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Original Research

Auditory Perception and Language Development

The Auditory Perception and the Language Development of Newborns with the Hearing Loss in Turkey

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Abstract

Background and aim: The aim of this retrospective cohort study was to show the demographic and clinical features of newborns diagnosed with hearing loss and to evaluate the results of hearing rehabilitation in terms of auditory perception and speech and language skills.
Materials and methods: Demographic data, auditory perception performances and language skills of newborns were evaluated with Ling's six sounds test, Infant-Toddler/Meaningful Auditory Integration Scale and Preschool Language Scale- Fourth Edition on the first admission and subsequently at 1st, 2nd, 3rd, 4th and 5th years.
Results: A total of 30 newborns (10 girls, 20 boys), with an average age of 48.70±17.19 (range, 5 to 75) months at the initial evaluation-were included in this study. There were significant increases in the performances of Ling's six sounds and IT-MAIS/MAIS scores. These improvements were observed more remarkably especially in the first and second years. Total language performances of newborns were increasing progressively and reached the level of chronologic age at the end of the second year.
Conclusion: Neonatal hearing screening programs must be popularized for early diagnosis and referral of newborns with hearing loss. Increased awareness and improvement of communication on these topics are mandatory for the achievement of better results.

Keywords: *Newborn; hearing loss; children; screening; diagnosis; cochlear implantation; auditory; perception; language development.*

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Introduction

The delay in diagnosis of hearing impairment may result in deficiency in terms of language, speech and cognition (Bolat, Bebitoglu, Ozbas, Altunsu & Kose, 2009; Willems, 2000). The ideal recommendation is the procuring of hearing loss in newborns in the first 3 months and to implement the essential interventions within the first 6 months of life. Recent publications have demonstrated that children even with no additional impairments in the first year of life should be screened especially in the first 6 months (Yoshinaga-Itano, Coulter & Thomson, 2000; Yoshinaga-Itano,1999; Yoshinaga-Itano, Sedey, Coulte & Mehl,1998). The auditory stimuli received in the early months of life form the basis for speech, language, and cognitive development. Due to the deprivation of auditory input in newborns with HL; not only auditory perception but also language and perceptual development can be adversely affected (May-Mederake, 2012). Exposure to auditory stimuli in young ages has been shown related to better understanding and usage of spoken language (O'Donoghue, Nikolopoulos & Archbold, 2000; Nikolopoulos, O'Donoghue & Archbold, 1999).

Even though National Newborn Hearing Screening Program (NNHSP) has started in 2003 in Turkey, the number of early detection is still relatively low. This is attributed to the limitations in the communication and awareness on the importance of hearing screening. Therefore, improvement of awareness and communication can aid in minimizing the distressing results of HL (Willems, 2000).

Diagnosing hearing impairment in infants has become easier thanks to new improvements in the area of newborn hearing screening (Harrison, Roush & Wallace, 2003; Dalzell, et al., 2000). Moreover, research on cochlear implantation showed that early intervention in terms of speech perception and linguistic ability served well on children with pre-lingual deafness (Robbins, Osberger, Miyamoto & Kessler, 1995; Miyamoto, Kirk, Todd, Robbins & Osberger, 1995). The age of cochlear implant is a significant agent of the profit provided in the spoken language by means of prelingual cochlear implantation (Yoshinaga-Itano, Coulter & Thomson, 2000).

It is currently acknowledged that age of implantation and rehabilitation is an important agent in the successful development of spoken language, speech perception and intelligibility outcomes (Nikolopoulos, et al., 1999; O'Donoghue, et al., 2000). Considering the importance of the developmental evaluation in children receiving training, the aim of our study was to present the demographic and clinical features of newborns diagnosed with hearing impairment and to evaluate the results of hearing rehabilitation in terms of auditory perception as well as

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language and speech skills. In accordance with this purpose, the auditory, speech and language development of these children have monitored annually for 5 years.

Materials and Methods

Participation

There were no restrictions to participate in this study except for additional handicaps. Only the newborns having additional handicaps except for hearing impairment were excluded from the study. No control group (normal hearing newborn) was defined as the main aim of this study is to evaluate the clinical features of the newborns receiving auditory, speech and language training.

