The Journal of Laryngology and Otology
June 1998, Vol. **112**, pp. 533–536

Cochlear implantation under local anaesthesia, the Belfast experience

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Abstract

The profoundly deaf, who gain little or no benefit from conventional hearing aids and meet various criteria are potential candidates for cochlear implantation. The last two decades have witnessed remarkable progress in this field, and it is now a routine clinical procedure. A few adult patients who are potential candidates for cochlear implantation have an unacceptably high risk for hypotensive general anaesthesia due to other systemic conditions. This group has been successfully implanted under local anaesthesia in our centre. The post-implantation progress of these patients was comparable to those carried out under hypotensive general anaesthesia. Data regarding patient selection criteria, examination, anaesthesia, surgery and the outcome are discussed. It was concluded that cochlear implantation under local anaesthesia is a safe and effective procedure for those patients who otherwise may be denied an implant.

Key words: Cochlear Implant; Anaesthesia, local

Introduction

Cochlear implantation has been established as a safe and effective method of aiding the rehabilitation of the profoundly deaf. A review of the literature showed that this procedure is normally only undertaken under hypotensive general anaesthesia. A small number of patients handicapped by their deafness, who are prospective candidates for implantation have initially been turned down due to their unacceptably high risk for hypotensive general anaesthesia. The use of local anaesthesia for ear surgery is well established. Naturally patients will feel nervous under local anaesthesia, necessitating a detailed pre-operative explanation of the procedure and its expected duration. To date four patients have been successfully implanted with a multichannel device under local anaesthesia. This paper describes the experience of the Northern Ireland Regional Cochlear Implant Centre in managing these patients pre-, intra- and post-operatively.

Materials and methods

A total of 83 patients have been implanted in our centre to date. Of the 41 adult patients four underwent the procedure under local anaesthesia. These four patients constitute approximately 10 per cent of the adults implanted. Apart from a routine ENT examination each patient had a computerized tomogram (CT) of the petrous temporal bone to establish patency of the cochlea (Phelps *et al.*, 1990). One patient had sustained a subarachnoid haemorrhage and underwent magnetic resonance imaging (MRI) to assess the integrity of the auditory pathways. All patients were also assessed using close-coupled audiometry and free field audiometry with optimal hearing aids. These tests were used to determine the more suitable ear for surgery, with the exception of the head injury patient who was subjected to promontory stimulation which revealed auditory sensation on the left side only. In this case the left side was implanted, while in all other cases the side with the poorer auditory response was implanted.

Standardized speech discrimination tests using everyday sentences were presented on video to assess each patient's lip-reading skills. These tests were carried out with, and without, conventional hearing aids. An audio tape of 20 environmental sounds was also used to assess each patient's awareness and possible discrimination of familiar sounds. Questionnaires were also used to assess perception of benefit using conventional hearing aids, quality of life issues regarding their deafness, communication difficulties caused by their deafness and their expectations of cochlear implantation. Table I shows causes responsible for categorizing each patient into a 'high risk' group for hypotensive general anaesthesia.

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Accepted for publication: 27 April 1998.

TABLE I
BIOGRAPHICAL DATA ON THE SUBJECTS WHO RECEIVED COCHLEAR IMPLANT UNDER LOCAL ANAESTHESIA

Patient series	Age	Sex	Deafness duration	Medical conditions	Device	Aided free field audiogram
1	57	F	2 years	Mitral stenosis, LVH* deep vein thrombosis hypothyroidism liver disease	Clarion	45–50 dB
2	27	M	1 year	Head injury hemiplegia	Nucleus 22	40–45 dB
3	78	F	23 years	Hypertension ischaemic heart disease recent CVA* obesity	Nucleus 22	40–50 dB
4	72	M	35 years	Ischaemic heart disease CABG < 1 year*	Clarion	40 dB

*LVH: left ventricular hypertrophy, CVA: cerebrovascular accident, CABG: coronary artery bypass grafting.

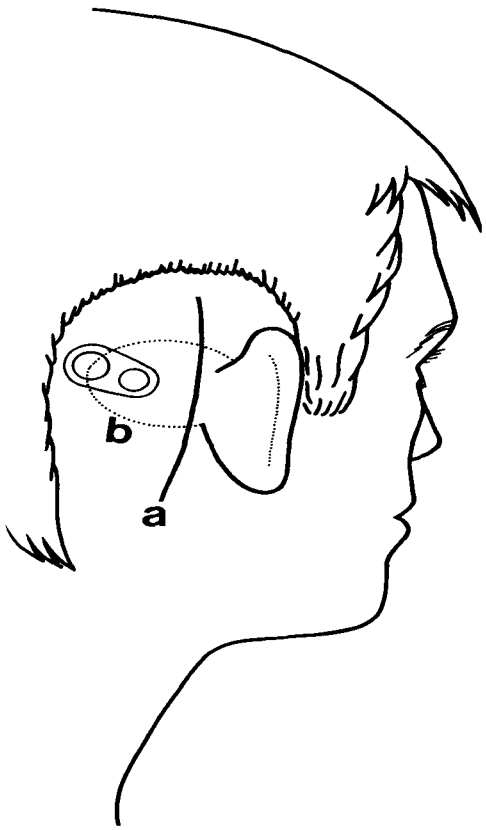

FIG. 1
a – Post-aural curvilinear incision.
b – Anteriorly-based musculoperiosteal flap.

