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Hearing and language development scale in cochlear implanted children

Escala de desenvolvimento auditivo e de linguagem na criança implantada

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ABSTRACT

Purpose: To characterize Auditory and oral language performance in children under 2 years of age with Hearing and Language Development Scale (EDAL-1) and to compare the results to those of hearing children up to two years of age. **Methods**: This is an experimental study of descriptive nature. A total of 141 children were divided into two groups: control group with 92 normal hearing, and the experimental group with 49 deaf children followed audiologically during the first two years after implantation. Normal hearing children underwent auditory assessment and parents responded to EDAL-1. The children implanted, every three months, underwent otorhinolaryngological and speech-language evaluation, and the parents answered EDAL-1. **Results**: In both groups we observed upward responses, with improvement as chronological and auditory age increases. Results obtained in the study group are statistically worse than in the control group, but with a tendency to grow. EDAL-1 was easy to apply and allowed to monitor the performance of the implanted children. **Conclusion**: Oral and auditory performance in deaf children with cochlear implants was characterized by EDAL-1, and it was shown to be growing as the time of auditory stimulation increased, a fact also seen in hearing children. Despite this, the results of the hearing children were better than those of the deaf children implanted.

Keywords: Hearing; Cochlear implantation; Language; Clinical protocols

RESUMO

Objetivo: Caracterizar o desempenho auditivo e de linguagem oral em crianças implantadas com menos de dois anos de idade auditiva, por meio da Escala de Desenvolvimento de Audição e Linguagem (EDAL-1) e comparar os resultados aos de crianças ouvintes até 2 anos de idade. **Métodos**: Estudo experimental de caráter descritivo. Participaram 141 crianças, divididas em dois grupos: grupo controle, com 92 normo-ouvintes, e grupo experimental, com 49 crianças surdas acompanhadas audiologicamente, durante os dois primeiros anos após a implantação. As normo-ouvintes passaram por avaliação auditiva e os pais responderam ao questionário EDAL-1. As crianças implantadas passaram por avaliação otorrinolaringológica e fonoaudiológica a cada três meses e os pais responderam ao EDAL-1. **Resultados**: Nos dois grupos foram observadas respostas ascendentes, com melhora de acordo com o aumento da idade cronológica. Os resultados obtidos no grupo experimental foram estatisticamente piores que no grupo controle, porém, com tendência de crescimento. O EDAL-1 mostrou-se de fácil aplicação e permitiu o monitoramento do desempenho das crianças implantadas. **Conclusão**: O desempenho auditivo e de linguagem oral em crianças surdas, usuárias de implante coclear, foi caracterizado pelo EDAL-1 e mostrou-se em crescimento, conforme o aumento do tempo de estimulação auditiva, fato também observado nas crianças ouvintes. Apesar disso, os resultados das crianças ouvintes foram melhores que os das crianças surdas implantadas.

Palavras-chave: Audição; Implante coclear; Linguagem; Protocolos clínicos

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INTRODUCTION

Technological advances have impressively marked the last years of human history, and when the subject is hearing health, the major milestone is the cochlear implant (CI). For more than 30 years this device has proved to be efficient and capable of providing access to the world of sound to people diagnosed with severe and profound hearing loss.

The CI is a biomedical, biocompatible and durable electronic device designed to perform the function of not present or damaged hair cells in the inner ear. It modifies the acoustic signal and provides electrical stimulation of the remaining fibers of the auditory nerve[1,2], which can lead to practically normal auditory thresholds.

Allow hearing is the first goal of the CI, and once access to the sound world is established, audibility thresholds and acoustic comfort are achieved; oral language is expected to develop[3]. However, despite the sophistication of the electronic resources currently achieved, several factors can influence the results obtained with the CI, as cause of hearing loss, duration of deafness and, consequently, the time of sensory deprivation, the age of the patient when receiving the implant, the auditory and language rehabilitation approach and the organism own neuroplasticity capacity[4].

In Brazil, the CI has been a reality in the Brazilian Unified Health System (SUS) for more than 20 years, and in the state of Paraná, specifically in the city of Curitiba, since 2010 there are two programs accredited by the SUS and qualified to carry out the procedure, being one of them in a children's hospital, the locus of this study.

