Tympanic membrane homografts

By G. D. L. Smyth and A. G. Kerr

The introduction of the tympanic homograft technique in tympanoplasty by Marquet (1966) has excited attention throughout the otologic world. This is undoubtedly due both to current general interest in transplant surgery and also to some unsatisfactory aspects of current techniques of drum repair with temporalis fascia. Drums repaired with temporalis fascia are at times considerably thicker and less conical than the normal membrana tympani and it was hoped that total replacement of the drum head with a homograft might result in a membrane with better anatomic and physiological properties. In order to evaluate Marquet's method we performed total drum replacement with tympanic homograft in twenty ears which have now been followed up for at least 18 months. Because there is at present a good deal of speculative comment about this technique, even in the lay press, and some of it possibly tendentious, we are presenting this report in the hope that it may prove helpful to those who wish to evaluate the relative merits of the tympanic membrane homograft and temporalis fascia.

Material and methods

Donor procedure

Each temporal bone was removed from the refrigerated body within 12 hours of death and immediately transferred to the deep freeze. On the evening before the intended tympanoplastic operation, after immersing the temporal bone in Hibitane solution for 5 minutes, the tympanic membrane was removed in continuity with the malleus, incus and stapes using sterilized instruments and gloves. The general method was similar to that described by Marquet but with certain modifications. A circumferential incision was made through the meatal skin down to the bone of the ear canal, 6 mm. from the periphery of the drum and the meatal skin and underlying periosteum elevated until the fibrous annulus was identified. After the annulus was dissected out of its bony sulcus then the tympanic membrane was attached only to the malleus handle. It was now necessary to liberate the ossicles from the tympanum. To achieve this the attic and additus were uncapped by removing the tegmen tympani with a small curette. The body of incus and head of malleus were quickly identified and after division of their superior ligaments and all of the following structures, the anterior and posterior malleolar ligaments and folds, the chorda tympani, the tensor tympani, the fibrous attachment of the short process of the incus to the fossa incudus, the stapedius

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tendon and the stapedial annular ligament, then the complex of tympanic membrane and ossicular chain could be removed in continuity and placed in 10 per cent soframycin solution where it remained until use.

Recipient procedure

These grafts were used in tympanoplasty procedures of all descriptions: transcanal or combined approach, with or without cholesteatoma, wet or dry. There were no hard and fast rules except that only ears requiring total drum replacement were selected because it was intended that the tympanic homograft should be subjected to exactly the same adverse conditions as temporalis fascia.

At the start of the operation, the homograft—drum and ossicles in continuity—were placed in normal saline where they remained until the tympanic reconstruction phase had been reached. At this stage then there had been radical excision of all irreversibly diseased tissue and the hypotympanum, mesotympanum and epitympanum were lined with 0·005 inch silastic film. In cases where combined approach tympanoplasty was necessary for total exposure and excision of diseased tissue then a larger piece of silastic film was used to line the antrum and mastoidectomy cavity also. What followed depended on the status of the patient's ossicular chain after the removal of irreversibly diseased tissue.

In eleven ears a tympanic homograft was combined with a homologous nasal cartilage strut (Fig. 1) placed on the stapes footplate and in seven ears it was combined with an incus transposed on the stapes head. In two ears after combined approach tympanoplasty where the patient's malleus and incus were missing, a homograft drum was implanted in continuity with its own malleus and incus to make contact with the patient's stapes head (in these two ears the preliminary combined approach procedure was an essential to give sufficient space to manœuvre this very delicate and relatively bulky complex into the correct position for function). The final positioning was complete when the fibrous annulus of the donor graft was set into the bony sulcus tympanicus of the recipient and the canal wall skin of the recipient positioned to overlap the 6 mm. of canal wall skin attached to the tympanic homograft. At this stage the appearance of the graft *in situ* is impressive, to say the least. The ear canal was then gently filled with gelfoam soaked in neomycin-steroid solution. After 5 days in hospital these patients were discharged. Further dressings were carried out in 10–14 days by which time, in the successful cases, healing was achieved.

We differed from the technique of Marquet in that (1) we included 6 mm. of canal skin attached to the drum in order to give peripheral support to the drum element of the graft, and (2) we made no attempt to remove the squamous layer from the tympanic membrane as we felt that to do so would carry a risk of tearing the graft.

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FIG. 1.

Homologous cartilage (C) successfully embedded in a homologous tympanic membrane. Marked round cell infiltration and excessive desquamation (K). (Wild M20 Photoautomat.) ×125.

Results

There were twenty operations performed between November 1967 and March 1968. In only thirteen, i.e. 65 per cent, was the take of the tympanic membrane homograft completely successful. In the successful drum graft cases, closure of the air-bone gap to 10 db. or less was achieved in 77 per cent.

In the failed group, containing seven ears, there were three instances of pinpoint central perforations, in two others there was eventual loss of at least half of the drum head, and in two more there was an immediate post-operative reaction with purulent discharge and total loss of the drum graft.

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Discussion of results

1. *Tympanic membrane repair*

In this series of twenty ears in which the securing of donor tissue and its implantation into the patient were carried out by the same not inexperienced surgeon in every case, there was a failure rate of 35 per cent. When this is compared with a failure rate of 2 per cent in over 900 ears with follow-up of 6 months to 5 years where temporalis fascia has been used, there would appear to be an obvious conclusion which does not favour the continued use of tympanic membrane homografts. It is interesting to note that Marquet (1969) and also Glasscock and House (1968) and Brandow (1969) have reported similar failure rates.

We would like to emphasize that we have used the tympanic membrane homograft under exactly the same 'unfavourable' ears to which temporalis fascia is routinely subjected in our hospital.

