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Full Length Research Paper

Evaluation of the Effectiveness of Cochlear Implant According to Age of Implantation

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Hearing loss in pediatric population is a major health concern, taking into account the immediate repercussions on the cognitive, emotional and language development, resulting in serious difficulties in communication and language development. Therefore, many institutions and official bodies emphasize the importance of its early diagnosis and implantation. The objective of this study is to know the effect of cochlear implant on the development of oral language in implanted children in the Province of Santa Cruz de Tenerife (Canary Islands) according to age of implantation. Study of the psycholinguistic profile of children who are implanted between 2011 and 2013 (n= 28) through the use of two standardized tests, Peabody Picture Vocabulary Test and Thelllinois Test of Psycholinguistic Abilities (ITPA). 18%of the children were implanted under two years of age, 26% between two and three years old and 56% over three years of age. There is a significant tendency to use the visual channel in the communication of those children who were implanted at a later age and a tendency to use the auditory channel at an early age of implantation. A later age of implantation implies a risk in the normal language development both at a level of language comprehension and expression. Children who are implanted at an early age showed both at a level of language comprehension and expression better results than those children who were implanted at a later age. Most of the cases studied were implanted at a later age. This situation leads them to a nonfunctional use of the implant and a limited development of their speaking skills.

Keywords: Hearing loss, Age of implantation, Language development, Psycholinguistic profile, Deafness.

INTRODUCTION

Cochlear implantation has become an increasingly common option for deaf children. An increasing number of studies have shown the advances in children's functionality after receiving a cochlear not immediate and they are not as good as expected (Geers, 2003). It is important to emphasize the

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significant variability of the results after the implantation implant, and more concretely, those advances related to the spoken language and the ability to communicate (Bat-Chava et al., 2005; Blamey et al., 2001; Connor et al., 2000; Geers, 2003; Svirsky et al., 2000). However, the success of the results after a cochlear implant are (Bat-Chava et al., 2005; Purdy, Chard et al., 1995; Sach and Whynes, 2005; Spencer, 2004; Spencer and Marschark, 2003; Svirsky et al., 2000; Álvarez et al., 1999). In fact, after a cochlear implant, continuous efforts are required in rehabilitation to get effectiveness (Christiansen and Leigh, 2002).

According to those data obtained from the Commission for Early Hearing Impairment Detection (CODEPEH, 1999), in Spain about 2000 children are born every year with hearing impairments to varying degrees, including mild cases (5% of newborn children). One out of thousand newborn children has severe or profound deafness. More than 90% of deaf children are born in families who have no hearing loss and only 50% of newborn children with deafness are identified at an early age.If we take into account that 80% of cases of hearing loss or permanent deafness in children are present at birth, between 50-60% of hearing loss in children have a genetic origin and about 400 genetic syndromes described in the scientific literature include hearing loss. We can observe that severe and profound deafness is a problem which can affect many children from an early age. Nevertheless, only 40% of these children will be candidates for cochlear implants (Bixquert et al., 2003; Marco et al., 2004; Moro, 2009; Manrrique et al., 1994).

Presently, it is necessary to perform protocols for the early detection of these cases. This procedure must define early diagnosis and treatments which let the children receive an early care, with speech therapy intervention and hearing health care services to make children access to spoken language at an early age, promoting the development of subsequent learning (Trinidad-Ramos et al., 2010).

If we take into account that, as Borkoski-Barreiro et al. (2013:405) state, “Hearing throughout life fulfills a key role in the acquisition, development and maintenance of speech and language characteristics, determining the communicative linguistic competence”, we must emphasize the importance ofensuring that those childrenwith severe auditory impairments and who are candidates for cochlear implants recover their hearing function as soon as possible, aiming at improving their communicative competence.