In this service, in accordance with Ordinance GM/MS No. 2,776 - December 18, 2014[5], an interdisciplinary team evaluates deaf patients and, if they are candidates, they are submitted to the implant. Further, the service should provide lifelong assistance for follow-up consultations, for CI activation and mapping, as well as monitoring of results.

In the children's hospital from November 2010 to June 2016, 65 children were implanted, 40% of which were from Curitiba, the state capital where the service is located, and 60% from other cities in the state of Paraná (coastal or inland). As a result, most children undergo speech therapy for hearing and language rehabilitation in the city of origin[6]. For guidance to parents and therapists to be satisfactorily addressed it is imperative to assess and monitor the performance of these children

At the beginning of the work in the hearing healthcare service, in mid-2010, the speech-language pathologist's team used international instruments to record and provide information about the hearing and oral language development of the implanted patients. However, it was noticed the need to elaborate a protocol that would meet the regional demands, that is, of easy and fast application and of easy understanding by parents/responsible of the patients. It was in this context that the Brazilian Hearing and Language Development Scale (EDAL)[7] emerged, a rapid protocol, composed of four tests, each one aimed at the evaluation of children in certain age groups.

The EDAL 1, the first battery of tests, is designed to evaluate the development of hearing and oral language skills after the prosthesis.

The objective of this research was to verify the hearing and oral language performance in implanted children less than 2 years of age with EDAL-1 and compare the results to those of hearing children up to 2 years of age.

METHODS

This is an experimental, descriptive study, approved by the Research Ethics Committee of the *Universidade Tuiuti do Paraná* (UTP), under the number CEP 1,761,002 / 2016. All those responsible for the participants signed the Informed Consent Term, authorizing the use of the data collected.

A total of 141 children, whose parents were invited to participate in the study, were evaluated and divided into two groups:

The Control Group (CG): formed by 92 normal-hearing children recruited in a waiting room of pediatric service accredited by the SUS, in Curitiba. Only children from 0 to 2 years of chronological age were included, without hearing loss complaint. Otorhinolaryngological evaluation, behavioral audiometry in a soundproof booth and acoustic immittance was performed in this group. Parents responded to EDAL-1 once, right after the clinical appointment.

The Experimental Group (EG): formed by 49 deaf implanted children. Children with severe or profound bilateral hearing loss, users of unilateral CI, with a hearing age of zero to two years, who underwent quarterly control and CI mapping in the service were included. Children with comorbidities that interfered with language development were excluded. Otorhinolaryngological evaluation, behavioral audiometry in a soundproof booth and acoustic immittance was performed in this group. Parents or guardians responded to the EDAL-1 at each electrode balancing session.

Both CG and EG were selected in a pediatric service accredited by the SUS, therefore, there was no concern in matching the children by social level. As for the academic question, it was not possible to make pairings, since the chronological age of the children, between the groups, was quite heterogeneous.

It is known that the comparison of the hearing age in a child implanted after 3 years and 5 months is unfair, since the time of hearing deprivation does not favor the development of the auditory pathway in the same chronology, however, this study evaluated all the children implanted in the service chosen as the locus of the research, where the implantation of children above this age was still a reality.

The EDAL-1 (Chart 1) is a test composed of 20 closed questions, which allow a quantitative analysis of the responses. The instrument should be applied to parents/guardians of children under evaluation. Questions 1a, 2a, 3a, 4a, and 6a are intended for hearing children and questions 1b, 2b, 3b, 4b, 5b and 6b are intended for children with hearing aids. The answer to the question can be positive (worth 5 points), or negative (worth zero), with the exception of question 2a, which was reversed, because of its answer, being positive, would become a negative point in the evaluation. Finally, the positive responses are added and the child's total score is obtained, which can vary from 0 to 100.

The responses obtained in each group were tabulated and analyzed. Auditory age categories were created for every three months to establish descriptive averages.

For statistical analysis, the age categories were grouped in 0 to 6 months, 6 months and 1 day to 15 months and 15 months and 1 day to 24 months. The comparison of means obtained among the children was performed using Student's t-test, with a significance level of 0.05.

