OSSICULAR SCULPTING FOR CONDUCTIVE HEARING LOSS

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Although declining in popularity, autograft bone and cartilage provide the surgeon with a predictable and well-established option for ossicular reconstruction. This article reviews the indications, advantages, techniques, and complications of sculpted autograft ossiculoplasty. Reconstructive procedures using bone and cartilage grafts are illustrated.

As the development of synthetic prostheses in otology has progressed, the use of sculpted autograft bone and cartilage has declined. A recent survey by Goldenberg and Emmit reported that 25% of surgeons ranked autograft or homograft bone as their first choice in reconstruction.[1] However, the satisfaction rate with using this material was 96%. Of respondents, 91% also reported satisfaction with cartilage grafts. It is important that skill in ossiculoplasty with these sources be maintained. There are a number of advantages with the use of autograft material, and this article will review the indications, contraindications, preoperative assessment, operative technique, and complications of ossicular reconstruction with autograft cartilage and bone.

INDICATIONS

The most common indication for ossicular sculpting occurs in chronic otitis media, with or without cholesteatoma. It is often performed in conjunction with tympanoplasty and mastoidectomy in a single stage in the absence of cholesteatoma or as a second stage procedure in cases of intact wall tympanoplasty, with mastoidectomy for cholesteatoma. In revision cases for difficult chronic ear disease with poor eustachian tube function, autologous material may be advantageous when compared with a synthetic prosthesis.[2] Many of these patients may have undergone multiple prior procedures and experienced extrusion of synthetic substances. If harvested cartilage is used as an ossiculoplasty material, it can also be integrated into the tympanic membrane reconstruction in the form of slabs or palisades.[3]

Cartilage sculpting is also a useful technique during second stage procedures following eradication of cholesteatoma, with an intact wall operation in the past. Sculpted cartilage can be inserted to cover titanium, hydroxyapatite, or other synthetic partial or total prosthesis.[4,5] This process will limit extrusion and support the previously reconstructed tympanic membrane after the removal of polymeric silicone (Silastic, Dow Corning Corp, Midland, MI) placed at the initial stage. During open cavity procedures, autograft cartilage can be fashioned for a type 3 reconstruction as an alternative to synthetic material.

Conductive hearing loss can also obviously occur in the absence of chronic ear disease. Ossicular discontinuity may be caused by trauma, past disease, tumor removal, or congenital malformation. Ossicular fixation may be caused by tympanosclerosis, congenital pathology, attic fibrosis or ossification, and otosclerosis. Sculpted autograft bone or cartilage should be an option in the surgeon's armamentarium for reconstruction. The use of homograft-sculpted bone has also been described for stapedectomy and revision stapedectomy but is not in wide use at most institutions.

CONTRAINDICATIONS

There are very few relative contraindications with sculpted ossicular reconstruction. These contraindications may also preclude any form of ossicular reconstruction and should be applied at the discretion of the surgeon on an individual case bases. The disease states may include recurrent cholesteatoma when a second stage is needed, advanced obliterative tympanosclerosis, and absent eustachian tube function. Poor word recognition in the operative ear or a conductive loss of less than 25 db are relative contraindications. In general terms, an operation for conductive loss in an only hearing ear should not be performed.

PREOPERATIVE EVALUATION

In cases of congenital conductive hearing loss, trauma, cholesteatoma, and chronic ear disease, high resolution computerized tomography of the temporal bone with axial and coronal views is often an integral part of the preoperative evaluation. Complete preoperative audiometric examination is obviously required. Microscopic otoscopy, with or without endoscopic documentation, is always performed preoperatively. Particular attention is given to external canal anatomy, the status of the middle ear, and the appearance of the contralateral ear. Tests for eustachian tube function can be performed but are not absolute indi-

