Achieving a Successful Closure of an Anterior Tympanic Membrane Perforation: Evidence-Based Systematic Review

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Abstract

Objectives. Surgical repair of a tympanic membrane perforation is a common otologic procedure. However, achieving a successful closure can be challenging, especially if the anterior margin of the tympanic membrane is involved. The aim of this study was to systematically review the literature on evidence published in closure of anterior tympanic membrane perforations.

Data Sources. The following data sources were searched: Cochrane Central Register of Controlled Trials (1997 to August 3, 2017), MEDLINE (February 1948 to August 3, 2017), and Embase (1975 to August 3, 2017).

Data Extraction. Two authors independently reviewed titles and abstracts. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines were followed. For the purpose of this study, the inclusion criteria were as follows: (1) studies reporting surgical technique for closure of anterior tympanic membrane perforations, (2) primary cases only, (3) articles published in the English language, (4) minimum 6-month follow-up, and (5) recorded pre- and postoperative audiometry. The exclusion criteria were non–English language articles, revision surgery, and no audiometric outcomes.

Results. On initial search, a total of 181 articles were identified (PubMed, n = 136; Cochrane, n = 28; Embase, n = 17). Based on the criteria, 136 articles were excluded. Full text of 45 articles was reviewed, and a further 24 articles were excluded. A total of 21 articles fulfilled the criteria for study inclusion.

Conclusions. All published evidence is level 4. High-quality controlled studies are required to determine the most effective method for closure of anterior tympanic membrane perforation.

Keywords
tympanic membrane perforation, chronic otitis media, myringoplasty, tympanoplasty

Surgical repair of a tympanic membrane perforation is a common yet challenging procedure performed in otologic surgery. Schukneckt mentioned that this procedure is deceptively difficult and its success is based on surgical experience and technical finesse.1 Successful surgery is associated with a significant improvement in disease-specific health-related quality of life.2 One of the main factors that influences complete closure of a tympanic membrane perforation is its location. The repair of an anterior or subtotal perforation is associated with a lower success rate than that of posterior or inferior perforations.3,5 Reasons for this poor success rate appear to be due to access, visualization, and inadequate support of the anterior margin for graft placement. Tympanic membrane fluorescein angiography showed that the posterior half of the tympanic membrane is better perfused than the anterior quadrants.6

Aims

The aim of this study was to systematically review the literature on surgical techniques reporting closure of anterior tympanic membrane perforations. We also aimed to identify techniques that have improved closure rates with minimal complications.

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Materials and Methods

For the purpose of this study, the inclusion criteria were as follows: (1) studies reporting surgical technique of repair of anterior tympanic membrane perforations in adults and children, (2) primary cases, (3) articles published in the English language, and (4) a minimum 6-month follow-up with pre- and postoperative audiometric outcomes. The exclusion criteria were as follows: (1) non-English language articles, (2) techniques reporting perforations other than anterior, (3) follow-up <6 months, and (4) no audiometric outcomes.

A comprehensive search was performed with PubMed (US National Library of Medicine), Embase, and Cochrane Library. The keywords in our search were “tympanoplasty” OR “myringoplasty” AND anterior perforations OR marginal perforations OR subtotal perforations OR tympanic membrane perforation AND surgical outcomes. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines were followed. There were no restrictions on date or design of publications. The date of final search was August 3, 2017.

The first 2 authors reviewed titles and abstracts independently. All studies included patients with chronic otitis media (active mucosal disease) undergoing surgical closure of anterior tympanic membrane perforations. Variables specifically recorded and studied in these articles were surgical technique (overlay vs underlay), associated procedures, audiometric outcomes, follow-up period, success rate, and complications.

For the purpose of this review, surgical success was defined as an anatomically intact tympanic membrane at 6 months following surgery with no evidence of retraction, graft lateralization, or blunting of the anterior tympanomental angle. The literature was assessed per the levels of evidence defined by the Oxford Centre of Evidence-Based Medicine, and articles were appraised with critical appraisal tools. The use of overlay and underlay was with reference to graft position in relation to the handle of malleus. Full access to articles was obtained, and references that fulfilled our criteria were also included.

