

Management of incus dislocation by physiological repositioning of the incus

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Abstract

Data have been collected prospectively from 11 patients (12 affected ears) with traumatic disruption of the ossicular chain. Isolated dislocation of the incus is the most common finding in our cases, but two had stapes arch features and two had fractures of the tympanic bone. The most common cause of the injuries was a road traffic accident. We describe a technique designed to reposition the incus in its physiological position. This involves a combination of a tympanotomy and a posterior approach to the attic region. The results in five patients (six ears) treated in this way are presented.

Key words: Hearing loss, Conductive; Trauma; Surgical Procedures, Operative; Incus

Introduction

Trauma to the ear may result in fractures of the temporal bone and damage to the cochlea and facial nerve. Lesser trauma results in damage to the ossicular chain. The most common lesion identified is dislocation of the incus.^{1–4} In some cases there is disruption of the incudo-stapedial joint with minimal displacement of the incus, but with more severe injuries there may be complete separation of the incus from the malleus and stapes.^{1,5} Fractures of the incus long process have also been described.⁶ The malleus handle may also be fractured;^{4,7,8} however, when this occurs in isolation a relatively minor degree of conductive hearing loss results. Malleus dislocation has also been reported.⁹ Trauma to the stapes may result in fracture of the arch^{1,6,9} or dislocation of the whole stapes.^{10,11} In some cases a combination of these lesions may be found⁶ and there may also be fractures of the bony external auditory meatus⁷ or fixation of the incus and or malleus.^{1,6}

Injuries to the ossicular chain may result from head injuries,^{2,6,7} direct trauma including surgery^{6,10} or lightning.¹² Quite often the lesion is not diagnosed until long after the original injury.^{6,7,13}

Surgical correction of incus dislocation can be carried out using conventional ossiculoplasty techniques, bone graft repair or repositioning of the incus.^{2,6,7,14,15} Fractures of the stapes arch can be managed by the use of a strut or piston between the incus and stapes,^{6,9} while stapes luxation can be treated by stapedectomy¹⁰ or restoration of the ossicle to its former position, secured with tissue adhesive.¹⁶ Small bone grafts can also be used to

treat malleus handle fractures.^{4,8,13} Following the success obtained with reconstructions of the incus long process with a cortical bone graft,¹⁷ the author has carried out a series of operations on patients with dislocation of the incus in which the incus is replaced in its physiological position. This paper describes the surgical technique and the early results obtained.

Methods

Patients

Data on all patients with ossicular chain trauma seen by the principal author at Ninewells Hospital Dundee between 1986 and 1998 and at the Royal Infirmary of Edinburgh between 1998 and 2001 have been collected prospectively. Six ears with incus dislocation have been treated with a novel surgical technique.

Surgical technique

A per-meatal tympanotomy is carried out to confirm the diagnosis. A post-aural incision is then made and a limited cortical mastoidectomy is performed. The mastoid antrum is opened and the lateral semicircular canal and the incus short process are identified. Bone removal is continued antero-superiorly to expose the body of the incus and the head of the malleus. Experience from mastoid surgery indicates that sometimes there is not enough space between the upper surfaces of the ossicles and the middle fossa dura to allow adequate access using this approach. However, in the cases of ossicular chain trauma treated thus far, ample space has been found. This may be because the subjects involved had no

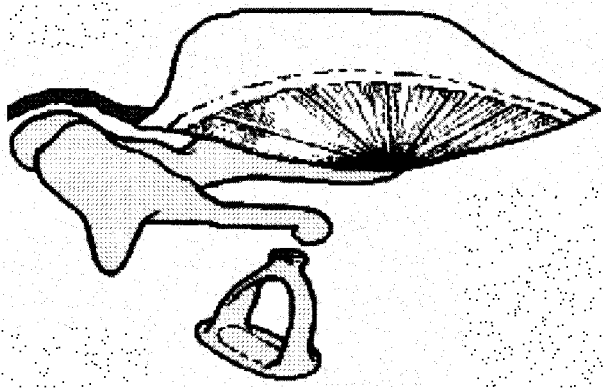


FIG. 1

Dislocated incus. In all cases the incudo-malleolar joint had reformed with incus in an incorrect alignment.