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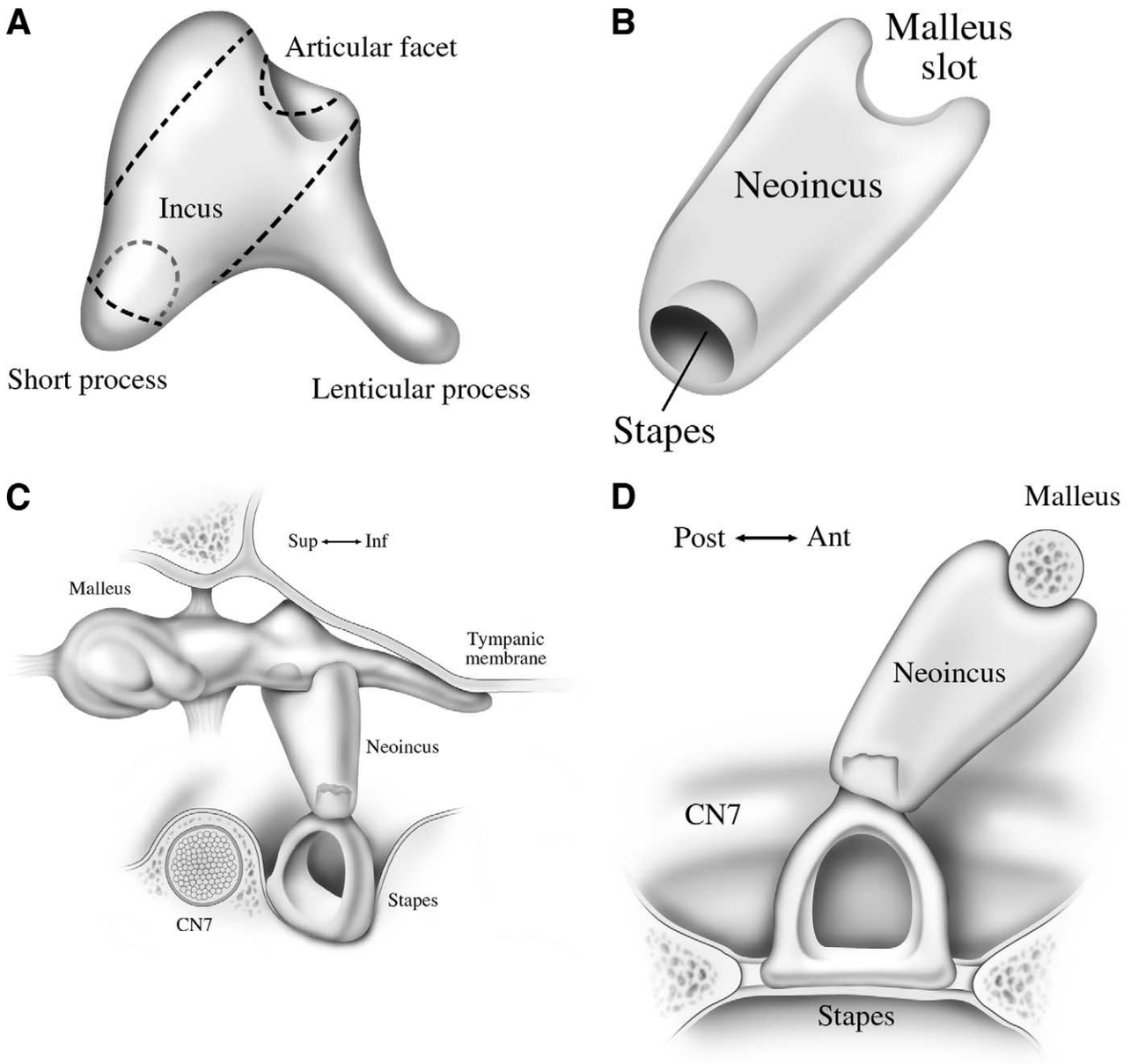

FIGURE 1. Sculpted autograft incus: option 1. (A) Neoincus outline. (B) Product. (C) Lateral view. (D) Inferior view.

cators of success or failure. Draining ears should be treated and dried preoperatively if possible.

One of the most important aspects of the preoperative visit is the consent process. In addition to a discussion of treatment options, risks, details of the procedure, and questions, the surgeon must make sure that the patient has realistic expectations. For example, a patient with mixed hearing loss must be informed that he/she may need amplification after successful surgery. Patients with normal hearing in the contralateral ear may not have a sense of binaural hearing, even with significant improvement on postoperative audiometric testing. This result is especially true in the case of revision surgery.

SURGICAL TECHNIQUES

There are many sources available to the surgeon for autologous bone and cartilage. If present, the patient's own incus remnant or malleus head may be used. A small piece of cortical bone can easily be harvested from the mastoid or posterior temporal bone if a postauricular approach has been performed. Small cutting burs or a dissecting tool with continuous irrigation are used to harvest a rectangular graft. Banked homograft bone from sources such as the femoral shaft is also available. Pretreatment has dramatically reduced the potential for spread of viral contaminants, but this rare possibility has led many to abandon this option.

