The use of the LittlEARS Auditory Questionnaire in assessing children before and after cochlear implantation

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Background
The age of cochlear implant (CI) is a crucial factor that affects auditory skills and speech outcome in children after CI. Speech and auditory skills outcome using the Arabic form of the LittlEARS Auditory Questionnaire (LEAQ) on Arabic-speaking cochlear-implanted children is not sufficiently studied.
Objective
The aim of the present study was to assess.
the use of the Arabic form of the LEAQ to determine the effect of age of CI on the outcome of auditory skills in children with CIs, to enhance better intervention protocols for children in need of CI and to achieve the best communicative skills for those children.
Patients and methods
A total of 45 children with CI were classified into three groups according to their ages, and they were assessed using the Arabic version of LEAQ preoperatively as well as 6 and 18 months after mapping.
Results
Significant improvement in auditory skills and speech was reported in the three groups. The improvement was highly significant in the youngest group in comparison with the other two groups 6 and 18 months after mapping. In addition, speech and auditory skills were highly significant in each group after CI.
Conclusion
The age of the child at which CI is placed is a crucial factor in speech and auditory skills development. The earlier the age of CI, the better the result.

Keywords:
auditory skills, cochlear implant, littlears auditory questionnaire

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Introduction

A cochlear implant (CI) is an auditory prosthesis that stimulates the primary auditory nerve fibers electrically to elicit sound perception in individuals with severe-to-profound sensorineural hearing impairments. The use of CI can facilitate the development of speech and auditory skills in children presenting with prelingual hearing impairment [1].

There are different tools for auditory skills assessment such as Categories of Auditory Performance Integrated Scales of Development [2], Educational Audiology for the Limited-Hearing Infant and Preschooler: an Auditory–Verbal Program [3], Auditory–Verbal Ages and Stages of Development in (Levels I–VIII) in Cochlear Implants for Kids [4], Cottage Acquisition Scales for Listening, Language, and Speech, Simple Sentence Level [5], Auditory Skills Checklist [6], St. Gabriel's Curriculum for the Development of Audition, Language, Speech, and Cognition [7], and Children with Hearing Loss: Developing Listening and Talking Birth to Six [8].

This variability in tools of auditory skills assessment was due to the individual preference; therefore, the scientists were looking for different tools. In addition, they were having difficulty in comparing children's progress and did not have detailed normative data. The assessment should detect early-to-advanced listening skills, it should be able to recorded individual skills in progress notes from every session, and find the overlap between auditory and receptive language skills [9].

The LittlEARS Auditory Questionnaire (LEAQ) was developed by MED-EL [10]. It was designed as a continuation of the Evaluation of Auditory Responses to Speech (EARS) [11], which is a comprehensive test battery developed in 1996 by Allum-Mecklenburg to aid the evaluation and rehabilitation of CI recipients aged 3 years and older. The LEAQ was the first LittlEARS1 module introduced and supplies a general picture of auditory behavior and functioning for young children [12]. Therefore, to our knowledge, only one study has assessed the auditory skills and speech outcome using the Arabic form of the LEAQ on Arabic-speaking cochlear-implanted children (n=13), which is not sufficient.

Aim

The aim of the present study was to assess the use of the Arabic form of the LEAQ to reveal the effect of age of CI on the outcome of auditory skills in children with CIs, to enhance better intervention protocol for children in need of CI and to achieve the best communicative skills for those children.

Patients and methods

This study was conducted on children who presented to the Phoniatrics Clinic at Soliman Fakeeh Hospital and ENT Center at King Fahd Hospital, Jeddah, KSA, during March 2013 to March 2015. All children were recruited for auditory rehabilitation after CI. All children presented with bilateral, severe-to-profound sensorineural hearing loss. Informed consent was signed by all parents or guardians of children included in the study, and ethics committee approval was obtained.

Inclusion criteria

(1) Children implanted with unilateral CIs between 1 and 6 years of age were included.
(2) Children who presented subjectively with normal cognitive abilities were also included.

Exclusion criteria

(1) Children who presented with other disabilities such as visual, motoric, mental retardation, or pervasive developmental disorders were excluded.
(2) Children who did not attend the speech therapy rehabilitation program regularly twice per week for at least 1 year were excluded.
(3) Children who received any rehabilitation sessions before the start of the study were also excluded.

This study included three equal groups of children with CI who were selected according to age at which CI was placed.

Group I: 15 children implanted at age 2 years or less.
Group II: 15 children implanted at age more than 2 years and 4 years or less.
Group III: 15 children implanted at age more than 4 years and 6 years or less.

All children presented preoperatively with poor auditory skills. They were assessed before implantation for speech and auditory skills using the LEAQ, Arabic version, to detect their basic speech abilities and auditory skills. The Arabic version was prepared as a double-translated form of the LEAQ. A 'back-translation' method was used to translate and adapt the LEAQ into Arabic. The Arabic version of the LEAQ was found to be reliable and valid for assessing the development of auditory behavior in children with CIs [13].