The grade of hearing loss before the application of CI or HA was determined by the thresholds for 500, 1000, 2000 and 4000 Hz tonal and click Auditory Brainstem Response results and age-matched behavioral response audiometry findings in newborns with hearing loss. Follow up hearing thresholds tests were conducted at 3 to 6 months intervals.

Study Design

This retrospective cohort study was carried out in the Audiology and Speech Pathology Section of the Otorhinolaryngology Department at Hacettepe University. Demographic data consisting of gender, chronologic age, hearing aid/cochlear implant age, the age of starting auditory-verbal therapy of newborns were noted. Children detected with HL with NNHSP were recruited in this study maximally 5 years after their initial admission to our institution.

Outcome Parameters

The auditory perception performances of newborns were evaluated on the first admission and subsequently annually during the first 5 years. The auditory perception was evaluated using Ling's six sounds test (Ling, 1989; Ling, 1976) and Infant-Toddler/Meaningful Auditory Integration Scale (IT-MAIS/MAIS) (Robbins, Renshaw & Berry, 1991). Preschool Language Scale-Fourth Edition (PLS-4) was used to define the receptive and expressive language skills (Zimmerman-Phillips, Robbins. & Osberger, 2000).

Ling's six sounds is used to test the child's hearing and to check the child's ability of the detection and the recognition of all sounds necessary for learning the language. The six sounds (/m/, /ah/, /oo/, /ee/, /sh/, /s/) represent various speech sounds from low to high frequency during

the initial evaluation each sound was presented at a distance of 1 meter from child's HA/CI microphone.

Definition of child's spontaneous responses to sound in his/her everyday environment was realised with the help of IT-MAIS/MAIS. It consists of three sections based on information provided by the child's parents in response to 10 questions: 1. vocalization, 2. detection of the sounds and 3. deriving meaning from the sounds. The test administration is in an interview format in which the specific questions were directed to the child's parents. Each question was mainly scaled from 0 (lowest) to 4 (highest) points. Scoring is generally based on the percentage of time during which a child demonstrates such specific auditory abilities.

PLS (Preschool Language Scale) evaluates the child's the ability of the auditory perception (understanding the words and sentences, following directions) and verbal language (syntactic, semantic and conceptual knowledge). The test application takes 20 to 45 minutes depending on the child's age.

Statistical analysis was performed by using IBM SPSS Statistics for Windows Ver. 23 software (IBM Corp., Armonk, NY). Frequency and percentage values for categorical variables, and mean, standard deviation, minimum and maximum values for numerical variables were calculated as descriptive statistics. Friedman test was used to analyze the change of Ling's six sounds test and Infant-Toddler/Meaningful Auditory Integration Scale scores in time.

Results

A total of 30 newborns (10 girls, 20 boys) were included in this study. The average age for the whole group was 48.70±17.19 (range, 5 to 75) months on the initial evaluation, while age at onset of wearing hearing aid was 5.83±1.53 (range, 3 to 10) months. The average time for initiation of auditory verbal therapy was 6.70±1.88 (range, 4 to 13) months. Types of HL diagnosed in our series were mild in 3 (10%) cases, moderate in 5 (16.7%) newborns, severe in 8 (26.7%) children and profound in 14 (46.6%) patients. To overcome HL, cochlear implantation was performed in 17 (56.7%) cases and hearing aids were used in 13 (43.3%) of newborns. The average at the time of cochlear implantation was 13.17±15.16 (range, 10 to 62) months. Duration of cochlear implant usage was 14.83±16.56 (range, 7 to 48) months.