Cartilage grafts for shaping and sculpting are readily available from the surgical field. Abundant material may be harvested from the tragus. Additional cartilage may be removed from the concha, helical root, or may already be available following a meatoplasty. The lateral tip of the tragal cartilage should be preserved for cosmesis when possible. Overlying perichondrium should also be preserved to facilitate later tympanoplasty or folding and stacking of cartilage blocks. Preservation of perichondrium may also prevent resorption in the future. The use

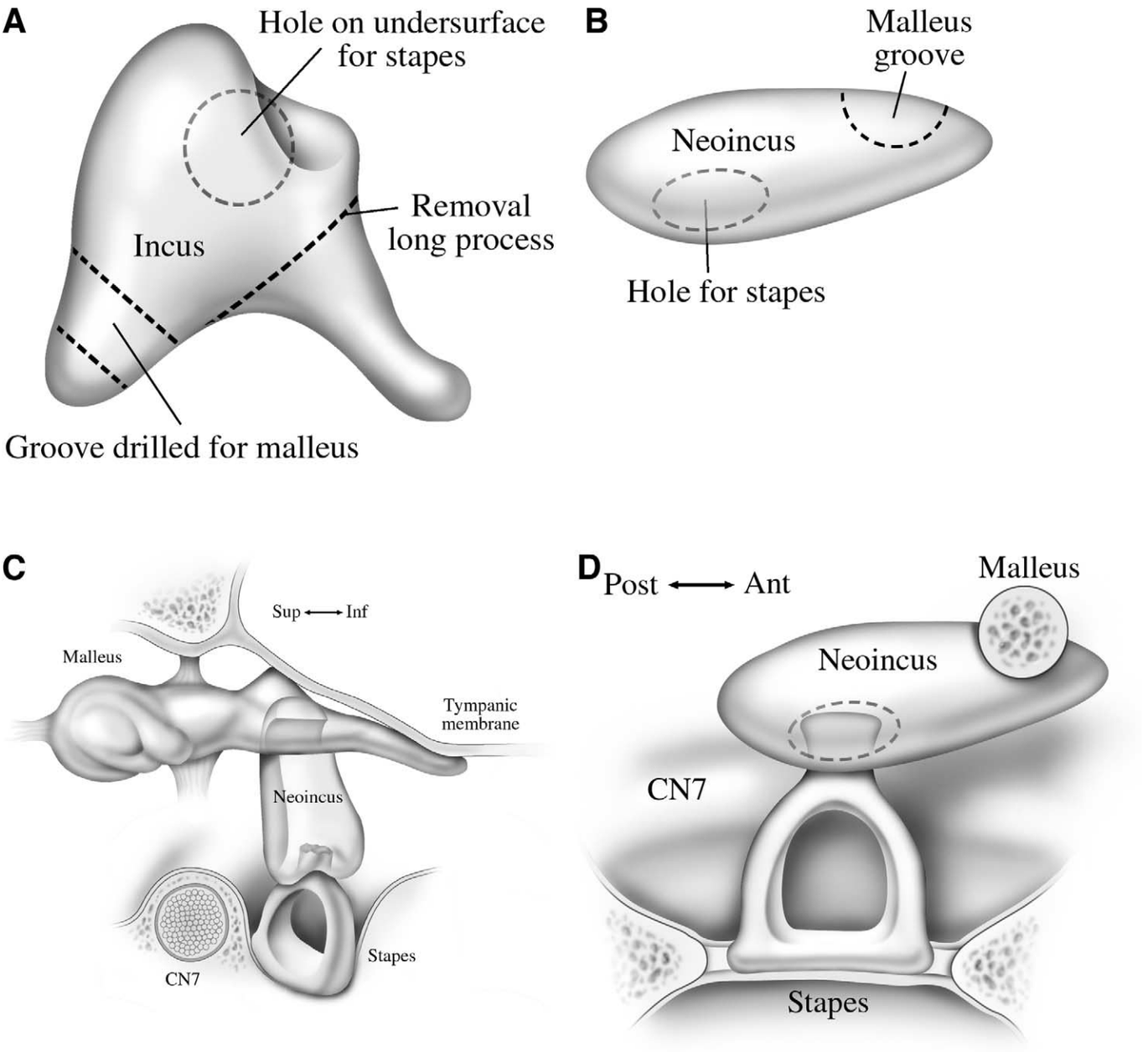

FIGURE 2. Sculpted autograft incus: option 2. (A) Neoincus outline. (B) Product. (C) Lateral view. (D) Inferior view.

of homograft cartilage is not recommended due to the potential for thinning and resorption,[6] and the wide availability of autograft material.

