Case Report

Auditory and language abilities in children with cochlear implants who live in bilingual homes: a cases report

Audição e linguagem em crianças deficientes auditivas implantadas inseridas em ambiente bilíngue: um estudo de casos

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ABSTRACT

The cochlear implant (CI) has been indicated for children with severe and/or profound bilateral hearing loss who do not benefit from hearing aids and have adequate and motivated family for the use of the device, as well as adequate rehabilitation conditions at their hometowns. Currently, the demand for CI also occurs by deaf parents, fluent in Brazilian Sign Language (LIBRAS), who resort to this treatment to offer their children another reality. The environment of these children is bilingual, with exposition to LIBRAS through their parents and to oral language through close relatives, audiologist/speech-language pathologist, and the school. In this sense, the present study aimed to follow-up four implanted deaf children –two with deaf parents fluent in LIBRAS (exposed to a bilingual environment), and two with hearing parents (exposed to oral environment). For this purpose, abilities of hearing and oral language development were compared in these children with CI. It was observed that all four children in this study presented similar language development and auditory skills throughout the first year of CI use. However, after this period, children inserted into a bilingual environment had better auditory and linguistic performance when compared to the other children. Children in bilingual environments can benefit from the CI, developing auditory skills and oral language similarly to children inserted into an oral environment. It is emphasized that the benefits of the device is dependent on several factors, and further studies are needed.

Keywords: Hearing loss; Cochlear implantation; Language; Multilingualism; Rehabilitation of hearing impaired

INTRODUCTION

The cochlear implant (CI) is the most important progress in the treatment for adults and children with severe to profound bilateral sensorineural hearing loss who do not receive adequate benefit from hearing aids and making possible better results in auditory, linguistic, social and academic development.

In Brazil, the preoperative assessment, the surgical process and the follow up are guaranteed by Unified Health System since 1993, based on the indication and contraindication criteria of the device for adults and children, established by the Ministry of Health.

According to this ordinance, in children aged under 18 years of age with bilateral severe to profound sensorineural hearing loss (pre-or postlingual), the CI should be indicated from the following criteria: minimal benefit from appropriate hearing aids (experience with hearing aids for at least three months); inability to recognize words in closed set; appropriate commitment and expectations of family for the use of the device; appropriate auditory habilitation in the child's hometown.

The patient selection criteria can change in different CI centers, however aspects as the cause of hearing loss, benefit from appropriate hearing aids, the existence of appropriate services for post-CI aural rehabilitation, realistic expectations about results and motivation of the family are always take into account when the device is indicate.

In bilingualism, oral language is developed as a second language of the deaf people, whereas sign language is acquired as the main form of communication[1].

Internationally there is an increasing search of the CI for the bilingual community as a treatment for the deafness[2-4], since the National Association of the Deaf recognized the

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Conflict of interests: None

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importance of the CI to improve the quality of life of all deaf and hard of hearing people[5-6].

In the national context it also occurs. Nowadays, deaf parents who are fluent in Brazilian Sign Language (LIBRAS) are also looking for CI as treatment option to provide rehabilitation for their children. The environment of these children is bilingual, given for the LIBRAS by the parents and the oral language of relatives, school, and speech therapy.

In this direction, it is necessary to know the auditory and language development profile of implanted children who are exposed in a bilingual environment.

CLINICAL CASE PRESENTATION

This case study focuses on the auditory and language development of implanted children – who were exposed in a bilingual environment. All children in this study are assisted at Audiological Research Center of Hospital Reabilitation of Craniofacial Anomalies – Universidade de São Paulo (CPA--HRAC/USP) and received the CI indication for fitting in the criteria of indication of this center. It should be noted that the statement was made, considering the request of parents and the inclusion of children in an oral environment by the relatives.

To this end, four children participated in this study – two children inserted in bilingual environment (referred to as child A and B) and two children inserted in oral environment (referred to as child A1 and B1) who their parents have not hearing impairment.

