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Further experience with a straight, vertical incision for placement of cochlear implants

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Abstract
Experience with a straight, vertical incision for cochlear implantation in 168 patients of all ages is reported and comparison made with previous experience using a 'C' shaped incision in 173 patients with regard to complications encountered. With the straight incision the only complication was a wound infection which settled in one week; this is in contrast to the 'C' shaped incision, which was associated with a number of serious complications. The straight incision also compared favourably with the other incisions commonly used for cochlear implantation and appears to offer advantages over them.

Key words: Cochlear implant; Surgery; operative; Wound healing; Wound infection

Introduction

In 1995, Gibson *et al.*, described a 7 cm long, straight, vertical post-auricular incision (Figure 1) for insertion of cochlear implants. This incision crosses the site of the implant in contrast to other incisions used for this purpose which completely circumscribe the implant site and which are, therefore, curved and considerably longer. Despite the absence of significant complications in their use of the straight incision, the authors recommended caution in its adoption by other surgeons because of concern by the reviewer that the incision would lead to a greater number of complications.

This study reports the use, to date, of the straight incision with regard to complications by two of the original authors over a 40-month period and includes the previously reported experience. It also describes a modification of the incision for use in some patients.

Materials and methods

From January 1994 to the end of April 1997, the straight incision was used for cochlear implantation in 168 patients of whom 100 were children (patients under the age of 14 years) and 68 adults. The youngest patient was aged 53 weeks and the oldest 85 years; Figure 2 shows the age distribution in years.

There had been no prior incision in the operative area in any of the children but five of the adults had had incisions in the post-auricular region. Two of these were standard post-auricular incisions for mastoidectomy or tympanoplasty but three were made in exactly the same position as the straight incision which is the subject of this report to facilitate later cochlear implantation; two of these were for mastoid obliteration using a 'blind sac' procedure and one for myringoplasty.

'Nucleus' (Cochlear Corporation) devices were implanted in all patients and until September 1996

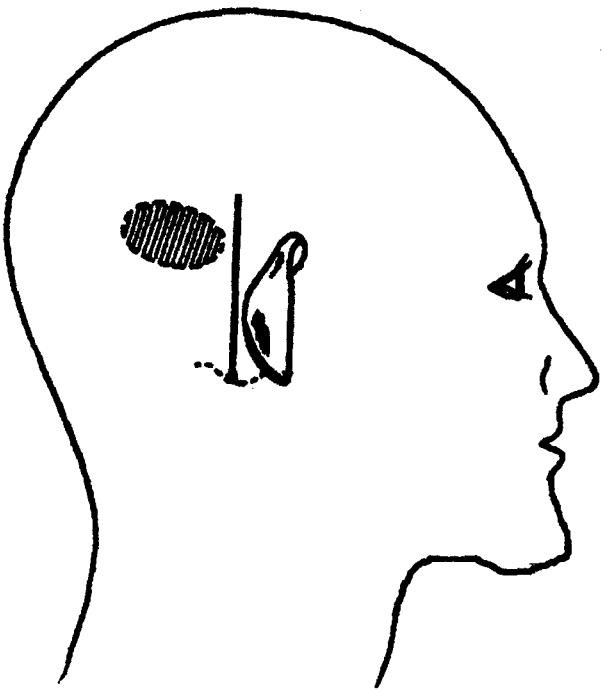

FIG. 1
Straight vertical incision.

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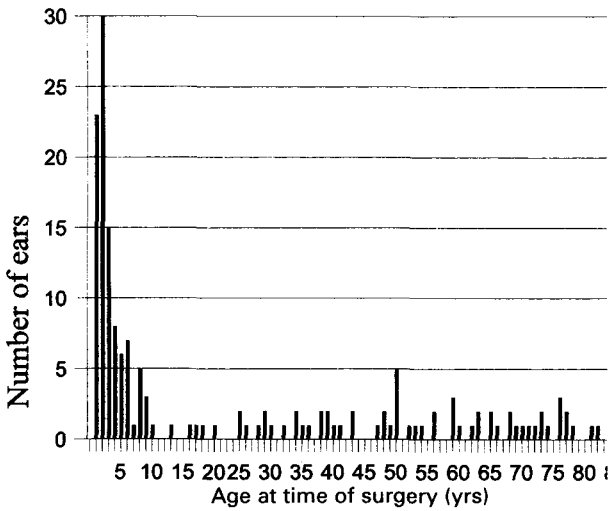

FIG. 2
Age distribution of patients in years.

these were all CI22M devices. After that time some of the patients were implanted with 'Nucleus' CI24M devices. Fifteen patients received the CI24M device and of these six were children and nine were adults.