Autologous bone is an option for reconstruction of the sound conducting mechanism when the malleus is present. A missing incus or incus-stapes complex can be reconstructed by interposing an appropriately sculpted ossicular bone graft to fit from stapes to malleus or oval window to malleus. If the stapes is absent, banked bone or a cortical graft would be necessary to span the needed distance. Many institutions do not carry banked femur, and harvesting bone in the absence of a postauricular exposure is more difficult. The time required to fashion a bone graft intraoperatively should also be considered. In the event of stapes footplate fixation, a bone graft can be interposed following a stapedotomy from the oval window to the malleus. This procedure is performed only in the absence of infection with a well-ventilated middle ear and an intact tympanic membrane. The stapedotomy must also be grafted with perichondrium or fascia before bone graft placement.

Two of the most common ossiculoplasty situations are incus interposition and reconstruction of the incudostapedial joint. Manufactured synthetic prostheses are also excellent options for these situations. In the first situation, the patient's incus remnant is sculpted and interposed between the stapes capitulum and the long process of the malleus. The neoincus may be fashioned in a number of ways (Figures 1 and 2). The shape depends primarily on the anterior-to-posterior and medial-to-lateral distances that must be bridged. Careful measurement must be emphasized. The head of the malleus may also be removed and machined to create a graft. When repairing a small gap in the incudostapedial joint, the native incus is left in place, and a small piece of cartilage is shaped to bridge the defect (Figure 3).

