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Main Article

Bilateral, simultaneous cochlear implantation in children: surgical considerations

L Migirov, J Kronenberg

Abstract

Problem: The advantages of bilateral, simultaneous cochlear implantation include: the possibility to pre-empt cochlear calcification following meningitis; reduction of the intervention to only one procedure, general anaesthetic and course of clinical care (with obvious benefits for the patient); and greater cost-effectiveness. The disadvantages of such a procedure include: doubling the risk of associated complications; placing the patient on the implanted side during contralateral implantation; the possibility of vestibular alteration simultaneously in both ears; the need for precise planning of symmetrical incisions and implant sites; and longer surgery time.

Methods: The study cohort included 10 children who underwent bilateral, simultaneous cochlear implantation using the suprameatal approach.

Results: The overall operation time, inclusive of anaesthesia, was approximately three hours in all cases. None of the children had any intra- or post-operative complications.

Conclusions: From a surgical perspective, bilateral, simultaneous cochlear implantation is a safe procedure. The use of a non-mastoidectomy approach is recommended.

Key words: Cochlear Implants; Sensorineural Deafness, Bilateral; Otologic Surgical Procedures

Introduction

The binaural hearing made possible by bilateral cochlear implantation (CI) gives implanted subjects greater ease and flexibility of hearing, improved speech comprehension, better sound localisation, and resolution of the 'head shadow' problem, compared with unilateral implantation.[1–6] The number of bilaterally implanted individuals is progressively increasing worldwide.

There is general agreement that the subject's age at implantation is one of the critical factors for a successful outcome,[4] and that simultaneous implantation is superior to a sequential approach. Specifically, an active preference for the first implanted ear has been found in patients who have undergone sequential CIs, with the two implants never reaching an equivalent level of benefit for the two ears.[7] However, the financial considerations involved in bilateral, simultaneous CI play a major role in its implementation, with costs varying between countries.

Bilateral, simultaneous CI is currently recommended for young children with genetic problems in addition to auditory ones, for patients with bilateral, sudden hearing loss with no recovery, and for patients with post-meningitis deafness.

This procedure has several advantages over unilateral and bilateral, sequential implantations. First, the 'better ear' dilemma is automatically resolved. Second, the bilateral, simultaneous approach pre-empts the advancing cochlear calcification seen in cases of meningitis and Cogan's syndrome. Third, a single operative procedure with a single general anaesthetic and a single course of pre- and post-operative care is more attractive for patients and their relatives as well as for surgeons and the whole CI team. Finally, a single procedure is more cost-effective.

Bilateral, simultaneous CI does however have a number of disadvantages. Bilateral cochlear implants have been associated with double the risk of surgical and medical complications. Brain computed tomography and magnetic resonance imaging (MRI) scans show large artefacts in bilaterally implanted patients (in addition, both magnets would need to be removed and reinserted for MRI scanning of 1.5 Tesla or more, in CI devices with removable magnets). There is the possibility of simultaneous vestibular alteration of both ears. Precise planning of symmetrical incisions and implant sites, in order to achieve good cosmetic results, poses yet another problem. In addition to the general problems of binaural CI, the bilateral, simultaneous procedure

From the Department of Otolaryngology and Head and Neck Surgery, Sheba Medical Center, Tel Hashomer, and the Sackler Faculty of Medicine, Tel Aviv University, Israel.
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extends the length of surgery and requires the patient to be placed on the implanted side during the contralateral implantation. These problems are currently all subjects of ongoing investigation in an attempt to find solutions.

To date, our group has performed over 630 cochlear implantations; 35 patients were implanted bilaterally. The current paper focuses on our surgical experience in performing bilateral, simultaneous CI in 10 children.

Methods and results

Table I displays the clinical characteristics of the 10 children (age range 14–132 months, mean 39.1 months) who underwent bilateral, simultaneous CI between November 2004 and June 2008. The duration of post-operative follow up ranged from four to 46 months (median 12.5 months).

High-resolution computed tomography of the temporal bones of the three children with hearing impairment associated with meningitis showed partial ossification of both cochlear ducts. Each of these children received two Med-El devices (Medical Electronics, Innsbruck, Austria) implanted during the same operation.

Four congenitally deaf children received Med-El devices (patients number four, five and seven) or Nucleus devices (Cochlear Corp, Lane Cove, Australia) (patient six), implanted simultaneously in both ears.

Two other children, one with congenital deafness and another with congenital cytomegalovirus-related deafness, were reimplanted due to electronic device failure in one ear, and both simultaneously underwent cochlear implantation in their contralateral ears.

One child (patient 10) had cytomegalovirus-related deafness and experienced recurrent falls associated with magnet displacements of a Nucleus device. After the third attempt to resolve the problem, we decided to place the magnet into a niche drilled into the skull and to put a receiver-stimulator over the magnet. The contralateral ear was implanted with a Med-El device at the same time. At the time of writing, two years after the last operation, this child was managing very well with two devices from different companies.

