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Outcomes of cochlear implanted children with cerebral palsy: A holistic approach

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ABSTRACT

Objective: Analyze the progress of hearing and language in a group of children with cerebral palsy (CP) who have received cochlear implants (CI) and compare their progress in the clinical and functional domains.
Methods: This is a prospective transdisciplinary study developed within a tertiary referral center, with a group of nine cochlear-implanted children with CP, two- to seven-year-old. The assessments undertaken included audiological, language, and communication assessments complemented by the assessment of functional abilities and the level of independence as evaluated by the Pediatric Evaluation of Disability Inventory (PEDI) and Gross Motor Function Classification System (GMFCS).
Results: The outcomes varied, as two children achieved hearing comprehension in open-set evaluations. These children presented the same type of CP, athetosis, but with different functional skills and GMFCS levels. Only one of the subjects had any spoken language at the single-word level.
Conclusions: A holistic view of change and development is central to understanding progress made in children with CP who received cochlear implants (CI). The functional evaluation of these children with CP is a useful tool for monitoring their progress and measuring their outcomes with CI.

1. Introduction

Studies in cochlear-implanted children with cerebral palsy (CP) have increased annually [1–9]. The first studies presented CP subjects within a group of children with various additional disabilities, such as autism, motor development delay, cognitive impairment, syndromes, and malformations [1,2]. A few studies explored the characteristics of children with CP by focusing on their language and hearing progress and types of motor disorders or their expected functional outcomes and how to classify the benefits.

CP is a health condition common among children who are born preterm at a low weight or with hyperbilirubinemia, hypoxia, or low Apgar [10]. These conditions are the same risk factors for children developing a hearing loss, which could explain the relatively high co-occurrence of hearing loss and CP.

CP is a term that encompasses a wide range of conditions. The clinical presentations of subjects vary across motor functions and social, emotional, cognitive, self-care, sleep, and other areas [10,12,13]. This variability exists between children and within each child who has CP, and one of the major reasons is because each type of CP represents a different level of a motor disorder, resulting in different levels of functionality [14].

To evaluate children with CP, a series of reviews are required to characterize and classify the type, the degree of motor and sensory impairments, considering how these characteristics affect the functionality in daily activities [15–18]. Functionality is considered a health component according to the International Classification of Functioning, Disability and Health (ICF) as proposed by the World

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Health Organization [17]. Understanding how a child develops functional ability in daily routines is essential to knowing whether an intervention will result in progress.

A function-specific assessment can be extremely useful to quantify and qualify the benefits of using the CI [8,9,17,19] and to provide information that encourages the understanding of the pattern of child development in different clinical manifestations of CP.

Considering the importance of a clinical picture of CP, the objectives of the study were (1) to review the progress of the hearing and language in CI-implanted children with cerebral palsy and (2) to establish a comparative progress of hearing and language versus clinical and functional characteristics.

2. Methods

2.1. Participants

The study's design was prospectively transdisciplinary and involved children with CP and a bilateral profound hearing loss. The study was supported by the Tertiary Referral Cochlear Implant Center, and the research was approved by the Research Ethics Committee (Case No. 018/2010). The reviews were initiated after the parents of participating children read and authorized the research within the norms stipulated in the "Statement of Consent" following the legislation that deals with the Ethics in Human Research of the National Ethics Council, Ministry of Health, Brazil.

The inclusion criteria were diagnosis of CP without cognitive impairment, auditory experience with CI for at least 18 months, and chronological ages of four to seven years. At that time, 12 cochlear implanted children presented CP, two with cognitive impairment, and one at 14 years old; nine participated in the study.

In respect to the whole process before the children received the acoustic device, the children and their families underwent routine evaluations in the Audiological Research Center. The routine of the diagnostic process consisted of interviews with each family, Audiometry (behavioral audiometry/visual reinforcement audiometry or play audiometry) and Verbal Detection Threshold (VDT), tympanometry, acoustic reflex test, evoked Otoacoustic Emissions transient and distortion product (EOE-T/PD), Auditory Brainstem Response (ABR), Auditory Steady State Response (ASSR), assessment of auditory behavior and auditory function. In addition, interviews were undertaken with other professionals—psychologists, neurologists, otorhinolaringologist, pediatricians, nurses, and social workers. All participants had some experience with hearing aids (HA) for at least 14 months before receiving the CI.

