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The effect of age at cochlear implantation outcomes in Saudi children

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ABSTRACT

Objectives: To determine for the effect of age (late versus early age) on the cochlear implant outcomes; in terms of language development, auditory skills, speech perception, and production outcomes).
Methods: 67 children were included in the study out of 93 implanted cases in the study period. Children were classified into 2 groups according to age at time of implantation. Group 1 contained 43 children who were implanted before the age of 5 years. Group 2 contained 24 children who were implanted after the age of 5 years. All children were evaluated pre-operatively and at 3, 6, 12, 24 months device experience using the language screening test, Standardized Arabic Language test, Listening Progress Profile (LiP Test), the Monosyllabic-Trochee-polysyllabic Test (MTP), and the meaningful Auditory Integration Scale (MAIS) Test. Charts with incomplete data were excluded.
Results: Only 67 children had complete data out of 93 patients. The mean age (in months) for Group 1 was (43.37 ± 8.63) and for Group 2 was (70.38 ± 9.97) at time of implantation. Significantly higher mean values were detected for Group 2 in comparison to Group 1 in the pre-operative period. No significant difference was detected after 2 years evaluation using the test battery for language development and auditory skills.
Conclusions: Children who were implanted under the 5 years of age had a better outcome in the form of better auditory skills, speech perception, and language production. Limited resources and the absence of a national hearing screening program in Saudi Arabia result in the late presentation of children for evaluation and intervention of hearing problem; this late intervention reduces the benefits the late – implanted children derive from cochlear implantation.

1. Introduction

Cochlear implants (CIs) are a popular treatment option for children with severe to profound hearing loss. Many studies have reported the audiological benefits of early implantation [1,2]. The first 5 years of the child's life are considered their critical period for learning language. This critical period is particularly important for deaf and hearing-impaired children. Providing CIs to deaf children at young age may enable them to take the advantage of this critical period for learning language and their speech perception to levels similar to those of normal hearing children [3]. The differences in language and speech performance between children with cochlear implants and their hearing age-mates, therefore, are mainly due to the existing delay in performance at the time of implantation. From this viewpoint, implantation should ideally occur before delays are present [4–6].

Deafness is a major health problem in Saudi Arabia, a country with one of the world's highest rates of per capita hearing impairment [7]. This is probably due the absence of a national neonatal hearing screening program, the high rate of positive consanguinity, the inaccessibility or unavailability of specialized medical centers, and the lack of health education.

Delays in presentation and referral to our center lead to delays in detection and intervention, which might be barrier to achieving optimal cochlear implant outcomes in older children. To date, no research has been done in Saudi Arabia on the effect of age at cochlear implantation and users' resultant language, auditory, speech perception, and speech production outcomes. We believe that implementing an early detection and intervention system in Saudi Arabia would be highly beneficial to both CI users and Saudi society, as studies have shown it has been in other countries [8–10].

The aim of this study is to investigate the relationship between age at implantation (late versus early age) on the language, auditory and speech perception skills of children who participated in the same auditory re(habilitation) program at King Abdul-Aziz University cochlear implant program.

2. Methods

We conducted a retrospective chart review of all children who underwent cochlear implantation at the King Abdul-Aziz

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University cochlear implant (CI) program between January 2010 and December 2012. Inclusion criteria for the study were that a child must (1) have prelingual severe to profound hearing loss, (2) have a normal imaging of temporal bone, (3) have been implanted with a CONCERTO (MED-EL, Innsbruck, Austria) cochlear implant, (4) have had a complete insertion of electrode into the cochlea, (5) have had no postoperative adverse events, and (6) have attended regular pre- and post-operative (re)habilitation sessions. All files with missing or incomplete data were excluded.

2.1. Assessment tests and questionnaires

All the children underwent the same assessment program.

a. Language age

Children's language age pre-implantation was assessed with a parent-questionnaire developed by Rifaie et al. [11]. It is used to screen children's language levels during the pre-operative assessment to profile the language development in the first two years of life. The parent-questionnaire assesses the monthly achievement of the children aged 0–1 and bimonthly progress when they are 2 years old. The items assess receptive and expressive elements and the social aspects of communication.