Anaesthesia and surgery

Local anaesthesia in the form of two per cent lignocaine with 1 in 80 000 adrenaline is infiltrated to the area of surgical exposure. The anaesthetic effect is augmented by a combination of a benzodiazepine (midazolam) and an opioid analgesic (fentanyl) given intravenously by an anaesthetist. Additionally a sedative dose of an intravenous anaesthetic agent, propofol was used in two cases. The patient is positioned with approximately 15 degrees of 'head up' tilt. This regimen offers excellent analgesia and operating conditions. A theatre nurse and a member of the implant team are available at all times to communicate with, and to reassure, the patient during the entire procedure.

Following a standard skin preparation a post-auricular curvilinear incision is used. This incision is a modification of the vertical incision as described by Gibson *et al.* (1995) (Figure 1). After dissection of skin and subcutaneous tissue a plane is developed. An anteriorly based musculoperiosteal flap is raised (Figure 1). This provides a two layer cover for the implant at the end of the procedure. A steep cortical mastoidectomy and posterior tympanotomy are completed to gain access to the round window region (Figure 2), (Luxford and House, 1987; Graham *et al.*, 1989; Clark *et al.*, 1991). A recess for placement of the device is drilled over the squamous temporal area, which at times needs dural exposure to ensure a proper fit. A cochleostomy is performed through the promontory anterior to the round window niche (Gantz *et al.*, 1988; Clark *et al.*, 1991). After insertion of the electrode array the cochleostomy is sealed with soft tissue. Once placement of the device is completed an intra-operative test of the implant is performed. Positive auditory responses were elicited in three of the four patients (the first patient was not tested). The test was performed by obtaining threshold measurements of the implant device. Using these

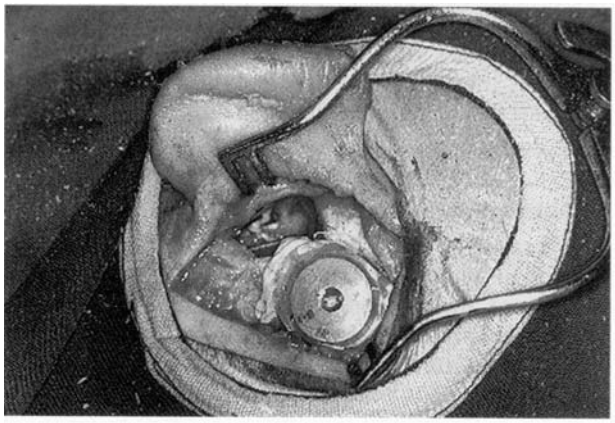

FIG. 2
Steep cortical mastoidectomy and posterior tympanotomy with implant in position.

https://doi.org/10.1017/S0022215100141027 Published online by Cambridge University Press

measurements a modified programme was created and the patient then experienced an initial 'on table switch on' of the implant. All three patients described positive experiences of auditory sensation and one was able to distinguish voice without lip-reading. Following closure of the wound local infiltration of bupivacaine 0.25 per cent is given to maintain adequate post-operative analgesia. Post-operatively a digital X-ray image is performed to confirm good positioning of the implant (Lawson *et al.*, 1996).

During the pre-operative visits and intra-operatively all patients were advised to inform about discomfort or pain during the procedure. Close observation and monitoring were maintained throughout the procedure to detect any form of discomfort or pain. Post-operatively all went home the following day except one patient who was being treated for varicose ulcers.

Discussion

Safety and reduction of bleeding are the two most important factors in ear surgery. Local anaesthesia constitutes a very satisfactory solution. The concomitant administration of midazolam and fentanyl relaxes the patient and ensures analgesia and anterograde amnesia allowing the surgeon to operate under excellent conditions (Martin *et al.*, 1989). The resultant amnesia is such that the patient is unlikely to have any unpleasant memories of the procedure. Midazolam is a water-soluble benzodiazepine which is often used in preference to diazepam due to a faster recovery time and low incidence of side effects. Fentanyl, an opioid analgesic, when added helps to augment these effects. For those patients in whom sufficient analgesia and sedation are not achieved by this, an intravenous anaesthetic agent such as propofol can be added in controlled doses. Although our series of cases did not have any untoward effects, benzodiazepines and opioid analgesics are known to cause respiratory depression sometimes associated with severe hypotension. Appropriate monitoring is therefore mandatory to promptly detect and reverse this serious complication. Our protocol is continuous monitoring of the electrocardiogram, blood pressure recording and pulse oximetry for assessing haemoglobin oxygen saturation.