The LEAQ is a parental questionnaire that evaluates auditory behavior in the preverbal developmental phase. It uses a series of 35 yes/no questions and can be completed in around 10 min.

For all cases, the auditory training rehabilitation program was given at both centers in the form of three sessions per week regularly for 1.5 years. We followed auditory training rehabilitation program elaborated by Estabrooks [4], who designed auditory training programs for rehabilitation of prelingual hearing-impaired children, which involves the following:

(1) Sound detection.
(2) Sound discrimination.
(3) Sound identification.
(4) Sound recognition.
(5) Comprehension.

Visual and auditory cues (lip reading) were used in the beginning of the training with gradual removal of visual cues. Next, only auditory cues were used. The training rooms were quiet and furnished with carpets on the ground and curtains on the walls to reduce noise for optimal listening conditions. Noise makers and different materials were used to facilitate training sessions.

Phoniatric evaluations were performed to reassess speech and auditory skills for all children 6 and 18 months after mapping (mapping was completed 2 months after implantation) using the LEAQ (Arabic version) [13].

Statistical methods

Statistical analyses were performed using SPSS version 18 (IBM Corporation, Chicago, Illinois, USA). Quantitative variables are presented as mean and SD. Qualitative variables are presented as frequencies and percentages. Paired *t*-test was used to analyze the interval differences between pairs of parametric variable follow-up measurements in each individual group. Parametric variables were compared between the three groups using one-way analysis of variance for independent samples test. Nonparametric variables were compared between the three groups using the χ^2-test. *P* values less than 0.05 were considered significant.

Results

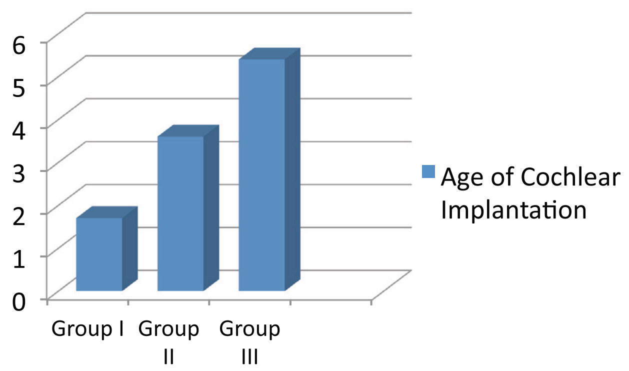
This comparative study included three groups of children with CIs. Each group included 15 participants.

Group I included eight male and seven female patients, with a mean±SD chronological age of 4.4±0.3 years (Table 1). They were implanted with unilateral CIs at a mean±SD age of 1.7±0.3 years (Fig. 1).

Group II included nine male and six female patients with a mean±SD chronological age of 6.2±0.5 years (Table 1). They were implanted with unilateral CIs at a mean±SD age of 3.6±0.3 years (Fig. 1).

Group III included eight male and seven female patients with a mean±SD chronological age of 7.8±0.3 years (Table 1). They were implanted with unilateral CIs at a mean±SD age of 5.4±0.3 years (Fig. 1).

Figure 1



Comparison between the three groups regarding the age of cochlear implantation.

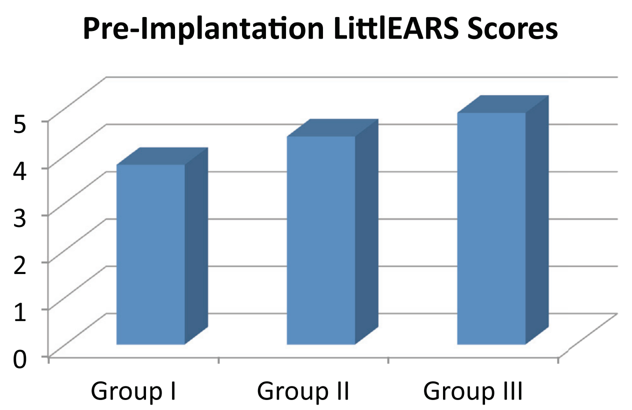
Comparison between the three groups regarding sex distribution was carried out, which showed no statistically significant difference (*P*>0.05). Meanwhile, comparison between the three groups regarding the chronological age and the age of implantation revealed statistically highly significant differences between them (*P*<0.001) (Table 1 and Fig. 1).

Preimplantation assessment of speech and auditory skills was performed for each child using the LEAQ (Arabic version) and revealed a basic preimplantation auditory skills score with a mean±SD of 3.8±0.9 for group I, a mean±SD of 4.4±0.99 for group II, and a mean±SD of 4.9±1.9 for group III (Fig. 2).

