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The Role of Mastoidectomy in Cochlear Implant Surgery

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Objective—The classical technique for cochlear implantation (CI) involves mastoidectomy and posterior tympanotomy. The question raised in this work is whether mastoidectomy is indispensable in CI surgery.

Material and Methods—The advantages and disadvantages of performing mastoidectomy during CI surgery were weighed, in particular the effect of mastoidectomy on chronic secretory otitis media (SOM) and the ability of the electrode to expand in the mastoid during skull growth.

Results—No effect of mastoidectomy on chronic SOM was found and the assumption that the electrode in the mastoid cavity has the ability to expand during skull growth was not proven. Eliminating mastoidectomy in CI surgery simplifies the procedure, shortens the duration of surgery, minimizes the amount of drilling and provides broader, better exposure of the middle ear and promontory. Mastoidectomy was found not to be obligatory in CI surgery and in fact may have more disadvantages than advantages.

Conclusion—The development of alternative CI techniques which eliminate the need for mastoidectomy is justified. *Key words: cochlear implant, mastoidectomy, surgical technique.*

INTRODUCTION

The classic technique for cochlear implantation (CI), mastoidectomy posterior tympanotomy approach (MPTA), was first suggested by House in 1961 (1) and comprises mastoidectomy and posterior tympanotomy. Although posterior tympanotomy can be relatively easy to perform, there have been reports in the literature describing temporary and permanent injury to the facial nerve (2–4). Few surgical alternatives that exclude mastoidectomy have been described in the literature. The endomeatal approach was used by Banfai et al. (5), by Schindler (6) and by Chouard and MacLeod (7) but the risk of infection and electrode extrusion through the skin of the external auditory canal (EAC) led to the abandonment of this approach. Colletti et al. (8) described an approach via the middle fossa and in 2000 Kiratzidis (9) described a technique employing a tunnel drilled in the posterior wall of the EAC. This technique has the advantage of avoiding mastoidectomy but the tunnel used for the electrodes may endanger a high-riding sigmoid sinus. The suprameatal approach (SMA) was developed in 1999 (10, 11). It is based on the retroauricular tympanotomy approach for access to the middle ear and cochleostomy site. The electrode is inserted into the middle ear via a suprameatal tunnel drilled in the suprameatal area.

The question raised in this work is whether mastoidectomy is indispensable in CI surgery. In order to answer this question the advantages and disadvantages of performing mastoidectomy in CI surgery are weighed.

MATERIAL AND METHODS

The CI program at Sheba Medical Center began in 1989. Since then, 262 patients (191 children, 71 adults; age range 11 months to 80 years) have been operated on. The surgical technique of MPTA was performed (until 1999) in a similar manner as described in the literature (12). The main steps include a J-shaped skin incision, mastoidectomy and posterior tympanotomy. Cochleostomy is performed through the facial recess and after opening the scala tympani the electrode is inserted into the cochlea. The SMA technique was developed in our department in 1999 and, to date, 106 patients (81 children, 25 adults) have undergone CI using this technique. A retroauricular skin flap is raised following a J-shaped skin incision. A tympano-meatal flap is elevated to expose the tympanic cavity, as in retroauricular tympanotomy. The chorda tympani nerve is exposed and a 1-mm long groove is drilled in the wall of the middle ear cavity, postero-superior to the chorda tympani and lateral to the body of the incus. A tunnel is drilled in the suprameatal region superior to Henle's spine. The electrode is passed through the suprameatal tunnel, medial to the chorda tympani, and into the cochleostomy hole, which is drilled antero-inferior to the oval window. Various types of cochlear implant were used in both the MPTA and SMA groups. Our series included 11 revision surgeries, 4 performed using the SMA technique and 7 using the classical MPTA. Of those 7 patients, 4 were children aged 3–5 years and revision surgery was performed 4–94 months following implantation. The mastoid cavity was studied in this group in order

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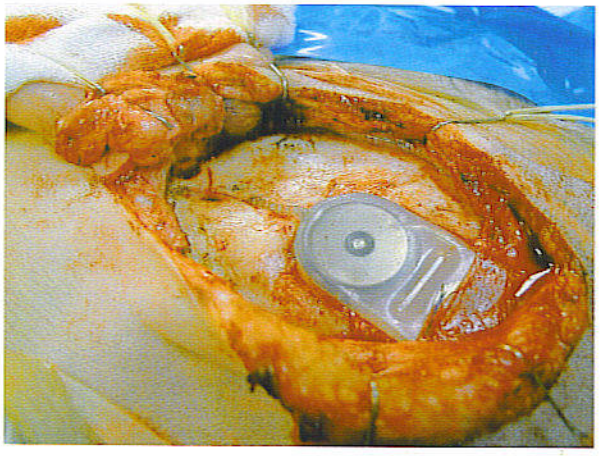

Fig. 1. An example of revision surgery in a patient in the MPTA group 34 months after implantation. The mastoid cavity has completely diminished.

to investigate reossification and electrode expandability.

A clinical study was conducted in order to evaluate the effect of mastoidectomy on the course of chronic secretory otitis media (SOM). Our series included two groups who underwent CI surgery with and without mastoidectomy. Fifty-six children who suffered from SOM for 6 months prior to CI surgery were enrolled in this study: 40 in the MPTA group (surgery with mastoidectomy) and 16 in the SMA group (no mastoidectomy). The age distribution was equal, as was the rate of preoperative surgical treatment for SOM, including adenoidectomy (Ad) and insertion of a ventilation tube (VT).