In the latter part of the study, the incision was modified in four adults to deal with excessive thickness of the tissue overlying the body of the implant (judged to be a skin thickness of greater than 8 mm when measured by inserting a needle down to bone to measure its thickness prior to planning the incision). If the tissue was shown to be excessively thick, the superior part of the incision was curved posteriorly (Figure 3) to allow thinning of the skin and subcutaneous tissue over the future site of the body of the implant without risk of 'button-holing' the skin which could occur if the incision was not so modified. Such thinning in these circumstances is necessary to maintain adequate attraction between the magnet in the body of the implant and the externally-worn microphone because the attraction is compromised by excessive thickness of the tissues. This modification produces an incision which is similar to one developed independently by Cohen (1995).

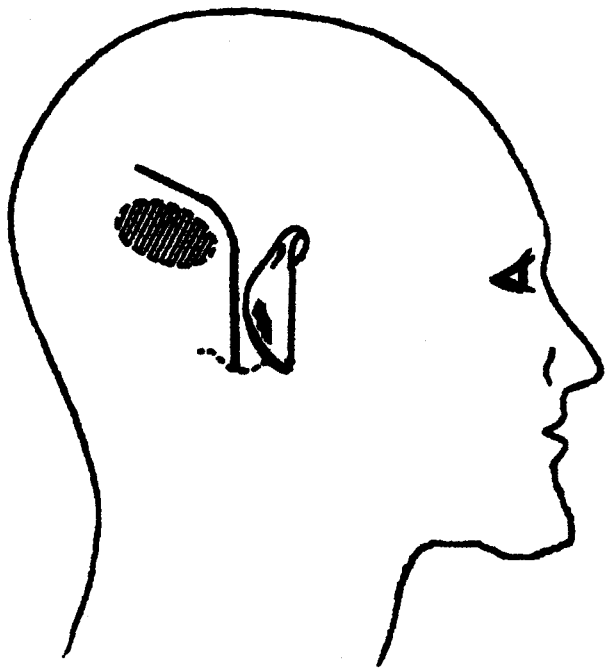

FIG. 3
Modified incision to allow thinning of skin and subcutaneous tissue over body of implant in cases of excessive soft tissue thickness.

The surgical technique used was largely as described in the original report of the incision (Gibson *et al.*, 1995) and this technique also involved placing the implant deeply in the skull by drilling down to dura, drilling a deep canal for the electrode array and creating overhanging edges of this canal and the mastoid cavity to assist in retention of the array. However during the study (after publication of the original report in 1995), the site of placement of the body of the implant was made somewhat more posterior and superior so that the body of the implant was no closer than 45 mm to the external margin of the posterior bony external ear canal. This was performed in expectation of the development of a 'behind the ear' speech processor to allow adequate room so that the pinna would not interfere with wearing of such a processor when it was in place over the body of the implant. It was found however that this modification of technique was also advantageous in that the coil of the implant was consequently placed over a flatter part of the skull so that it more easily conformed with the lessened curvature of the skull in that region (parietal bone) than where it had previously been placed (posterior part of mastoid, lowest part of parietal bone and possibly adjacent occipital bone); this is particularly advantageous in young children in whom the small skull is relatively very curved in the site where the implant was formerly placed (Harrison *et al.*, 1995).

All patients are seen by the surgical team until three months post-operatively and remain under supervision of habilitationists or rehabilitationists (audiologists, speech therapists or teachers of the deaf) for the first two post-operative years; these professionals can be relied upon to contact the surgeon if any surgical problem arises after the first three months. The last patient was operated upon five weeks before completion of the study.

Features relevant to healing of the incision and complications which reasonably could be related to it were recorded.

Results

Patients were discharged from hospital on the first post-operative day as a routine. Only six patients remained for a further post-operative day and five of these were older patients over the age of 74. Healing occurred in all cases by the time of the first routine post-discharge visit one week post-operatively.

