Review

Techniques of ossiculoplasty with middle ear prosthesis

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Abstract

Surgical reconstruction of the sound conduction mechanism of the middle ear remains one of the most difficult challenges in otology. Many factors influence the functional results including the status of the ossicular chain and the nature of the disease process. Recent progress in the development of middle ear prostheses has facilitated the achievement of good functional results.

Keywords

Ossiculoplasty, middle ear prosthesis, tympanoplasty.

I - Introduction

Several techniques including prostheses are used for ossicular reconstruction depending upon the status of the ossicular chain. Recent developments in the field of biocompatible prostheses have increased the success rate of ossiculoplasty, particularly the introduction of hydroxylapatite. Due to its nonporous and homogeneous nature, it is resistant to penetration and destruction by granulation tissue. Hydroxylapatite, when in composite form with Flex (60% HA-40% silicone) or Teflon, offers a wide range of surgical options in either chronic ear surgery or for purely functional surgery.

II - Material : prosthesis used

One partial and two total prostheses (available from Xomed) are the ones that we generally use (Figure 1). They are made with a round head of dense hydroxylapatite with a groove for the malleus handle, a flexible metallic link of titanium and a shaft of either Flex H/A or Teflon.

Figure 1. The Flex-HA prostheses. From left to right: Mod 1 (partial prosthesis), Mod 2 (total prosthesis) and Mod 3 (total prosthesis).

The biocompatibility of Hydroxylapatite is excellent and well documented, therefore it is not necessary to interpose cartilage between the head of the prosthesis and the drum. In certain circumstances when the incus is normal, a Teflon piston may also be used (0.4 mm-diameter shaft) with or without a stapedotomy according to the status of the footplate.

III - Surgical techniques

These prostheses have a wide range of applications, however several criteria may influence the success rate of ossiculoplasty. In our experience one of the most important is the presence or absence of the handle of malleus as it contributes to the long-term stability of the prosthesis.

Therefore, it is important to present the use of prostheses according to the status of the malleus and the condition of the stapes as proposed by other authors.[1-3]

1- Handle of malleus present

The mobility of the malleus must always be checked first in order to rule out any ankylosis.

A- Erosion of the incus - Stapes present and mobile

The partial prosthesis (Mod. 1) is used. The shaft is trimmed with a knife after the appropriate length is determined. The link allows the head of the prosthesis to be slightly angulated to accommodate the handle of the malleus. A notch may also be fashioned in the inferior portion of the shaft with a knife or microscissors in order to leave room for the stapes tendon and the crura thus improving the stability of the prosthesis. First, the shaft is introduced on to the stapes head. Using a hook, the malleus handle is then slightly elevated and the groove of the prosthesis head is slipped under the malleus handle (Figure 2). The correct mobility of the ossicular chain is tested with a fine hook looking, if possible, for the presence of a round window membrane reflex. The prosthesis should fit tightly between the stapes head and the malleus but without

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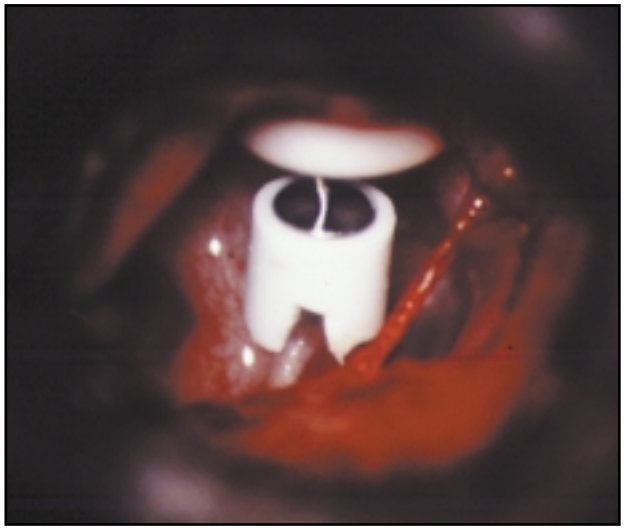

Figure 2. The partial prosthesis (Mod 1) is placed between the stapes head and the malleus handle.