The experience has proven that cochlear implantation in children at an early age has obtained very positive results, helping to improve the quality of life of these children (Schwartz et al., 2012). Some studies have shown that cochlear implantationin babies at an early age, and in those children whohave overcome the first year of life, hasimplied a relevant improvement in the hearing capacity of these children, being their level of development similar to that of those children with the same age without deafness (McConkey, 2003; Schwart et al., 2012). These results have underlined the need for an early cochlear implant. We must also take into account the challenge this implies for those specialists who perform the cochlear implant surgery and the subsequent rehabilitation, and also the challenge it implies for the child’s family. Although it is essential to enhance the role of the background of the child who has been implanted,we must not forget that the benefit of implantation in these young children depends not only on the implantation itself but also on the work of families, the support staff and the children’s follow-upafter the implantation.

The objective of this research is to know the functional effectiveness of cochlear implants performed in a group of children who were implantedin Tenerife between 2011 and 2013 and its effect on the development of the communicative function of these children.

METHOD

The psycholinguistic profiles of twenty eight of the thirty children who were implanted in the Province of Santa Cruz de Tenerife were studied. At the time of the evaluation of their psycholinguistic profiles, 9 children were studying at preferential integration centers for hearing impaired people in childhood education, 17students were studying at preferential integration centers in primary education and 2students in ordinary centers.

In order to evaluate the children’s psycholinguistic profiles two instrument were selected:

1) Peabody Picture Vocabulary Test (Dunn et al., 1986). It does not require lip and verbal reading and written responses. It consists of 125 image plates. Each

image plate has four black and white illustrations with a multiple choice organization.The task consists in choosing an image plate that illustrates the meaning of the word that the examiner presents orally. It is designed to measure the listening comprehension, measuring, therefore, the receptive or auditory vocabulary of the individual. It can be used with children who do not read or have language problems and can be considered as an aptitude test (verbal skill or intelligence). It is used to evaluate the language development in preschool children and the vocabulary of older students.

2) The Illinois Test of Psycholinguistic Abilities (ITPA; Kirk et al., 1968) which tries to evaluate the cognitive and linguistic functions involved in communication activities and to provide an analysis of the inter- and intra-subjective differences. This test is structured in the following way:a) *Communication canals*: auditory-vocal canal and visual-motor canal. *Psycholinguistic processes*: receptive process (ability to understand what has been seen and heard), expressive process (ability to express verbally or motorically an information), and organizational or associative process (internal processing of the information perceived). c) *Levels of organization*: Level in which communication habits have been developed: 1) representative level: it requires manipulation and reorganization of communication symbols and processes, and 2) automatic level: communication habits are highly organized and give rise to chains of automatic responses.

To perform the statistical processing we made use of the statistical package SPSS for Windows, version 21.0. The possible relations among the psycholinguistic profiles of those children who were implanted and their ages were explored. Data analysis was carried out through the calculation of the different analysis of variance, using as factor variables *chronological age* (under two years of age, between two and three years of age and over three years of age), *age of implantation* (under two years of age, between two and three years of age and over three years of age) and *auditory age* (under three years of age and over three years of age).

RESULTS

As regards the chronological age, we could observe that 7,1% (N=2) of the children were under the age of two. The same values were obtained in the group of children between two and three years of age. Finally, 85,7% (N=24) of the children were over three years of age. In relation to age of implantation, we could observe that 18% of the children were implanted under two years of age, 26% between two and three years of age and 56% over three years of age.

The results of the Peabody Picture Vocabulary Test revealed that 22% of the children who were implanted at an early age showed a good adaptation as regards vocabulary. Nevertheless, those children who were implanted at a later age, although theyhad had the implant for a longer period of time, showed worse results. 66% of these children obtain low or very low scores. This reveals their difficulties as regards the vocabulary used.

If we refer to ITPA factors, we can observe that there is a prevalence of visual factors over auditory factors. The visual resourceand the power of visual information is an aspect which must be considered as an educational strategy in any circumstancerelated to the deaf child. There is a predominant tendency of visual factors in children who have been implanted at a later age ($F_{(-2years\ old\ /\ +3\ years\ old)}=5,696;\ p<.05$) and a tendency to the use of auditory factors at an early age of implantation ($F_{(-3\ years\ old\ /\ +3\ years\ old)}=4,651;\ p<.05$). We could think that, in all cases after the implantation, the power of visual information would be better. However, we have proven in our study that this is not the case.