We used a suprameatal approach for all the above-mentioned implantations. This technique was developed in our department in 1999, and it has been presented at numerous international meetings in addition to being described in detail in the literature.[8] Briefly, rather than performing a mastoidectomy, the suprameatal technique involves entering the middle ear by means of a retroauricular tympanotomy. A cochleostomy is drilled transcanally, and a closed suprameatal tunnel is created between the suprameatal region superior-posterior to the external auditory canal and the middle ear. The electrode is passed through the tunnel and then through the area between the chorda tympani and incus into the cochleostomy.

The overall surgery time, inclusive of anaesthesia, was approximately three hours in all of our 10 reported cases. This included drilling out the basal turn of the cochlea in two patients who had meningitis-related ossification. One child with post-meningitis deafness had intra-operative cerebrospinal fluid leakage, which was managed with meticulous sealing of the cochleostomy with pieces of temporalis muscle and fascia. None of the 10 children had any surgical complications.

Discussion

Based on our 19 years of experience with CI for various aetiologies, and in patients of all ages, we believe that there are four main groups of patients for whom a bilateral procedure is essential: (1) those with post-meningitis deafness; (2) those experiencing device malfunction or requiring an upgrade of a functioning device; (3) patients with other handicaps in addition to deafness; and (4) young, congenitally deaf children.

For the first group, the possibility of labyrinthine ossification due to post-meningitis changes makes bilateral cochlear implantation the only way to preserve residual hearing.

The second group is a large one, including not only patients who experienced device failure but also those who have been implanted many years ago and who wish to upgrade their devices. The two main problems with this second group lie in defining

TABLE I

CHARACTERISTICS OF THE 10 BILATERALLY IMPLANTED CHILDREN

Pt no	Gender	Age (mths)	Cause of deafness	Procedure	Device
1	F	31	Meningitis	BSCI	M + M
2	M	37	Meningitis	BSCI	M + M
3	M	26	Meningitis	BSCI	M + M
4	M	14	Congenital	BSCI	M + M
5	F	21	Congenital	BSCI	M + M
6	M	18	Congenital	BSCI	N + N
7	M	28	Congenital	BSCI	M + M
8	M	48	Congenital	R + Co	C + C
9	F	132	CMV	R + Co	N + N
10	F	36	CMV	Re + Co	N + M

Pt no = patient number; mths = months; F = female; M = male; BSCI = bilateral, simultaneous cochlear implantation; R = reimplantation; Co = contralateral implantation; Re = replacement of magnet; M = Med-El; N = Nucleus; C = Clarion; CMV = cytomegalovirus

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when a second implant is of sufficiently significant benefit, and weighing the cost involved.

The third group includes individuals who are blind or have neurological disabilities and who would manage much better with two implants than with one.

The fourth group is more problematic, since some parents prefer to 'save' the second ear in order to potentially benefit from future technologies (such as the development of gene therapy).

Despite the well documented advantages of bilateral cochlear implantation,[1–6] the Israeli healthcare system cannot offer a second implant to every patient who needs it, because of cost considerations. Worldwide, most profoundly hearing-impaired individuals usually receive only one implant because of the financial restraints prevalent in most healthcare systems. Our pre-operative counselling for cochlear implant candidates and their relatives usually includes information about the reported decrease in brain plasticity with increasing age.[3] As reported by our colleagues,[7] we also warn our patients about the potential for relatively poorer performance of the second ear following sequential implantation involving a delay of more than one year between implantations.

- **The binaural hearing made possible by bilateral cochlear implantation (CI) allows greater ease and flexibility of hearing, improved comprehension and localisation of speech and everyday sounds, and resolution of the 'head shadow' problem, compared with unilateral implantation**
- **Bilateral, simultaneous implantation does however double the risk of associated complications, require placing the patient on the implanted side during contralateral implantation, and can alter the vestibular system simultaneously in both ears**
- **This paper describes the authors' experience with the suprameatal approach for bilateral, simultaneous CI, thereby avoiding the associated morbidity of mastoidectomy**

We take pains to reassure our patients that there are no grounds for the fear that a bilateral, simultaneous surgical procedure is more extensive and more dangerous than two sequential implantations. By using a non-mastoidectomy technique such as the suprameatal approach, we can reduce the surgical time by half, compared with a bilateral procedure with a posterior tympanotomy approach. The benefits of avoiding the risk of facial nerve damage, chorda tympani damage and electrode misplacement[9] have turned the non-mastoidectomy techniques into routine CI approaches in many European centres.

Conclusion

We recommend the suprameatal approach as a shorter and safer technique for CI, especially for bilateral, simultaneous procedures in young children with undeveloped mastoids and a narrow facial recess, as well as in patients with malformed inner ears.

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Address for correspondence:
Dr Lela Migirov,
Dept of Otolaryngology and Head and Neck Surgery,
Sheba Medical Center,
Tel Hashomer, 5262l, Israel.

Fax: (972) 3 530 5387
E-mail: sabim@bezeqint.net

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