Results

A total of 181 articles were displayed on initial search. On reviewing the citation and abstracts, a total of 136 articles were unsuitable for this study. The full text of 45 articles were reviewed, and 24 were excluded. This meant that a total of 21 articles were suitable for our study and analyzed.

Figure 1 summarizes the literature search. Table 1 summarizes the complete list of articles, including number of patients, surgical technique, follow-up period, associated procedures, audiologic outcome, success rate, and complications. All articles reviewed were of level 4 evidence (retrospective/prospective case series). Due to the variations in reporting formats, it is difficult to combine or compare published data.

Discussion

Our literature search identified several techniques described with appreciable outcomes. Variations in operative technique and audiometric outcomes make it difficult to directly compare or recommend one technique over another. Despite an overlap in described surgical techniques, we attempted to summarize techniques into 4 categories: anterior anchoring techniques, lateral graft tympanoplasty, techniques for large and subtotal perforations, and endoscopic transcanal techniques.

Anterior Anchoring Techniques

The anterior hitch method described by Primrose and Kerr is a well-recognized technique for anchoring the anterior margin of the graft. It is useful in perforations with minimal anterior drum remnant. Harris et al published their experience with this method and reported an 84.6% success rate. In a series of 12 patients, Ralli et al described an anchored myringoplasty technique, which involves creation of a spiral tympanomeatal flap and elevation of tunnels in the anterior canal wall. A success rate of 91.7% was reported with appreciable hearing results.