In the preoperative assessment all patient assisted in this center are submitted to ENT, audiological, psychological and social evaluation as preoperative imaging and others complementary evaluation, if necessary. In this stage all children are assessed regarding their cognitive style for the observation and report of some behaviors that are part of the development of the child and for others that, when present, may indicate pathologies or specific difficulties that prevent the full development of the child. The families are assessed according to the reference criteria regarding permeability degree in the therapeutic and higher scores indicates higher parental participation in the (re)habilitation of implanted children. Both assessments were developed in internal protocols at the CPA-HRAC/USP.

The information about the audiologic profile of children before surgery CI is presented in Table 1 and Table 2 shows the data about cognitive style of the child, familiar permeability

Table 1. Audiologic profile of children before surgery for cochlear implantation

Child	Etiology	Threshold before CI (without hearing aids)				Threshold before CI (with hearing aids)				Effective use of hearing aid (before CI)	Hearing aid model
		0.5 kHz	1 kHz	2 kHz	4 kHz	0.5 kHz	1 kHz	2 kHz	4 kHz		
A	Genetic	↓100 dB	↓100 dB	↓100 dB	↓100 dB	65 dB	75 dB	80 dB	80 dB	Yes	Phoenix 303 (Siemens®)
A1	Rubella	90 dB	100 dB	↓100 dB	↓100 dB	80 dB	95 dB	↓100 dB	↓100 dB	Yes	Phoenix 303 (Siemens®)
B	Waanderburg syndrome	↓100 dB	↓100 dB	↓100 dB	↓100 dB	75 dB	85 dB	↓100 dB	↓100 dB	Yes	Phoenix 303 (Siemens®)
B1	Rubella	75dB	85 dB	80 dB	95 dB	65 dB	50 dB	60 dB	70 dB	Yes	Phoenix 303 (Siemens®)

0,5; 1 k;2k e 4khz – free field

Note: CI = cochlear implant; ↓100 dB = absent auditory threshold in 100 dB (maximum of the equipment); Children A e B = bilingual environment; Children A1 e B1 = oral environment

Table 2. Information about cognitive style of the child, familiar permeability degree in the therapeutic process and socioeconomic status of the family of the studied children

Child	Cognitive style of the child (%)	Familiar permeability degree (%)	Socioeconomic status	Education level (mother/father)
A	71.20	77.50	E-LS	High school
A1	80.00	95.00	E-LS	High school
B	70.84	85.00	D-LM	High school
B1	97.92	93.00	E-LS	High school

Note: E-LS = class E – low superior; D-LM = class D – lower middle; Children A e B = bilingual environment; Children A1 e B1 = oral environment

degree in the therapeutic process and socioeconomic status of the family of the studied children. The socioeconomic rating used by the CI service is divided into: high (H), upper middle (UM), medium (ME), lower middle (LM), low superior (LS) and low (L), according to family income (in minimum wages), the number of resident members family, higher educational level of family, type and housing conditions and higher occupational level.

This study was conducted with bilateral profound sensorineural hearing loss children (prelingual), recipients of 24 K Nucleus (Cochlear Corporation). All cases had total insertion of electrodes. For all children, the speech processor was programmed with Advanced Combination Encoders (ACE) speech coding strategy and spectral maximum equal to 12. Both children were hearing aids users prior to the surgery and are inserted into an aurioral rehabilitation approach.

The auditory and oral language abilities of the two children inserted in bilingual environment were compared with the abilities of the two children inserted in an oral environment, matched for chronological age, time of sensorial deprivation and time of CI use.

All the responsible guardians signed the Informed Consent Term to participate in this study.

For analysis of this information, the collecting data was carried in the records of the patients. Information about speech perception, language development was collecting in accordance with hearing categories[7] and expressive language categories[8], as shown in Appendix 1. Information about use of CI, speech therapy and school were also collected for this study.

The procedures for the assignment of hearing categories were: clinical evaluation of hearing behavior; Assessment Test for Minimum Hearing Capacity (TACAM)[9]; Infant Toddler: Meaningful Auditory Integration Scale (IT-MAIS)[10]; Procedure for the Assessment of Profound Hearing Impairment Children[11] and List of words as procedure for assessment of speech sound perception[12].

The procedures for the assignment of language categories were: assessment of the oral communication behavior under playful interaction situation and under special activities with the audiologist and the adult responsible for the child and Meaningful Use of Speech Scales (MUSS)[13].

