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The Singapore swing

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Abstract
The use of a rotation pedicled flap, entitled the 'Singapore Swing', comprising temporalis fascia and mastoid periosteum, is presented as a new method of promoting healing in 'open' mastoid surgery for chronic ear discharge. Cadaver studies show that the main blood supply of the flap is derived from a branch of the postauricular artery which enters the pedicle near the mastoid tip. A review of the first 14 operations showed complete healing with dry ears and intact tympanic membranes in all instances, three cases requiring secondary grafting of residual perforations. We consider the results sufficiently encouraging to merit an extended trial of the technique.

Key words: Otitis media, suppurative; Cholesteatoma; Surgery, operative

Introduction

Although numerous surgical techniques have been employed in the treatment of chronic suppurative otitis media, the majority of general ENT surgeons find the canal wall down, open cavity, operation with wide access to the middle ear to be the safest and simplest means of managing middle-ear cholesteatoma. The main disadvantage of this method is a variable legacy of persistent or intermittent discharge from the middle ear and mastoid cavity.

Most of the operations devised to solve the problem of the wet mastoid cavity have focussed on either a closed technique or obliteration of the cavity. Both these methods have a common disadvantage, namely that by obscuring the original site of the disease, the detection of recurrent cholesteatoma is rendered much more difficult. For this reason the open cavity technique is still preferred by many in the management of cholesteatoma.

Healing of the open mastoid cavity

In addressing the problem of post-operative discharge, an awareness and understanding of the mode of healing of the open mastoid cavity is essential.

The fundamental objective is a complete coverage of the operation cavity with healthy squamous epithelium. In the classical radical operation epithelial regeneration is left to nature and involves spontaneous proliferation of epithelium from the adjacent skin edges over the entire bony cavity. As this new lining has to grow and survive on a sclerotic, poorly vascularized bony surface, epithelialization in many cases is tenuous and break down is common. Paradoxically, one of the most significant advances in operative technique, namely the introduction of the high-speed dental drill, may well have compounded the problem: the common practice of 'finishing off' the mastoid cavity with a diamond burr to create a smooth bowl may burnish the underlying bone and compromise epithelial regeneration.

Predisposing factors to discharging cavities

Based on our own experience and the researches of Sadé *et al.*, we believe that the main factors influencing post-operative healing fall into the following categories (Sadé *et al.*, 1982).

Size of cavity – the larger the cavity, the greater the liability to post-operative problems.

Shape of cavity – a poorly fashioned cavity with a high facial ridge and irregular bony overhangs increases the incidence of post-operative discharge.

Inadequate meatus – an inadequate meatal orifice causing impaired ventilation and difficulties of visualization and access to the post-operative mastoid cavity for cleaning purposes, adversely affects the changes of obtaining a healed stable ear.

'Open' mesotympanum and Eustachian tube – failure to seal off the tympanic cavity and Eustachian tube leaves the middle ear and mastoid exposed and vulnerable to infection.

Shortcomings in after-care and lack of sterile precautions in early post-operative toilet – reinfection is a potential source of wet cavities.

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Yet even with careful attention to the foregoing factors a proportion of ears remain wet or prone to breakdown after open mastoid surgery, prompting otologists to seek methods of promoting sounder healing.

Cavity grafting

Early attempts to secure a sound epithelial lining in the post-operative mastoid cavity were logically focussed on implanting squamous epithelium in the form of skin grafts. Initially split skin was used but later, coinciding with the birth of tympanoplasty, full thickness skin grafting came into vogue. However, survival of free skin proved difficult on the bare sclerotic bone and although both techniques were greeted initially with enthusiasm, they were later deemed ineffective and abandoned. Indeed, Bocca went as far as to suggest that all healing problems in mastoid operations started with the introduction of skin into the cavities. (Bocca, 1963).

Following the failure of skin grafts, attention was directed to covering the bony cavity with non-epithelial tissues to provide a more favourable foundation for the spontaneous proliferation of an epithelial lining. Both periosteum and fascia have been utilized for this purpose but to our knowledge a composite fascial-periosteal graft has not hitherto been described.

