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Submission title:

**Type I Tympanoplasty Meta-Analysis: A Single Variable Analysis**

Short running head:

Type I Tympanoplasty Meta-Analysis

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**ABSTRACT**

**Objective:** To determine which independent variables influencing the efficacy of type I tympanoplasty in adult and pediatric populations.

**Data Sources:** A search of the PubMed database and Cochrane Database of Systematic Reviews using the key words “tympanoplasty OR myringoplasty” from January 1966 to July 2014 was performed.

**Study Selection:** Studies reporting outcomes of myringoplasty or Type I tympanoplasty in primary non-cholesteatomatous chronic tympanic membrane perforation were included.

**Data Extraction:** Of 4,698 abstracts reviewed, 214 studies involving 26,097 cases met our inclusion criteria and contributed to meta-analysis.

**Data Synthesis:** The primary outcome of success was defined as closure rate at 12 months. The independent variables analyzed were age, follow-up period, approach, graft material, perforation cause, size, location, ear dryness, and surgical technique. Only those studies providing data on a given parameter of interest could be included when comparing each variable.

**Conclusion:** The weighted average success rate of tympanic closure was 86.6%. Based on this meta-analysis, pediatric surgery has a 5.8% higher failure rate than adults and there is no correlation between follow-up period and success. Other variables associated with improved closure rates include perforation with a size less than 50% of total area (improved by 6.1%) and the use of cartilage as a graft (improved by 2.8% compared to fascia), while ears that were operated on while still discharging, those in different locations of the pars tensa, or using different surgical approaches or techniques did not have significantly different outcomes.



**Key Words:**

Myringoplasty, Meta-analysis, Tympanoplasty, Tympanic membrane perforation

## INTRODUCTION

Type I tympanoplasty is a relatively common procedure in otolaryngology. The history of the management of a perforated tympanic membrane (TM) can the traced back to 1644, when Banzer used a tube of elk's claw covered in pig's bladder to close the perforation in a TM. (1) It was not until the nineteenth century that the British otologists, James Yearsley and Joseph Toynbee, targeted an improvement in hearing with their innovative devices. (2,3) Berthold introduced the term "myringoplasty", when he performed the first surgical closure of a TM perforation in 1878. (4) However, myringoplasty was not widely accepted until Wullstein and Zollner, utilizing the operative microscope, re-introduced it in 1951. (5) Tympanoplasty is the surgical repair of the TM and/or the middle ear ossicles. Horst Wullstein classified it into five types as described first in 1956. (6) Type I tympanoplasty, involving an intact ossicular chain, involves the grafting of TM alone onto an intact ossicular chain. The difference between type I tympanoplasty and myringoplasty is that tympanoplasty involves the raising of a tympanomeatal flap whereas myringoplasty does not, although the terms are often used interchangeably. (7) To avoid confusion for the remainder of this analysis both type I tympanoplasty and myringoplasty will be referred to as tympanoplasty. Two previous meta-analyses investigate outcomes in pediatric populations only. (8,9) This study aims to identify and analyze the variables that influence the success of TM repair in terms of closure rates and hearing outcomes in both the adult and pediatric population.

## METHODS

This meta-analysis was performed in accordance with the PRISMA guidelines. (10)

*Search method and study selection*

All observational and experimental studies reporting closure rates were eligible for inclusion. Using the key words of tympanoplasty or myringoplasty a systematic literature search of the PubMed database and Cochrane Database of Systematic Reviews for studies published, in the English language, from January 1966 to July 2014 was conducted (July 2nd 2014), yielding 4698 articles. The search strategy for PubMed was ("myringoplasty"[MeSH Terms] OR "myringoplasty"[All Fields]) OR ("tympanoplasty"[MeSH Terms] OR "tympanoplasty"[All Fields]) AND ("1966/01/01"[PDAT] : "2014/07/01"[PDAT]). The primary author reviewed all abstracts of studies found with the above search strategy before two other independent authors selected studies for inclusion based on the defined criteria. If there were any abstracts that lacked clarity or adequate detail in their methodology or results, the full manuscript was read to assess suitability for inclusion. The inclusion and exclusion criteria were only applied after detailed assessment of full-text manuscripts. Duplicate reporting of results by authors were discarded. Studies were classified by a particular variable if at least 90% of the population fitted into that category, otherwise the options of unclassified, mixed or other were used and therefore being excluded in data analysis.