Taking into account the auditory age of children, the results improve as regards the chronological age ($F_{(-2years\ old\ /\ +3\ years\ old)}= 4,320;\ p<.05$), what seems to indicate that the implant plays an important role as compensating element of the communicative and language functions which can be affected by hearing loss (See figures 1 and 2).

As regards the chronological age, we can observe that children over three years of ageshow a tendency to decrease the scores related to auditory factors. Children under two years of age show a tendency to increase those scores related to visual factors.

In relation to the auditory age, we can state that when the child is implanted at an early age,visual factors obtain lower scores whereas auditory factors get better scores. As regars the result of the implantation at a later age, we could observe that children obtain a lower score in auditory factors and gradually improve their scores as regards visual factors.

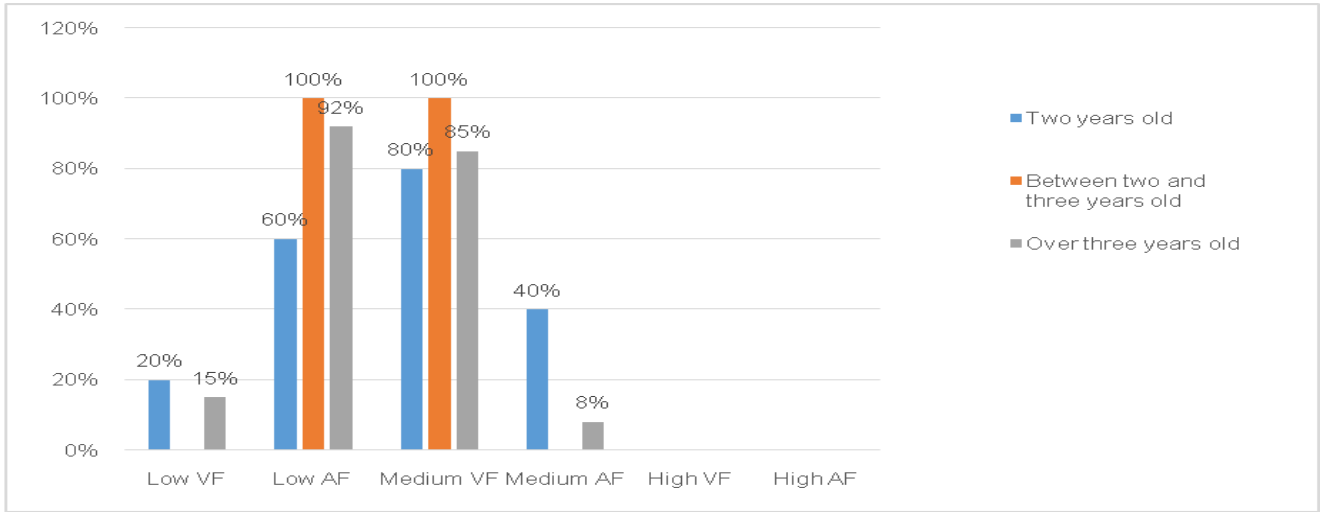

Figure 1. Chronological age

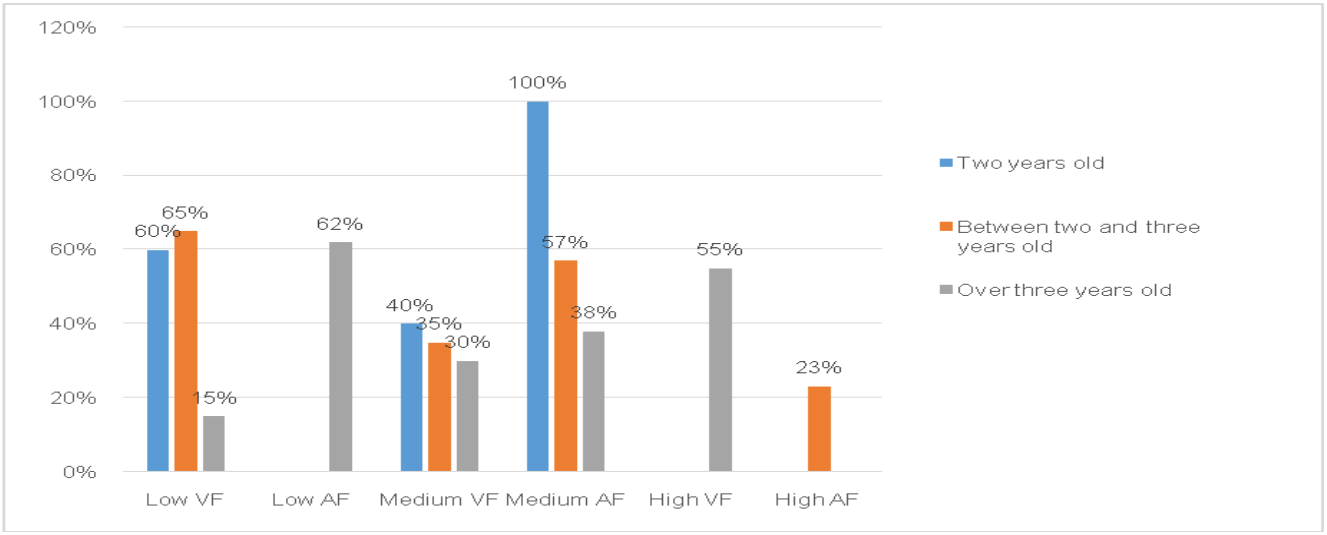

Figure 2. Hearing age

DISCUSSION

Hearing loss is a significant problem due to the implications which can be derived both at the level of communicative functions and the effects that an inadequate acquisition can produce at an educational, emotional and social level.Some studies, such as those recently published by Borkoski-Barreiro et al. (2013), have revealed the importance of early intervention in children hearing loss.

If we consider the processes of language maturity and production as regards the processes of myelinization of cortical areas of association, we can state that these are produced in later childhood (9 and 12 years old). However, a series of basic processes related to the initial language production occur previously.The first sounds appear in the first two or three months of life due to the subcortical activity. The appearance of echolalia between the fourth and seventh months of life reflects the start of the cortico-subcortical connections and the learning of the articulated functions of speech take place between sixteen and twenty four months of age and prevail until children reach the age of five or six. As we can observe, before the end of the optimal period of language development, activation processes of areas of the brainwhich are basic in their development take place. These processes of activation and stimulation of such areas are not possible without the exposure to specific sounds of language.

