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Research Article

Language Skills in Pediatric Patients Cochlear Implant Users

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Keywords

- Cochlear implant
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Abstract

Objective: The aim of the study is to describe the linguistic skills achieved by implanted patients from 0 to 24 months of age of hearing.

Methods: We included 36 pediatric patients with bilateral deep sensorineural hearing loss, cochlear implant users, who, at the time of implantation, had 1 year (n = 15) and 2 years (n = 16), with the use of a cochlear implant of more than 8 hours a day. This was done prior to the placement of the cochlear implant, as well as to the months: 1, 3, 6, 9, 12, 18 and 24 after the placement. For the processing of the data, the Wilcoxon nonparametric test was carried out (statistical significance with $p < 0.05$).

Results: The 2-year-old group at the time of implantation showed the best performance in the tests applied. The group of tests to evaluate "speech perception" was the one in which the most progress was observed in both groups, while in the "receptive language" it was the worst performance.

Conclusion: Early diagnosis and early cochlear implantation around 12 months of age in children with profound hearing loss should be prioritized to maximize auditory development and subsequent language learning, as it can provide a significant advantage for the achievement of spoken language observed at 5 years of age.

INTRODUCTION

Deep sensorineural hearing loss has a significant impact on the acquisition and development of oral language in affected children. The cochlear implant (CI) allows the development of language in this population of children, in which the benefit with the use of hearing aids is limited and is a great promise to facilitate a great advance in language development. Specifically, it has been shown that the recovery of hearing ability improves oral language, sound perception and speech recognition [1].

The objective of cochlear implantation is to stimulate hearing in structures of the inner ear, through a coded signal that is sent to a matrix of electrodes, which stimulates directly the auditory nerve. In conjunction with auditory-verbal rehabilitation after implant placement, it improves auditory functionality and language development [2].

A cochlear implant is most beneficial when placed before the age of three years, allowing the young child to be exposed to sounds during the so-called critical period, in which neurological skills are developed allowing better language learning. Children who receive a CI between the ages of 12-24 months achieve higher levels of language comprehension and use, as well as faster growth rates in the domain of language [3].

Language is a system of codes with the help of which are designated the objects of the external world, their actions, qualities and relationships between them; on the other hand, speech is the physical and perceptive execution of language. The skills of speech perception, expressive language (that is, the production of language, oral expression behavior constantly readjusted as a function of auditory information) and receptive (capturing and understanding the spoken signal) are part of the language development of all human being, starting with babbling at 6 months of age, first word or bisyllabic word at 12 months, juxtaposed word at 18 months, short phrases at 24 months [4-6].

The expressive vocabulary corresponds to the lexicon, which can be emitted by the child and is evaluated by the number of words it produces. Therefore, it is possible to evaluate the expressive vocabulary from the moment the child begins to speak [7].

Receptive vocabulary is necessary for the reception and processing of information and is one of the most important measurements of intellectual ability. The acquisition of receptive vocabulary in children with normal development is directly related to the cognitive development of inferential capacity, since the use of contextual information and phrases to infer meanings in front of unknown words is one of the main ways to acquire vocabulary [8].

The auditory development in a normal-hearing patient, within the first year of age, in which children acquire a wide range of

auditory-perceptual discrimination and previously unrecognized skills, such as the development of word segmentation skills between 7.5-10.5 months of age, the ability to associate words with people, common objects and body parts at 6 months; are the main justification for performing cochlear implantation at younger ages.

All the emerging abilities of babies to process spoken linguistic content depend on listening and paying proper attention to the sounds of the baby's native language, probably starting at birth [9].

It has been shown that children implanted before the age of 1 year and after a period of 3-8 months of CI use, can reach the level of listening necessary to start the production of vocal babbling [10].

Auditory age is the time in which the children with a hearing loss use their CI, appropriately programmed, and use it all the hours they are awake, from day zero. Pollack and Northcott called the hearing age "Child's hearing age" and used it to help parents to have an idea of their expectations regarding the progress of a child after the beginning of the use of hearing aids.

As time goes by, the difference between the chronological age and the auditory age should be shortened until the level of language development is matched to the chronological age. This is the goal of auditory and language habilitation.

The objective of this work is to describe the linguistic skills achieved by implanted patients from zero to 24 months of hearing age [11], with the purpose of assessing speech perception, expressive language, and receptive language.

All evaluations should evaluate the level of development of the child's auditory skills according to their maturational age (detection, discrimination, identification and comprehension) [12].