The factors related to prematurity, the type of CP, and the radiological findings of each child considered in hearing evaluation, because prematurity and brain lesions may interfere in the electrophysiological recordings from the auditory system. Therefore, the hearing diagnosis was complete after a series of reviews, with the average age of two years and nine months. The complete characterization, including the hearing diagnosis and type of CP are in Table 1.

Regarding the type of CI, six participants used the Advanced Bionics-Harmony/HiRes 90k, three Med-El-Opus2/SonataTI100, and one Cochlear-Freedom/Nucleus24. All were implaned in the left ear. Other characteristics related to CI—age at the activation of the CI, age of the children as to the time of CI use, and age of the evaluation—are included in Table 1.

For classification of the motor profile, the Gross Motor Function Classification System (GMFCS) [14] was used. This is a system of classification of motor functions that is particularly suitable for children with CP. The children evaluated by a trained professional with experience in evaluating children with CP (Table 1).

All subjects participated in motor rehabilitation programs, received hearing and language therapy, and were regularly enrolled in school. Four attended a special school (P5–P7, P9) and five attended regular school (P1–P4 and P8). Two used the Brazilian Sign Language (LIBRAS) for communication, predominantly in school before the CI (P7 and P9).

2.2. Evaluation procedures

2.2.1. Hearing and language evaluations

The levels of auditory and language development were obtained in the last assessment prior to receiving the CI and then afterwards. The performance in hearing and expressive language was classified according to the Hearing Categories [20] that rank the development of speech perception into seven categories and by the Categories of Expressive Language [21] that evaluate the use of oral language in communication without regard to speech intelligibility (Fig. 1).

The classifications in hearing [20] and expressive language [21] were made on the basis of the following assessments: Glendonald Auditory Speech Perception (GASP) translated and adapted to Brazilian Portuguese [22]; Delgado Test: List of words extracted from the child's vocabulary [23]; Meaningful Use of Speech Scale [24]; and Meaningful Auditory Integration Scale [25].

Table 1
Demographic data.

Participants	Gender	Age (y.m)	CI age (y.m)	Lenght of CI (y.m)	Hearing loss	Type subtype cerebral palsy	GMFCS	Associated risk factors				
								Pre-term	HPBR	Neonatal infections	ICU	Convulsions in the 1th year of life
1	M	4.0	1.8	2.4	BPSHL	L-hemiparesis	II	+	+	–	–	–
2	F	4.0	2.3	1.11	ANSD	L-hemiparesis	I	+	–	CMV	–	–
3	M	4.7	2.8	1.9	ANSD	Athetoid quadriparesis	I	+	+	–	–	–
4	M	4.8	2.9	1.11	ANSD	Spastic quadriparesis	V	–	+	SEP	+	+
5[a]	F	5.2	3.2	2.0	BPSHL	R-hemiparesis	II	–	–	MII	–	+
6	M	5.9	3.10	1.11	ANSD	Spastic quadriparesis	IV	+	+	–	+	+
7	M	6.1	4.3	1.11	ANSD	Spastic quadriparesis and athetoid components	V	+	+	MEN	–	–
8	M	6.0	4.6	1.6	ANSD	Athethoid quadriparesis	IV	+	+	–	+	–
9	M	7.0	5.1	2.0	BPSHL	R-hemiparesis	I	+	–	–	–	–

Y: years; m: months; R: right; L: left; F: female; M: male; +: risk factor present; –: risk fator absent; GMFCS: Gross Motor Function Classification System; BPSHL: bilateral profound sensorioneural hearing loss; ANSD: Auditory Neuropathy Spectrum Disorder; HPBR: hyperbilirrubinemia; ICU: intensive care unit; CMV: cytomegalovírus; SEP: septicaemia; MII: maternal intrauterine infection; MEN: meningitis.

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