Children's post-implantation language development was assessed using the Standardized Arabic Language test [12]. During language assessment procedures each subject's language age deficit (LAD) and language improvement quotient (LIQ) were evaluated. The LAD was determined by calculating the difference between chronological age at time of evaluation and the corresponding language age score obtained at that time. The LIQ was determined by calculating the difference between the language ages in the period of assessment.

b. Speech intelligibility

To assess speech intelligibility, a 5–10 min audio recording of the child was requested and collected from the parents. Natural conversation, naming, and describing 3 standardized pictures were used as the sampling materials for collecting language samples to rate speech intelligibility. Because of the scarcity of the children's language before and after 1-year of device experience, speech intelligibility was evaluated only after 2 years device experience. 3 people who were neither hearing professionals nor familiar with the children assessed the speech intelligibility using a 5-point speech intelligibility rating scale, a score of 5 means the most intelligible. Children's scores are the mean score obtained from the 3 raters.

c. Receptive and productive auditory skills

Children's were tested with the LiP, the MTP, and the MAIS at pre-implantation and after 1, 3, 6, 12, and 24 months of device experience.

The Listening Progress Profile (LiP Test) [13], which is a closed-set measure of auditory discrimination and identification of environmental sounds, voices (male versus female), phonemes (a, i, u, ss, sch), and musical instruments. Upon hearing a sound, children were shown pictures or real musical instruments and asked to point to the one they believed was the correct answer. An identification task was also to recognize his/her own name. For each question, the frequency of the correct reaction is scored (never/not known = 0 points, sometimes = 1 point, always = 2 points) for 21 situations to yield a maximum possible score of 42 points. Children's scores are given as the percentage of total possible points scored.

The Monosyllabic-Trochee-polysyllabic Test (MTP) [14] tests children's ability to identify one word from a closed set of words which are different in syllable number (e.g., bed, monkey, banana) and also the correct number of syllables. Children with low linguistic levels (according to the language test used) were tested with group of 3 or 6 words. Children with high linguistic levels (according to the language test used) were tested with group of 6 or 12 words, if the 3 or 6-word test was successful. Once the child was familiar with the words, the words were presented once without lip reading by the test speaker. In the 3-word test, every picture was repeated 4 times, in the 6-word test every picture was repeated 3 times, and in the 12-word test every picture was repeated 2 times. Children's scores are given as the percentage of correct answers.

The Meaningful Auditory Integration Scale (MAIS) [15] is a parent-report scale designed to assess hearing impaired children's meaningful use of sound in everyday situations. The scale (which was used in an interview format) provides information on the children bonding to their device, on their alertness to sound, and on their ability to derive meaning from sound stimuli. The assessment was based upon information provided by parents in response to 10 probes.

Each of the 10 probes can be answered rating the frequency of the behavior in question from 0 to 4 points (a score of 4 means the behavior is most frequent).Children's scores are given as the percentage of total possible points scored.

2.2. Data analysis

Data were presented as means and standard deviations. To compare the results between groups, we used unpaired Independent sample *t*-test for parametric results and Mann–Whitney-test for non-parametric variables. We used the Statistical Package for the Social Sciences (IBM SPSS Statistics) version 20.0 for all statistical analysis. Results were considered significant at $p \leq 0.05$ level.

2.3. Ethics and consent

The study was approved by the ethical committee of the College of Medicine at King Saud University. The subjects' parents gave written consent.

3. Results

3.1. Subjects

93 children were implanted during this time, 26 of whom did not meet inclusion criteria or had missing or incomplete data (especially who did not attend post-operative rehabilitation sessions due to many reasons) were therefore excluded. The remaining 67 children were divided into 2 groups based on age at implantation: Group 1 consisted of children under the age 5 years old and Group 2 five years old or older. Group 1 had 43 subjects (20 male, 23 female), with a mean age of 43.37 (±8.63) months old. Group 2 had 24 subjects (10 male, 14 female), with a mean age of 70.38 (±9.97) months old at time of implantation. All children were represented with congenital hearing loss of unknown etiology. Table 1 represents the descriptive data for the included subjects in both groups.

Table 1
Demographic data of the patients of both groups expressed as means and ± SD.

	Group I, Means ± SD	Group II, Means ± SD
Age of subjects (in ms)	67.37 ± 8.63	94.04 ± 9.97
Age of hearing loss detection (in ms)	12.81 ± 5.54	23.67 ± 12.85
Age of hearing aid fitting (in ms)	21.35 ± 7.11	35.33 ± 12.09
Age at implantation (in ms)	43.37 ± 8.63	70.38 ± 9.97