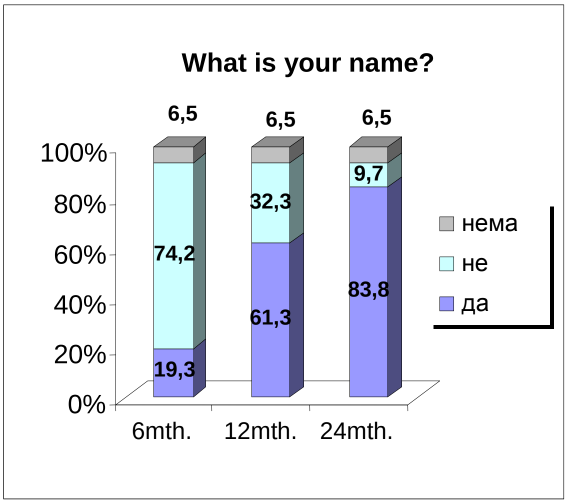

Figure 2a. Understanding the question. What is your name?

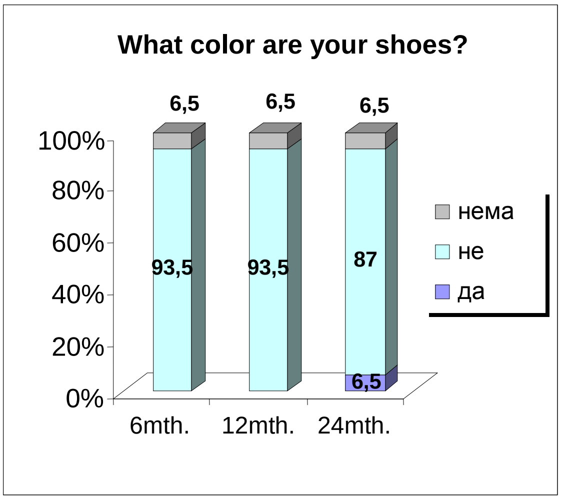

Figure 2b Understanding the question What colour are your shoes?

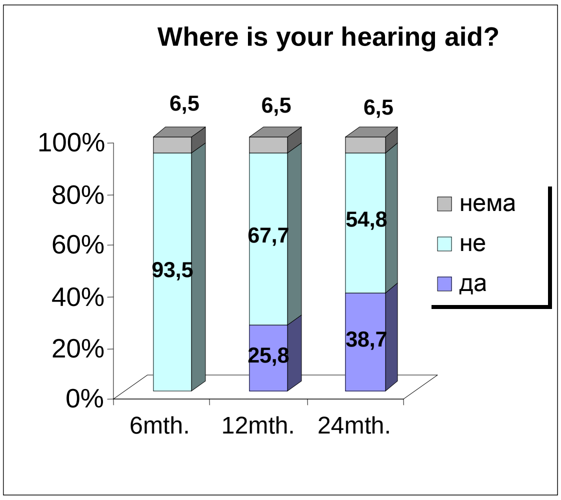

Figure 2c. Understanding the question Where is your hearing aid?

Conclusion

Hearing and verbal perception in subjects with prelingual hearing impairment was statistically significantly better in comparison with the results obtained in the same subjects when they used hearing amplifiers.

Hearing and verbal perception in subjects with prelingual hearing impairment with cochlear implant was improved during the rehabilitation treatment and was proportional to its duration, that is, the longer cochlear implant was used the better results were achieved.

References

1. Clark GM, Hallworth RJ. A multiple electrode array for cochlear implantation in deaf patiens. Med Prog Technol. 1976; 5:127.
2. Clark GM. The University of Melburne Nucleus multielectrode coclear implant Adv Otol Rhinol Laryngol. 1987; 38:1-129.
3. Clark GM. A multiple electrode array for cochlear implant. J Laryngol Otol. 1976; 90: 623-627.
4. Clark GM. A multiple electrode intracochlear implant forchildrenArchOtorynolaryngol.1977; 113:825-828
5. Clark GM. Desigen and fabrication of the banded electrode array. AnnNew York Acad Sci. 1983; 405:191-201
6. Patrick JF, Clark GM. The Nucleus 22-channel cochlear implant system. Ear Hear. 1991; 12[Supp11]:3S-9S.
7. Gantz BJ. Cochlear implants: an overview. Adv Otolaryngol Head Neck Surg;1987; 1:171-200.
8. Gantz BJ, Tyler RS, Knutson JF. Evaluation of fibe different cochlear implantde signs: audiologic assessment and predictor of performance. Laringoscope. 1988; 10: 1100-1106.
9. Gantz BJ, Tyler RS, Woodford G, Tye-Murray N, Frauf- Bertschu H. Results of multichannel cochlear implants in congenital and acquired prelinqual deafness in children: Five-year follow up. Am J Otol. 1994;15: 1-8.
10. Gantz BJ, Ryler RS, Woodford GG. Results of multichannel cochlear implants in congenital and acquired deafness in children: five-years follow-up. Am J Otol. 1994;2 [Supp11]:1-34. 55. 11.
11. Clark GM. Cochlear implants: Future research directions. Am J Otol. 1995; 22-27.
12. Hartmann R, Shepard R, Heid S, Klinke R. Response of the primary auditory cortex to electrical stimulation of the auditory nerve in the congenitally deaf white cat. Hearing Res. 1997;112:115–133.
13. Klinke R, Hartmann R, Heid S, Tillein J, Kral A. Plastic changes in the auditory cortex of congenitally deaf cats following cochlear implantation. Audiology Neuro-Otol. 2001; 6:203–206.
14. Klinke R, Kral A, Heid S, Tillein J, Hartmann R. Recruitment of the auditory cortex in congenitally deaf cats by long-term cochlear electrostimulation. Science. 1999;285:1729–1733.
15. Kral A, Hartmann R, Tillein J, Heid S, Klinke R. Congenital auditory deprivation reduces synaptic activity within the auditory cortex in a layer-specific manner. Cerebral Cortex 2000;10:714–726.
16. Wilson BS, Finley CC, Lawson DT, Zebri M. Temporal representation with cochlear implants. Am J Otol. 1997;18 30-34.
17. Wilson BS. Engineering Design of Cochlear Implants. In: Zeng FG, Popeer AN, Fay RR, editors. Cochlear Implants: Auditory Prostheses and Electric Hearing. New York: Springer; 2004. pp.14.

18. Wilson BS, Finley CC, Lawson DT. Wolford RD. Eddington DK. Rabinowitz WM. Better speech recognition with cochlear implants. Nature. 1991; 352;236-238.