

Ossiculoplasty

This surgical procedure aims to rebuild the continuity and or mobility of the ossicular chain which may have been fixed, disrupted, or destroyed, by trauma or disease. The reconstruction is performed using inter-positioned material. The operation has been part of the ENT surgeon's armoury for at least 40-50 years but recent developments in biocompatible materials available have improved the success rate of surgery.

The task that faces the otologist is to regain the original mechanics of the ossicular chain in order to convey the mechanical energy necessary to supply a stimulus to generate electrical impulses within the cochlear.

The commonest causes of damage to the ossicular chain are disease, e.g. cholesteatoma, or as a result of surgical resection of that disease, and trauma.

Whilst a relatively robust assembly in normal life and physiology, the mechanical integrity of the ossicular chain is extremely susceptible to certain disease processes. The presence of cholesteatoma may damage the chain either by interfering with the blood supply to the ossicles or local enzymatic damage. The most susceptible area of the chain is the long process of the incus. This has a tenuous blood supply and anything that interferes with this, such as pressure exerted by a cholesteatoma may lead to erosion and discontinuity.

Traumatic disruption of the chain is less common. This may be intentional as in removal of the incus by the surgeon operating for cholesteatoma in order to gain access to and clear the cholesteatoma, or trauma including penetrating injuries of the tympanic membrane and head injuries.

Three main categories of ossicular defects are summarized below.

Ossicular Defects

1. Loss of continuity:

Traumatic dislocation

Surgical disconnection/dislocation

Middle ear pathology like ear drum perforation or cholesteatoma

2. Fixation with otosclerosis or tympanosclerosis.

3. A combination of the two.

Ossicular defects can be simply divided into three groups: -

1. Small defects between the incus and stapes

2. Larger defects between the incus and stapes, which may include a missing incus or long process of the incus +/- stapes superstructure

3. No incus, malleus or stapes superstructure

For ossiculoplasty, auto-grafts are the commonest materials used for reconstruction. The most successful of these is the incus remnant. Cartilage from the tragus or nasal septum are also used. Homografts using stored cartilage and donor ossicles are used successfully by preserving them in ossicle bank.

Over the last 35 - 40 years a whole series of synthetic and refined materials have been utilised. Polythene tubing struts were first used in North America and Europe in the mid 1950's, but have been superseded by more modern materials over the last 2-3 decades. Materials currently employed include the metals - stainless steel, platinum, titanium alloy, and gold, plastics - PTFE, silastic, Polycel® and Plastipore® and, more recently, biocompatible materials such as hydroxylapatite and ionomeric bone cement. Each of these materials have some advantages and most can be employed for partial ossicular replacement (ie) between stapes and malleus or stapes and eroded long process of incus. However they have extrusion rate of up to 3-5%. Where reconstruction material comes in contact with the tympanic membrane, experience has shown that hydroxylapatite probably has the lowest extrusion rate.

Anaesthetic

The operation may be performed under local or general anaesthesia. Local anaesthesia, however, has some distinct advantages. These include the near bloodless field, plus the opportunity to confer with the patient and establish when the ossicle is positioned satisfactorily and hearing improved.

The problems that need to be overcome during the procedure are similar to those in other middle ear surgery:-

1. Maintenance of a clear operating field

2. Ensuring good access

3. Stabilization of the prosthesis.

Technique

In many cases the operation can be performed by a permeal technique via a speculum and where this does not afford adequate access an endaural releasing incision can be made, although, this is best avoided if possible as there may be oozing of blood into the operative field during the procedure. Where there is a narrow meatus, bony meatoplasty is performed by post aural route prior to ossiculoplasty.

A circumferential incision is made at the limit of the speculum at 1 o'clock around to 5 o'clock. The skin of the deep meatus is raised and the tympanic membrane reflected forwards to reveal the ossicular complex.

Drilling or curetting of the bony annulus may be performed to improve access. The chorda tympani should be preserved where possible because of the taste disturbance that results from damaging it and because it may be used to increase stability of the prosthesis.

Mobility of the ossicular remnants, namely the malleus and stapes is confirmed by gentle palpation with an appropriate instrument. There may be attic fixation of the malleus, in which case, exploration of the attic with removal of the head of the malleus is required. Adhesions of the middle ear are divided where possible.