If we consider that, in these optimal periods, maturation and development of all functional areas of language are produced (Blakemore and Frith, 2005), we will be aware of the importance of early exposure to the sounds of language. If we start from this idea and from the malleability and plasticity that our brain has in order to compensate hypo-stimulated areas, we will understand the relevant role that stimulation plays from the perspective of neurosensory maturation of language areas.

As Werker and Curtis (2002) point out, the recovery of these optimal periods of stimulation becomes a priority task to achieve optimal results in language development. Early diagnosis and intervention are the best strategies to compensate for the effects of hearing loss in childhood since they let the children receive the stimulation whichthey could not receive without the early implant. In this sense, Moro (2009) argues that although the performance of children who have received an implant at the age of two is optimal, when they have been operated on in the first year of life,there is high spontaneous language learning, lower cost of rehabilitation and a greater potential of normalized language development. This fact, together with a communication system, places the children in an optimal situation to acquire a school-based learning.

CONCLUSIONS

This research has shown that early implantation has a positive effect on the language development of deaf children. The age of implantation can be regarded as a good indicator of the linguistic development of these children. We are conscious of the fact that the evidences of the improvements in the processes of language development are not exclusively products of early implantation.Therefore, we consider that the future possibilities of functional and practical improvements of the integration of children who have been implanted need a common effort on the part of both medical and educational institutions and the family.From this perspective and taking into account the results obtained in this study, we consider necessary:

1. To generalize protocols for the early detection of hearing loss.

2. To promote the creation ofsupport, advice and information units from an interdisciplinary perspective capable of promoting collaboration among educational and medical implantation units.

3. To raise the awareness of family and professionals as regards the need of an early implantation.

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