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Original Article

Artigo Original

Global developmental abilities of cochlear implanted children with spastic cerebral palsy: two experimental groups

Habilidades do desenvolvimento global de crianças com paralisia cerebral usuárias de implante coclear: dois grupos experimentais

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Keywords

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ABSTRACT

Purpose: To analyze gross motor, fine motor-adaptive, language, social function performance, and communicative behaviors among cochlear-implanted children with spastic cerebral palsy (CP) and children with CP without hearing loss (HL) and to compare them with children with normal development. **Methods:** Prospective cross-sectional study involving 12 children with mean age of 63 months, distributed into two experimental groups: G1 – 4 children with CP and cochlear implant (CI) users and G2 – 4 children with CP without HL. A third group (G3) was the control group with four typically developing children. In the experimental groups, six children were classified in level II and two in level IV, using the Gross Motor Function Classification System. We used the Denver Developmental Screening Test II and the Communicative Behavior Observation (CBO). **Results:** G3 showed better performance than G1 and G2 in all evaluations. G2 showed better results than G1 in language, communication, personal-social, and fine motor-adaptive areas, except in the gross motor area. Aspects of language and communicative behaviors were lower in both experimental groups, especially in G1. Skills related to personal-social area showed no differences among the groups. **Conclusion:** Motor impairment of G1 and G2 and HL in G1 affected the development in the assessed areas, but these factors did not restrict personal-social development. Children with CP did not achieve high development in social function; however, the difference with relation to G3 was not statically significant. The CI provided a channel for oral language reception and social interaction, which has a key role in determining the quality of life.

Descritores

Paralisia cerebral
Implante coclear
Linguagem
Audição
Comunicação

RESUMO

Objetivo: Analisar o desempenho motor grosso, motor fino-adaptativo, linguagem, pessoal-social e comportamentos comunicativos de crianças com paralisia cerebral (PC) usuárias de implante coclear (IC) e crianças com PC sem deficiência auditiva (DA), e compará-las com crianças com desenvolvimento típico de linguagem. **Métodos:** Estudo prospectivo transversal de 12 crianças, idade média de 63 meses, distribuídas em dois grupos experimentais: G1 – quatro crianças com PC e IC; G2 – quatro crianças com PC sem DA; e G3 – quatro crianças do grupo controle. Seis crianças foram classificadas no nível II e duas no nível IV no *Gross Motor Function Classification System* (GMFCS). Foram utilizados o Teste de *Screening* do Desenvolvimento Denver-II (TSDD-II) e a Observação do Comportamento Comunicativo (OCC). **Resultados:** G3 apresentou desempenho superior ao de G1 e de G2 em todas as avaliações. G2 foi superior a G1 em linguagem, comunicação, pessoal-social e motor fino-adaptativo, exceto na área motora grossa. Os aspectos de linguagem e comportamentos comunicativos foram inferiores nos dois grupos experimentais, especialmente no G1. As habilidades avaliadas na área pessoal-social não apresentaram diferenças entre os grupos. **Conclusão:** A limitação motora de G1 e G2 e a DA de G1 influenciaram o desenvolvimento nas áreas avaliadas, porém esses fatores não restringiram o desenvolvimento pessoal-social. A habilidade pessoal-social também esteve rebaixada para os grupos com PC, porém a diferença dessa função com G3 não foi significante. O IC proporcionou um canal de recepção da linguagem oral e interação social, o que o determina como uma ferramenta para a melhoria da qualidade de vida nessas crianças.

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INTRODUCTION

The term cerebral palsy (CP) describes a group of movement and postural disorders attributed to nonprogressive dysfunctions that occur during fetal or child brain development[1,2]. Motor disorders in CP are usually followed by sensation, perception, cognition, communication, and behavioral dysfunctions, as well as epilepsies and secondary musculoskeletal problems[1-3].