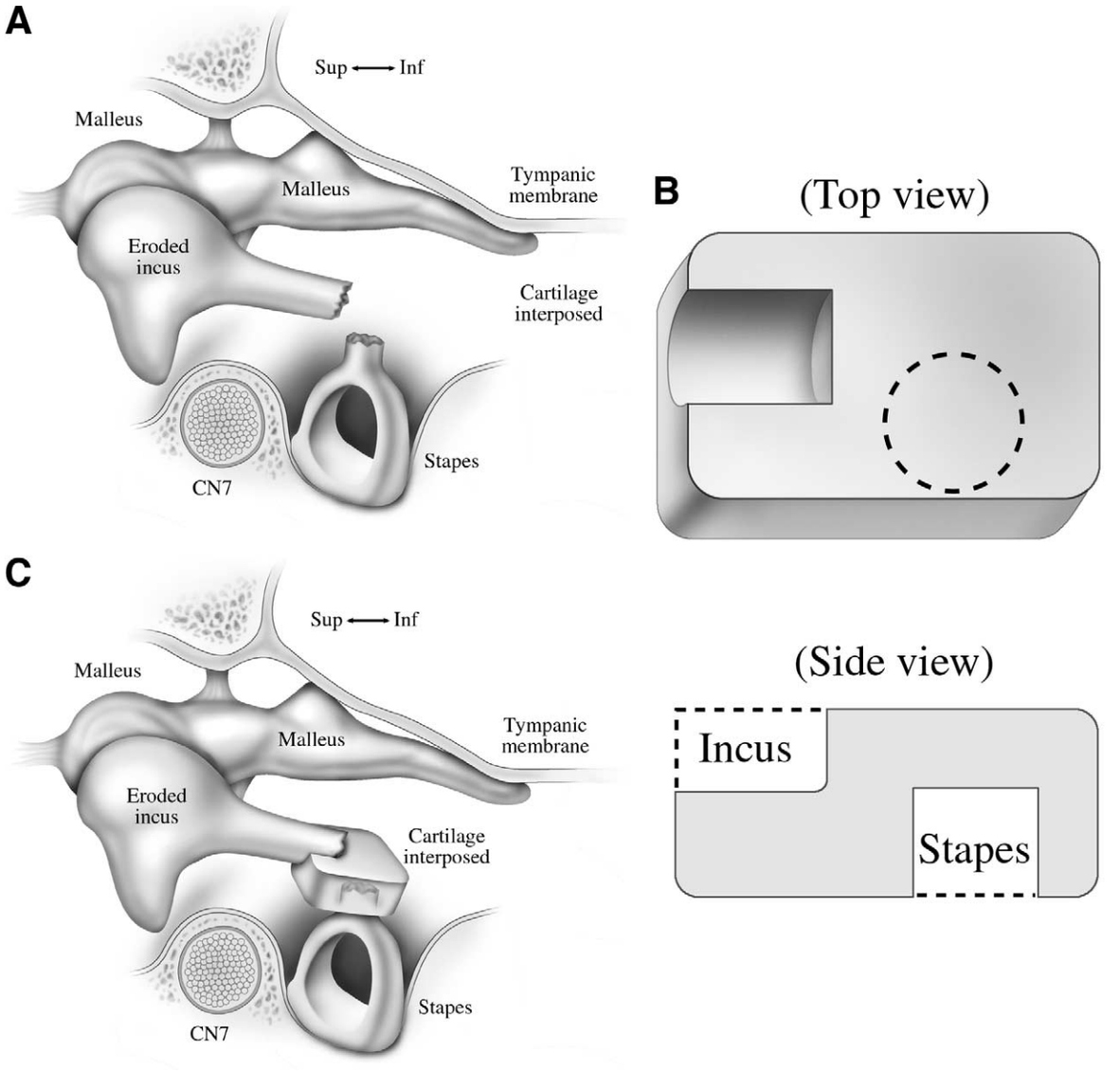

FIGURE 3. Incudostapedial joint reconstruction. (A) Defect. (B) Cartilage block construct. (C) Autograft joint.

Sculpted cartilage blocks are particularly useful in the atelectatic ear with poor eustachian tube function and an intact stapes. In this case, the ossiculoplasty is a part of the cartilage tympanoplasty. Cartilage can be thinned or folded and stacked to gain more height depending on the required mediolateral distance from stapes to membrane (Figure 4). Small microblades are useful to shave and trim cartilage to the required degree. Some investigators have suggested that a cartilage thickness more than 0.5 mm results in poorer acoustic transmission.[7] A shaped cartilage slab is also useful as a stapes columella in a patient after an open cavity procedure.

Sculpted cartilage is required as an additional material to interface with the tympanic membrane when using other materials such as titanium or porous polyethylene. The cartilage may be secured in these settings with suture, bonded with "glue," placed on an available peg, or simply overlaid as a dome (Figure 5). In these cases, the composite graft acts as a cover for the synthetic partial or total ossicular prosthesis.

COMPLICATIONS

Sensorineural hearing loss is a rare complication following ossiculoplasty or middle ear surgery in any form. It may be caused by footplate trauma with associated perilymph leak or serous labyrinthitis. Dizziness may be present for a brief period, but prolonged dizziness is uncommon. The most common complication is persistent conductive hearing loss. This result may be caused by graft fixation, migration, extrusion, or, in the case of cartilage, graft resorption.[8] It may simply be due to end stage middle ear disease, with absent ventilation, retraction, and fibrosis. Classification systems have been developed that attempt to predict success based on the preoperative ossicular situation and status of the middle ear.[9] Guidelines standardizing the reporting of results have also been established.[10] The benefits of revision surgery should be carefully considered, and the causes of failure should be analyzed before performing any additional surgery for persistent conductive hearing loss.

