Cartilage Tympanoplasty

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History of Tympanoplasty

- Banzer (1640): repair TM w/ pig’s bladder.
- Toynbee (1853): rubber disk.
- Blake (1877): paper patch.
- Zoellner and Wullstein in 1952, using STSG

1958 – Jansen
- First reported use of cartilage in OCR

1963 – Salen and Jansen
- First reported use of cartilage for reconstruction of the TM
Tympanic Membrane

- Oval shape.
- 8x10 mm.
- 55° angle w/ respect to floor of meatus.
- 130 µm thick.
- 3 layers:
  - Outer epithelial – keratinizing squamous
  - Middle fibrous – superficial radial, deep circular
  - Inner – mucosa
Tympanic Membrane Perforations

➢ Etiology:
  • Middle ear infections.
  • EAC infections.
  • Blunt Trauma.
  • Iatrogenic.
Risk factors for Re-perforation

- Large perforation (Lee P 2002)
  - 56% success vs. 74% in small perf
- Anterior location (Bhat NA 2000)
  - 67% success vs. 90% in posterior perf
- Disease in contralateral ear (Ophir D 1987)
- Otorrhea during surgery (Lau T 1986)
- Middle ear mucosa status (Albu S 1998)
- Smoking (Becvaroski Z 2001)
## Age and Success of Cartilage Tympanoplasty

**TABLE 1. SUCCESS IN RELATION TO AGE**

<table>
<thead>
<tr>
<th>Age (y)</th>
<th>Closure</th>
<th></th>
<th>Reperforation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>&lt;18</td>
<td>25</td>
<td>86</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>18-50</td>
<td>114</td>
<td>88</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>&gt;50</td>
<td>43</td>
<td>81</td>
<td>10</td>
<td>19</td>
</tr>
</tbody>
</table>

Differences are not significant on \( \chi^2 \) test (\( p > .05 \)).

*Albera et al, 2006 EBM III*
Graft Materials

- Fascia
- Perichondrium
- Vein
- Dura
- Skin
- Cartilage
Why Cartilage?

- Fascia and perichondrium undergo atrophy
- Skin graft: Infection
- Cartilage
  - More rigid and resist resorption
  - Good long-term survival
  - Nourished largely by diffusion
Mucosal Traction Theory

- Mucosal layers of TM and middle ear linings undergo constant migration.
- ETD creates the initial retraction and contact between mucosa of TM and ossicles.
- If mucosa of TM and ossicles are coupled by mucous or fibrous adhesions, migratory forces pull mucosa towards the incus.
- Mucosal traction plays a stronger role than Eustachian tube dysfunction in forming cholesteatoma.
Indications for Cartilage Tympanoplasty

- Atelectatic ear
- Retraction pocket/Cholesteatoma
- High Risk Perforation
  - Revision
  - Anterior perforation
  - > 50%
  - Otorrhea at the time of surgery
  - Bilateral
Techniques

- **Perichondrium/ Cartilage island flap**
  - Tragal cartilage

- **Cartilage shield technique**
  - Conchal cartilage

- **Palisade technique**
  - Tragal cartilage
  - Concha cymba

- **Inlay Butterfly graft**
  - Tragal cartilage
Inlay Butterfly Graft

- Originally designed for small perforation (< 1/3 TM diameter) myringoplasty without cholesteatoma
- Inlay technique without elevation of tympanomeatal flap
- Quick office procedure
- Expanded recently to repair larger perforations in conjunction with mastoidectomy
- Split thickness skin graft over perichondrium for large perforation
Inlay Butterfly Graft
Placement of Butterfly graft
Postop Inlay Butterfly graft
Inlay graft for large perforation

Ghanem MA 2006
Tragal Cartilage Harvest

- Cut on medial side of tragus
- Leave 2 mm tragal cartilage for cosmesis
- Abundance: 15 x 10 mm
- Flat
- ~ 1 mm thickness
- Perichondrium from the side away from the EAC is removed

Dornhofer 2003
Perichondrium/ Cartilage Graft
Medial Grafting

Fig. 3. Lateral line drawing demonstrating proper placement of graft.

External Auditory Canal Skin
Perichondrium
Maleus
Postop Perichondrium/ Cartilage Island Graft
Cartilage Shield
Cartilage Shield
This technique is favored when OCR is performed in malleus-present situation

- Cartilage from either tragus or cymba
  - Post-auricular: Cymba
  - Transcanal: Tragus

Dornhoffer 2003
Conchal Cartilage Graft
Preparation of Cartilage Strips

Kazikdas KC 2007
Palisade technique

Anderson J et al. Otol Neurotol. 2004
Palisade Postop result
Modified Palisade technique

Fig. 7. Modified cartilage plate technique for reconstruction of the tympanic membrane with overlapping position of thin cartilage transplants as with leaves of a tulip blossom.