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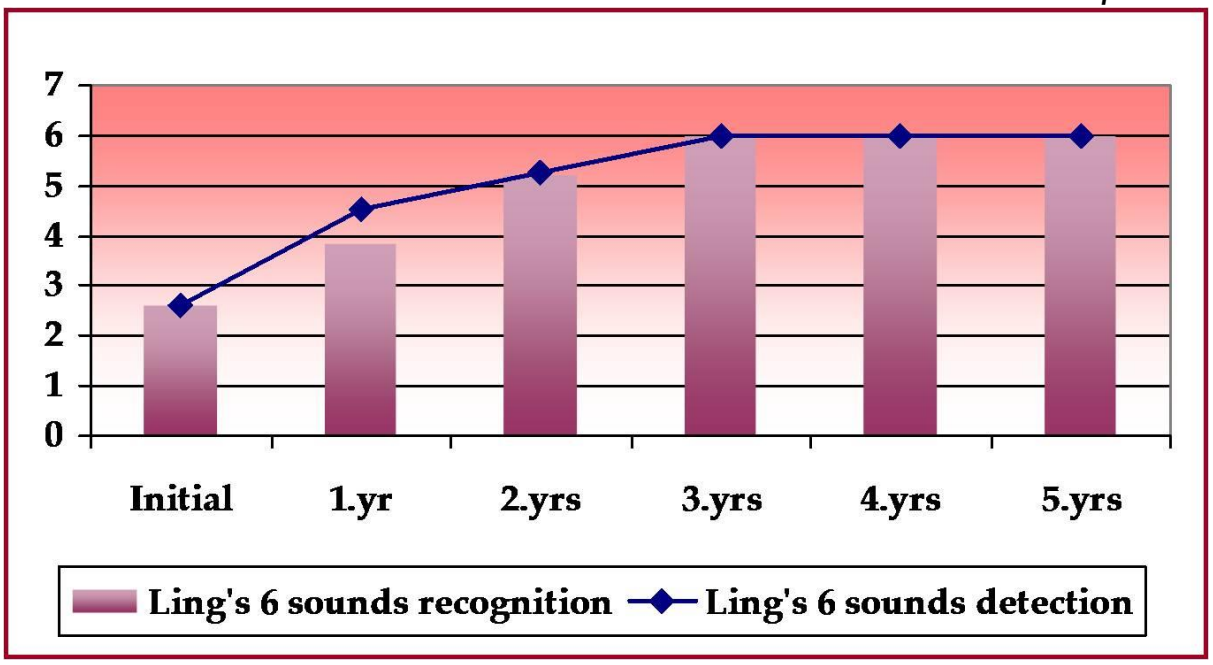

Figure 1. Percentages of average detection and recognition of Ling's six sounds of newborns.

*"Initial" on the X axis indicates the score after the intervention (CI/HA)

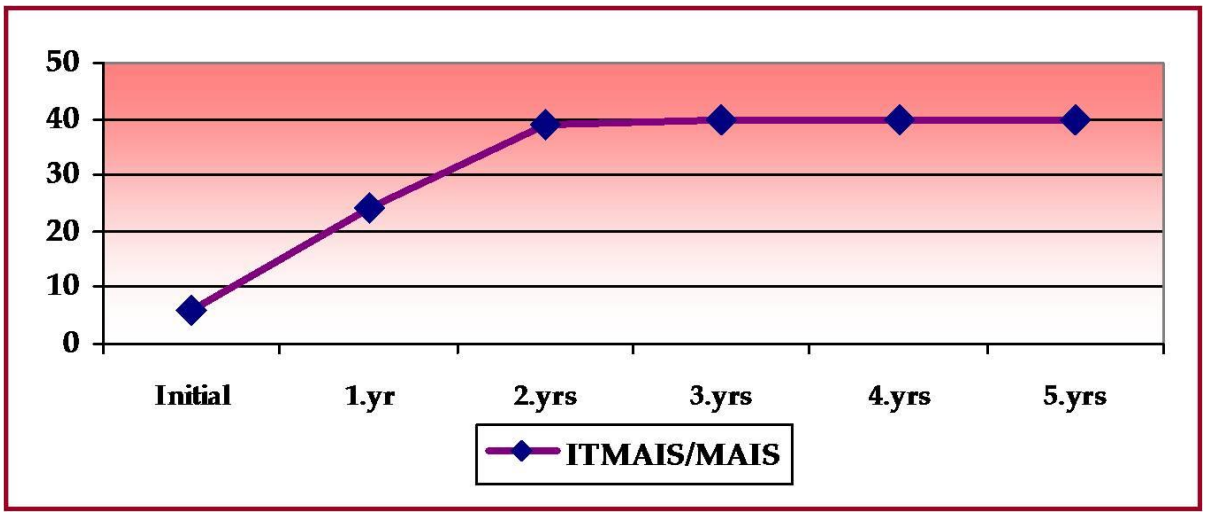

Figure 2. Percentages of average Infant-Toddler/Meaningful Auditory Integration Scale scores of newborns.