Comparison between the three groups regarding preimplantation LEAQ scores revealed no statistical significant difference (*P*>0.05).

Follow-up of each patient was carried out using the LEAQ (Arabic version) at two intervals. The first follow-up using the LEAQ scores was reported for each patients at 6 months after mapping and showed a mean±SD of 13.5±2.2 for group I, a mean±SD of 8.2±1.7 for group II, and a mean±SD of 6.3±2 for group III. Comparison between the three groups regarding the scores of the LEAQ at the 6-month interval after mapping revealed a statistically highly significant difference between the three groups (*P*<0.001) with

Figure 2



Comparison between the three groups regarding preimplantation LittlEARS scores.

Table 1 Comparison between the three study groups regarding demographic data

Variables	Group I (*n*=15)	Group II (*n*=15)	Group III (*n*=15)	*P* value (significance)
Sex [*n* (%)]				
Male	8 (53.3)	9 (60)	8 (53.3)	>0.05 (NS)
Female	7 (46.7)	6 (40)	7 (46.7)	
Chronological age (mean±SD) (years)	4.4±0.3	6.2±0.5	7.8±0.3	<0.001 (HS)

HS, highly significant.

group I having the highest scores and group III having the lowest scores.

At 18 months after mapping, a second follow-up was carried out using the LEAQ, which revealed a mean±SD of 27.8±2 for group I, a mean±SD of 20.5±2.8 for group II, and a mean±SD of 13.7±5.1 for group III. Another comparison was carried out between the three groups regarding the scores of the LEAQ at the 18-month interval after mapping revealed a statistically highly significant difference between the three groups ($P<0.001$) with group I having the highest scores and group III having the lowest scores (Fig. 3).

In addition, comparison between the mean scores of the LEAQ at 6- and 18-month intervals after mapping was performed for each individual group. These comparisons showed a statistically highly significant increase within each group between the means of the scores at 6- and 18-month intervals ($P<0.001$) (Fig. 4).

Discussion

The LEAQ (MED-EL) was designed to monitor preoperative and postoperative auditory development in children with CIs [14].

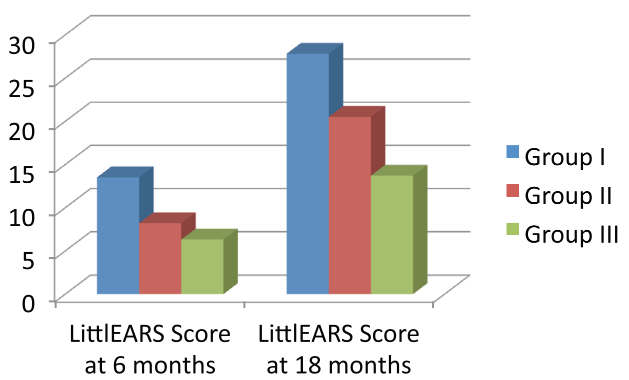
The recent trend of CI at an early age of about 12 months, or even earlier, increases the need for the development of the LEAQ [15]. The LEAQ is an easy 'yes/no' questionnaire. It is scored in a straightforward manner, and requires between 5 and 10 min for completion [16].

Subjective pediatric outcome evaluation tools similar to that of the LEAQ include the Auditory Behaviour in Everyday Life [17], Early Listening Function [18], Parents' Evaluation of Aural/Oral Performance of Children [19], and Functional Auditory Performance Indicators [20]. Bagatto *et al.* [20] evaluated these tools depending on conceptual clarity, norms, measurement model, item/instrument bias, respondent and administrative burden, reliability, different types of validity, responsiveness, alternate/accessible forms, and language adaptations scales. They found that the LEAQ achieved an 'A' grade on the conceptual clarity domain and performed very well on the scale of 'lack of respondent and administrative burden'.

The LEAQ has had several applications documented in the literature. For example, May-Mederake *et al.* [21] found that LEAQ was a rapid and effective tool for assessing auditory skills of hearing-impaired children. Similarly, Schäfer [22] discovered six children with permanent hearing loss from 5320 German children in the second hearing screening and identified infants as well with frequent otitis media and speech or other developmental dysfunctions, such as autism and cognitive deficits. Therefore, LEAQ is useful in screening infants and children.

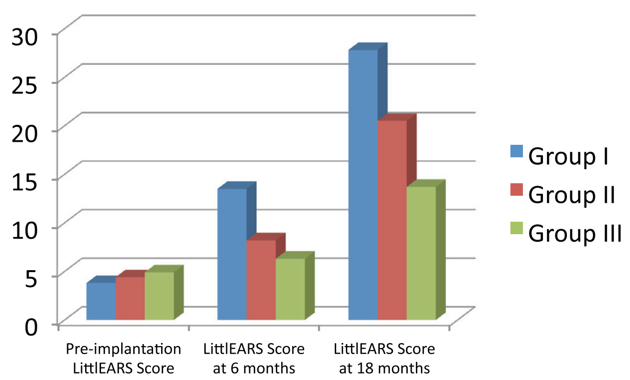
Bagatto *et al.* [20] noticed that LEAQ is a perfect tool for assessing auditory skills as it fulfilled the following criteria of the gold standard tests. LEAQ has alternative ways of administration, does not have biases within the items or the instrument, the responses are not contaminated by cultural differences or social circumstances, and the LEAQ has good test–retest reliability, internal consistency, and validity. Furthermore, the length and the content of the tool are acceptable to the respondent and reasonably administered, easily scored, and interpreted by the clinician.