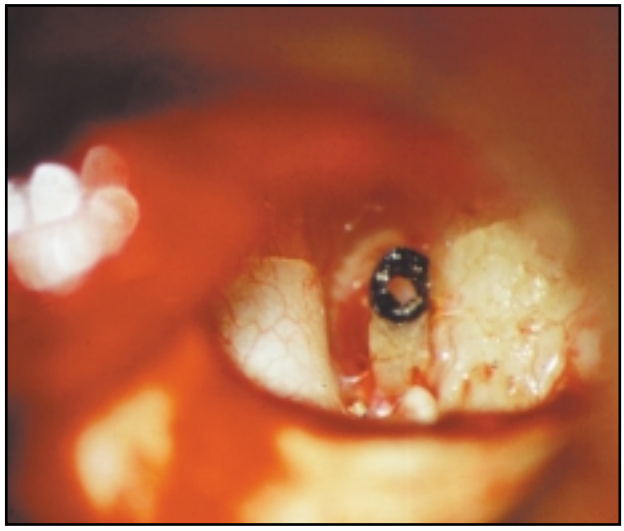

Figure 3. Opening of the stapes head with Argon laser with preservation of the superstructure.

excessive tension which should be suspected if the malleus handle is excessively lateralized. In some revision cases where failure is due to recurrent prosthetic displacement associated with stapes superstructure malformation (congenital abnormalities), tilting of the head toward the promontory or stapes head erosion, a partial prosthesis should be avoided. According to Moretz[1] and other authors[4-6], in many of these cases there is enough room between the facial nerve and the stapes superstructure to use a total prosthesis (Mod. 2) despite the presence of the stapedial arch. The distal tip of the shaft is centered on the stapes footplate. The presence of the superstructure may in fact keep the prosthesis in proper position and decrease the risk of recurrence of migration or displacement.

Also in some of these cases, we advocate a new method of total ossicular replacement prosthesis with preservation of the stapes superstructure. Using an Argon laser (setting 0.8 W - 0.2 seconds), a hole is created within the head of the stapes, large enough to insert the 0.4 mm teflon shaft of the Mod. 3 total prosthesis, centering its lower end on the footplate without the creation of a stapedotomy if the stapes is mobile (Figures 3 & 4). This technique must be chosen only in cases of revision surgery with a history of several prosthetic displacements and requires the presence of a large stapes head as a fine ring must be preserved in the stapes head to keep the shaft in position.

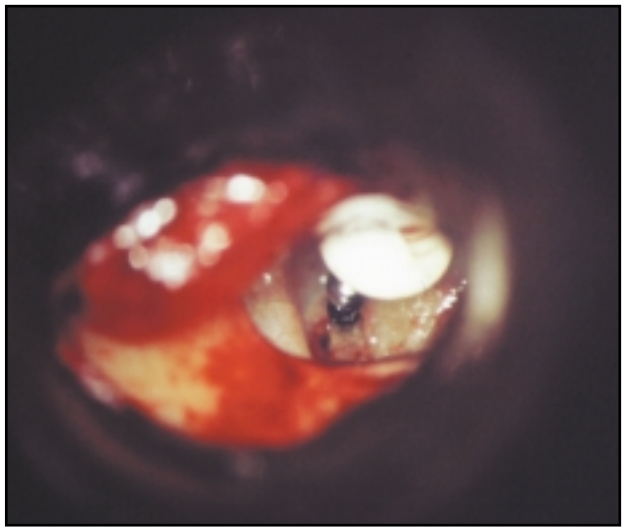

Figure 4. The shaft of the Mod 3 total prosthesis is introduced within the opening of the stapes head centering its lower end on to the mobile footplate.

B- Erosion of the stapes superstructure - Mobile footplate

B-1 Intact incus

This situation may occur following head trauma and may be sometimes difficult to assess.

In this instance we recommend a Teflon piston from the incus to the footplate (without stapedotomy) after assessment of the distance from the undersurface of the incus to the footplate with a measuring device. It may be advantageous to use a Flex or Silicone "shoe" positioned at the distal end of the shaft.

B-2 Erosion of the incus

In this instance a total prosthesis is used (Mod. 2). The distance between the footplate and the malleus handle is determined using several pre-shaped measuring pistons available from Xomed. The shaft is then sectioned to the appropriate length with a knife. The shaft of the prosthesis must fit snugly on the posterior half of the footplate. The groove of the head of the prosthesis is then slipped under the malleus handle (Figure 5).