Hay and Blanshard described an anterior interlay technique for 116 patients. The closure rate achieved was 94% (62 of 66 patients).
<table>
<thead>
<tr>
<th>Author</th>
<th>Patients, n (Mean Age, y)</th>
<th>Technique</th>
<th>Follow-up</th>
<th>Other Procedures (n)</th>
<th>Success Rate, %</th>
<th>Complications (n)</th>
<th>Audiometric Outcomes (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Celik27</td>
<td>32 (40.3)</td>
<td>Endoscopic push through</td>
<td>24 mo</td>
<td>None</td>
<td>87.5</td>
<td>Cholesteatoma pearl (1)</td>
<td>Mean dB gap: preoperative, 11.9 dB; postoperative, 5.3 dB</td>
</tr>
<tr>
<td>Hung21</td>
<td>105 (34.1)</td>
<td>Anterosuperior anchoring myringoplasty</td>
<td>12 mo</td>
<td>None</td>
<td>90.1</td>
<td>6.2-dB improvement in air-conducted thresholds</td>
<td>Mean AB gap improvement, 10.2 dB</td>
</tr>
<tr>
<td>Faramarzi11</td>
<td>45 (38)</td>
<td>Mucosal pocket myringoplasty</td>
<td>6 mo</td>
<td>ICM (3), CWD (5)</td>
<td>91.1</td>
<td>High-frequency sensorineural loss (8)</td>
<td>AB gap improvement in 84.6% (audio available for 39 of 64)</td>
</tr>
<tr>
<td>Castelli20</td>
<td>64 (40)</td>
<td>Felix tympanoplasty</td>
<td>2 y</td>
<td>None</td>
<td>95.3</td>
<td>6.2-dB improvement in air-conducted thresholds</td>
<td>Mean hearing gain, 9.98 dB</td>
</tr>
<tr>
<td>Tseng26</td>
<td>59 (49.5)</td>
<td>Endoscopic transcanal tympanoplasty</td>
<td>6 mo</td>
<td>None</td>
<td>93</td>
<td>15.4-dB AB gap improvement</td>
<td></td>
</tr>
<tr>
<td>Jung17</td>
<td>100 (42.1)</td>
<td>Mediolateral graft tympanoplasty</td>
<td>6 mo</td>
<td>Mastoidectomy (86)</td>
<td>97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lee28</td>
<td>429 (47.8)</td>
<td>Loop overlay tympanoplasty</td>
<td>6 mo</td>
<td>Ossiculoplasty (23), mastoidectomy (65)</td>
<td>98.8</td>
<td>Postoperative infections (3), tympanic membrane pearl (10), middle ear effusion (2)</td>
<td></td>
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<tr>
<td>Hay and Blanshard10</td>
<td>116 (22.1)a</td>
<td>Anterior interlay myringoplasty</td>
<td>12 mo</td>
<td>Cortical mastoidectomy (3), ossiculoplasty (6)</td>
<td>91</td>
<td>Myringitis (11), infections (6), postoperative vertigo (1)</td>
<td>Mean hearing gain, 9.98 dB</td>
</tr>
<tr>
<td>Memari22</td>
<td>50 (34)</td>
<td>Canal skin rotational flap</td>
<td>24 mo</td>
<td>Mastoidectomy (43), ossiculoplasty (20)</td>
<td>96</td>
<td>Infection (2)</td>
<td>AB gap improvement, 16 dB</td>
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<tr>
<td>Shim12</td>
<td>234 (49)</td>
<td>3-point fix tympanoplasty</td>
<td>12-18 mo</td>
<td></td>
<td>93.2</td>
<td></td>
<td>AB gap improvement, &lt;20 dB (76.4%)</td>
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<tr>
<td>Schraff24</td>
<td>164 (46)</td>
<td>Window shade tympanoplasty</td>
<td>6 mo</td>
<td>Mastoidectomy (93), ossiculoplasty (8)</td>
<td>94.5</td>
<td>Epithelial pearls (2), middle ear effusion (3), infection (1), otorrhea (3)</td>
<td>AB gap, &lt;10 dB (122), &lt;20 dB (23), &lt;30 dB (3)</td>
</tr>
<tr>
<td>Peng and Lalwani18</td>
<td>25 (40.6)</td>
<td>Hammock</td>
<td>3.5 y</td>
<td></td>
<td>96</td>
<td></td>
<td>AB gap improvement, 7.8 dB</td>
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<tr>
<td>Seidman13</td>
<td>45 (23)</td>
<td>Anterior transcanal</td>
<td>12 mo</td>
<td></td>
<td>88</td>
<td></td>
<td>Mean postoperative AB gap, 14 dB</td>
</tr>
<tr>
<td>Aidonis19</td>
<td>62 (32)</td>
<td>Cartilage shield</td>
<td>23 mo</td>
<td>Mastoidectomy (12), ossiculoplasty (54)</td>
<td>98.4</td>
<td></td>
<td>AB gap improvement, 8.4 dB</td>
</tr>
<tr>
<td>Alain23</td>
<td>48 (34)</td>
<td>Butterfly myringoplasty</td>
<td>14.5 mo</td>
<td></td>
<td>88</td>
<td>Tragal seroma (1)</td>
<td>PTA improvement, 27.1 dB</td>
</tr>
<tr>
<td>Harris8</td>
<td>17</td>
<td>Anterior pull-through</td>
<td>15 mo</td>
<td></td>
<td>84.6</td>
<td></td>
<td>AB gap improvement, 9.75 dB</td>
</tr>
<tr>
<td>Ralli9</td>
<td>12 (40.7)</td>
<td>Anchored myringoplasty</td>
<td>54 mo</td>
<td></td>
<td>91.7</td>
<td></td>
<td>28-dB PTA improvement</td>
</tr>
<tr>
<td>Potcis25</td>
<td>42 (9.69)</td>
<td>Overlay tympanoplasty</td>
<td>2.19 y</td>
<td></td>
<td>95</td>
<td></td>
<td>AB gap: &lt;20 dB (90%), &lt;30 dB (100%)</td>
</tr>
<tr>
<td>Sakalli14</td>
<td>42</td>
<td>Underlay</td>
<td>12 mo</td>
<td></td>
<td>97.7</td>
<td></td>
<td>AB gap improvement, 14.16 dB</td>
</tr>
</tbody>
</table>

*Abbreviations: AB, air-bone; CWD, canal wall down mastoidectomy; ICW, intact canal wall surgery; PTA, pure tone average.

