12-Month Post-Operative Results for Older Children Using Sequential Bilateral Implants

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Summary

Within a long-term project investigating the perceptual benefits of bilateral implants, six children aged 5 to 15 years received a second implant. Parent reports of functional performance were collected, and localisation and spondee discrimination in noise was assessed. Outcomes varied from no benefit to significant benefit, although no improvement in localisation was demonstrated. A major proportion of the benefit was likely due to headshadow effect. Success did not correlate with hearing aid use, age, time between implants, or second implant experience.

Introduction

In contrast to the routine fitting of bilateral hearing aids to children, the standard practice for cochlear implantation remains a unilateral fitting, with the second ear “saved” for an implant replacement or an alternative. Recent research with bilaterally implanted adults (see, for example, van Hoesel & Tyler, 2003) and with children using an implant plus hearing aid (Ching, Psarros, Hill, Dillon, & Incerti, 2001) suggests children may benefit from a second implant. Also, some reasons for “saving” one ear (such as limited experience with reimplantation) are not as valid as they once were.

Although adult research is relevant, potential benefit for children must be assessed with pediatric subjects. Significant differences between the groups include the impact of early onset hearing loss on auditory system development, and the resulting lack of binaural experience. Initial bilateral pediatric results have been generally positive on objective and/or subjective criteria (Kühn-Inacker, Shehata-Dieler, Müller et al., 2004; Litovsky, Johnstone, Parkinson et al., 2004; Litovsky, Johnstone, Godar et al., 2006; Lenarz, Lesinski-Shiedat, Boehm et al., 2003; Vermeire, Brokx, Van de Heyning et al., 2003). Nevertheless, more research is needed to understand the benefits of pediatric bilateral implants.

The aim of the study was to determine whether greater perceptual benefits are provided to older children through use of sequential bilateral cochlear implants in comparison to one after 12 months of bilateral implant experience. A longer-term aim of the research project is to consider the relationship

between benefit gained and factors such as experience, age, and pre-operative hearing aid use.

Materials and Methods

Subjects

Key selection criteria were: 5-15 yrs, full-time implant use, and the standard medical and audiological criteria for implantation (applied to unimplanted ear). Table 1 presents the six subjects' age at implantation and time between implants. Five were aged <2.5 yrs at the first implant, and the time between implants was 4.5 to 10 yrs. Age at onset was assumed congenital for all except S7 (11 mo). In the non-implanted ear, the three-frequency average was ≥ 103 dB SPL (mean = 113 dB SPL) and no subject consistently wore a hearing aid.

Assessments

Parental reports: Details of implant use, the child's attitude, and functional listening skills were collected monthly.

Speech perception: AdSpon, a new 4-alternative, forced-choice spondee discrimination test was used. Stimuli and foils were presented pictorially on a touchscreen. Continuous speech-shaped broadband noise was used in an adaptive procedure to determine the signal-to-noise ratio (SNR) at which the criterion level of performance (79.4%) was maintained. Assessment was in six conditions: two noise conditions (with speech always from 0° and noise from 90° to the right or left) and three device conditions (first implant alone (CI-1), both implants (BiCI) and second implant alone (CI-2)).

Localisation: The subject faced an array of loudspeakers positioned at head height at a distance of 1.15m and numbered 1 (at 90° left) through 8 (at 90° right) (van Hoesel & Tyler, 2003). The stimulus was 4 pink noise bursts, nominally presented at 70dB, with 8dB jitter. Feedback was not provided. Assessment was in the CI-1 and BiCI conditions.

Results

Device use: Both implants were worn most of the time by most subjects, with no evidence of interference between the signals. Although all subjects were encouraged to practice using CI-2 alone, only S8 gained significant ($> \frac{1}{2}$ hr per day) daily experience using CI-2 alone.

Listening skills with CI-2 alone: Auditory skills varied from limited closed-set skills (30% vowel discrimination for S1) to excellent open-set sentence perception ($>90\%$ for S4). Performance was somewhat correlated with general success using CI-1.

Reported functional performance using BiCI: There was a range of parental reports. For the poorest performer (S1) there was no noticeable difference between the CI-1 and BiCI conditions. For the best performer (S4), there was significant additional benefit in the BiCI condition, especially in noisy and group situations. This subject also had a very strong preference for bilateral

use. Reported functional performance with BiCI was generally consistent with the objective results.

Spondee discrimination: No subject demonstrated improved performance in the BiCI over the CI-1 condition with noise contralateral to CI-1. Figure 1 presents the SNR at which the criterion level of performance was maintained with noise ipsilateral to the active implant (or ipsilateral to CI-1 for BiCIs). Comparison of CI-1 and BiCI bars indicates performance for S4, S5 and S7 improved significantly with the addition of CI-2 (which was shadowed from the noise). Comparison of CI-1 and CI-2 bars indicates superior CI-1 performance for all except S7.

Figure 1. Mean (n=4; CI-2: n=2) SNR at which each subject maintained criterion performance on the AdSpon test with noise ipsilateral to the active implant (ipsilateral to CI-1 for BiCI).

Localisation: Performance for each subject was similar in the CI-1 and BiCI conditions.

Conclusions

Bilateral implants provided functional and speech perception benefits for some, but not all, older children in this small and heterogeneous sample. The major proportion of the benefit was likely due to the headshadow effect. Success did not necessarily require pre-operative hearing aid use, receipt of the second implant at a young age or close to the first implant, or significant experience using CI-2 alone. A great many additional subjects will be required to determine the factors influencing the degree of benefit gained.

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