C- Fixed stapes footplate

In the presence of a fixed footplate, the stapedotomy required for functional improvement cannot be performed without considering a number of factors concerning the pathology within the middle ear. A successful stapedotomy requires a closed middle ear with a clean dry external auditory canal. The middle ear status must be stable for at least 1 year with normal eustachian tube function and aeration, with normal mucosa and no

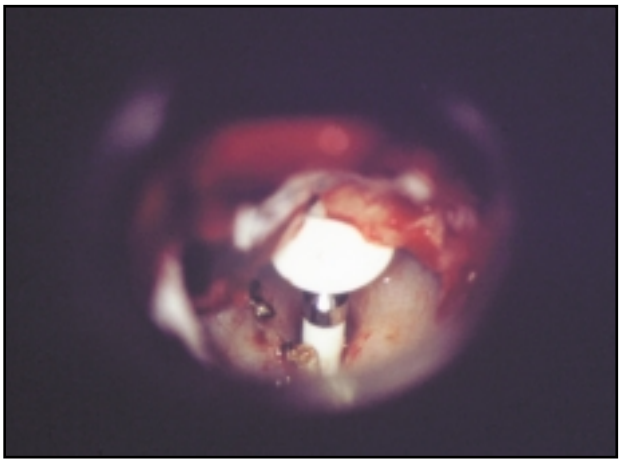

Figure 5. The total prosthesis (Mod 2) is placed between the stapes footplate and the malleus handle.

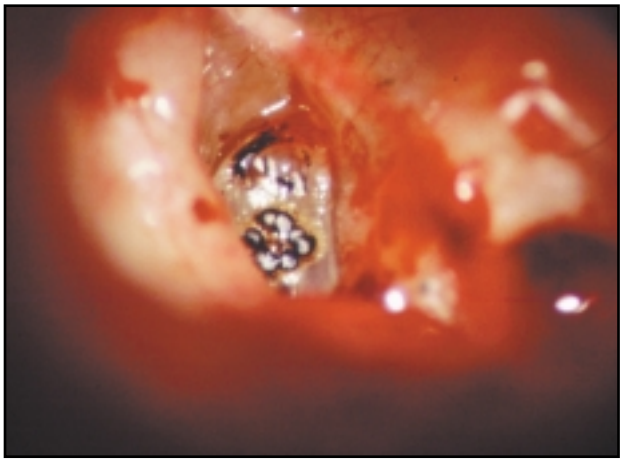

Figure 6. A rosette of spots is created onto the footplate with an Argon laser.

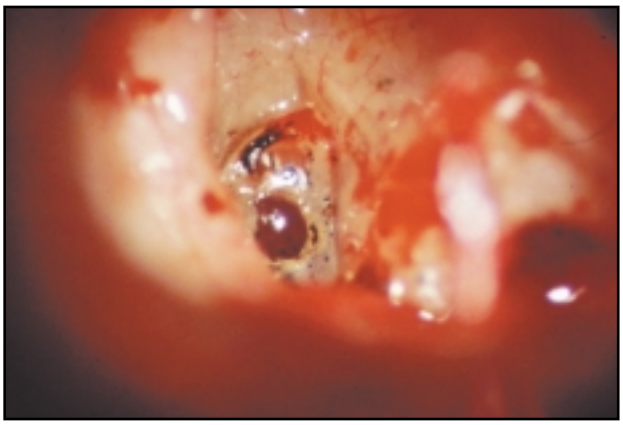

Figure 7. An 0.8 mm stapedotomy is drilled with the Skeeter drill.

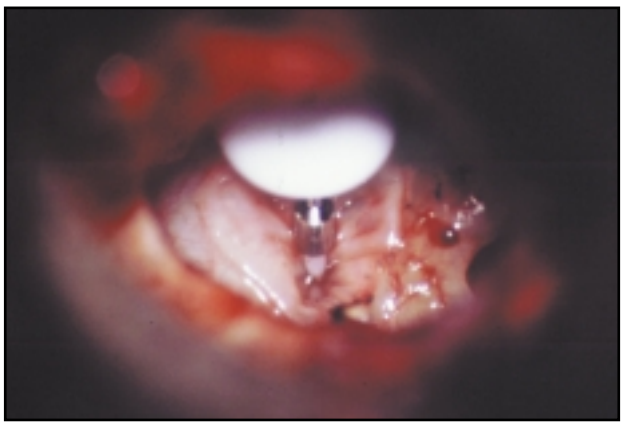

Figure 8. The total prosthesis (Mod 3) is placed between the malleus handle and the stapedotomy with a vein graft interposition. The adventitial side of the vein is placed on the footplate.

effusion. When all these conditions are met a stapedotomy is a viable choice. The stapes superstructure is vaporized with argon laser (setting: 2 W - 0.5 seconds), and drilled with an 0.7 mm-diameter diamond burr. A round rosette is created in the stapes footplate with an Argon laser using a setting of 1 W and 0.2 seconds (Figure. 6). The stapedotomy is then performed using a Skeeter microdrill with an 0.7 mm-diameter diamond burr (Figure 7). A vein graft is then interposed. The adventitial side of the vein (sticky side) should face the footplate.