METHODS

This study was conducted at Instituto Nacional de Rehabilitación LGII (INR-LGII), once the approval of the Research Ethics Committee was obtained, with the definitive registration number of the research protocol: 76/17 AE-T1.

Participants

From a total of 132 patients implanted at INR-LGII, both sexes, localized in the Metropolitan Area of Mexico City from November 2007 to June 2018, 36 pediatric patients with bilateral deep sensorineural hearing loss, cochlear implant users, were included, who, at the time of implantation, had 1 year (n = 15) and 2 years (n = 16), with the use of a cochlear implant of more than 8 hours a day and ongoing follow-up in the audiology service, where audiological studies, periodic mappings and modifications were carried out according to the needs of each patient, in addition to regular assistance to Hearing Therapy (Auditory-Verbal Method). We excluded patients who had less than 1 year and more than 2 years of follow-up for language therapy.

Instruments

Therapy and language evaluation was carried out in the Hearing Therapy service. We analyzed the data obtained in the report made in each patient assessment, based on the Latin American Cochlear Implant Protocol, which consists of the selection and exclusion criteria in the different groups of patients, preoperative and postoperative assessment of the patient with a cochlear implant.

The report consisted in the evaluation of linguistic skills divided into 3 groups: speech perception that includes: identification, detection of 6 Ling sounds, and detection of sound source and identification of consonants. In relation to expressive language; evaluates babbling, vocalization, one word utterance, juxtaposed word, sentences of 2, 3, 4 words, structured phrases and open phrases with and without support and receptive language that includes discrimination of environmental and onomatopoeic sounds, discrimination of intensity and tone, discrimination with words of different syllables, gross sentence discrimination, closed series, disyllables, fine discrimination, minimum pair discrimination, dictation discrimination, dialogue and conversation.

The evaluations were made prior to the placement of the cochlear implant, as well as at month 1, 3, 6, 9, 12, 18 and 24 months after the placement of the same.

Type of study

Retrospective and descriptive.

Statistical analysis

For the processing of the data, a non-parametric Wilcoxon test was carried out, taking into account a statistical significance when the value of $p < 0.05$.

RESULTS

In the group of those implanted at one year of age, the items that evaluated speech perception, it is observed that most of them achieved a strong statistical significance after 3 months of age, but not in the detection of sound source and that of the 6 Ling sounds whose statistical significance could be observed from the first month after activation of the cochlear implant; in the group of those implanted at 2 years of age, for the item identifying Ling sounds, the significance began after 6 months (Table 1).

In the group of those implanted at one year of age, in the items that evaluated the expressive language, it is observed that the babbling shows statistical significance only in month 12. However in the other months this trend is not observed; for the group implanted at 2 years, significance is observed from the first month and maintained after the cochlear implant is switched on.

In the group of one year of age of implantation, we found that in vocalization, the statistical significance starts from 6 months after implantation and for the group of 2 years from 3 months. In the group of 1 year, the emission of the first word shows statistical significance from 9 months and in the group of 2 years of age from 3 months. Regarding the item of 2 words, the group of 1 year, statistical significance was observed from 12 months and 9 months for the 2-year group (Table 2a).

In the group of 1 year, in the item of formation of sentences of 2 words, it is observed that the significance begins after 9 months, however, the group of 2 years, begins after 18 months.

In the group of 1 year, for the items of formation of sentences of 3-4 words there is statistical significance from 18 months and for the group of 2 years in month 24. In the group of 2 years, for the item of Structured Phrases, only significance is observed after 24 months. In the 1-year group, with respect to the item of open phrases with support, significance can be observed at 18 months and at 24 months for the 2-year group. Particularly for the item of open phrases without support, no significance can be observed in any of the evaluations in both age groups (Table 2b).

In the 1-year group, the items that evaluated receptive language, in relation to the use of closed series, statistical significance was observed after 9 months and in the 2-year group from 18 months. For the bisyllabic test, significance is observed at month 12 and 24, for the 1-year group and from 18 months for the 2-year group. In the group of those implanted at one year of age, in the item of discrimination of environmental sounds and onomatopoeias, from the first month, significance was observed and in the group of 2 years after 6 months. For both age groups, the intensity discrimination item, the significance started at 3 months. In the group of 1 year, the discrimination of tone, beginning significance from 3 months and in the group of those implanted at 2 years of age from 9 months (Table 3a).