*Study Inclusion Criteria*

The inclusion criteria for individual studies were any observational (retrospective or prospective) or treatment (randomized or non-randomized clinical trials) study reporting the outcome of tympanoplasty in adult and pediatric populations. Only studies reporting clinically diagnosed, primary non-cholesteatomatous chronic TM perforations were included. Studies were excluded if they reported patients who had tympanoplasty for acute perforations, for conditions other than perforation, revision surgery (if >10% of study population required revision surgery), other types of tympanoplasty (non-type I), ossicular chain pathology or mastoidectomy.

*Variables*

Variables examined included: the patient's age (at the time of surgery), follow-up period (months from surgery to the latest follow-up appointment), surgical approach (endaural or postaural), perforation cause (otitis media or traumatic – as defined by individual studies), graft material (cartilage, fascia, fat or other materials), perforation size (above or below 50% of TM surface area), perforation location (anterior, central or posterior), ear status (dry ear or 'wet' ear – defined as discharge from the middle ear at time of preadmission surgery appointment or a history of discharge within three months before surgery) and surgical technique (underlay, inlay or overlay graft positioning). For clarification, only chronic perforations were included and traumatic or other perforations that were not chronic were not included. Age and follow-up period were analyzed as a continuous variables with the range of ages, mean age and mean follow-up period extracted from each study.

*Outcome measures*

The primary outcome measure was the complete closure of the TM perforation, defined as an intact neo-membrane at 12 months follow-up. Secondary outcome measures were the presence of adverse events (re-perforation, re-operation / revision surgery, blunting, lateralization) and degree of improvement of conductive hearing loss (by pure tone audiometry).

*Assessment of risk of bias in included studies*

Risk of bias was assessed at the individual study level at time of first appraisal and in the finally included studies, using the studies own summary assessment of the risk of bias. No studies were excluded on this basis.

*Data synthesis*

A meta-analysis applying the methodology of Einarson was performed using S-PLUS 2000 (Insightful Corporation, Seattle, WA, USA). (11) An overall success rate was calculated, as well as rates for each variable. For each category, the number of studies that the results were based on was recorded, and the homogeneity of the studies ($p < 0.05$ indicates a non-homogeneous population), the meta-analytic average success rate, the standard error, and 95% confidence intervals were calculated. A $p$ value less than 0.05 was considered statistically significant. Linear regression technique was used to analyze the correlation between follow-up period and success rate.

## RESULTS

The search strategy identified 4704 articles after duplicates were removed. Figure 1 shows the method of study identification according to PRISMA. (10) Following screening, 321 full-text articles were assessed for eligibility and 107 articles were excluded. A total of 214 studies were included in quantitative analysis (see supplementary table). Of the 214 studies, two were randomized control trials and the rest were observational retrospective or prospective cohort studies. Across 214 included studies, there were 26,097 cases and the mean number of patients in each study was 122 (121.92 ± 149.51, range of 7 to 1298 cases). The mean closure rate was 86.6% (range of 46.8% to 100%, 95% CI [85.3, 87.9]) and the mean age of patients in the included studies was 28 (27.63 ± 13.59, range of 5.50 to 70.70 years of age). Figure 2 demonstrates the increasing trend in the number of articles published concerning Type I tympanoplasty or myringoplasty since 1970.

The results of the meta-analysis are plotted in Figure 3 and summarized in Table 1, showing that the overall meta-analytic average success rate for closure of perforations was 86.6%. Highest failure rates were detected in studies with follow-up periods greater than 12 months (4.38% worse with follow-up periods >12 months compared to ≤6 months). Though a decreasing success rate is observed with average longer follow-up times (≤6 months: 87.15%, ≤12 months: 85.61%, >12months: 82.77%), simple linear regression analysis calculated no correlation between success rate and follow-up period (Pearson's $r = 0.037$, $p = 0.625$, after adjusting for outlier studies). The adult population (defined as 18 years and above) had 5.8% better closure rates compared to the pediatric population (defined as 17 years old and below) (adult: 89.25%, pediatric: 83.42%). Within the pediatric population, children < 12 years had the worst closure rate of all age groups (≤12 years: 83.11%, >12 years 88.23%, 13 to 17 years: 92.81%). Patients with otitis media pre-operatively had 3.4% worse closure rates compared to patients with traumatic perforations (otitis media: 83.86%, traumatic: 87.25%). Patients with actively discharging ears had 3.6%

**Figure 1:** Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)(10) flowchart summarizing the search results and the application of eligibility criteria.

