Article

Advantages of bilateral cochlear implantation

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Abstract: The authors studied the indicators of speech intelligibility – a critical indicator of the effectiveness of cochlear implantation (CI) in patients with deafness. The purpose of the study was to compare results of speech audiometry in deaf patients with single-side and bilateral cochlear implantation (CI). The study was conducted in children aged 6 to 17 years with matured speech skills. The results showed that speech intelligibility in group with bilateral CI higher than in single-side CI group. Bilateral cochlear implantation has more potential for efficient speech rehabilitation than single-side CI.

Keywords: deafness, cochlear implantation, speech audiometry.

Citation: Pashkov A., Voevodina K., Naumova I., Popadyuk V., Pashkova A. Heart Rate Variability, Advantages Of Bilateral Cochlear Implantation Otorhinolaryn-gology, Head and Neck Pathology (ORLHNP). 2023; 2 (4): 28-30

https://doi.org/10.59315/ORLHNP.2023-2-4.28-30

Academic Editor: Valentin Popadyuk

Received: 13.12.2023
Revised: 20.12.2023
Accepted: 01.01.2024
Published: 30.01.2024

1. Introduction

Cochlear implantation (CI) is a technology of insertion an electrode system in the cochlea to stimulate the auditory nerve with subsequent rehabilitation. This is the method of choice for patients with bilateral deafness associated with damage to the cochlea. In recent years, according to various studies, there has been a steady increase in the number of children with bilateral sensorineural deafness who underwent CI on both sides [1]. The choice of this solution is mainly reasonable by the possibility of determining the sound source in space (ototopic) and the relatively higher rates of speech intelligibility, which become available due to spatial hearing in bilateral CI [2].

Traditionally bilateral hearing provides intelligibility, localization of the sound source, understanding of speech in a noisy environment and sound perception with sufficient volume. One of the functions of the auditory analyzer is to isolate "useful" sound/speech information, including from several sound sources, which "asymmetric" hearing cannot potentially provide [3]. In a complex acoustic space, a person's head creates a shadow effect, which works as an acoustic barrier and weakens the intensity of the sound signal, including speech on the one hand. The effect of noise reduction is the ability of the brain to isolate a useful auditory (speech) signal coming binaurally. The mutual amplification effect, also known as loudness summation, refers to the same perception on both sides due to balanced action potentials emanating from both auditory nerves to the brain stem. Localization (ototopy) is the ability to perceive the direction of the sound source, which helps in orientation [4]. All these effects should be taken into account in the rehabilitation of patients with deafness who underwent CI surgery.

The number of children born annually with bilateral deafness is approximately 1 in 1000 [5], and the number of CI operations performed in the Russian Federation is in the range of 1500 annually, which imposes additional requirements on the constant search for solutions to improve the effectiveness of cochlear implantation.

2. Patients and Methods

The present study analyzed the data of 61 patients with bilateral sensorineural deafness (n=61) who were users of the CI system. The age of the subjects varied from 6 to 17 years (Me=12±2.9). By gender, patients were distributed as follows: girls - 37.7% (n=23), boys - 62.3% (n = 38). Unilateral cochlear implantation was performed in 54.1% of cases (n=33), bilaterally in (n=28) 45.9%. The default sound processor (SP) microphone gain was 90% in all observations. Criteria for non-inclusion in the study were: abnormal development of the cochlea, previous meningococcal infection, incomplete insertion of the electrode array into the cochlea, or deactivation of one or more electrodes. To assess speech intelligibility, all children underwent speech audiometry via processor in a free field. The study was carried out according to the traditional method: with the supply of speech material with an intensity of 65 decibels (dB) of sound pressure level (SPL) through loudspeakers located at an angle of 45° at a distance of 1 meter from the SP microphone. Speech audiometry was performed in a quiet environment. The residual noise level was less than 50 dB SPL.

Statistical analysis

Statistical analysis was performed using the IBM program © SPSS Statistics New Seas Subscription © version 25.0.0. The sample was tested for normal distribution using the Smirnov-Kolmogorov and Shapiro-Wilk tests (p-value≥0.05).

Descriptive statistics were used with the calculation of the mean, standard deviation, median, mode, standard error of the mean, analysis of frequency tables. An exploratory analysis was used to compare speech intelligibility scores in patients with unilateral and bilateral cochlear implantation.

3. Results and discussion

All patients demonstrated a high level of development of auditory speech skills: speech intelligibility ranged from 33 to 100% (Me=90±14.2) In the group of patients with unilateral CI, speech intelligibility ranged from 33% to 100% (Me=87.0±17); in patients with bilateral implantation, speech intelligibility ranged from 78 to 100% (Me=93.5±5.8). Analysis of the data showed that the group of patients with bilateral cochlear implants demonstrated higher speech intelligibility scores compared to patients who underwent CI on one side (Fig. 1.) A statistically significant relationship was established between the number of cochlear implants in a patient and speech intelligibility scores (p =0.046).