Literature shows the effect of the motor condition of CP on several areas of development[3-11]. In the presence of motor delay, the child may lose opportunities to acquire knowledge, which is influenced by the relationships the child establishes with the environment and with important interferences for general learning and quality of life[5,7,11].

Hearing impairment (HI) is common, especially because the etiological factor of CP may be the same for hearing loss[12,13]. Studies present a rate of 12 to 30% of hearing loss (HL) in children with CP[14]. The early identification of HL in these children is also relevant due to the impact on communication, cognitive, and psychosocial development[9-17].

Besides hearing aids, the cochlear implant (CI) has been advised for children with CP and for those with deep and/or severe sensorineural HL. It has shown good results concerning hearing ability and language, as well as aspects of quality of life[12,13,15,18-24].

Besides data related to speech perception, a few studies analyzed other aspects of global development regarding the performance of children with CP after CI[13,20,21,23], and none of them presented how the development of children with CP without HI takes place, in comparison with that of children with CP undergoing the process of hearing rehabilitation by using a CI.

The objective of this study was to analyze the performance of cochlear implanted children with CP, children with CP and normal hearing, and children without CP and HL, in the areas of gross motor (GM), fine-motor personal-social (PS) and communication behaviors

METHODS

This study received the appoval by the research ethics committee of the Bauru School of Dentistry, University of São Paulo (FOB-USP) (protocol numbers 096/2010 and 019/2010), and all the legal representatives of the children participating in the study signed the informed consent form. The evaluations were conducted in the facilities of the Speech Language Pathology and Audiology clinic in FOB-USP for groups of children with CP and no HI and for children with normal hearing, language, and motor function development. Children with CP using CI were followed up by the Cochlear Implant Sector in the Center of Audiology Studies at the Hospital for Rehabilitation of Craniofacial Anomalies at USP.

The sample consisted of 12 children aged between 44 and 84 months divided into three groups and paired according to gender and chronological age (Table 1). Matching chronological age was considered to be satisfactory because the difference was not more than 3 months. Both experimental groups presented with CP, and the third group (control) had proper development for their age:

- Group 1 (G1): four children with spastic CP andcochlear implant users with no intellectual disability;
- Group 2 (G2): four children with spastic CP, with no hearing impairment or intellectual disability; and
- Group 3 (G3): four children with typical development.

Children in G1 were followed up under Cochlear Implant Program in the Hospital for Rehabilitation of Craniofacial Anomalies at USP and they met all the eligibility criteria for the CI surgery[25]; requirements involved preserved intellectual skills. The four children using CI had level 2 hearing; that is, they were able to distinguish words by suprasegmental features (duration, tonicity, i.e., pé – menino, mão – geladeira)[26] and, in some situations, it was necessary to use gestures. Only one child (participant 1) produced isolated words more frequently, being in category 2 of expressive language[26]. The other children produced only a few full words, or those considered to be intelligible, therefore, they communicated by gestures and vocalizations.

All the participants in G1 and G2 attended school and rehabilitation centers, being assisted in the fields of Physical Therapy and Speech Language and Audiology Therapy since early childhood. Children using CI attended weekly therapy to develop hearing skills.

Children in G2 and G3 underwent a psychological evaluation with Stanford–Binet Intelligence Scale, and results were found to be within normality rates. Children in G1 were

Table 1. Sample characterization

P	Gender	Chronological age*			Age at CI surgery*			Time of CI use*			GMFCS		
		G1	G2	G3	G1	G2	G3	G1	G2	G3	G1	G2	G3
1	F	48	45	44	27	–	–	21	–	–	II	II	–
2	F	54	53	54	38	–	–	16	–	–	II	II	–
3	M	69	70	69	46	–	–	23	–	–	IV	II	–
4	M	84	83	83	61	–	–	23	–	–	II	IV	–
Mean		63.75	62.75	62.5	43	–	–	20,75	–	–	–	–	–

*Months of age and use of cochlear implant

Caption: P = participants; G1 = Group 1; G2 = Group 2; G3 = Group 3; F = female; M = male; CI = cochlear implant; GMFCS = Gross Motor Function Classification System

assessed by a team of specialized psychologists, excluding the presence of cognitive changes. No children in G1 or G2 presented seizures or episodes of epilepsy.

