How we do it: ionomeric cement to attach the stapes prosthesis to the long process of the incus

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Keypoints

- The successful use of glass–ionomeric cement in primary stapes surgery for attachment of the wire loop of the stapes prosthesis to the long process of the incus is reported.
- Early hearing outcomes were similar in patients where cement was used for stapes prosthesis attachment compared with those with standard wire crimping technique.
- Use of glass–ionomeric cement to attach the stapes prosthesis to the incus may prevent stapes prosthesis displacement and loosening.
- This technique may decrease rates of revision stapes surgery and allow the safe use of magnetic resonance image scanning.

Stable and long-term fixation of the stapes prosthesis to the long process of the incus in stapes surgery is important in maximizing energy transfer through the piston in order to restore hearing. Although crimping has been shown to be adequate in achieving this, the prosthesis can cause incus erosion.[1,2] This leads to loosening of the piston over time and even displacement, the most common causes of revision surgery.[1–3]

Use of magnetic resonance imaging (MRI) is increasing in the field of medicine. Concerns have been raised regarding the safety of MRI in patients with stapes prostheses as MRI can induce a magnetic field in platinum–stainless steel stapes prostheses.[4] This may cause displacement of the prosthesis from the long process of the incus which could cause inner ear damage or disturb the conductive mechanism.

The use of glass–ionomeric cement is well established in otological surgery. It has been used successfully in revision stapes surgery in order to reconstruct the long process of the incus following erosion.[5] However, the use of cement to attach the wire of the stapes prostheses to the long process of the incus in primary stapes surgery has not been described. This has the potential benefit of preventing prosthesis loosening and displacement, and possibly incus erosion thereby decreasing rates of revision stapes surgery. It may also allow the safe use of MRI scanning in these patients by preventing prosthesis displacement. We demonstrate the successful use of Serenocem™ (Corithian Laboratory, Nottingham, UK) glass–ionomeric cement for attachment of the wire loop of the stapes prosthesis to the long process of the incus in primary stapes surgery.

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Materials and methods

This prospective study included 25 stapedotomies performed on 23 consecutive patients with otosclerosis. There were 10 males and 13 females with a median age of 52 years. Two patients had bilateral stapedotomies performed separately. All patients were operated on by the senior author (J. Harcourt) in a university teaching hospital. Preoperative pure tone audiograms (PTA) were prospectively recorded for all patients and compared with PTA at 3 months postoperatively. Patients were followed up for 1–4 years.

Technique

A permeatal or endaural approach was used. Absolute haemostasis was gained prior to opening the middle ear. A Skeeter drill (Xomed, Jacksonville, FL, USA) was used to perform a 0.7 mm stapedotomy. A Schuknecht wire piston and teflon stapes prosthesis (Xomed) of 0.6 mm diameter and 4.5 or 4.25 mm in length was used. In the first 12 patients, the standard technique of crimping of the wire loop to the incus was performed. Palpation of the ossicular chain was used to ensure that there was no free movement of the prosthesis along the incus. In the

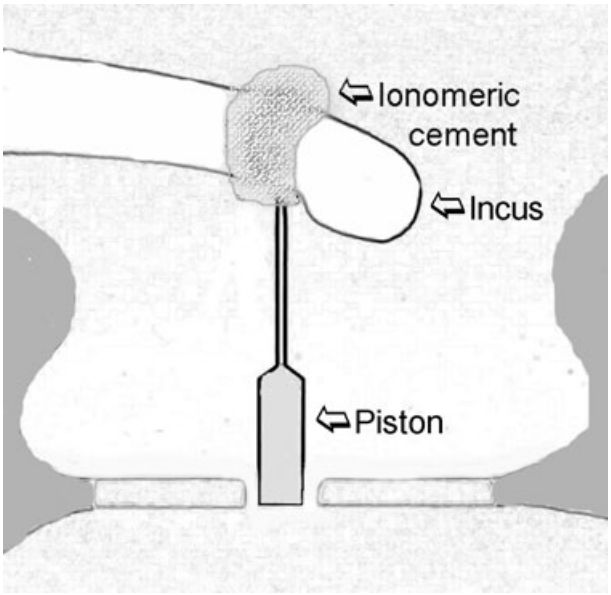

Fig. 1. Attachment of stapes prosthesis to the long process of the incus using glass–ionomeric cement.

next 13 cases ionomeric cement was used for wire loop attachment to the incus without crimping.

Serenocem™ (Corithian Laboratory) glass–ionomeric cement is supplied with its contents separated into two sections in a plastic capsule. The barrier between the sections is broken within the capsule. This is then mixed by a vibrating machine for 10 s. Then the cement can be squeezed out of the capsule. A small amount of cement was applied to the wire loop of the stapes prosthesis on the lateral surface of the incus with an otological pick (Fig. 1). The cement was not allowed to come into contact with any other middle ear structures. The operative field was kept absolutely dry for at least 10 min while the cement was setting. Palpation of the ossicular chain was again used to ensure that there was no free movement of the prosthesis along the incus.

Results

Pure tone audiograms documented a hearing threshold improvement of 27 dB averaged across 0.5, 1.0, 2.0 and 4.0 kHz in patients where cement was used and 25 dB where crimping was used. Seventy-seven per cent of patients had a successful closure of air–bone gap (ABG) to below 10 dB where cement was used for piston attachment and 92% to below 20 dB. This was more than the 65% closure of ABG to below 10 dB and 85% to below 20 dB where crimping was only used (Table 1). The mean postoperative ABG (using postoperative bone conduction (BC)) was 5 dB (SD 8) for patients where cement was used for piston attachment and 9 dB (SD 7) in those where crimping was used. Using a *t*-test, there was no significant difference between these groups (ABG using postoperative BC: $t = 1.05$, d.f. $= 23$, $P = 0.31$; ABG using preoperative BC: $t = 1.41$, d.f. $= 23$, $P = 0.17$). The 95% confidence interval for the difference between the two means is −1.6 to 8.4 dB (ABG using postoperative BC). The chorda tympani was torn in one patient where cement was used. There were no other complications and no significant sensorineural hearing loss occurred. No patients required revision surgery at 1 to 4-year follow-up.