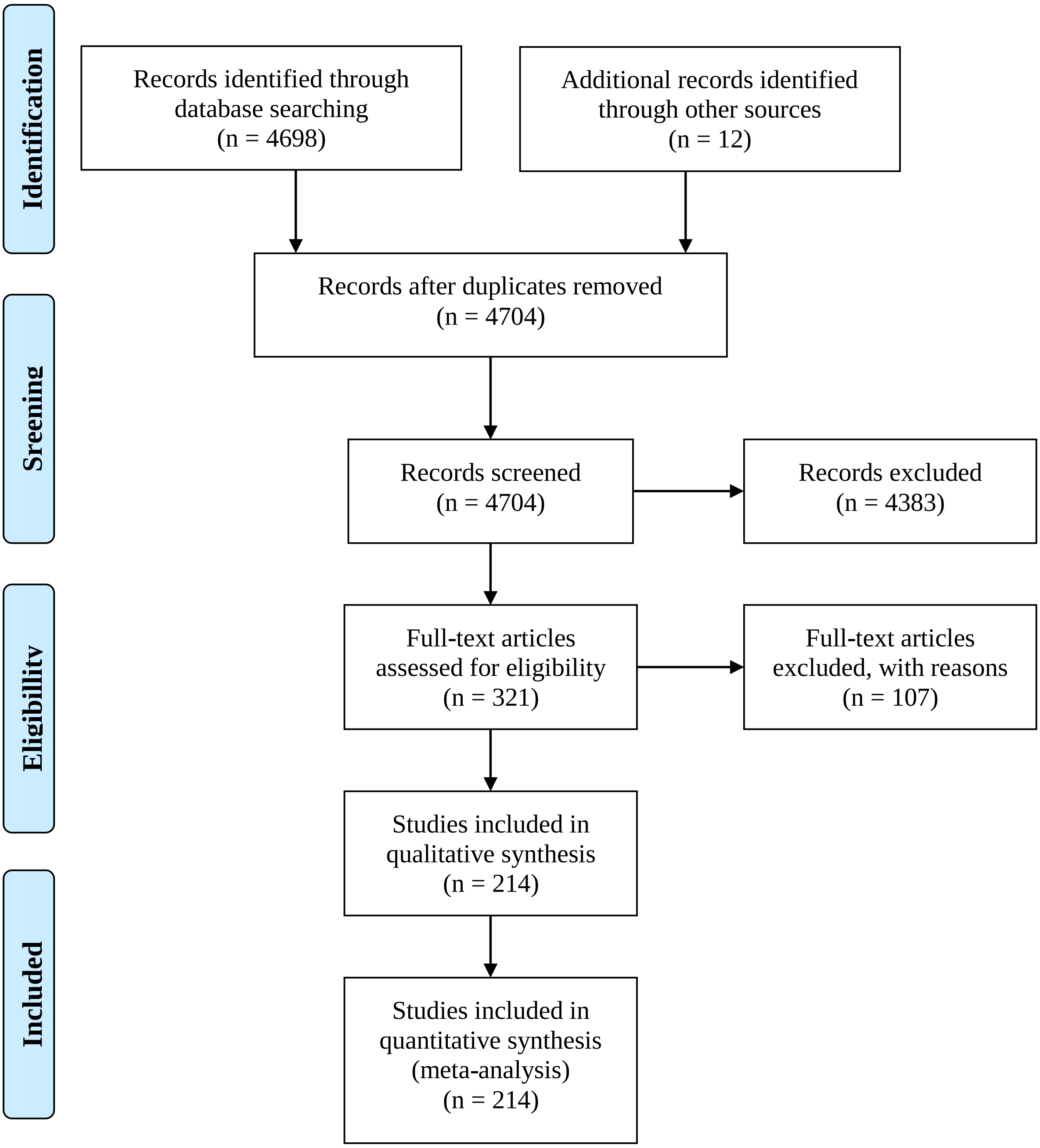

**Figure 2:** Graph demonstrating the number of studies regarding Type I tympanoplasty or myringoplasty published since 1970 per 5-year interval.