The auditory and oral language abilities were evaluated longitudinally during the follow-up as shown in Table 3. The information on the variables that may influence the development of the studied abilities is shown in Table 4.

Both pairs (A and A1, B and B1) had auditory and language abilities similar throughout the first year of CI use. However, from this, the children inserted in bilingual environment shows better auditory and language development compared to other children.

From the auditory perspective, children "A" and "B" (bilingual environment) achieved the open-set recognition (ability to recognize the word without contextual cues through listening alone) after two and three years of CI, respectively. On the

Table 3. Auditory and language abilities evolution of the studied children

Child	Age at surgery	Preoperate evaluation		First stimulation		3 months of CI		6 months of CI		1 year of CI		1 year and 6 months of CI		2 years of CI		3 years of CI		4 years of CI		5 years of CI	
		HC	LC	HC	LC	HC	LC	HC	LC	HC	LC	HC	LC	HC	LC	HC	LC	HC	LC	HC	LC
A	22 months	1	1	1	1	1	1	2	2	2	2	4	3	6	3	6	5	6	5	6	5
A1	22 months	1	1	1	1	1	1	2	2	2	2	3	3	3	3	4	4	6	4	6	4
B	12 months	0	0	1	1	1	1	2	2	3	3	4	3	5	4	6	5	6	5	6	5
B1	12 months	1	1	1	1	2	2	2	2	2	2	2	2	2	2	4	3	4	3	5	4

Note: CI = cochlear implant; HC = hearing categories; LC = expressive language categories. Children A e B = bilingual environment; Children A1 e B1 = oral environment

Table 4. Information on the variables that may influence the development of the studied abilities

Child	Effective use of CI	Hearing aids in opposite ear	Speech therapy approach	Weekly frequency of speech therapy	Duration of speech therapy	Regular school
A	Yes	No	Aurioral	3 times	50 minutes	Yes
A1	Yes	No	Aurioral	2 times	60 minutes	Yes
B	Yes	No	Aurioral	2 times	50 minutes	Yes
B1	Yes	No	Aurioral	2 times	45 minutes	Yes

Note: CI = cochlear implant; Children A e B = bilingual environment; Children A1 e B1 = oral environment

other hand, the child inserted in the oral environment (child "A1") was this ability after four years of CI and child "B1" not achieved this ability through the last evaluation proposed by this study (five years use of CI).

From the oral language perspective, children "A" and "B" (bilingual environment), after three years of CI use were able to construct sentences of more than five words, using connecting elements, different verbal tenses and plural (expressive language - category 5). Children inserted in oral environment ("A1" and "B1"), after five years of CI use, have not yet reached this ability.

DISCUSSION

Due to the growing demand for CI for deaf parents who are fluent in LIBRAS, it is important to relate scientific evidence about the auditory and language development of these children[3], in order to help in the indication of the device in different Brazilian CI centers.

The results of this study shows that bilingual children with CI can benefits from CI, developing auditory and oral language abilities similar or better than children placed in the oral environment[3,14]. The development of these skills by children with CI is related to the individual characteristics of each patient, but also of rehabilitation program and the familiar permeability degree in the therapeutic process[15]. Thus, it reinforces the participation of close relatives of these children inserted in bilingual environment, which provided rich auditory experiences to acquire these skills by children.

All children studied used effectively the CI, but did not use the contralateral hearing aid (Table 4). They were attending the aurioral rehabilitation approach and regular school. Thus, it is possible to observe the homogeneity of the studied children in relation to these aspects evaluated. So, these aspects did not influence the better auditory and language performance of bilingual children.

This homogeneity is also observed in other aspects evaluated as the family permeability degree in the therapeutic process, the child's cognitive style, socioeconomic status and education level of the parents (Table 2). These variables were quite similar in children studied and does not explain the better auditory and language performance of bilingual children.