All evaluations were conducted by speech language pathologists having experience in the application of the instruments used in the study and assisting children with CP. The motor function of children in G1 and G2 was classified according to the Gross Motor Function Classification System (GMFCS[27] (Table 1).

Communicative behavior observation (CBO)[28] protocol was used and analyzed the following categories: interaction, communicative intention, eye contact, vocalization, production of words, production of sentence, respect to changing shifts, maintenance of dialogical activity, comprehension of concrete and abstract situations, acceptance of simple orders, acceptance of complex orders, symbolic act of playing, use of gestures, time of attention, function of informing, function of protesting, function of requesting, and function of offering and mimicking. These categories used to analyze the communicative behavior were calculated by the following criteria: 0 – did not present it; 1 – presented it in restricted situations of interest; and 2 – presented it in any situation. For statistical treatment, scores obtained after the evaluation of recordings about the status of ludic activity were added. By considering the total number of items and analysis criteria, the maximum sum reached 40 points.

The Denver Developmental Screening Test II (DDST-II)[29] was applied in the areas of GM, FMA, LG, and PS. Initially, while administering the instrument, the age of the child was calculated in months and, afterwards, a vertical line was traced in the specific protocol of the test. The procedures related to this age group were applied for all the areas, according to the rules of application of the procedure. The analyses were carried out in accordance with the instructions of the instruments. Statistical tests included analysis of variance and Tukey's test ($p \leq 0.05$), chosen according to the characteristics of the variables.

RESULTS

Table 2 presents mean, minimum, and maximum scores obtained by the groups in the skills tested by the CBO[28] and the DDST-II[29]. It can be observed that mean, minimum, and maximum scores obtained in G1 are lower in all the assessed aspects than those in other groups.

The analysis of variance was significant in all the assessed areas, except for the personal-social feature. Therefore, Table 3 presents the results of the statistical analysis carried out using the Tukey's test, for only those aspects that were found significant in the analysis of variance.

DISCUSSION

Children with CP may present with developmental changes in different domains, because motor disorders affect childhood development in general[3-7]. Motor difficulties are limited to experiences of the children not only regarding interaction with people, objects, and events, but also regarding how to manipulate objects, repeat actions, control their own bodies and body scheme. Therefore, the child with neuropsychomotor development delay may lose concrete opportunities to evolve his or her abilities, thus causing gaps

Table 2. Mean, minimum, and maximum values of the skills tested by the Denver Developmental Screening Test II and in the communicative behavior observation in the three groups of the study

Assessed aspects	Mean			Minimum			Maximum		
	G1	G2	G3	G1	G2	G3	G1	G2	G3
Personal-social	37.5	58.2	71.7	10	38	60	56	83	83
Fine-motor adaptation	47.5	66.7	70.2	36	56	63	57	83	83
Language	23.2	62.5	69.7	21	45	58	26	83	83
Gross motor	37.5	31.5	73.2	10	22	66	56	40	83
Communicative behavior observation	24.2	38.7	39.7	18	36	39	30	40	40

Caption: G1 = Group 1; G2 = Group 2; G3 = Group 3

Table 3. Correlations between the four assessed areas in the Denver Developmental Screening Test II and score in the communicative behavior observation between the three analyzed groups

Assessed aspects	G1–G2	G1–G3	G2–G3
		p-value	
Personal-social*	–	–	
Fine-motor adaptation	0.071	0.034**	0.889
Language	0.002**	0.000**	0.662
Gross motor	0.809	0.011**	0.004**
Communicative behavior observation	0.000**	0.000**	0.913

*Tukey's test was not applied because it was not significant in the analysis of variance; **$p < 0.05$

Caption: G1 = Group 1; G2 = Group 2; G3 = Group 3

in the perceptive, cognitive, linguistic, and social areas[5,7-10]. So, limitations to explore the environment voluntarily are expected, which can lead to flaws in the sensory input, causing deficit in perceptive areas and damage in the development of language and cognition. As there will be important reflections in the interpretations of information coming from the environment, there may be difficulties to judge the received information properly[5].