The use of periosteum can be traced as far back as 1925. Addressing the Otorhinolaryngology Section of the British Medical Association, Jenkins described a superiorly based flap taken from the mastoid cortex which he was able to spread over the area of the mastoid antrum and aditus (Jenkins, 1925). Almost a decade later, Popper in South Africa, also favouring mastoid periosteum, designed a large flap, pedicled posteriorly, with which he helped to line the mastoid cavity (Popper, 1935). However, as the supply of mastoid periosteum is limited, it would be difficult to fashion a pedicled graft large enough to cover the entire mastoid cavity. Periosteum has also been used for free grafting (Bocca, 1963) and in obliterative techniques (Moffat *et al.*, 1994).

Grafting the mastoid cavity with fascia became popular following its successful use in tympanic membrane repair. Free temporalis fascia grafts were employed by the senior author to line areas of the mastoid cavity over a period of many years. The results, although in general satisfactory were inconsistent, occasional grafts failing to survive probably due to inadequate blood supply. Pedicled fascial grafts, however, proved much more successful, presumably on account of their better blood supply. Our interest in these was initiated by the involvement of one of us in the development of the Hong Kong flap in which the operation cavity is lined with a pedicled graft of temporalis fascia (Van Hasselt, 1994). This technique added a new dimension to open mastoid surgery for, not only was healing rapid and reliable, but the resulting epithelium was strong and tough so that subsequent breakdown was avoided. Furthermore, although the graft is initially thick, it gradually becomes thinner and increasingly transparent in the course of time, while at the same time remaining stable and healthy. This delayed attenuation of the graft has proved advantageous and of great importance as it overcomes the inherent disadvantage of closed or obliterative operations by facilitating detection of disease recurrences beneath the 'see-through' lining.

The signal success of the Hong Kong flap encouraged the senior author (AGG) to consider other pedicled flaps to provide additional surgical options. The outcome was an inferiorly based rotation graft which he entitled 'The Singapore swing'.

Singapore swing

The Singapore swing is a composite flap, shaped like a boomerang, comprising temporalis fascia superiorly and the periosteum of the outer mastoid cortex inferiorly. The pedicle is sited inferiorly near the mastoid tip and is based on a branch of the postauricular artery. The flap can be readily rotated and swung forward into the operation area and is large enough both to line the entire mastoid cavity and repair the tympanic membrane.

Cadaver studies

Cadaver dissections were carried out on 18 fresh specimens of the head and neck to display the vascular pattern of the mastoid and temporal areas after injection of the postauricular and superficial temporal arteries with latex or methylene blue. These showed that the periosteal segment of the Singapore swing derives its blood supply from a branch of the postauricular artery which crosses the anterior edge of the mastoid tip and passes upwards and backwards over the surface of the mastoid stopping short of the temporalis fascia (Figure 1). The main vessel supplying the temporal area is the superficial temporal artery, the main branches of which pass to the layer of loose connective tissue lying superficial to the temporalis fascia which is normally discarded when taking a fascial graft. However, one or two small vessels could be identified entering the true fascia on its deep surface near its antero-inferior extremity. These, as a rule,

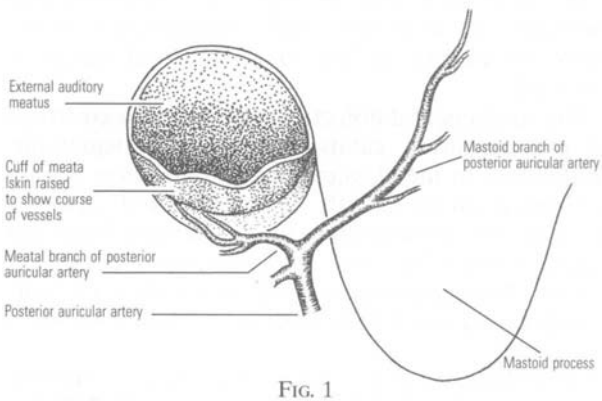


FIG. 1
Diagram showing branches of postauricular artery.