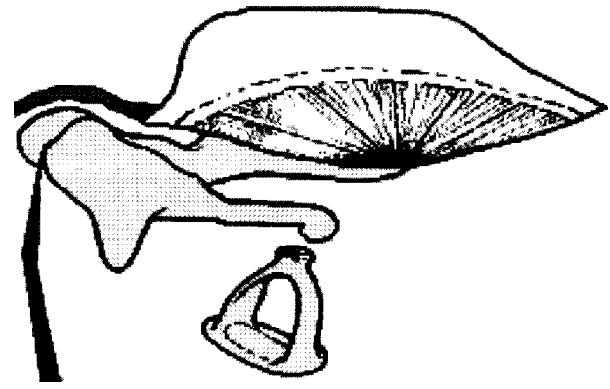
past history of chronic otitis media and cellular mastoids. Following dislocation of the incus, it is evident from the operative findings that the incus and malleus become reconnected to each other by soft tissue, but with the incus incorrectly aligned (Figure 1). The first task is therefore to mobilize the incus (Figure 2a). Partial mobilization may allow realignment of the incus if it is not too far out of place, but if a greater degree of displacement has occurred, it will need to be fully mobilized. The incudo-malleolar joint is relatively easy to re-establish because the articular surfaces are complementary. If complete mobilization is required, the incus tends to become displaced posteriorly. This can be avoided by supporting it with 'Spongostan' (Johnson & Johnson) (Figure 2b). The incudo-stapedial joint, with its small area of contact, is more of a challenge. The author has used a small incudo-stapedial joint splint, made by modifying a silicone grommet, to stabilize the joint during healing (Figure 2c). This also helps to prevent the formation of adhesions around the joint, which may prevent full mobility of the stapes.

Assessment of hearing results

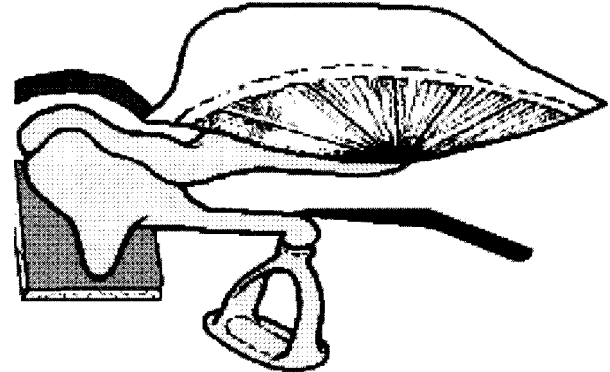
Mean air-bone gaps, mean residual hearing losses and mean hearing changes were calculated using three frequencies (500, 1000 and 2000 Hz). Post-operative mean air-bone gaps were calculated using the pre-operative bone conduction thresholds. Mean hearing changes were calculated by subtracting the mean post-operative air conduction thresholds from the mean pre-operative thresholds.

Results

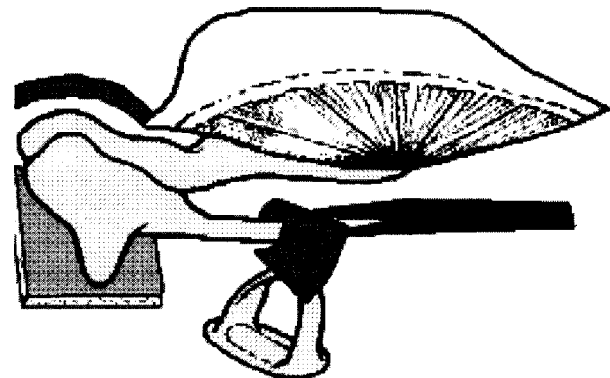
Data of 11 patients (12 affected ears) with ossicular chain trauma indicate that the most common injury was incus dislocation. Two patients had stapes fractures in addition and two also had fractures of the bony tympanic ring. The injuries occurred during a road traffic accident in six patients (seven ears). Three of these patients (including the bilateral case) were motorcyclists. The other types of trauma reported are presented in Table I. To date, the novel technique has been used to treat five patients



(a) Opening of the incudo-malleolar joint.



(b) Re-creation of the incudo-stapedial joint.



(c) Stabilization of the incudo-stapedial joint with an incudo-stapedial joint splint made from a silicone grommet.

FIG. 2

Surgical technique for physiological incus repositioning.

(six ears) with incus dislocation following head trauma. The only female (case 1) had complete fixation of the incus in the attic. The others all had mobile ossicular chains, but one had a stapes fracture. In this case the repositioning technique was combined with a stapes piston. Previously described surgical techniques have been used in an additional five patients. The duration of follow-up to date varies between six months and four years.