The choice of the prosthesis for ossicular reconstruction will depend on the status of the incus:

C-1 Intact incus

In this case a Teflon piston is placed between the incus to the stapedotomy. The correct position of the piston within the stapedotomy is checked with a fine hook: the shaft should bend but not be distracted from the stapedotomy (Bending test).

C-2 Erosion of the incus

In this situation a Mod. 3 Total prosthesis is used after incus removal (Figure 8). As previously described, the correct position of the shaft of the prosthesis is checked with a fine hook (Bending test).

D- Unusual situations

D-1 Malleus ankylosis

This situation can be found during either primary or revision surgery. The malleus and incus mobility must be systematically assessed at the time of primary surgery, after the separation of the incudo-stapedial joint. Palpation with a 45° hook shows whether the malleus is fixed. If there is malleus ankylosis, the incus is removed and the neck of the malleus is cut with a malleus nipper. The head of the malleus must be removed in order to avoid any recurrence of the ankylosis. The handle of the malleus remains mobile. Ossicular reconstruction depends on the status of the ossicular chain: When the stapes is present and mobile, a partial prosthesis is used from the malleus handle to the stapes (Mod 1). In the case of erosion of the stapes crura with a mobile footplate, a total prosthesis is placed from the malleus to the footplate (Mod 2). When the stapes is fixed, a laser stapedotomy is performed and a total prosthesis (Mod. 3) is used with a vein graft interposition.

D-2 Anterior Malleus

The malleus handle is too anterior so that placement of a standard prosthesis is precluded. In this situation, the

usual methods of ossiculoplasty, presented in the current literature, have used reconstruction from the stapes head directly to the drum. We advocate a method of repositioning the malleus. After dissecting the malleus from the tympanic membrane, the tensor tympani is sectioned as near as possible to its insertion to the malleus handle. The malleus should be entirely separated from the drum. Using a hook placed anterior to the neck, the malleus is then progressively retracted posteriorly, until it lies immediately above the stapes. In order to avoid a recurrence of anterior displacement of the malleus it is necessary to "break" or overstretch the anterior malleolar ligament. The position of the ossicle is maintained by the superior ligament of the malleus which is preserved.

D-3 Lateralized tympanic membrane

Dealing with an excessively lateralized tympanic membrane represents one of the most difficult challenges in ossicular reconstruction. Moretz[1] advocates the use of a TORP or PORP from the drum to the stapes head or footplate according to the status of the stapes. As the shaft of the prosthesis appears to be very long in these situations, this will increase the risk of prosthetic displacement with a consequently higher incidence of failure. In these instances, we advocate the use of tympanic membrane repositionning with a skin grafting technique.[7] We use an electric Aesculap® dermatome which gives a regular, 0.2-0.3 mm split-thickness skin graft, taken from the medial upper thigh surface. The graft is laid out epidermis side down on a teflon plaque and cut to the appropriate size to be inserted into the canal. A connective tissue graft is always interposed between the bony canal and fibrous layer of the tympanum and the split skin graft. If the anterio-inferior angle needs to be re-established, the fascia is cut in a T-shape that allows the reconstruction of the entire distal part of the canal. The fascia is then covered by the skin graft in two pieces: one trapezoid shaped piece is placed antero-inferiorly and a second piece is placed to cover the drum and the postero-superior part of the canal. Two silastic sheets and a merocel sponge are used to keep the graft in place.

2- Malleus handle absent

It is generally acknowledged that the presence or absence of a malleus handle affects the results of ossicular reconstruction.[8] Absence of the malleus handle is most often seen in cholesteatoma surgery and in some cases of revision surgery. This increases the risk of prosthesis displacement as it is difficult to stabilize the head of the prosthesis against the tympanic membrane. Using a different technique than the one described by Fish[4], we have also tried to rebuild a neo malleus fashioned from a piece of tragal cartilage which is trimmed and fixed to the superior wall of the bony canal with fibrin glue. In our experience, this technique did not really increase the rate of success in ossicular reconstruction in case of an absent malleus. The types of prostheses and techniques used depend on the status of the stapes and have been previously described. In concert with other authors[1,4] we prefer a total ossicular reconstruction in some cases even in the presence of a normal stapes. The distal tip of the shaft is placed in the center of the footplate, with a flex shoe if possible. The stapes superstructure may stabilise the shaft of the prosthesis. With stapes fixation we do not believe it appropriate to perform a stapedotomy. At this point in history we believe that there is no safe and efficient solution in this situation.

IV- Conclusion

Ossicular reconstruction remains a surgical challenge that often results in significant improvement of conductive hearing loss. The surgical technique should be chosen according to the status of the ossicular chain and other anatomical situations. The prospects of progress are encouraging both in relation to materials used and of their design.

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