Discussion

The aim of stapes surgery is to obtain an ABG of <10 dB. The reasons for failure of primary stapes surgery can only be elucidated at revision surgery. The most common findings are prosthesis displacement, prosthesis loosening and incus erosion at the attachment of the prosthesis.[1–3] The use of glass–ionomeric cement to attach the stapes prosthesis to the incus may prevent some of these.

The mechanisms of failure of stapes surgery are not fully understood. It has been suggested that incus erosion is due to compromise of its blood supply by over tightening of the wire loop when crimping, and also by loose

Table 1. Hearing results of patients who underwent stapes surgery with and without the use of glass–ionomeric cement

			Percentage					
ABG (dB) (0.5, 1, 2, 4 kHz)	Mean	SD	≤0	1–10	11–20	21–30	31–40	41–50
Preoperative								
Cement	28	10	0	0	38	31	15	15
Crimping	32	8	0	0	8	33	42	17
Postoperative (Postop. BC)								
Cement	5	8	31	46	15	8	0	0
Crimping	9	7	8	58	25	8	0	0
Postoperative (Preop. BC)								
Cement	1	13	54	23	8	15	0	0
Crimping	8	10	25	25	33	17	0	0

attachment allowing constant movement of a mobile wire loop against the incus.[1] Loose wire attachment could be prevented by cement.

Lesinski[2] reported that the prosthesis was displaced out of the oval window fenestra in 81% of 279 consecutive stapes revisions. He proposed that the mechanism was collagen contracture of a sealing neomembrane (fascia, fat, perichondrium or vein) lifting the prosthesis above the stapedotomy fenestration. This is unlikely to be affected by cement stapes fixation. He also found complete or near complete incus erosion in 31% and partial erosion in a further 60% of cases. He proposed that this was because of a stapes piston fixed by adhesions at its base, vibrating at its wire loop against the mobile incus. The firm bond of cement may prevent this vibration-induced incus erosion. Huttenbrink[3] believes that prosthesis displacement is not large enough to cause bone resorption, but rather that incus erosion is a foreign body reaction similar to that common in orthopaedic prostheses. Cement use is unlikely to prevent this. Optimal crimping is difficult to judge, but can affect hearing outcome. Cement use ensures a firm bond with the incus.

Magnetic resonance imaging functions by generating rapidly varying magnetic fields. The metal component of stapes prostheses may be displaced by these, posing a potential risk to hearing. *Ex vivo* studies have demonstrated that magnetic fields produced by MRI scanners can induce translation and rotational movement in stapes prostheses made of supposed non-magnetic metals including stainless steel alloy and platinum.[4] As there are no reports in the literature of prosthesis displacement, the real potential risk cannot be evaluated. The use of cement for prosthesis attachment could prevent stapes prosthesis displacement during MRI scanning. We currently have no experience in using cement for prosthesis attachment, as none of the patients required an MRI scan.

The use of glass–ionomer cement to attach the wire loop of stapes prostheses to the long process of the incus is a simple procedure. Glass–ionomeric cement adheres well to metal and bone. It sets in 10 min in a minimal exothermic reaction, during which it can be moulded. The cement is stable after setting. Cases of neurological deficit caused by aluminium have occurred where glass–ionomeric cement was in contact with neural tissue. However, Serenocem^{TM} has a lower aluminium content than most cements and we ensure that it does not come into contact with any neural tissue. None of our cases where cement was used have required revision surgery. However, if required, the wire could be bent or even cut to allow the piston to be pulled out. This risks damage the inner ear, as reported in all cases of revision stapedectomy with prosthesis removal.

Our study demonstrates that early hearing outcomes at 3 months postoperative in patients where cement was used for prosthesis attachment are as good as those where crimping was used (Table 1). The success rate as determined by ABG is comparable with published series.[5] The mean postoperative ABG was smaller in the cement group, although this was not significant. This study is limited by low power and lack of long-term hearing results.

Firm attachment by cement of the prosthesis to the incus should allow MRI scanning to be carried out safely. None of the cases where ionomeric cement was used have required revision surgery at 12 to 44-month follow-up. The causes of prosthesis displacement and incus erosion are not clear. The use of ionomeric cement for stapes prosthesis attachment may prevent some failures and so decrease the number of cases requiring revision stapes surgery, although a longer follow-up period of more cases is required to prove this.

Conflict of interest

None declared.

References

1 McGee T.M. (1981) The loose wire syndrome. *Laryngoscope* **91,** 1478–1483

2 Lesinski S.G. (2002) Causes of conductive hearing loss after stapedectomy or stapedotomy: a prospective study of 279 consecutive surgical revisions. *Otol. Neurotol.* **23,** 281–288

3 Huttenbrink K.B. (2003) Biomechanics of stapesplasty: a review. *Otol. Neurotol.* **24,** 548–559

4 Syms A.J. & Petermann G.W. (2000) Magnetic resonance imaging of stapes prostheses. *Am. J. Otol.* **21,** 494–498

5 Chen D.A. & Arriaga M.A. (2003) Technical refinements and precautions during ionomeric cement reconstruction of incus erosion during revision stapedectomy. *Laryngoscope* **113,** 848–852