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Outcomes after cochlear reimplantation in children

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ABSTRACT

Objectives: With cochlear implantation now a routine procedure, reimplantation is becoming more commonplace for medical/surgical complications or device malfunctions. This study investigated the indications for reimplantation and the auditory outcomes following reimplantation surgery in prelingually-deafened children.

Methods: Of the 539 prelingually deafened children implanted between 1990 and 2013, 45 were reimplanted (8.3% of implantations). Causes of reimplantation, type of device and angle of insertion at initial implantation were recorded, as well as type of implant reinserted, number of electrodes inserted and angle of insertion (calculated on cone beam computed tomography) on reimplantation, and finally any surgical findings. Speech perception test scores (phonetically balanced kindergarten (PBK) words, open-set sentence testing in quiet and in noise (S/N+ 10dB SNR), and speech tracking scores) were obtained 1, 2 and 3 years after reimplantation, and compared against the best speech recognition score obtained with the first implant before failure.

Results: Medical reasons for reimplantation were found in 10 cases (22.2%). A malfunctioning device had occurred in 35 cases (77.7%) including hard failure in 24 and soft failure in 11.

Complete insertion was achieved in the scala tympani in 42 cases and in the scala vestibuli in one case; partial insertion occurred in the remaining two cases. In two cases, one or two electrode rings snatched off from the electrode array during removal. The mean insertion angle was 330.5° before surgery and 311.8° after reimplantation (no statistical difference $p = 0.48$).

The postoperative speech perception outcome measures showed no significant difference to the best score before reimplantation. Angle of insertion, type of device and etiology of deafness did not influence the results. The PBK performance improved over 10% in 43.2% of children, was similar in 40.5%, and showed a more than 10% decrease in 16.2% of children after reimplantation. The latter decline in performance was explained for some children by a partial insertion.

Conclusions: Reimplantation has no negative effect on auditory outcome. In rare cases, speech perception outcome may not improve, requiring a specific rehabilitation program.

Cochlear implantation has become a routine procedure for restoring serviceable hearing to children having suffered a bilateral severe-to-profound sensorineural hearing loss with little or no benefit from hearing aids. In some cases, a reimplantation surgery is mandatory. The reasons for cochlear implant explantation or reimplantation can be divided into medical or surgical complications and device malfunctions. Device malfunctions comprise hard and soft failures and account for the majority of reimplantation surgeries.

Several studies have investigated the indications, complications and results of reimplantation [1–10]. Most of these included both adults and children and showed no detrimental effect on speech perception outcome of reimplantation. Few specific pediatric series has been published recently [11,12], yet children may have a slightly higher rate of reimplantation, believed due to a higher incidence of trauma among children than in adults.

This study aimed to investigate the indications for reimplantation, to assess the auditory outcomes following reimplantation surgery in prelingually deafened children, and to identify factors that may influence these outcomes.

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1. Materials and methods

Medical reports from a total of 539 prelingually deafened children implanted between 1990 and 2013 were retrospectively analyzed. Overall, 45 cochlear implants had been replaced (8.3% of the implantations).

Age at initial implantation ranged from 1.1 to 14.9 years (mean 5.07 years). Twenty boys and 25 girls aged from 5.2 to 22.8 years (average 13.9 years) underwent a reimplantation. Time from initial implantation to reimplantation ranged from 5 months to 21.7 years.

Etiologies, detailed in Table 1, were primarily genetics-related (29%), meningitis (13%), and unknown (31%).

Medical records were reviewed to identify causes of reimplantation, type of device and length of insertion at initial implantation, type of implant reinserted, number of electrodes inserted and angle of insertion (calculated on cone beam computed tomography [13]) on reimplantation, and surgical findings.

The primary outcome measures were speech discrimination measured using phonetically balanced kindergarten (PBK) words, open-set sentence testing in quiet and in noise (S/N+ 10dB SNR), and speech tracking scores. Speech perception test scores were obtained 1, 2 and 3 years after reimplantation, and compared to the best results obtained with the first implant before failure.

For individual patients, an increase in PBK scores between the first and second implantation of 10% or greater was regarded as an improved performance. Similarly, a reduction in PKB scores of 10% or more was regarded as a deterioration in performance.