The patient selection criterion in Brazilian CI centers does not prohibit the CI indication to children inserted in bilingual environment, but there are many questions about the outcomes in these cases. One of the most important concerns is the influence of sign language in oral language. An international research shows that after the oral language acquisition, there is no negative interference of sign language and there is a gradual reduction in the use of signs while oral language begins to be developed[4]. In agreement with this research, bilingual children studied in this work experienced no negative interference in their CI outcomes, since these have been developed auditory and language skills similar to children inserted in oral environments.

These researchers also highlight that the use of sign language or oral language during the interaction of these children depends directly on their interlocutor and communicative context. This confirms the reports of relatives of the studied children, who reported that the bilingual children often translated what the parents wanted to say. This shown that a bilingual child adapts his form of communication in accordance with the interlocutor.

Based on the results above, associated with scientific literature, is possible to infer that if the implanted child is inserted in an educational environment that offers appropriate oral language, the knowledge of sign language does not adversely affect the auditory and language development. In this sense, it is important to respect the parents' choice to look at the CI as a treatment for deaf children.

FINAL COMMENTS

Over the years, the CI centers of the country will include the demand of children inserted in bilingual environment. The professionals involved in different stages of the CI indication should be prepared to the attendance of these families as well as for the preoperative evaluation of these cases, because the CI indication is closely related to the inclusion of children in the oral environment provided by family members, speech therapist and school context.

RESUMO

O implante coclear (IC) tem sido indicado para crianças deficientes auditivas de grau severo e/ou profundo que não tem benefício com o aparelho de amplificação sonora individual (AASI), e que apresentem família adequada e motivada para o uso do dispositivo, bem como condições adequadas de reabilitação na cidade de origem. Atualmente, a procura pelo IC também ocorre por pais surdos, fluentes na Língua Brasileira de Sinais (LIBRAS), que recorrem a este tratamento para oferecer outra realidade para seus filhos. O ambiente destas crianças é bilíngue, dado pela LIBRAS dos pais e pela linguagem oral dos familiares próximos, do fonoaudiólogo e da escola. Neste sentido, o presente estudo visou acompanhar quatro crianças deficientes auditivas implantadas, sendo duas crianças filhas de pais deficientes auditivos fluentes na LIBRAS (expostas a ambiente bilíngue) e duas crianças filhas de pais sem alterações auditivas (expostas a ambiente oral). Para tanto, as habilidades de audição e de aquisição da linguagem oral foram comparadas nas quatro crianças implantadas. Foi possível observar que as quatro crianças apresentaram habilidades auditivas e de linguagem semelhantes ao longo do primeiro ano de uso do IC. Contudo, a partir disto, as crianças inseridas em ambiente bilíngue apresentaram melhor desempenho auditivo e linguístico, comparado ao desenvolvimento das outras crianças. As crianças inseridas em ambiente bilíngue podem se beneficiar do IC, desenvolvendo habilidades auditivas e de linguagem similares às das crianças inseridas em ambiente oral. Ressalta-se que os benefícios do dispositivo são obtidos a partir de aspectos multifatoriais, e estudos mais aprofundados são necessários.

Descritores: Perda auditiva; Implante coclear; Linguagem; Multilinguismo; Reabilitação de deficientes auditivos

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Appendix 1. Hearing and expressive language categories

Category	Hearing categories[7]	Expressive language categories[8]
0	*No detection of speech* Aided speech detection threshold > 65 dB.	---
1	*Speech detection* This child detects the speech signal.	The child does not speak and may present indistinct vocalization.
2	*Pattern perception* Discrimination based on temporal or stress cues (e.g. baby vs. airplane)	The child speaks only few words.
3	*Beginning word identification* Close-set word identification based on phoneme information (e.g. airplane vs. lunchbox)	The child makes simple sentences (with 2 or 3 words)
4	*Word identification via vowel recognition* Closed-set word identification based on vowel information (e.g. bat vs. boat).	The child makes complex sentences (with 4 or 5 words and initiates the use of connecting elements as pronouns, articles, prepositions).
5	*Word identification via consonant recognition* Closed-set word identification based on consonant information (e.g. pear vs. chair).	This child constructs sentences of more than five words, using connecting elements, conjugating verbs and using plurals. The child is fluent in oral language.
6	*Open-set word recognition* The child can recognize the word without contextual cues through listening alone.	---