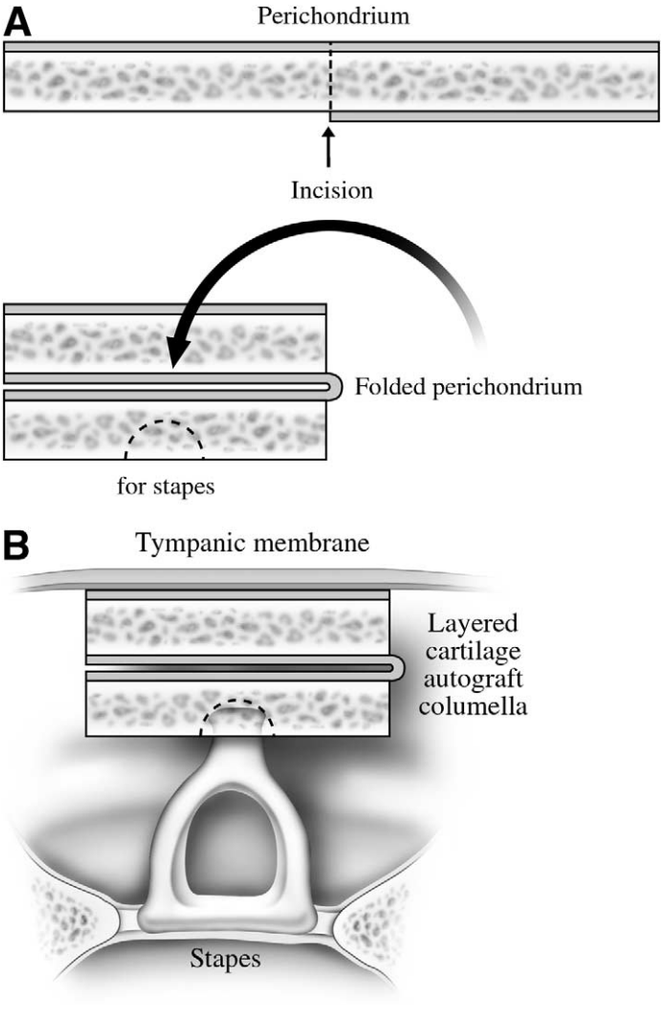

FIGURE 4. Stacked cartilage assembly. (A) Folding of blocks. (B) Composite graft in place.

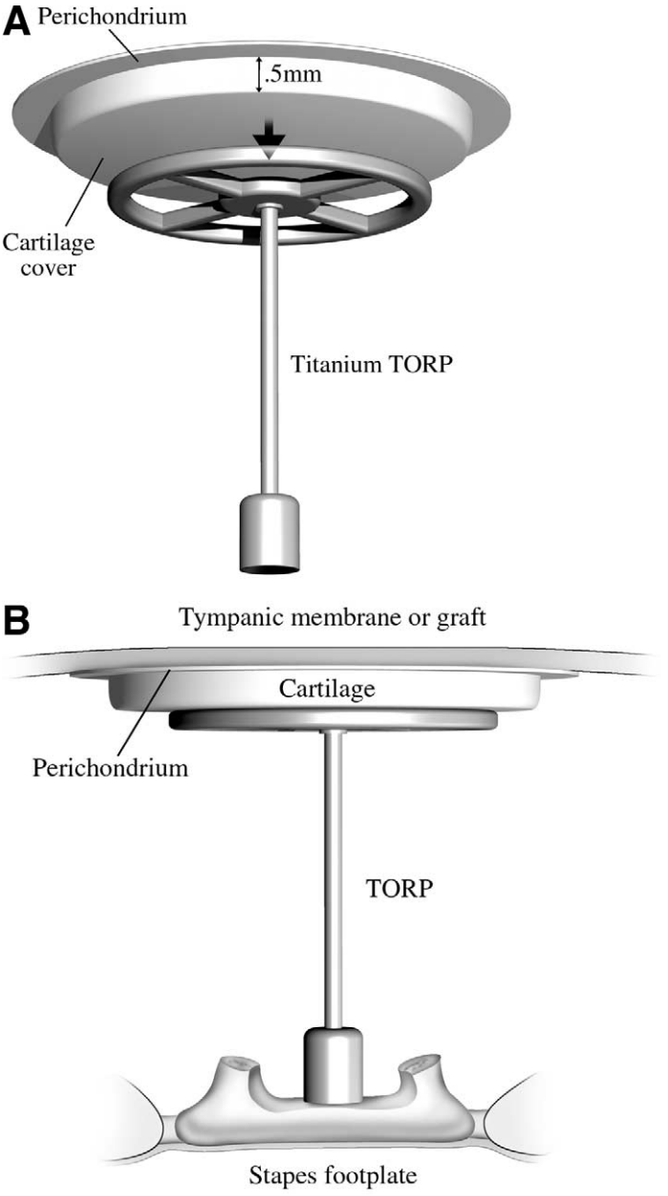

FIGURE 5. Cartilage graft for prosthesis—drum interface. (A) Composite dome for total ossicular replacement prosthesis (TORP). (B) Completed reconstruction.

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