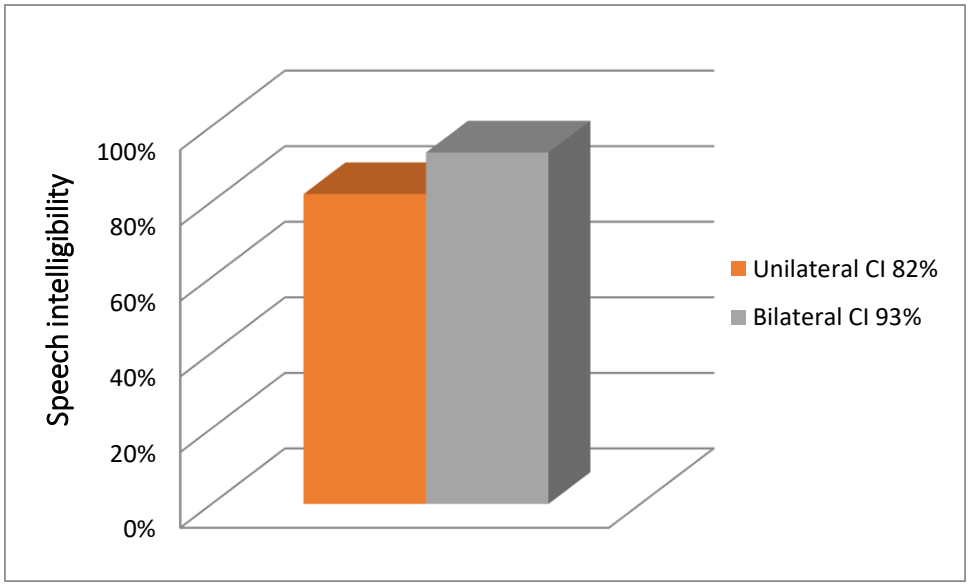

Figure 1. Speech intelligibility in patients with unilateral and bilateral CI.

4. Conclusions

The data obtained show that children with bilaterally installed CI systems have higher rates of speech intelligibility, which potentially brings them closer to their normal hearing peers in terms of cognitive development. However, bilateral cochlear implantation alone does not allow patients to achieve the same level of academic achievement as their normal hearing peers, even taking into account the duration of deafness and the timing of the surgery [6]. There are other factors that explain the differences in academic performance between children with bilateral CI and normal-hearing peers. These reasons include the possible lack of coordinated activation of the microphones of the processors of both ears to the incoming stream of speech information, as well as the discrepancy in the presentation of the contacts of the electrode array and the tonotopic representation of one or another frequency region of the organ of Corti [1]. If the solution of the first problem has a purely technical basis and can be performed during the evolution of CI systems, then the discrepancy in the anatomical parameters of the depth of insertion of the CI electrode array and the location in the cochlea requires further study using radiation diagnostic technologies.

Author Contributions: Conceptualization, **A.P.**, I.N. and A.P.; methodology, V.K. and N.I.; software, V.K.; validation, A.P., M.F. and A.P.; formal analysis, N.I.; investigation, M.F. and G.M.; resources, A.P.; data curation, A.P..; writing—original draft preparation, A.P. and I.N.; writing—review and editing, A.P., I.N. and F.M..; visualization, K.V.; supervision, A.P., V.P.; project administration, A.P. All authors have read and agreed to the published version of the manuscript."

Funding: Not specified.

Institutional Review Board Statement: Informed consent was obtained from all subjects involved in the study.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Dhanasingh A., Hochmair I. Bilateral cochlear implantation // Acta Oto-Laryngologica. - 2021. - T. 141. - No. sup1. - S. 1-21. doi.org/10.1080/00016489.2021.1888193
2. Litovsky RY, Gordon K. Bilateral cochlear implants in children: Effects of auditory experience and deprivation on auditory perception. Hear Res. 2016 Aug;338:76-87. doi: 10.1016/j.heares.2016.01.003. Epub 2016 Jan 30. PMID: 26828740; PMCID: PMC5647834.
3. Kumpik DP, King AJ. A review of the effects of unilateral hearing loss on spatial hearing. Hear Res. 2019 Feb;372:17-28. doi: 10.1016/j.heares.2018.08.003. Epub 2018 Aug 11. PMID: 30143248; PMCID: PMC6341410.
4. Myhrum M, Strøm-Roum H, Heldahl MG, Rødvik AK, Eksveen B, Landsvik B, Rasmussen K, Tvete OE. Sequential Bilateral Cochlear Implantation in Children: Outcome of the Second Implant and Long-Term Use. Ear Hear. 2017 May/Jun;38(3):301-313. doi: 10.1097/AUD.0000000000000383. PMID: 27828788.
5. Universal audiological screening of newborns and infants. Daihes N.A., Tavartkiladze G.A., Yablonsky S.V., Yasinskaya A.A., Gvelesiani T.G., Kuyan S.M., Zagoryanskaya M.E., Pashkov A.V., Guz E. IN. A guide for doctors / Moscow, 2007. - 21p.
6. Pashkov Aleksandr V., Namazova-Baranova Leyla S., Vishneva Elena A., Naumova Irina V., Zelenkova Irina V. Hearing Loss Effect on the Educational Process in Children and Adolescents. Voprosy sovremennoi pediatrii — Current Pediatrics. 2020; 19 (4): 272–278. doi: 10.15690/vsp.v19i4.2134