Local anaesthetic agents act by causing a reversible block to conduction along nerve fibres. Use of two per cent lignocaine with 1: 80 000 adrenaline provides adequate local anaesthesia and a reasonably good operative field. The periosteum has a rich sensory nerve supply and is very pain sensitive. Adequate infiltration to anaesthetize this structure is therefore important. Bupivacaine 0.25 per cent is infiltrated at the end of the procedure. The advantage of bupivacaine over other local anaesthetics is its longer duration of action, taking up to 30 minutes for full effect and lasting approximately three to four hours.

This ensures adequate analgesia during the early post-operative period. We have found that use of this protocol ensures patient compliance with all aspects of treatment. Yung (1996) surveyed patients' attitudes to local anaesthesia for middle ear surgery. The intense sensation of noise during the operation was the single most distressing factor. Since cochlear implantation is done in the profoundly deaf this is not a limiting factor.

The duration of the procedure becomes an important factor when performing any procedure under local anaesthesia. To have maximum patient compliance it is important to keep operating time to a minimum. The curvilinear incision gives a quick and adequate exposure as well as good flap vascularity. The mastoid cavity is drilled more steeply than by the conventional method. This gives more space posteriorly for placement of the device. The disadvantage of this is the difficulty in making the posterior tympanotomy through a narrow cavity. The patients were asked to avoid head movements particularly when the cochleostomy was being made and during placement of the electrode array. This was done by a designated theatre nurse and a member of the implant team communicating with the patient. Post-operatively three of the patients were discharged the following day. One patient remained for treatment of varicose

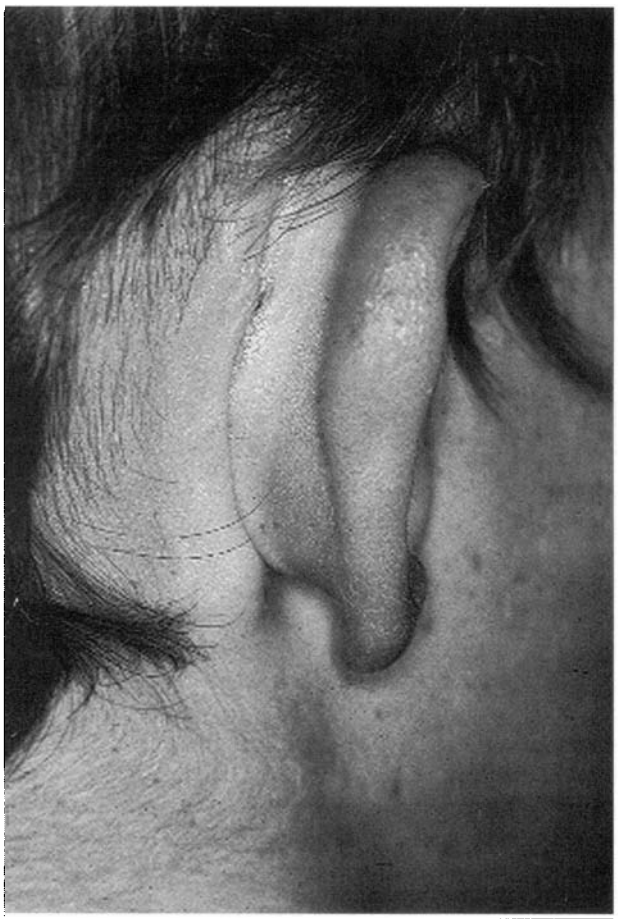

FIG. 3
Healed post-aural incision.

https://doi.org/10.1017/S0022215100141027 Published online by Cambridge University Press

ulcers. All patients made an uneventful recovery and had rapid healing of their surgical incisions with a good cosmetic result (Figure 3).

Table I shows the post-operative implant-aided free field audiograms. Performance is comparable to the post-operative progress of patients who have undergone conventional implantation. During post-operative follow-up all patients were asked about their assessment of the adequacy of local anaesthesia. Three of the patients maintained that the procedure was completely pain free. One patient in whom tinnitus was a distressing pre-operative complaint reported a short period of acoustic discomfort which was tolerable.

To be able to hear again is a much cherished moment in the life of a profoundly or totally deaf person. Acoustical and psychological factors, have been cited as the main benefits of cochlear implantation e.g. 'environmental sound awareness', 'facilitating general conversation', and promoting a 'feeling of self-confidence' (Zhao *et al.*, 1997). This sub-group of patients would not normally have received an implant. We believe that these patients have had a considerable improvement in their quality of life by being implanted under local anaesthesia.

Conclusion

Subjecting 'high risk' patients for a non-life-saving measure like cochlear implantation under a general anaesthetic with hypotensive anaesthesia may not be justifiable on most occasions. We recommend that by following the above mentioned, or a similar local anaesthetic protocol some high risk adult patients can be safely implanted without compromising any of the well established benefits of cochlear implantation.

Acknowledgement

We would like to thank members of the cochlear implant team, Cecilia McAnallen, Joanne Dickson, Jayne McCullough, Irene Brannigan, and Joanne Clarke-Lyttle for their help in the preparation of this paper, David Fleming for photography and Adrienne Ruddock for illustration.

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