Statview software (Abacus®) for PC was used for statistical analysis. Statistical differences were analyzed using a non parametric test for paired data (Wilcoxon's rank test). Statistical significance was set at the 5% level. Correlations were analyzed using ANOVA analysis.

2. Results

2.1. Type of device

Three manufacturers were used for implantation: Cochlear, Neurelec and Advanced Bionics. Table 2 indicates the specific distribution of cochlear implant models (Cochlear 80% of population, Neurelec 4.5%, AB 15.5%) that required reimplantation and that of the models used to replace them. Forty-four reimplantations were performed with a device from the same company. The vast majority of Nucleus CI 22 were upgraded with a Nucleus CI 24 device, while the vast majority of the Clarion 1.2 CI were upgraded with a Clarion HF 90 CI.

Table 1
Etiology of deafness for the 45 reimplanted children.

Etiology		*N*	%
Genetics—nonsyndromic	GJB2 or GJB6 gene mutation	4	9
	Other	9	20
Genetics—syndromic	Usher type 1	5	11
	Waardenburg	1	2
	Down syndrome	1	2
	Landau–Kleffner	1	2
	Mohr–Tranebjaerg syndrome	1	2
Infectious	Meningitis	6	13
	Labyrinthitis	1	2
	CMV	1	2
Perinatal Anoxia		1	2
Unknown		14	31

Table 2
Distribution of the models of cochlear implants at implantation and at reimplantation.

CI model	At implantation	At reimplantation
Nucleus CI22	24	3
Nucleus CI24 (M–R–RE)	10	33
Nucleus CI512	2	1
Clarion 1.2	6	0
Clarion HF 90	1	6
Digisonic	2	2

2.2. Reasons for reimplantation

Medical reasons accounted for the reimplantation in 10 cases (22.2%). These were infection in four cases all related to flap problems, head trauma with decreasing performance in another four, and neurologic problems in two. One of these latter children had Landau–Kleffner syndrome without improvement of language skills despite a 20% correct score on open-set recognition tests, and the other child required deep brain stimulation to control a severe dystonia (Mohr–Tranebjaerg syndrome).

Malfunctioning device accounted for the decrement in clinical performance found in 35 cases (77.7%). This was a hard failure (abnormal integrity testing) in 24 cases (53.3%) and a soft failure (normal integrity testing though poor performance from the implant and/or nonauditory symptoms) in the remaining 11 (24.4%).

2.3. Surgical findings

All reimplantations were performed at the same side, with one patient undergoing bilateral implantation during the reimplantation surgery. We achieved complete insertion in the scala tympani in 42 cases (93.3%). Partial insertion occurred in two cases: one child with unknown etiology of deafness with partial insertion at reimplantation (Nucleus CI24M; 12 active electrodes outside the cochleostomy), and the other child deafened from meningitis in whom insertion was partial during both implantation and reimplantation (Nucleus CI 512; 6 active electrodes outside the cochleostomy at reimplantation–ossification of the basal turn with partial insertion at implantation). Reimplantation was easy in all other cases of post-meningitis deafness, even in a child with round window ossification at implantation. In one case, we performed a complete insertion in the scala vestibuli at reimplantation.

In two cases, electrode rings were snatched off the electrode array during removal and were left in place (one apical electrode ring snatched off a Digisonic SP device in one child, and two apical electrodes in another implanted with a Nucleus CI22 device): complete insertion of the new electrode array was achieved in both cases. Three cases required a complementary tympanoplasty (one eardrum perforation–two tympanic membrane retractions). No reimplantation was performed in cochlear abnormality cases (two children has an enlarged vestibular aqueduct with no problem at reimplantation).

2.4. Speech perception

Mean scores on speech perception tests are shown in Table 3. The postoperative speech perception outcome measures showed no significant difference as compared to the best score achieved before reimplantation (phonetically balanced kindergarten (PBK) words, open-set sentence testing in quiet and in noise (S/N+ 10dB SNR), and speech tracking scores – Wilcoxon's rank test for paired data – $p > 0.05$). The PBK performance improved by over 10% in 43.2% of children, was similar (an increase or a decrease in PBK