In the group of 1 year, the word discrimination item with different syllables, showed statistical significance from 9 months and in the group of 2 years from 12 months. In both groups, the coarse discrimination of sentences with key words began after 12 months and in relation to fine discrimination, the significance began after 18 months.

In both age groups, the items destined to minimum pairs discrimination, dictation, dialogue and conversation, did not present statistical significance in any of the months evaluated (Table 3b).

DISCUSSION

With regard to speech perception, it is evident that children with cochlear implants achieve higher scores in tests that evaluate this linguistic ability, related to the earlier implantation ages and the longer duration of the use of the cochlear implant [13].

Other studies, in which the CI has been placed before 12 months of age, reveal that there is improvement in speech perception; early childhood communication and auditory perception [9]. However, in the groups of patients studied, it was very similar between the one-year group and the two-year-old group at the time of implantation, except for the items that evaluated sound source detection and 6 Ling sounds, where they were presented earlier in the group of those implanted at one year of age. Because children have the greatest access to the sound provided through the cochlear implant to develop expressive and receptive language skills over time [13-18].

In relation to the development of expressive language, compared to the development of the normal-hearing child, we find that the babbling in the normal-hearing child begins at 6 months of age, however, in the one-year-old group, it started at 12 months after implantation and in the group of 2 years to the first month after implantation, these data differ with the published, since the hypoacoustic patient presents babbling in a similar way to the normal-hearing child, but as there is no greater auditory stimulation, this does not progress as in the normal child. It is expected that the first word in the normal, developed around 12 months of age, in our groups of children, it was observed that in the group of those implanted a year, it started after 9 months post-implant and in the group from 2 years to 3 months, again, the group of 2 years, starts it earlier.

In the normal-hearing child, the acquisition of two words, it is expected, begins after 18 months. The group of those implanted at one year of age, started at 12 months after implantation and in the group implanted at two years of age at nine months, continuing with the trend that the patients of the two-year group, initiates earlier.

In relation to the formation of sentences of 2 words, the opposite happens, since the group of 1 year, initiates it before the group of two years, coinciding with the literature that tells us that the smaller the patient is at the moment of implantation, the earlier you can acquire the language and the lower the gap compared with the normal-hearing child. As more specialized is the evaluation of language, our study showed that patients took more time to start the valued activity, not so, in the case of open sentences without support that did not develop it. This is due to the fact that the development of structured sentences, open with support and without support, begins at ages older than 3 years and the follow-up of our patients took place up to 24 months, so it was not possible to observe major changes.

The analysis of other linguistic abilities of children with CI reveals an improvement in the expressive vocabulary and the narrative production, but the morphology and syntax, remains weak, this could not be observed in our group of patients because the test to evaluate language expressive, takes into account the development of open phrases with or without support, which does not give us the information about narrative or syntax [19].

In relation to receptive language, it was observed that in the case of the test of disyllables, closed series, discrimination of tone, environmental and onomatopoeic sounds and discrimination of words with different syllables, the group of patients implanted at one year of age, developed it earlier, however, in the items that assess intensity discrimination, fine discrimination and coarse discrimination of sentences with key words, both groups initiate it around 3 months after implantation. Contrary to discrimination of minimums pairs, dictation, dialogue and conversation, none of the groups of patients showed changes, because all were evaluated up to 24 months after implant and this is expected to develop at major age. A growing number of studies involving implanted children show that they are able to acquire the necessary vocabulary and syntactic structures to communicate through oral language, in a similar way to normal-hearing children. In our study, most patients achieve to develop perception of speech and expressive language in a similar way to the normal hearing of similar age [3].

CONCLUSION

Early diagnosis and early cochlear implantation around 12 months of age in children with bilateral profound sensory hearing loss should be prioritized to maximize the development of auditory skills and subsequent language learning, as it

undoubtedly that this provides a significant advantage for spoken language development acquired at 5 years of age.

In the present study, we did not agree with this prediction, because our results showed that in the group of 2 years at the time of implantation, there was better performance in the tests applied, we consider that it was due to the fact that at this age they presented better cooperation, concentration as well as neurological and cognitive maturity and better phonological awareness, which was not evaluated by the test. We consider that due to this fact we find greater statistical significance in earlier evaluation periods compared with the group implanted at 12 months of age.

In order to carry out a reliable evaluation of patients with a cochlear implant, comprehensive and multidisciplinary evaluations should be carried out, and the therapeutic program should focus on increasing the strengths acquired according to the patient's age. Therefore, verbal auditory therapy, cognitive, motor and psychological sensory therapy should be included in order to observe better results in language performance for patients.

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