Chapter XIII

Summary

Although ossiculoplasty was attempted initially in the early 1900's, it was not until the era of Wullstein and Zollner in the 1950's that it became commonplace and relatively well understood. Since then, there have been numerous technologic advances and a gain in the understanding of ossiculoplasty, also known as ossicular chain reconstruction (OCR). However, even in primary cases performed by an experienced otologic surgeon, successful OCR with resulting long-term stability can be a daunting task (Zollner F,1995 ; O'Reilly RC, et al.,2005).

The anatomic goal of OCR is to restore the middle ear transformer mechanism. OCR is not performed if cochlear function is poor, particularly with regards to word discrimination. OCR is also contraindicated in an only hearing ear; a hearing aid is the preferred option in this instance. Patients with bilateral CHL should have the worse hearing ear operated on first; an alternative to this approach is to operate on the more diseased ear in patients with bilateral COM (Merchant SN.,2005).

Ideally, implants should be biocompatible, inert, inexpensive, and easy to handle and use; they should resist adhesion formation, resorption, or fixation; and they should allow for tissue ingrowth, and stabilization and long-term hearing improvement (Merchant SN.,2005). No single implant meets all the above criteria. The numerous types of prostheses, in terms of both design and construction, attest to this problem. No evidence exists that one type of prosthesis performs significantly better than another in the long term ; each prosthesis type has its advantages and disadvantages (Iurato S,et al.,2001).

Different prostheses are used, based on the variable ossicular defects. Usually, the more minimal the ossicular defect, the better the long-term hearing results (Iurato S,et al.,2001).

The Appelbaum HA prosthesis, introduced in 1993, is used to reconstruct the IS joint and the lever mechanism "instead of using an incus interposition graft" (Ravi N.et al.,2006). If there is too much erosion of the long process, the incus needs to be removed and a partial ossicular reconstruction prosthesis placed between the TM or malleus and the stapes capitulum. A total ossicular reconstruction prosthesis is used for ears with both the incus and stapes superstructure missing. The total ossicular reconstruction prosthesis is coupled between the malleus or TM and the stapes footplate (Ravi N.et al.,2006).

The two main categories of prosthetic materials are: (1) biologic (autografts and homografts) and (2) synthetic (alloplasts or allografts).

Autograft materials include cortical bone chips, native ossicles (usually the incus), and cartilage (from tragus or concha). Although resorption of autograft materials can occur, particularly with cartilage, the material is biocompatible, readily available, low in cost, and has a low risk of extrusion(Merchant SN.,2005 ; Romanet P.,et al.,2000 ; O'Reilly RC,et al.,2005).

The other biologic materials, homograft ossicles and cartilage, were first used in the 1960's. The use of homografts in the United States still ranks second in middle ear reconstruction because of compliance with the actual infectious guidelines, the proposed inactivation/preservation procedure allows maintaining this successful and well proven middle ear reconstruction technique. However,

in the future, the inactivation procedure will remain the critical step in homograft preparation because infectious profiles may undergo rapid and considerable changes (Goldenberg RA,2001). Homografts are typically available as cadaveric TM and ossicles, cartilage, and cortical bone. They can be obtained presculpted or modified intraoperatively. Although they have many of the same advantages and disadvantages as autografts, they arguably have a higher resorption rate (Babu S and Seidman MD ,2004).

Alloplastic materials have been used since 1952 for OCR(Yung MW,2006). Typically, studies have shown no significant differences among synthetic prostheses in extrusion risk, failure rates, and short- and long-term hearing results, when comparing ears similar in ossicular defects and disease. Prostheses are made of numerous artificial substances, including Teflon, polyethylene, metal wire, polycel, carbon, bioactive glass, Ceravital, and aluminum oxide ceramic (Yung MW,2006). Most current prostheses are made of titanium, plastipore, and HA (singly or in combination), with dense HA the most commonly used material (Yung MW,2006).

HA has been used since 1981 and is composed of calcium-phosphate and is similar to native bone. HA is well tolerated, can have overgrowth of mucosa, and resists infection and resorption. HA prostheses are the only prostheses that currently do not require placement of cartilage to prevent extrusion (extrusion rate of 5%–10%). Problems with HA include difficulty in trimming (it requires use of a drill with irrigation) and risk of shattering. One must avoid placement of the HA prosthesis near the scutum to avoid osseointegration and fixation. Another criticism of these prostheses is that some HA prostheses are top-heavy and may tip over easily if not positioned securely (Ravi N,et al.,2006).

HA has also been used in a malleable fashion as bone cement, instead of preformed prostheses (Grote J.,1984 ; Goebel JA and Jacob A.,2005). Goebel and Jacob used HA bone cement in 25 subjects in a variety of ossicular defects (such as incus erosion) and to assist with OCR "eg, to secure total or partial ossicular reconstruction prosthesis placement" (Goebel JA and Jacob A.,2005).

High-density polyethylene sponge is available as plastipore, which has been used since the 1970's and was the first alloplast sold commercially worldwide (Daniels RL and Shelton C. ,1997 ; Yung MW,2006 ; Iurato S,et al.,2001). It requires the use of cartilage when in contact with the TM, to prevent extrusion. Plastipore is nonreactive and allows tissue ingrowth because of its porosity. Thus, it is used most often as a shaft material in a hybrid or combination prosthesis (eg, with HA head). It is easy to trim and modify (Daniels RL and Shelton C.,1997).

Titanium is another alloplastic material that is newer, increasingly used, and has shown much promise. It is inert, light, and rigid (Martin and Harner ,2004). Titanium was first used in 1993. It has been reported that visibility is improved over other types of prostheses because of fenestrations in the head (Maassen MM, et al. ,2005 ; Yung MW,2006). Titanium requires cartilage to prevent extrusion but, overall, its success rate and extrusion rate (5%) approximates that of HA prostheses (Sheehy JL.1965).

Hybrid prostheses have been developed by some companies to minimize the disadvantages of each material, while capitalizing on their advantages. For example, HA is used typically as the head material to reduce risk of extrusion.

Plastipore or titanium is used as shaft material for ease in trimming and modification. Unfortunately, because of HA comprising the head, these types of prostheses are top-heavy and have a risk of tipping over (Ravi N.et al.,2006).

Ossiculoplasty is an effective surgical option for reconstruction of the diseased middle ear that can very effectively treat conductive hearing loss. However, techniques and prostheses used in reconstruction are still imperfect (Luv Ram Javia,et al.,2006).

Based on the data available today, the following conclusions can be drawn pertaining to ossiculoplasty (Luv Ram Javia,et al.,2006):

1. Autograft prostheses largely have been replaced with more readily available and durable allograft prostheses.
2. Titanium and hydroxylapatite prostheses are the most widely used and successful implants available at this time and have good biomechanical properties, low extrusion rates, and good hearing results. More prospective trials will help delineate the differences between implants. Titanium prostheses are somewhat more ‘‘user friendly’’ and have therefore become more popular in recent years.
3. A prosthesis should be placed with as little tension as possible without significant tenting of the tympanic membrane, while maintaining prosthesis stability.
4. An interface of cartilage should be placed between all of the currently available prostheses and the tympanic membrane to minimize extrusion.
5. The axis of pistonlike movement should be kept in mind and angulation minimized to prevent slippage and inefficient sound energy transfer.

6. The tympanic membrane should be mobile with emphasis placed on middle ear aeration and minimal surgical destruction of mucosa.
7. Bone cements are promising in selected applications and require further study with more patients and investigation into the biomechanical properties after reconstruction.