*"Initial" on the X axis indicates the score after the intervention (CI/HA)

Our results indicated that there were significant increases in the performances of detection and recognition of Ling's six sounds of the newborns and IT-MAIS/MAIS scores. These improvements were observed more remarkably especially in the first and second years

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(**Figure 1, 2**). In terms of the detection and recognition of Ling's six sounds, the most significant increase in performance was noted after the second year (**Figure 1**).

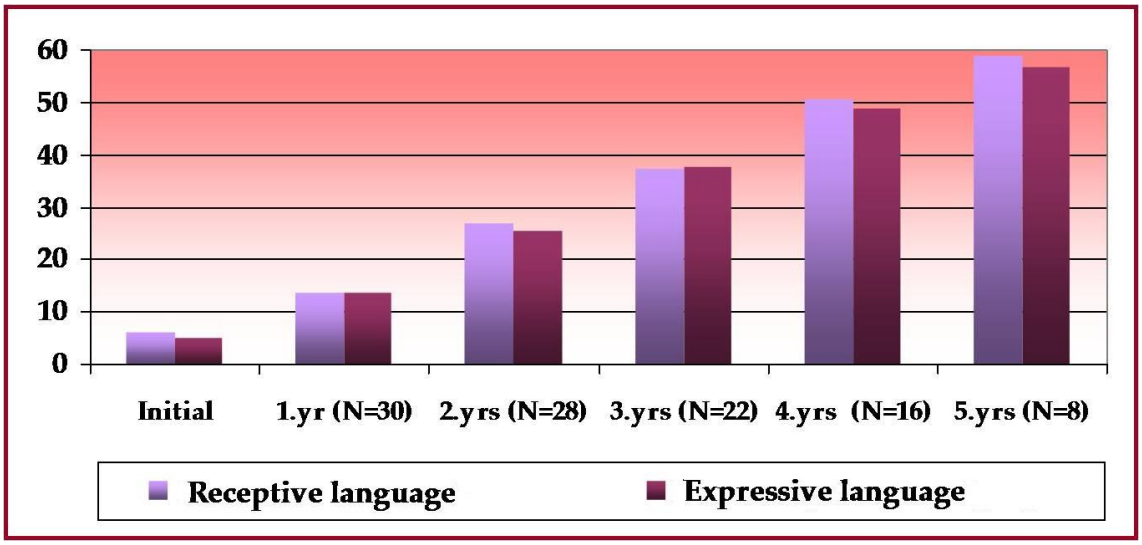

Figure 3. Percentages of average of newborns receptive and expressive language performances of newborns according to Preschool Language Scale.

According to the results derived from Preschool Language Scale, receptive and expressive language performances of newborns were increasing gradually and reached the level of chronologic age at the end of the second year (**Figure 3**). In other words, two-year evaluation scores (regardless of the age of intervention) on the PLS-4 mirrored hearing peers of the same age.

Discussion

In this study, we attempted to outline the demographic and clinical features of children with HL together with an overview of their auditory perceptive profile and language development. Our results have shown that early diagnosis and timely referral of newborns by NNHSP can help the restoration of HL with appropriate measures. Thereby, newborns can display better performances in terms of auditory perception, language skills and speech, allowing them to continue their cognitive and psychosocial development.

In previous years, children that had lost their hearing after the acquisition of spoken language were considered as candidates for implantation. However, the procedure has proven effective for a larger group of children with congenital deafness. Actually, cochlear implants do not restore normal hearing but provide the recipient with hearing sensitivity in the range of

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speech. Interpretation of what is heard via an implant and assistance of lip reading in order to understand a conversational speech can take several years for a child (Nikolopoulos, et al., 1999; Miyamoto, et al., 1995). The primary measure of profit from cochlear implantation is the ability to perceive speech (Nikolopoulos, et al., 1999).