*aMedian age.
Lateral Graft Tymanoplasty

Lateral graft tymanoplasty involves raising a tympanomeatal flap separating the squamous layer from the middle fibrous layer of the tympanic membrane. Vascular strip incisions maintain the blood supply to the entire tympanic membrane, which aids graft uptake. Angeli et al indicated that the lateral graft tymanoplasty can be undertaken when there is minimal drum anterior to the perforation. In their description, the technique can be combined with a mastoidectomy and/or ossiculoplasty as well. In a series of 46 patients, the modified house tymanoplasty had a reported 98% success rate. Anterior canalplasty is often required in the lateral graft technique. Jung and Park reported a 97% success rate in a series of 100 patients. They described a combined mediolateral graft technique. As this technique incorporates the principles of an underlay and overlay technique, it is suitable for all types of anterior perforations.

Techniques for Large and Subtotal Perforation

Peng and Lalwani reported their technique of “hammock” tymanoplasty in anterior and large subtotal perforations. The procedure involves creating a wide tympanomeatal flap and placing the graft from the anterior canal wall to the posterior canal wall, akin to a hammock. A success rate of 96% was observed.

In a series of 62 patients, Aidonis et al showed only 1 failure in their management of total and subtotal perforations. Cartilage is used in an underlay fashion, which is also reinforced by loose areolar tissue. One of the disadvantages of using cartilage, especially in mastoid surgery for cholesteatoma, is its opaque property, making it difficult to assess for recurrent epithelial disease. Diffusion weighted magnetic resonance imaging or second-look procedures can be considered for these patients.

Castelli et al described the “Felix” tymanoplasty to repair perforations involving >40% of the tympanic membrane. It involves removing all tympanic membrane remnants and leaving the anterior annulus intact. Although a high success rate is reported, there is a significant area of normal tympanic membrane excised, thereby raising concerns on the effect of surgery on hearing outcomes. Audiometric outcomes were available for only 39 of 64 patients.

In a series of 49 adult patients with 25 anterior and 25 subtotal perforations, Hung et al reported a 90.5% success rate. There was no statistically significant difference in the success rate between consultant and trainees. For patients with no residual anterior tympanic membrane, Memari et al described a rotational flap involving the anterior canal skin. A 96% closure rate was reported in 50 patients.

Alain et al reported the butterfly technique for total, annular, and subtotal perforations. Although this technique was reported for small perforations, a success rate of 88% was seen after a follow-up of 14 months. The “window shade” tymanoplasty described by Schraff et al is also a suitable technique for large anterior perforations.

Although graft uptake is poorer in pediatric cases than in adult patients, this does not appear to be statistically significant.

Endoscopic Transcanal Techniques

Endoscopic repair of tympanic membrane perforations is gaining popularity. Endoscopic techniques are useful for perforations that are difficult to fully visualize due to an anterior bony overhang but in which there remains a normal area of tympanic membrane anterior to the perforation.

Endoscopic use minimizes the need for an anterior canalplasty and avoids an external incision. Factors to consider in the use of endoscopes are the learning curve involved in this relatively new technique and single-handed surgery. Success rates between 87% and 93% were reported with its use.

Conclusions

All published evidence is level 4. It is therefore difficult to recommend one technique over another. There is a need for conducting high-quality prospective controlled studies to determine the most effective method for successful closure of anterior tympanic membrane perforations.

Author Contributions

Vikranth Visvanathan, study concept, literature search, articles review, preparation of manuscript and submission; Vamsidhar Vallamkondu, literature search, articles review, manuscript review; Sanjiv K. Bhimrao, study concept, manuscript review and revision, article review.

Disclosures

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References