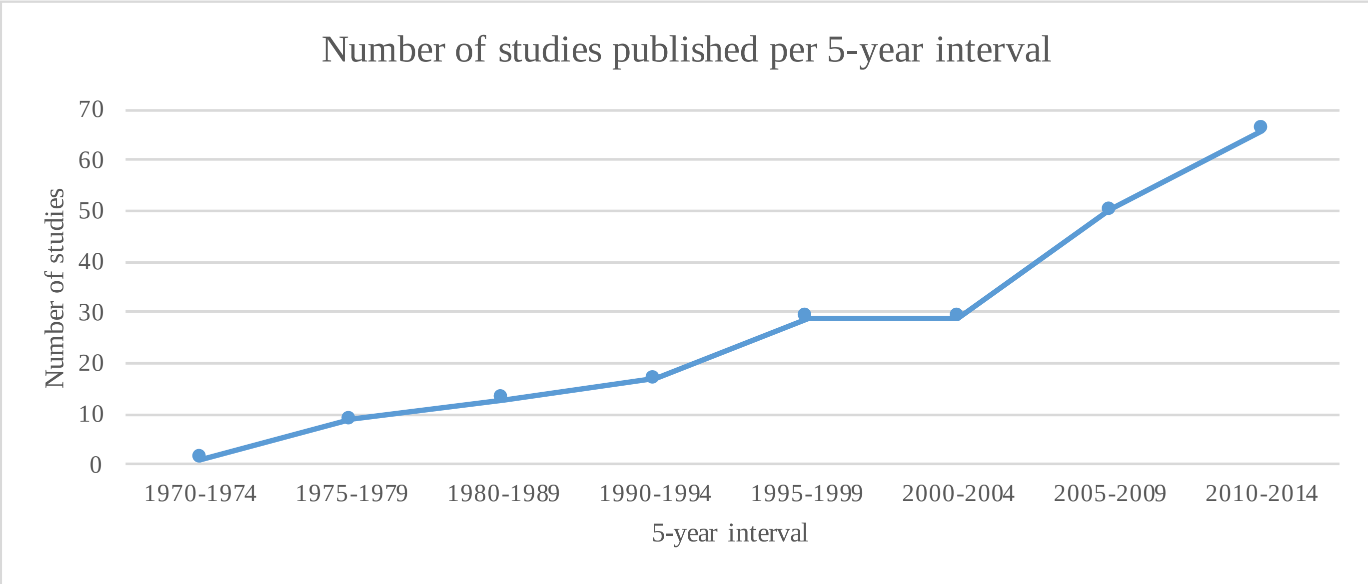

**Figure 3:** Graph of results depicting the overall closure rate and success rates stratified by each variable.

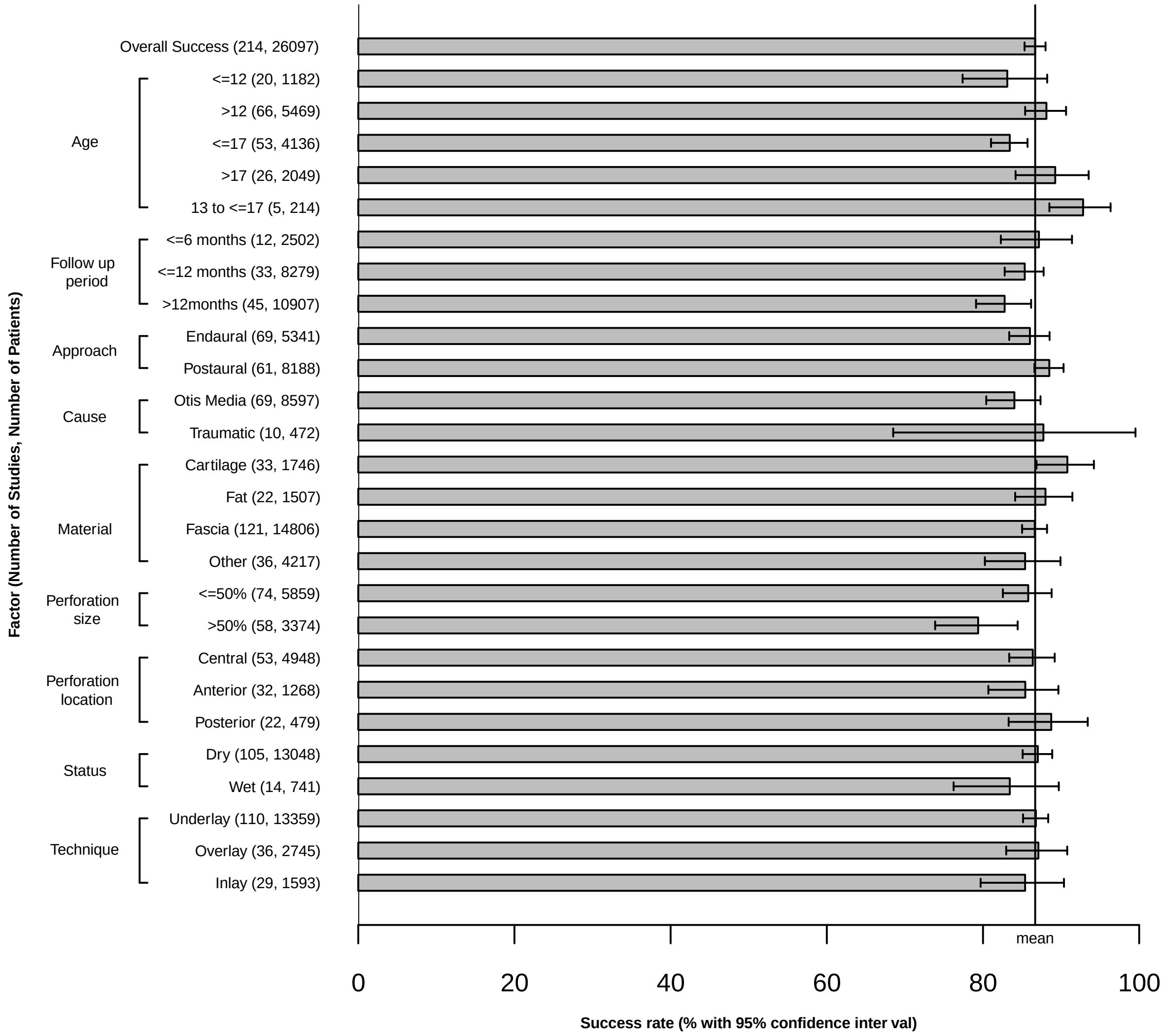

**Table 1:** Variables and their effects on the primary outcome of success of tympanoplasty.

| Variable | Type | No. Studies | No. Patients | Success (%) | 95% CI Range | *p* value* |
|---|---|---|---|---|---|---|
| | Overall Success | 214 | 26097 | 86.62 | 85.27 – 87.92 | - |
| Age | ≤12 | 20 | 1182 | 83.11 | 77.38 – 88.21 | 0.075 |
| | >12 | 66 | 5469 | 88.23 | 85.55 – 90.68 | |
| | ≤17 | 53 | 4136 | 83.42 | 81.01 – 85.70 | **0.017** |
| | >17 | 26 | 2049 | 89.25 | 84.17 – 93.52 | |
| | 13 to ≤17 | 5 | 214 | 92.81 | 88.49 – 96.33 | - |
| Follow-up period | ≤6 months | 12 | 2502 | 87.15 | 82.28 – 91.38 | - |
| | ≤12 months | 33 | 8279 | 85.61 | 83.07 – 87.98 | 0.320 |
| | >12months | 45 | 10907 | 82.77 | 79.11 – 86.15 | |
| Approach | Endaural | 69 | 5341 | 86.02 | 83.35 – 88.51 | 0.112 |
| | Postaural | 64 | 8188 | 88.06 | 86.12 – 89.88 | |