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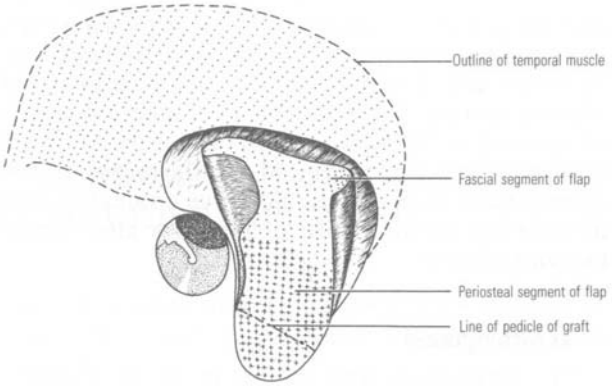


FIG. 2
Elevation of the Singapore Swing.

terminated in the anterior part of the fascia, but in two specimens they could be traced back to the posterior half. There was no evidence of vascular continuity between the fascial and periosteal components of the Singapore swing but it was recognized that a micro-anastomosis might exist without showing up on the dye studies.

In contrast to cadaver studies, an extensive anastomosis between the fascial and periosteal segments of the swing is clearly seen during live surgery. Furthermore the viability of the entire flap can be convincingly demonstrated by applying compression and observing the rapid refilling of blood vessels in all areas on release of pressure.

Surgical technique

The Singapore swing is used in conjunction with a postauricular modified radical, or radical, mastoid operation. An extended approach, carrying the standard postauricular skin incision vertically

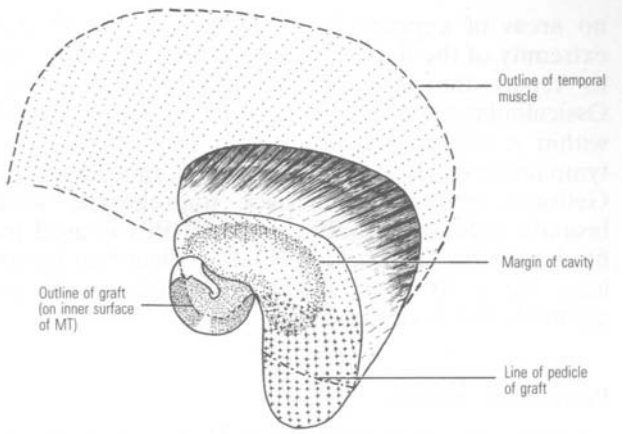


FIG. 4
Flap 'swung' into final position.

upwards for 2.5 cm, is employed to provide wide exposure of the mastoid and temporalis fascia. A large tongue-shaped fascial flap, based inferiorly, is then incised and elevated from above downwards as far as the attachment of the fascia along the lower border of the temporalis muscle (Figure 2, 3a). At this point sharp dissection is required to release the flap on its deep surface so that further elevation can be continued sub-periosteally down to the mastoid tip (Figure 3b). The periosteal segment of the flap should be kept as broad as possible as it is required to line much of the mastoid cavity. The pedicle of the flap, which should be at least 2 cm in breadth, is sited over the mastoid tip and contains the main feeder vessel from the postauricular artery, which should be carefully identified and preserved. The flap is protected in a moist swab during the subsequent mastoidectomy procedure. An adequate meatoplasty is then carried out. Finally, the Singapore swing is spread out to cover the entire mastoid cavity leaving