In CP, motor impairment should be analyzed by considering functional aspects, once functionality is considered to be a health feature. By using the GMFCS[26], it was possible to characterize the motor function in terms of functionality, particularly emphasizing trunk and gait control. The motor scores obtained by participants in G1 and G2 (Table 1) indicate the level of functional autonomy to act independently in an environment.

Some authors showed that degree of motor disorders is directly related to functional capacity, that is, the higher the motor severity, the higher the functional capacity, and this can reflect on the global development of skills in the several fields[7,10,11], because, for the child, the performance of movements favors the construction of sensorimotor patterns. These are necessary to develop functional activities that contribute to the learning process.

In GM skill, assessed by the DDST-II, performance differences between the control group (G3) and the other groups (G1 and G2) were expected, once the main characteristics of CP are changed in motor function classification. The scores obtained in GMFCS already indicated that this area would be more affected for these groups (Table 1).

The motor performance of individuals with CP is influenced by abnormal postural reactions, changes in tonic reflexes, persistence of primitive responses, and delay in neuropsychomotor development, depending on the severity of neurological damage and motor sequelae, which define the clinical variability several clinical outcome[1,2].

The FMA analyzes the ability of the child regarding the organization of stimuli, perception of relations, decomposition of the whole in several parts and its reintegration, and the use of these skills in daily tasks during manual activities. In this context, it is important that the children can perform activities independently, aiming to develop their motor skills in a more elaborate and coordinated way, even if adaptations are necessary to improve their performances. This can cause relevant progress on the interaction of the children with CP, favoring their global development.

Findings regarding the motor area in this study (Table 2) show a specially relevant characteristic of CP, that is, the diversity of clinical outcome regarding the acquisition and performances in the different development dimensions, as reported in literature[7-11]. Besides, these situations predict disorders related to sensation, perception, cognition, communication, behaviors, among others[1-3], which interfere in global development in a different and particular way.

It can be inferred that motor limitation may have an impact on global development; however, it may not have been sufficient to interfere substantially in acquisition of language skills in G2 (Table 2). In G1, both comorbidities, motor limitation and HI, interfered with language more strongly. Participants in G1 produced isolated words, and their linguistic ability was restricted to immediate events and objects related to their daily routine. All of them presented with hearing level 2[26] and began communication by the oral language, unlike the other groups in which participants were able to produce more elaborated sentences. These results show that hearing privation is a determinant and prevalent factor for the oral language acquisition and development[17,22-25]. In G1, mean time of CI use was 20 months, which is considerable to observe open-set speech perception skills and oral language and communication skills among children without CP[25].

Studies reported slower development of hearing and language skills among children with CP, especially regarding expressive language development[4,12,20], due to the interference of the involved motor aspects. Other studies[16,17,24] that analyzed the progress of CI use among children with CP and/or multiple disabilities did not indicate a relationship between the hearing and language performance and age at which children underwent CI, unlike what can be observed in studies that focus on the progress of CI use among children with no associated disabilities. This should be further analyzed due to the several variables involved, when it comes to populations with multiple disabilities.

According to some studies[5,9], the development trajectory is determined by complex interactions between biological, psychosocial, and environmental factors and, to know the profile of childhood development, it is necessary to verify the variables that interfere in this process.