During the time of the study (which includes the total period of usage of the incision by the authors) the only complication related to the straight incision which was encountered was a wound infection in an

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TABLE I
COMPLICATIONS OBSERVED IN USAGE OF STRAIGHT INCISION AND 'C' SHAPED INCISION

Complication	Straight incision (n = 168)	'C' shaped incision (n = 173)
Delayed wound healing	0	5
Infection requiring intravenous antibiotics	1	4
Infection requiring explantation	0	3
Scalp necrosis	0	3
Implant extrusion	0	1
Numbness of ear or scalp	0	15

(More than one complication could occur in the same ear – 10 ears had wound problems with the 'C' shaped incision.)

adult which required intravenous antibiotics for one week – this was recorded in the original report (Gibson *et al.*, 1995). Table I presents complications encountered to date by the authors using the straight incision in contrast to those encountered previously using the 'C' shaped incision in 173 patients.

A transient facial palsy occurred in an 81-year-old female who had a bifid facial nerve, the lateral half of which passed through the middle of the region of the posterior tympanotomy, but this was considered to be due to manipulation in drilling the posterior tympanotomy rather than to the straight incision.

Discussion

Prior to their adopting the straight incision, the authors used the 'C' shaped incision (Cochlear Corporation) for cochlear implantation in 93 children and 80 adults. Despite the fact that the only difference in technique was the change of incision (the technique of placement of the implant in the skull was the same), there were a number of significant complications using the 'C' shaped incision (Table I) and some of them have been detailed by Harrison and Gibson, (1992) and Harrison *et al.* (1995). In addition, a number of adults complained of persistent numbness of the top of the scalp in association with the 'C' shaped incision. Other authors have also reported significant complications using this incision including necrosis of the flap (Harris and Cueva, 1987; Cohen *et al.*, 1988; Haberkamp and Schwaber, 1992) which is a serious problem. In view of their lack of any significant complications using the straight incision, the authors therefore believe that the straight incision is much less likely to result in complications than the 'C' shaped incision. The 'C' shape incision is also unsuitable for use when there has been a previous post-auricular incision because of compromise of the blood supply of the flap due to the previous incision across its base whereas the straight incision is well suited to this situation. Also, as stated earlier, the 'C' shaped incision often results in an area of numbness superior to it which is not encountered with the straight incision. The authors have gained the subjective impression that post-operative pain is much less with the straight incision, but have not been able to document this adequately.

Two other incisions are currently used for cochlear implantation. These are: an 'inverted U' incision (Clark *et al.*, 1979) and an extended endaural incision with a horizontal posterior arm (Franz *et al.*, 1989). The authors compared these incisions with the straight incision in their original report (Gibson *et al.*, 1995) and detailed their disadvantages which include areas of post-operative numbness with both incisions, flap necrosis and implant extrusion with the 'inverted U' incision (El-Nagger and Hawthorne, 1995). The 'inverted U' incision can also be associated with difficulty in retraction of the edges of the incision sufficiently to gain adequate exposure. The extended endaural incision requires opening of the external auditory canal which may be a source of infection which is of great concern in the presence of an implant; the authors believe that even commensals (such as are normally present in the external auditory canal) may be of great concern in the presence of a cochlear implant. The straight incision avoids or minimizes the chance of all these potential problems and complications.

Conclusion

The straight incision requires less tissue elevation and provides a pocket for the implant which is surrounded by intact vasculature on three sides as opposed to the alternative incisions which require elevation of flaps over a wide area. Two of these alternative incisions interrupt the vasculature on three sides and the other (the extended endaural) which interrupts it on two sides. Hence the straight incision leaves tissues healthier by adhering better to basic surgical principles.

The authors have encountered no major complications in the use of the straight incision in 168 patients of all ages including the very young and octogenerians and there has been only one minor complication (a wound infection) which settled quickly. There have been no further complications encountered since the original description of the incision (Gibson *et al.*, 1995). The incision heals rapidly and is not associated with numbness of the scalp which is often complained of when alternative incisions are used. The authors therefore recommend that others consider adoption of the straight incision but recommend that those who do adopt it place the implant deeply in the skull by drilling down to dura and having a deep canal for the electrode array with overhanging edges of the canal and mastoid cavity to assist in retention of the array (Gibson *et al.*, 1995). In this way surgeons will be fully utilizing the technique which the authors have used in this study and which has given very favourable results. Although they have not used the straight incision for implants other than 'Nucleus' devices, the authors believe that it should be suitable for use with other such devices.

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