Otopathologic Evaluation of Temporalis Fascia Grafts Following Successful Tympanoplasty

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Background

Tympanic Membrane (TM) Perforation

- TM perforation is typically caused by trauma or chronic infections (Fig 1)
- Patients with TM perforations experience hearing loss, pain, drainage and dizziness

Tympanoplasty

- Successful tympanoplasty recreates a robust barrier between the canal and middle ear, as well as re-establishes sound transmission to the ossicular chain
- Materials used for grafting the tympanic membrane are typically allografts of temporalis fascia, perichondrium, fat, skin or cartilage
- Despite appropriate technique, surgical failure and conductive hearing loss occur in up to 30-50% of surgical cases[1, 2]
- Intrinsic defects and variability in graft preparation may be in part to blame for surgical failures

Histopathology

- Little is known about how allografts change over time following implantation in tympanoplasty. Whether graft materials significantly remodel, changes in fiber structure or thickness is unknown.
- Herein, we aim to quantify the pre- and post-operative microstructure of temporalis fascia and compare histological findings to the normal tympanic membrane

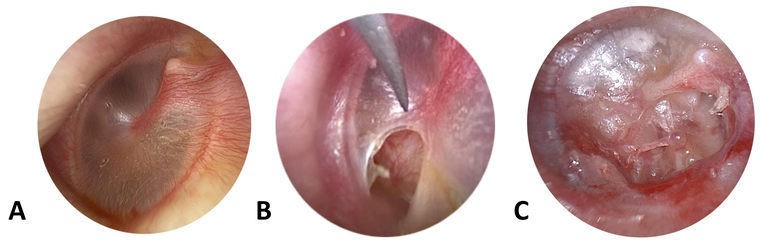


Fig 1. Human Tympanic Membrane. (A) Normal left sided TM. (B) Perforation results in a propensity for infections, pain and conductive hearing loss. (C) Left TM showing a dimeric membrane with complex retraction and perforation.

Rational and Hypothesis

Rationale

- Allografts used in tympanoplasty, such as temporalis fascia, do not posses similar structural arrangements as the native TM and may have intrinsic defects rendering them susceptible to chronic otitis media and imperfect sound conduction
- Preparation of graft material at the time of surgery may present an opportunity to improve long-term graft function
- Synthetic (non-allogenic) grafts may provide an opportunity to refine post-implantation healing and recapitulation of normal TM structure, which is critical for effective sound conduction

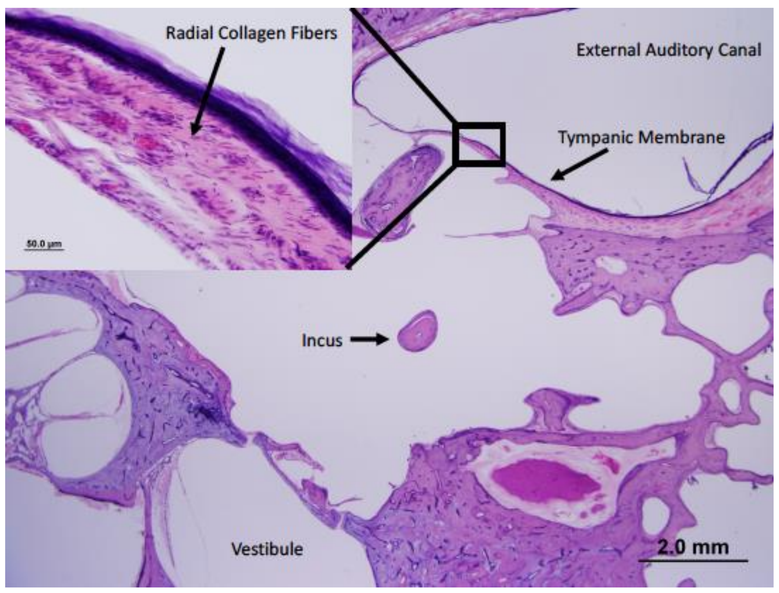
Hypothesis

- Implanted temporalis fascia following successful tympanoplasty will have persistent structural features that may influence post-operative TM function

Methodology

National Temporal Bone Registry

- A review of temporal bone specimens from patients having undergone tympanoplasty using temporalis fascia were identified (n=3)
- Histopathologically prepared pre-implantation temporalis fascia (PreTF, n=4) and normal, unoperated human TMs (TM, n=5) were used as controls
- Serial measurements of thickness of PreTF and TMs at the mesotympanum and hypotympanum were obtained.
- Collagen and elastin fiber thickness and orientation of normal and reconstructed TMs were analyzed by light microscopy.