The reconstructive technique now employed is dictated by the position of the malleus handle.

Where the malleus overlies the footplate of the stapes ossiculoplasty is straightforward with interposition of the ossicular replacement between the two. Invariably, however, the malleus handle is sited more anteriorly meaning that any ossicular replacement will be at an oblique angle, decreasing the stability and mechanical efficiency. In this situation, the technique of malleus re-location can be employed.

The incudial remnant is removed and discarded. The distance between the stapes footplate and the underside of the malleus is measured accurately with an appropriate measuring device. Anhydroxylapatite ossicular prosthesis is prepared to a length of approximately 0.5 mm greater than this. The ossicle is inserted on the end of a sucker, with its distal tip being gently placed on the footplate of the stapes and its shaft passing between the facial nerve and crura of the stapes. Great care must be taken if the bony covering of the facial nerve is dehiscent. The shaft of the prosthesis may have to be thinned by paring with a scalpel to fit into this confined space. A notch on the head of the prosthesis is placed on the upper part of the handle of the malleus under slight tension (the reason for cutting the prosthesis slightly longer than the distance measured). Mechanical continuity is confirmed by gentle palpation of the handle of the malleus whilst watching for a round window reflex (the movement of reflections of the fluid of the round window niche in response to bulging out of the round window due to changes in intra cochlear pressure).

The above assembly may be stable, but if not, techniques to improve stability may be employed. In addition to the tension already mentioned, Gelfoam® blocks, cartilage blocks and fixation with tissue glue and vein grafts may be employed. The tympanic membrane is returned to its normal position and gently held in place with Gelfoam® packs and a light ribbon gauze impregnated with antibiotic dressing in the external canal.

Length of Operation

Depending on the experience of the surgeon, access and the presence or absence of adhesions in the middle ear, a typical ossiculoplasty will take between 60-90 minutes.

Time in Hospital

Where the operation has been performed under local anaesthesia, many patients may opt to go home within a few hours. If general anaesthesia has been employed, particularly when combined with hypotension, the patient should be watched for at least 4 hours post operatively and practically this means that most will need to spend one night in hospital.

Time off Work

In experienced hands, where there has been minimal manipulation of the ossicular chain post-operative disequilibrium is short lived. Patients with sedentary occupations can return to work within 2-4 days. Where the patient is employed in an occupation requiring more physical activity, stability of the prosthesis may be a risk and 7-14 days off work is advisable. Since the operated ear is packed, there is little usable hearing during this period and the patient's safety at work with this disability must be taken into account.

Risks and Complications

The risks of anaesthetic and surgical risk for this type of surgery are extremely low. If hypotensive anaesthesia is employed, assisted ventilation is advisable because of the risk of loss of central control mechanisms as the systemic blood pressure falls.

Complications are the same as for all surgery within the middle ear. In experienced hands the risk of an acute sensorineural hearing loss as a result of surgical intervention should be no greater than 0.5 - 1%. The chorda tympani can be damaged during raising of the tympanic membrane leading to disturbances of taste sensation post operatively. Most authorities believe that if the chorda is stretched to any great degree, it is better to cut the nerve and leave it. A recent paper, however, has questioned the advisability of doing this.

The stapes can easily be damaged and particular care should be taken to avoid instrumenting the stapes suprastructure or footplate area. As with all middle ear cases, the bony covering of the facial nerve may be dehiscent and any dissection to remove adhesions or granulations in this vicinity should be performed with great care. Where local anaesthesia is employed, particularly when combined with vasoconstrictors, such as Adrenaline, there may be a transient facial weakness lasting for an hour or so, which can be distressing for both the patient and the surgeon!

Prognosis

The long-term results of ossiculoplasty are dependent on several factors. The most important of these are eustachian tube function, recurrent middle ear disease and the biocompatibility of the prosthesis material.

In the best hands the overall success rate of the procedure is no better than 70%. The average clinician would be lucky to exceed 60%. If all the above are favourable, however, and the malleus is still present success rates of 80% may be achieved in this highly selected group. This figure is certainly achievable in cases of ossicular disruption.