Murbe D 2002
Postop care

- 2 weeks postop: Gelfoam completely suctioned from EAC
- Start topical antibiotics x 2 weeks
- Adult: Start valsalva
- Children: Otovent TID
- 3-4 months: Audiogram
  - Air bone gap
  - Tympanogram no longer reliable. Type B tymp despite normal hearing
Criticisms of Cartilage T-plasty

- Time consuming to shape cartilage
- Opaque - Difficulty in surveillance
- Rigidity of cartilage raises concern about audiologic outcome
Effect of TM perforation on Hearing

- Diminished surface area on which sound pressure can exert
  - Decreased area effect of TM: stapes footplate (normally 17:1)
  - → dampening of lever action of the ossicular chain

- Sound reaching round window at same intensity and phase as oval window → cancelling fluid vibration in cochlear

- Sound pressure entering the perforation acts on the medial surface of the TM against that on the lateral surface
Hearing Results: Dornhoffer et al.

- 95 patients who failed at least 1 temporalis fascia graft tympanoplasty
- 29 required OCR
- Avg f/u 12 months
- 90/95 (94.7%) with successful TM closure
- Pediatric group has similar success rate as adults

PTA \((p < 0.001)\)
- Preop: 24.6
- Postop: 12.2
Hearing Results: Gerber 2000

- 11 patients
- 2 groups: Cartilage vs. temporalis fascia
- Intact ossicular chain
- Size of graft: 1/3 – 2/3 of mesotympanum
- Tragal cartilage island graft (10), conchal (1)
- Primary indication: Retraction pocket
- Post-auricular or transcanal
- Average f/u: 12 months
Fig. 2. Speech reception threshold: this graph demonstrates the mean preoperative and postoperative speech reception thresholds (SRT) after tympanoplasty with either cartilage or temporalis fascia.
Hearing Results: Gerber 2000
### Thickness of Cartilage graft

#### Table I.
First Resonance Frequency (Hz) and Amplitude of First Resonance Frequency (nm/Pa) for the Different Tympanic Membrane Reconstruction Techniques and the Underlying Perichondrium.

<table>
<thead>
<tr>
<th>Reconstruction Technique</th>
<th>First Resonance Frequency (Hz)</th>
<th>Amplitude of First Resonance Frequency (nm/Pa)</th>
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</thead>
<tbody>
<tr>
<td>Plate (thickness 1 mm)</td>
<td>1188</td>
<td>30</td>
</tr>
<tr>
<td>Palisade</td>
<td>744</td>
<td>106</td>
</tr>
<tr>
<td>Plate (thickness 0.7 mm)</td>
<td>684</td>
<td>101</td>
</tr>
<tr>
<td>Plate (thickness 0.5 mm)</td>
<td>581</td>
<td>152</td>
</tr>
<tr>
<td>Plate (thickness 0.3 mm)</td>
<td>478</td>
<td>225</td>
</tr>
<tr>
<td>Island large</td>
<td>337</td>
<td>264</td>
</tr>
<tr>
<td>Island small</td>
<td>281</td>
<td>784</td>
</tr>
<tr>
<td>Perichondrium</td>
<td>297</td>
<td>5320</td>
</tr>
</tbody>
</table>

\[ I(\omega) \propto \frac{\Gamma}{(\omega - \Omega)^2 + \left(\frac{\Gamma}{2}\right)^2} \]

Murbe D 2002
Acoustic Properties
Management of Middle ear effusion postop

- Appearance of TM
- Air-bone gap on audiogram
- CT temporal bone

**Initial treatment:**
- Nasal steroids
- Valsalva
- 3 months

**Surgical treatment:**
- Myringotomy (eg. CO2 laser)
- Tympanostomy tube (eg. soft Goode tube)
High Risk perforation

- Account for 1/3 cases of cartilage tympanoplasty
- > 95% successful closure of TM after cartilage t-plasty
- 5 % requires postop MT
- Hearing results comparable to fascia graft
Ossicular Chain Reconstruction

- Cartilage reinforces prosthesis to prevent extrusion

- When malleus is present
  - Palisade technique over island flap (obscure malleus and reconstruction)

- When malleus is absent
  - Tragal cartilage island flap
Cartilage T-plasty with TORP
Cholesteatoma

- Palisade technique preferred
  - Allow precise placement of prosthesis against the malleus
- Leave anterior TM without cartilage to allow surveillance and future tube placement
- Consider 2\textsuperscript{nd} look if sac disrupted during initial cholesteatoma excision
Pervasive Eustachian Tube Dysfunction

- **Criteria for intraoperative tube placement**
  - Craniofacial abnormalities
  - Nasopharyngeal carcinoma
  - Recurrent otitis media with ETD

- **Round knife used to create a window in the anterior graft**

- **Goode tube placed prior to insetting the graft**
Conclusions

- Cartilage tympanoplasty is a reliable technique in reconstruction of TM
- Hearing results after cartilage tympanoplasty is comparable to temporalis fascia graft
- Choice of techniques depend on surgeon’s preference, status of ossicular chain, Eustachian tube, presence of cholesteatoma, etc.
Thank You!

kőszönöm  
תודה!  
děkuji  
mahalo  
고맙습니다

thank you

merci  
谢谢  
danke

Ευχαριστώ  
شكرا  
gracias

どうもありがとうございます