Figure 3



Individual comparisons between the 6- and 18-month scores of LittlEARS Auditory Questionnaire in the three groups.

Figure 4



Individual comparisons between the 6- and the 18-month scores of LittlEARS Auditory Questionnaire for each group.

Obrycka *et al*. [23] declared that using LEAQ as a structured questionnaire enable parents or other caregivers to comment on their children's auditory behavior in the preverbal stage. LEAQ supports the professional assessments that are administered before and after CI. In this way, parents' reports have been shown to be a reliable way of assessing child development.

This study is considered unique as it is the second study to apply LEAQ on Arabic-speaking cochlear-implanted children.

In our study 45 cochlear-implanted Arabic-speaking children were divided into three equal groups (15 in each) according to their age of CI.

The first group of children was implanted at the age of 2 years or less, including eight male and seven female patients with a mean chronological age±SD of 4.4±0.3 years.

The second group of children was implanted at ages above 2 years and less than or equal 4 years, including nine male and six female patients with a mean chronological age±SD of 6.2±0.5 years.

The third group of children was implanted at ages above 4 years and less than or equal 6 years.

The three groups showed no significant difference with regard to sex; therefore, sex of the children was not a determinant factor affecting the results when the groups were compared (the groups were matched according to sex).

The three groups showed highly significant differences according to age. This means that age is a crucial variable affecting the results when the groups are compared.

In the present study, all the three groups were evaluated by the LEAQ preoperatively for speech abilities and auditory skills. All children showed poor auditory skills and poor linguistic abilities when the three groups were compared with each other. There were insignificant differences regarding speech and auditory skills. The CI was the only choice to improve their language and auditory development. Different auditory outcomes were noted clinically and statistically postoperatively.

All the groups were subjected to the LEAQ in the Arabic form twice at 6 and 18 months after mapping and regular auditory training.

The results showed highly significant differences between the three groups in both evaluations (at 6- and 18-month interval after mapping). The first group (youngest implanted) achieved the highest scores and the third group (the oldest implanted) achieved the lowest scores in both evaluations. This indicated that in children implanted early at the age of 2 years or less auditory skills developed rapidly and more toward the norm.

Our results demonstrated that age at implantation influenced auditory skills in children with CIs. The youngest-implanted group showed significantly better results than the other 2 older-implanted groups. Tait *et al*. [24] in their study on 99 cochlear-implanted children aged 1–4 years measured preverbal skills. They concluded that vocal and auditory preverbal skills develop much more rapidly in children implanted between 1 and 2 years of age in comparison with older-implanted children and reach a significantly higher level of skills by 6 and 12 months after implantation. Many previous studies have shown similar results, with children implanted at younger ages displaying better speech perception skills compared with children implanted at older ages, particularly in the immediate years following implantation [25–29].

Other authors reported different speech and auditory skill outcomes after CIs – for example, Geers *et al*. [30] found no effect of age on implantation in a group of children who were implanted between 2 and 5 years of age. In addition, Dunn *et al*. [31] concluded that speech perception skills, language, and reading improvement diminishes after the age of 4 years, and some children who receive CIs after the age of 2 years have the capacity to approximate language and reading skills of their earlier-implanted peers, suggesting that additional factors may moderate the influence of age at implantation on outcomes over time.

The results also showed highly significant increases in LEAQ scores in all groups when the scores of both evaluations were compared in each group. This indicates that the positive effect of the auditory training on the development of auditory skills such as hearing abilities improve with practice, showing that the auditory system is not rigid but rather can be changed through experience.

Many studies support this finding: Hassan *et al*. [32] concluded that auditory training improves both auditory abilities and speech intelligibility as it enhances auditory recognition and discrimination skills that actually indirectly improve speech intelligibility of cochlear-implanted children, Kirk *et al.* [33] observed the superiority of oral auditory training in improving auditory skills on total communication.

Conclusion

The age of child at which CI is placed is a crucial factor in speech and auditory skills development. The earlier the age of CI, the better the results.

Recommendation

The Arabic form of the LEAQ should be used for the assessment of auditory skills of children before CI and during follow-up visits after implantation. To generalize these results, application of LEAQ on wider scales of children of different dialects is mandatory.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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