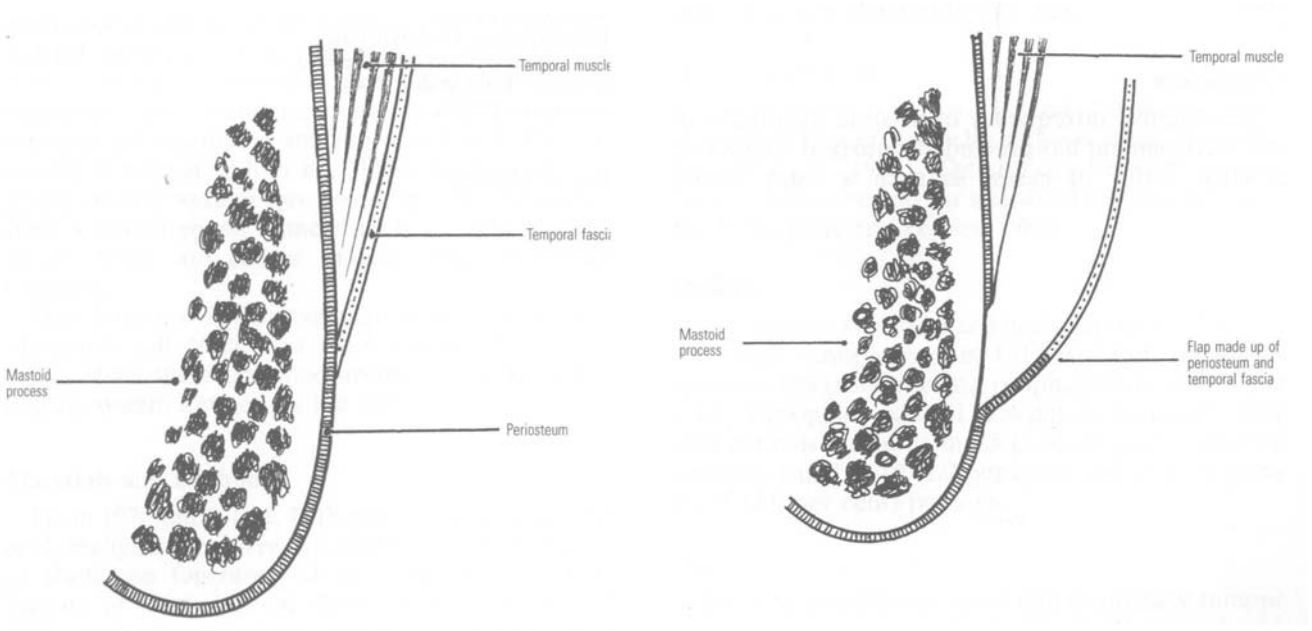


FIG. 3
Coronal representation of the Singapore Swing.
(a) before elevation
(b) after elevation

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no areas of exposed bone, while the free fascial extremity of the flap is inserted as an underlay graft to repair the tympanic membrane (Figure 4). Ossiculoplasty, if required, can be incorporated within a single-stage procedure. The area of the tympanoplasty is protected with a thin layer of Gelfoam, and a gauze pack impregnated with bismuth iodoform paraffin paste (BIPP) is used to fill the cavity. The packing is left undisturbed for at least three to four weeks. Antibiotic cover is administered as routine.

Preliminary results

During the three-year period March 1994–February 1997, a total of 17 cases of chronic suppurative otitis media underwent operation by the 'open' mastoid technique combined with the Singapore swing: of these, three cases were excluded from our analysis, two having very recent operations, while the other patient, whose ear was already almost healed, was lost to further follow-up. Of the 14 remaining cases, cholesteatoma was encountered in 11, while three had granulation tissue only. Ossiculoplasty was performed in three ears. The average follow-up period was 10 months. Healing was straightforward in 11 ears resulting in a dry cavity and intact tympanic membrane. In the other three cases, tympanic membrane defects were encountered post-operatively, all of which were successfully closed by grafting. Thus all 14 ears were dry and soundly healed at the time of review. Healing in general was rapid but in six instances it was delayed by the development of granulations in the area of the tegmen, which required removal or cauterization in the clinic. The quality of epithelium in the mastoid cavities after final healing was excellent and the chances of subsequent breakdown appeared minimal.

Conclusion

The relative infrequency of mastoid operations in our environment has precluded statistical analysis of a large series of cases, as such a study would inevitably occupy a period of many years. However, even in our limited series of cases, we have been able to refine our technique, assess its potential and observe several of the patients over a period of two to three years. While we regard our results as purely preliminary, we are convinced that the technique has considerable merit and should prove a valuable asset in reducing the incidence of wet ears after 'open' mastoid surgery.

Acknowledgment

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