Chart 1. Brazilian Hearing and Language Development Scale - 1

Question	Behavior	Yes	No
1	a) Do you think your child listens? b) The child's adaptation to the device was positive?		
2	a) Have they ever had ear problems? Which ones? b) They use the device 6+ hours a day?		
3	a) Do they like to listen to music or TV? b) Do they handle their device?		
4	a) Do they like noisy toys? b) Does their behavior changes when wearing the device?		
5	a) Do they react to loud sounds? b) Do they emit more vocalic sounds when you put the device?		
6	a) Do they wake up with noises? b) Are they disturbed when the device does not work?		
7	Do they respond when called by name, in silence?		
8	Do they respond when they`re called by name, in noise?		
9	Do They notice environmental sounds of everyday life? Which ones?		
10	Do they vocalize during communicative interactions?		
11	Do they use speech/vocalizations to attract the attention of others? Which ones?		
12	Do their vocalizations vary according to the situation?		
13	Do they try to imitate sounds, words or vocalizations? Which ones?		
14	Do they dance to music?		
15	Do they distinguish different voices?		
16	Do they distinguish different sounds: voice, toys, music?		
17	Do they respond to simple questions without gesture support?		
18	Do they speak isolated words? Which ones?		
19	Have their vocabulary grown?		
20	Can they speak two-word sentences? Which ones?		
Total	Quantity of Yes X 5 = _____		

Reference: Ribas and Kochen[7]

Subtitle: a) questions to be addressed to normal-hearing children; b) questions to be addressed to implanted deaf children

Table 1. Descriptive means of the results of the Brazilian Hearing and Language Development Scale - 1

Hearing age (months)	CG			EG		
	Mean	Standard deviation	Median	Mean	Standard deviation	Median
0-3	34.23	8.12	30	29.28	12.53	25
3.1-6	54.68	8.65	55	43.88	17	50
6.1-9	73	10.59	75	42.14	14.23	45
9.1-12	82.50	10.34	80	44.54	12.93	45
12.1-15	87	7.52	85	61	21.95	55
15.1-18	91	5.16	90	66.50	22.97	65
18.1-21	92.50	6.34	95	72.85	21.18	70
21.1-24	95.83	5.06	95	82.77	17.25	90

Subtitle: CG = Control Group; EG = Experimental Group

RESULTS

The 92 children in the CG showed normal hearing results in the medical evaluation, tympanometry (type A curves and acoustic reflex present) and behavioral audiometry. The group consisted of 43 (47%) girls and 49 (53%) boys, with chronological age ranging from 0 to 2 years of age.

The 49 children of the CG had a profound hearing loss and used unilateral CI. This group contained 25 (51%) girls and 24 (49%) boys, with chronological age ranging from 1 to 8 years, but with a hearing age between 0 and 2 years. All were users of hearing aids, with no proven benefit before receiving the CI. The mean age for implantation was 3 years and 8 months.

When comparing the results obtained using Student's t-test, with a significance level of 0.05 (5%), there was a significant difference between means for both groups in the three age groups. Therefore, the means were significantly higher in the CG, that is, the hearing children had better performance in the EDAL-1 than the children implanted with the same time of hearing age.

The results obtained in the EDAL-1, for each established age group, are described in Table 1 and the comparison of the results between CG and EG, presented in Table 2.

From the descriptive means obtained for the two groups evaluated, it was possible to design the performance curve in the test, as shown in Figure 1.

Table 2. Comparison between the results of the experimental group and the control group (n=141)

Hearing age (months)	Control Group			Experimental Group			p-value
	n	Mean	Standard deviation	n	Mean	Standard deviation	
0-6	29	45.51	8.41	32	37.49	15.4	0.0070
6.1-15	30	80.83	9.48	35	48.28	16.03	0.0000
15.1-24	33	93.36	5.48	35	76.14	19.67	0.0000

Obs.: To allow for the application of the test, only three age groups were considered, as shown in the table. Analysis: The Student's t-test, with a significance level of 0.05 (5%), showed a significant difference between the means for both groups in the three age groups