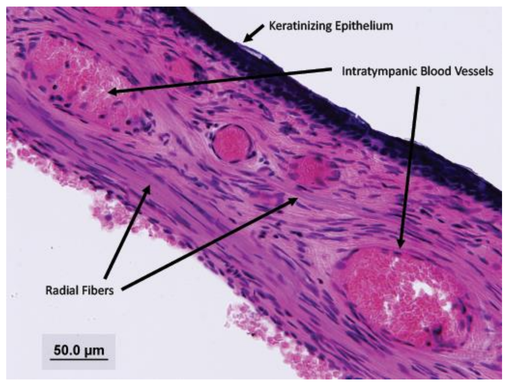


Fig. 2 (Above) Normal human TM and aerated middle ear. TM has stereo-typed, aligned, radial collagen fiber pattern.(Inset)

Fig 3. (Left) Note the thin, cellularized TM with radial fibers and intratympanic blood vessels.

Results

Patient Demographics

- In cases of tympanoplasty, the average duration from time of surgery to death was 16 years (range 8-28)
- All cases contained an aerated middle ear without residual perforation

Temporalis Fascia Thickness Does Not Change Significantly over Time

- No significant difference between the thickness of PreTF and the tympanoplasty specimens were identified (289 um +/-230 vs 226um +/- 105, p=0.4).

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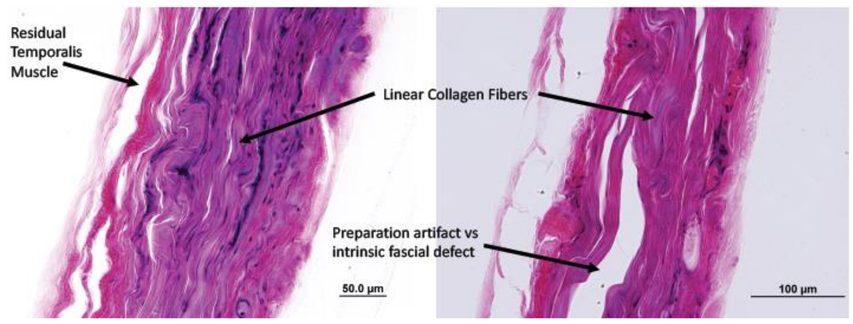
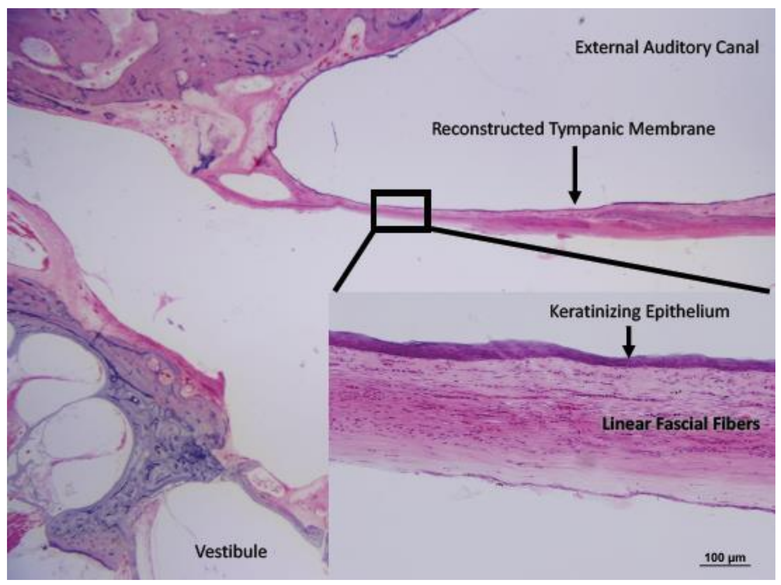
Temporalis Fascia Fiber Orientation Does Not Change Significantly Over Time

- Temporalis fascia in tympanoplasty cases did not change its perpendicular, longitudinal fibrous structure over time, with preserved inner and outer collagen layers

Reconstructed TMs are Thicker than Normal TMs

- The normal TMs were thinner than the PreTF or TM cases consistently (p=0.002, p=0.01, respectively).





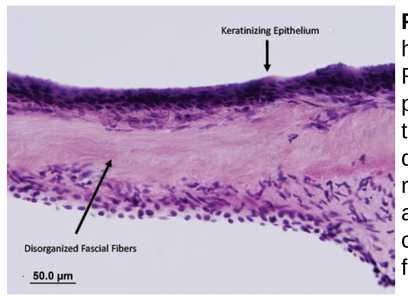


Fig. 4 (top) Pre-Implant temporalis fascia has thick linear fibers. **Fig 5.** (above) Reconstructed TM demonstrates persistence of linear fascial fibers without thinning. **Fig 6.** (left) Fascial fibers appear disorganized without structural reestablishment of normal TM fiber architecture. Fascia does not significantly change in thickness or fiber structure following implantation.

Conclusions

- Based on temporal bone studies, temporalis fascia does not significantly change thickness or fibrous structure following successful tympanoplasty with an aerated middle ear
- Fascial should be thinned at the time of operation to enable effective sound conduction.
- Given the role radial and circumferential fibers play in normal TM sound conduction, temporalis fascia may have inherent limitations for restoration of sound transmission

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