The social environment also favors language development, that is, if family or other social environments integrate in daily and social life activities of the children, requiring elaborate linguistic contents, the children will have chances of not only acquiring verbal skills, but also expanding their linguistic structures, thus becoming, according to their capacity, effective communicators. All the participants in this study attended school, and those in G1 and G2 also attended therapeutic activities, involving the development of linguistic and communicational skills. Therefore, we cannot deny the influence of sensory loss on the acquisition of linguistic skills, even for children in G1, who participated in stimulation programs since early childhood.

A noteworthy aspect pertaining to CBO is that children with CP without HI (G2) presented more developed communicational behaviors than those with CP and HI (G1) (Table 3). We can infer that individuals in G1, even after participating in early intervention programs addressing motor and linguistic aspects, were influenced by their hearing conditions, time of sensory privation, time of implant surgery, and hearing rehabilitation, besides other variables, such as individual characteristics, maturation, motivation, and family and school environment, involved in the language acquisition process, as shown in literature[12,22,24,25]. Studies also reported restricted oral language development among children with HL and CP or other motor function changes[12,13,15,16,18-20,22,23].

Besides hearing and motor privation factors, it is also important that no child presented with intellectual changes; therefore, the development of language skills is observed, even if slowly, for children using CI. Other researchers have reported the same[19-24]. A study[18] presented that cognitive skills, especially nonverbal ones, for individuals with HI and associated disabilities, should always be evaluated once they show language levels that are disproportional to their nonverbal cognitive skills or their cognitive potential.

Cognitive function[4-6,22] and functionality in other fields of development should be taken into account during rehabilitation and follow-up of children with CP using CI[18,21,22,24,30], including in the evaluations to indicate CI[20].

One interesting finding of this study was the performance of groups concerning personal-social function. In the DDST-II, the personal-social score assesses reactions of the child in response to stimuli from social environment as compared to the independent performance of daily and concrete tasks, involving organization of, and response to stimuli; social skill; and understanding of the context. HI interferes in the development of verbal communicative skills, affecting social functions. However, such damage was not relevant to limit the social activity in G1. We can infer that this can be attributed to the intellectual skills and benefits derived from CI, which has the objective of establishing contact with the world of sound, thus proportioning the development of hearing and linguistic skills for communication, even if slowly. Also, after the child with CP receives the benefit of speech perception by CI, the child starts presenting receptive language. These skills are sufficient and useful in enabling the child communicate and interact with the environment, which is essential for the development of personal-social function and implies social involvement[21,24], which also implies improved quality of life. Another explanation for this result can be related to the participation in therapeutic processes and school life.

Studies showed that the possibility of reciprocal social relations may have a positive effect on the learning process in general and on the quality of life of people who have severe motor disorders. This is because if the individual is inserted in a social community effectively, his or her interaction, integration, and learning is notably high, as well as quality of life that is observed among individuals with or without severe motor disorders[29,30].

CI was found to be a proper treatment for HI among children with CP, helping in the development of hearing and language skills that provide ways to interact and communicate with the social environment[12,13,16,17,21-24]. Longitudinal follow-ups involving more individuals with CP who use CI are necessary to know the trajectory of the global development of these children.

Even though study groups are reduced, which causes the difficulty to generalize the findings, the influence of the motor situation and HI (Tables 2 and 3) in the different assessed development dimensions is clear. This leads to reflections about the importance of diagnosing and intervening earlier, with the objective of improving the quality of life of people with CP with and without other comorbidities.

CONCLUSION

In the comparison between groups of individuals with CP and the control group, the influence of motor and hearing changes on the development of the assessed skills was observed. G1 presented slower development in relation to the other groups in all the areas, especially in communicative language and behaviors. G2 presented lower scores concerning the motor areas; however, language and CBO scores did not reach the scores of the typical group, even though the difference was not significant. Social skills were also low in groups with CP; however, the difference between the development of this function in relation to the control group (G3) was not significant.

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**DACL contributed with data analysis and writing the manuscript; MJDS and CSTP contributed by collecting data from the study participants, with data analysis and writing the manuscript; LNTS contributed with data analysis and writing the manuscript.*

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