Preoperatively, there had been a total drum loss in all cases, from many there had been profuse purulent discharge at the time of operation and often accompanying cholesteatoma. There were no traditional safe dry ears in this series, because we were interested in solving as expeditiously as possible the everyday problems in the surgical treatment of chronic infective middle-ear disease. The results of this investigation resoundingly confirm our faith in temporalis fascia as the best material at present available for repair of tympanic membrane perforations.

2. *Tympanic membrane appearance*

There is no doubt that the contour of the successful homograft drums is superior to that usually obtained with temporalis fascia. They are also thinner and look more like the normal drum. There were several cases in this series, however, where there was difficulty with excessive desquamation, and one wonders whether, in the long-term, problems might not arise because of this (Fig. 2).

3. *Functional results*

This could be fairly evaluated only in cases where the ossicular chain was intact at the time of operation and where the only transplanted element was the drum head. There were no such cases in this series.

TABLE I.

RESULTS

Total number of operations	20
Successful take of drum	13 (65%)
When drum repair successful air-bone gap 10 db. or less	10/13 (77%)

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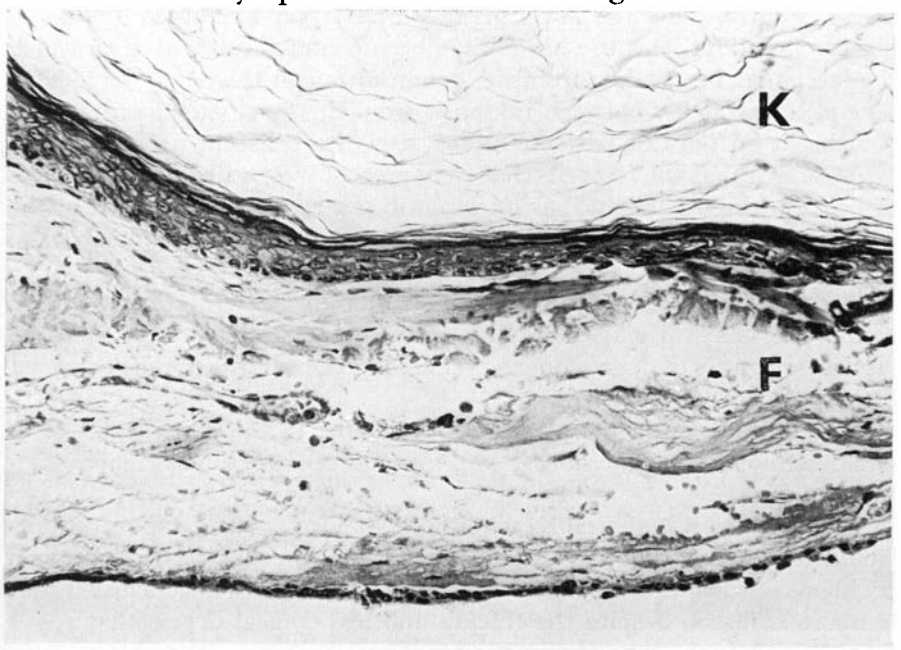


FIG. 2.

Homologous tympanic membrane (same case as Fig. 1) showing excessive desquamation (K) and oedematous fibrous layer (F) with a few plasma cells and disintegration of much of the connective tissue. (Wild M20 Photoautomat.) × 250.

Conclusions

The main aim of this trial was to provide evidence for comparison between two materials—homologous tympanic membrane and temporalis fascia—used for the repair of total tympanic membrane perforations in chronic infective middle-ear disease. In addition, we were interested to observe the performance of several combinations of the homologous drum and homologous ossicles in sound transformer reconstruction, but the scope of this communication does not allow for a consideration of this topic which will be dealt with in a further publication.

From our results, there can be no doubt about the superiority of fascia, autologous or homologous, over homologous tympanic membrane as a grafting material, as the high percentage take rate with autologous fascia also has been obtained with homologous fascia.

The success of fascia as a grafting material lies mainly in its low degree of metabolic activity, with its ability to withstand prolonged anoxia, enabling it to endure while a blood supply is developed. Connective tissue is not only hardy, but also immunologically uncomplicated with low antigenicity, explaining why our results with autologous and homologous fascia do not differ significantly.

There are probably three main reasons for the superior results from

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fascia. Firstly, we have never used stored fascia in human tympanoplasty operations. Our use has always been confined to the day on which the fascia has been taken from the donor, although there may have been several hours' delay between taking it from the first patient on the list, to using it on the last patient. As fascia is of a resistant nature, it may be presumed that the few cells that were present were still alive at the time of use. On the other hand, as an osmotic protector was not used in the preservation, most of the cells of the homologous tympanic membrane probably were dead.

Secondly, assuming that the middle fibrous layer of the tympanic membrane was still viable, because of its thinness relative to temporalis fascia, its powers of overcoming adverse conditions in the middle ear must be correspondingly reduced.

Finally, any antigenic properties remaining in the homologous tympanic membrane with a skin sleeve, must have been much greater than those of fascia.

Perhaps the use of freshly acquired homologous tympanic membrane would have enhanced our results, but when one considers the practical problems of such a routine we are left with the undoubted conclusion that temporalis fascia, despite the thicker and less conical drums that result from its use, is the superior grafting material.

Summary

Homologous tympanic membranes, stored in the deep freeze, have been used in the repair of total perforations, with a success rate of 65 per cent in twenty cases, compared with 98 per cent in 900 cases using temporalis fascia. In the successful homograft cases, the appearance of the drums has been superior to those repaired with fascia, where they tended to be thicker and less conical. Despite this, fascia is undoubtedly the superior grafting material. The most probable explanations for the success of fascia, autologous or homologous, are its increased chances of being viable, its greater thickness and its immunological simplicity.

Acknowledgements

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