Early identification and intervention of HL can prevent severe psychosocial, educational, and linguistic defects. Recent evidence suggests that timely applied hearing aid and rehabilitative interventions are decisive for the positive management of hearing-impaired children: with the use of a suitable hearing aid within the first 3-6 months, speech and language development, psychological balance, school and social integration can become similar to children of the same age with normal hearing (Molini, Ricci, Baroni, Ciorba, Bellocci & Simoncelli, 2004; Moeller, 2000; Yoshinaga-Itano, et al., 1998).

If the hearing loss is diagnosed before 6 months of age with the Newborn Hearing Screening, the auditory perception and language development of the children with HL can be brought to the level of their peers. Investigation put forward that the age of cochlear implantation in young children was is a significant agent in terms of auditory and speech development (Vlastarakos, Proikas, Papacharalampous, Exadaktylou, Mochloulis & Nikolopoulos, 2010; Watson, Archbold & Nikolopoulos, 2006). Thus, decreasing the age at implantation has become a current practice. By providing the child opportunities of exploration with spoken language at an earlier age, acquisition of learning skills and development of language may be accelerated (Tait, Nikolopoulos & Lutman, 2007). In our study, a gradual increase in auditory, speech and language test results especially in the first and second year after the CI or HA intervention, and reaching the same level of auditory, speech and language development with their age group even as early as at the second year of the training program support the main idea of early intervention program for hearing loss.

Early years of life are generally known as a critical period for the development of spoken language (Tait, et al., 2007). The age at implantation was found to be an important factor concerning the development of speech perception and speech intelligibility of children with deafness. Hence, the mean age at implantation is currently decreasing worldwide and has become less than 2 years of age. Several publications have demonstrated that implantation under the age of 2 years offers a notable advantage in terms of the early development of auditory processing and this advantage is obvious even when comparing the children under 2 years with as young as between 2 and 3 years old (Tait, De Raeve & Nikolopoulos, 2007). It was reported that 3 years after implantation the expressive language of 50% of the children who received

their implant between 10 and 18 months was within the normal range (De Raeve, 2006). These findings are in accordance with our results indicating the gain in perception and language skills go in parallel to the early and appropriate rehabilitation of HL.

With the advent of NNHSP and improvement of surgical facilities, cochlear implantation is now indicated for children with deafness younger than 12 months of age. Since the results with children less than 2 years old are promising, it can be expected that children implanted under 1 year of age can do even better. From this point of view, acquisition of normal speech can be possible by shortening the time interval before there is auditory access to spoken language (Tait, De Raeve & Nikolopoulos, 2007). Assessment of the progress in these children is crucial especially in the first year after implantation.

In addition to conventional and well-documented measures we have used, new behavioural procedures are developed for assessment of cognitive, perceptive and language skills. Since standardized tests and procedures can be inappropriate for this age, observation of babbling, visual habituation and interviews with parents and caretakers can be preferred (Tait, De Raeve & Nikolopoulos, 2007).

Owing to the early provision of the cochlear implant with the aid of NNHSP, the children may follow the normal procedure of receiving communication through the audition without a requirement to integrate visual and spoken signals. It is noteworthy that there are no significant differences between the normal hearing and the deaf groups with respect to vocal autonomy and non-looking vocal turns at the 12-month interval. The vocal autonomy measure indicates that not only a child has communicated vocally, but there is something else which is important to them for induction of vocal communication. Not only does the child communicate vocally, but they also do in response to an auditory stimulus to the adult. The vocal and auditory responses supply the adult with the feedback that encourages them to continue this natural pattern of communication and these processes provide the framework for the child to maintain the development of their vocal and auditory communication skills (Tait, De Raeve & Nikolopoulos, 2007).

Some limitations of the present study should be mentioned. Even though we focused on auditory perception and development of language skills, other dimensions that are prone to affect the success or failure of hearing rehabilitation must not be ignored. Relatively small sample size, lack of a control group and impacts of environmental, social and economic factors are likely to influence the outcomes.

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To conclude, our results have shown that neonatal hearing screening programs must be popularized for early diagnosis and referral of newborns with HL. Appropriate and timely interventions such as cochlear implantation and hearing aids may allow the newborns to improve their auditory perception, speech and language skills. Increased awareness and improvement of communication on these topics are mandatory for the achievement of better results.

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Legends for Figures

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