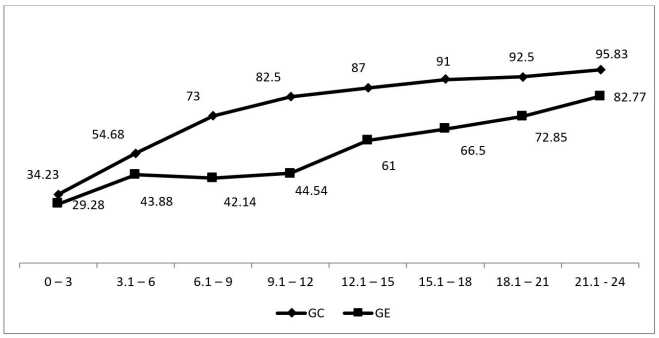

Figure 1. Response curve considering the means by hearing age group

DISCUSSION

The two groups studied had homogeneous characteristics, in relation to gender and hearing age, which was between zero and two years. Hearing age means the time of hearing stimulation that a deaf person has, after the adaptation of the electronic device. For normal-hearing children, the chronological age is equal to the hearing age[8].

The CG children had normal hearing. The normal hearing is critical in the early years of life, which are considered the most important for the development of hearing and oral language abilities. It is during this period that the maturation of the nervous system occurs, with greater brain growth and formation of new neural connections[9]. It is in the stage between 0 and 2 years, known as the pre-linguistic period, that the baby establishes the basis of communication with those around him. It can be said that it is at this stage that the child learns to listen and the perception of speech sounds is the first step in the comprehension of oral language[10].

The EG children had profound, disabling hearing loss. The absence of hearing in the child's early years compromises their linguistic and cognitive development and generates important impact for the rest of their lives. In this sense, diagnosing deafness and initiating auditory rehabilitation as early as possible is essential[11]. In this group, the mean age at which children received CI was 3 years and 8 months, that is, delayed in relation to the pre-linguistic period[10]. Research has shown that the earlier the brain receives meaningful sounds, the better the condition children will have to produce good results, due to the functional plasticity of the central nervous system and decreased sensory deprivation[8].

Both in the CG, as in EG, the results of the EDAL 1 were upward (Figure 1); however, the means by age group of the hearing children were always significantly higher than those of the implanted children, despite the fact that the hearing age was the same. This finding reveals that sensory deprivation causes damage to the development of hearing and language abilities. Nevertheless, if we consider the standard deviation described in Table 1, it is possible to verify that many children of the EG reached the CG results. This fact reinforces the need for constant evaluation and follow-up of cases of children with CI[12-15], in order to map the evolutions and offer subsidies for therapeutic approach.

The search for better ways to evaluate the oral language of children who use CI is incessant and stimulates scholars and researchers in this area, probably according to the local needs that each hearing health service experiences. A systematic review[15] recently undertaken on the subject sought to examine the instruments available. The authors searched in three different databases, using six different descriptors, to select articles published from 2004 to 2009. A total of 47 articles were found and the studies included in the systematic review presented varied methodologies and low levels of evidence, with a higher concentration of instruments that assessed the receptive and expressive language, emphasizing the vocabulary research and child questionnaires. They pointed to the fact that important linguistic abilities (morphosyntactic, semantic, and narrative/pragmatic) in structuring speech and language for the child's speech efficacy were not being focused. In this sense, it is important to clarify that the EDAL-1 is the first part of a comprehensive test, which is based on the parents' response to the hearing and language development of the implanted children and focuses on the first months of CI rehabilitation.

Considering that the EDAL-1 is a protocol developed by speech-language pathologists for the SUS hearing health service[7] reality, it is possible to affirm that the instrument was effective in the follow-up of newly implanted children.

From the data collected in the EDAL-1, it was possible to draw a line of development of each implanted child, comparing the findings recorded in each of the follow-up sessions, and to visualize the advances made since the day of activation. This comparison allows the monitoring of hearing and language performance in implanted children and, thus, provides subsidies for speech therapy[13,15].

It is also possible to compare the results of the implanted children with those of hearing children and, thus, set goals for the families and speech therapists, in search of better answers with the use of the device.

Although it is an indirect measurement tool, based on the responses of an observer, it is necessary to think that communication is dependent on the two-way interaction between parents and children and should be considered in the evaluation of young children in the process of rehabilitation.

CONCLUSION

The hearing and oral language performance in deaf children with cochlear implants were characterized by EDAL-1 and was shown to be growing, according to the increase in the time of auditory stimulation, a fact also observed in hearing children. Despite this, the results of the hearing children were better than those of the implanted deaf children.

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