Five of the six ears treated with the novel technique have mean air-bone gaps less than 10 dB post-operatively and five out of six had mean residual hearing losses of less than 30 dB at one

TABLE I

TYPES OF TRAUMA ASSOCIATED WITH OSSICULAR CHAIN INJURIES

Type of trauma	Number of cases
Road traffic accident	6
Assault	2
Fall	2
Previous surgery	1
Total	11

year. The results for physiological repositioning operations are presented in Figure 3, using the Glasgow Benefit Plot.¹⁸ One of the patients treated by a conventional ossiculoplasty was lost to follow-up after surgery. Of the other four, only one had an air-bone gap of less than 10 dB at one year.

Case 1 developed recurrence of conductive hearing loss three years after initial surgery. The ear was re-explored and re-fixation of the incus in the attic was found. The correct alignment of the incus was maintained. The incus was mobilized once again but only a modest hearing gain was obtained on this occasion. Case 2 had incomplete closure of the air-bone gap following initial surgery. A tympanotomy was carried out and adhesions were found around the incudo-stapedial joint. An incudo-stapedial joint splint was applied. Following this procedure the hearing improved further.

Discussion

Dislocation of joints is usually treated by manipulation to restore the dislocated bone to its correct position. This has been previously attempted in the case of the incus.^{2,14} These authors used a wire passing around the incus and through the stapes arch. No attempt was made to mobilize the body of the incus. The authors' experience indicates that there is considerable resistance to realignment of the incus when this is attempted via a tympanotomy. This is because the incudo-malleolar joint reforms as a result of soft-tissue growth following trauma, but with an altered relationship between the articular surfaces of the malleus and incus. Considerable tension must have existed following the reconstructions described above and necrosis of the incus long process is likely to have occurred in time.

The technique described above allows realignment of the incus without tension. The incudo-malleolar joint is easily recreated because the articular surfaces of the two bones are designed to fit together. The incudo-stapedial joint is more of a challenge, as the articular surfaces are very small. The incudo-stapedial joint splint described above holds the bones together gently and prevents the formation of adhesions around the joint.

The excellent results obtained are in part due to the physiological nature of the reconstruction. However, it should be pointed out that these ears, in contrast to those encountered in chronic ear surgery, have a healthy mucosal lining and normal Eustachian tube function. This means that good results can also be obtained using conventional reconstructive techniques, though in this small series the hearing outcomes were not as good as for the

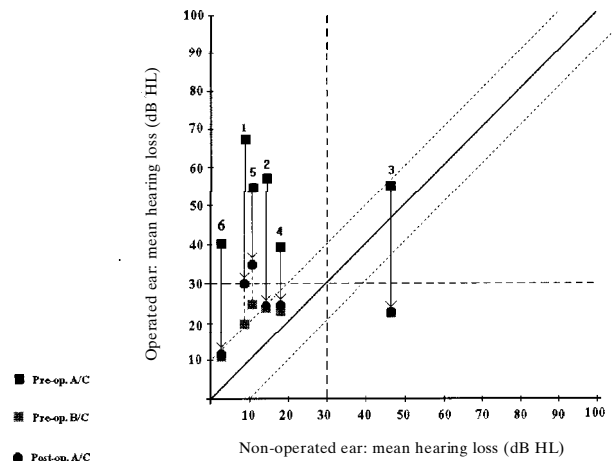


FIG. 3

Hearing results for physiological incus repositioning displayed using the Glasgow Benefit Plot.

novel technique. Large numbers of cases would be required to prove that physiological repositioning produces superior results. Given the low incidence of these injuries it is unlikely that this will be possible.

It is of some interest that motorcyclists predominate in the study group. It is possible that previously these individuals would have sustained more severe head injuries and that the wearing of crash helmets has prevented this, but not the lesser injury of incus dislocation. It is also possible that wearing a crash helmet in some way predisposes the rider to this type of injury. The relative ease with which the incus can be displaced in this way is fortuitous in that it probably helps to protect the cochlea from damage.

Individuals involved in injuries of this kind are by and large young and have high expectations with regard to their hearing. Some have a degree of sensori-neural hearing loss as a result of the trauma, though fortunately this is usually confined to the highest frequencies. It is therefore important to choose a technique which carries a high chance of closing the air-bone gap. This technique appears to be the method of choice in this regard. The additional surgery involved in the posterior attic approach is not a significant disadvantage in a fit young person and is not excessively time-consuming.

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