RESULTS

A total of 13/40 children (32.5%) who suffered from SOM prior to surgery had SOM after surgery in the mastoidectomy group, compared to 5/16 (31.3%) in the group without mastoidectomy. No statistically significant difference was found between these two groups.

In all four revision operations performed for device failure in patients in the MPTA group, the mastoid was found to be completely closed by regrowth of bone on the cortical portion of the mastoid (Fig. 1). The mastoid cavity had completely diminished and the electrode was embedded in dense fibrous tissue and bony spicules, preventing electrode expansion.

DISCUSSION

The performance of mastoidectomy in CI surgery is based on three assumptions, as described in the following sections.

Mastoidectomy is a known and widely-used technique

When performing the classical technique for CI, namely MPTA, mastoidectomy and posterior tympanotomy are always done together. Mastoidectomy is, in truth, a commonly practiced technique but posterior tympanotomy is less universally practiced and is completely neglected in some institutions. The SMA technique is based on two steps: a retroauricular tympanotomy approach; and a suprameatal tunnel drilled superior to Henle's spine. The retroauricular tympanotomy approach is a widely practiced technique for middle ear surgery and the drilling of the suprameatal tunnel is easy and safe to learn.

Mastoidectomy is beneficial for chronic SOM

Mastoidectomy was proposed by some authors (13, 14) as the treatment of choice in cases of stubborn chronic SOM. This is based on the assumption that an increase in the mastoid volume is favorable for middle ear aeration when the Eustachian tube is blocked. Sade and co-workers (15, 16) proved that gas exchange in the mastoid depends mainly on functioning mucosa over the entire surface area. During mastoidectomy the mastoid volume may increase, but the total surface area is reduced and the mucosa is converted into non-functioning scar tissue with scanty blood vessels. Converting a mastoid into a single cavity reduces both the surface area and gas exchange and the influence on SOM is rather negative. A clinical study was conducted in order to evaluate the effect of mastoidectomy on the course of chronic SOM (Table I). Two groups underwent CI surgery with and without mastoidectomy. Thirteen children in the MPTA group (32.5%) and 5 in the SMA group (31.3%) suffered from SOM after implantation. The rate of preoperative surgical treatment for SOM, including Ad and VT insertion, was higher in the MPTA group; nevertheless the rate of SOM was found to be equal, with no statistically significant difference between the two groups. Our own experience of performing mastoidectomy for

Table I. *The effect of mastoidectomy on the course of chronic SOM*

Group	No. of children with SOM		Mean age (years)	Rate of Ad and VT insertion (%)
	Before surgery	After surgery (%)		
MPTA	40	13 (32.5)	4.8	42.5
SMA	16	5 (31.3)	4.2	31.3
Total	56	18 (32.1)	4.41	39.3

chronic SOM is rather limited. In three children, however, (not from the CI group) aged 2, 3 and 3 years, respectively who suffered from chronic SOM and in whom VT insertion and Ad did not help, mastoidectomy was not beneficial, and these children continued to suffer from severe SOM with hearing impairment.

Mastoidectomy enables electrode expansion

More than 50% of postnatal temporal bone growth occurs during the first 2 years of life (17). Skull growth in implanted children of this age may cause electrode extrusion. O'Donoghue et al. (18), in an animal study, found that an electrode implanted within an air-containing space distended freely. In contrast, Marks et al. (19) observed fibrous tethering of the electrode when implanted in the mastoid cavity. They stated that placing an expansile loop in the mastoid is not likely to provide sufficient redundancy to accommodate both lateral and posterior vectors of growth of the temporal and parietal bones. They therefore suggested the use of expansile devices in order to prevent fixation of the electrodes in the mastoid cavity.

Our series included 11 revision surgeries, 7 of whom were operated on using mastoidectomy and 4 of whom were children aged 3–5 years. During revision surgery performed 4–49 months following CI the mastoid was found to be completely closed by regrowth of bone on the cortical portion of the mastoid (Fig. 1). The mastoid cavity had completely diminished and the electrode was embedded in dense fibrous tissue and bony spicules, preventing it from expanding. A similar experience was described by Burton et al. (20), who found, in an animal study, complete regrowth of bone in the mastoid and no evidence that mastoidectomy had even been performed. In the present study, 81 children (31 of whom were aged < 2 years) were operated on using SMA. In the follow-up period (mean 19 months; range 2–35 months) no extrusion of the implant was seen, even though no mastoidectomy had been performed.

The disadvantage of using mastoidectomy in CI surgery is obvious: drilling through the facial recess during posterior tympanotomy endangers the facial nerve and chorda tympani. The risk of facial nerve palsy due to drilling of the facial recess was found to be 0.3–3% in terms of temporary palsy and 0.6% in terms of permanent incomplete recovery (2–4). Posterior tympanotomy is a "keyhole" approach. The facial recess, bordered posteriorly by the mastoid segment of the facial nerve and anteriorly by the chorda tympani, develops to a mean width of 2.6–4.1 mm (17, 21). This provides rather limited access to the middle ear cavity and promontory, especially when the facial recess is narrow. There is a possibility of retroauricular bony defects and posterior wall atrophy (22, 23). Eliminating mastoidectomy in CI surgery simplifies the procedure, shortens the duration of surgery, minimizes the amount of drilling, provides wide exposure of the middle ear and promontory and thus enables exact determination of the position of the cochleostomy hole and safe electrode insertion into the cochlea. Mastoidectomy in CI surgery is not obligatory and probably has more disadvantages than advantages.

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