| Perforation cause | Otis Media | 69 | 8597 | 83.86 | 80.33 – 87.12 | 0.8610 |
| | Traumatic | 10 | 472 | 87.25 | 70.21 – 98.62 | |
| Graft material | Cartilage | 33 | 1746 | 90.80 | 86.85 – 94.19 | **0.048** |
| | Fascia | 121 | 14806 | 88.00 | 84.13 – 91.44 | |
| | Fat | 22 | 1507 | 86.52 | 84.91 – 88.05 | 0.469 |
| | Other | 36 | 4217 | 85.39 | 80.23 – 89.92 | |
| Perforation size | ≤50% | 74 | 5859 | 85.56 | 82.39 – 88.48 | **0.019** |
| | >50% | 58 | 3374 | 79.44 | 74.06 – 84.40 | |
| Perforation location | Central | 53 | 4948 | 86.03 | 83.08 – 88.77 | 0.822 |
| | Anterior | 32 | 1268 | 85.42 | 80.68 – 89.66 | |
| | Posterior | 22 | 479 | 88.72 | 83.28 – 93.41 | |
| Ear status | Dry | 105 | 13048 | 87.02 | 85.09 – 88.85 | 0.155 |
| | Wet | 14 | 741 | 83.44 | 76.24 – 89.69 | |
| Surgical technique | Underlay | 110 | 13359 | 86.71 | 85.09 – 88.26 | 0.712 |
| | Overlay | 36 | 2745 | 86.83 | 82.78 – 90.45 | |
| | Inlay | 29 | 1593 | 85.39 | 79.69 – 90.36 | |

worse closure rates compared to pre-operatively dry ears (dry: 87.02%, wet: 83.44%). Perforations greater than 50% have a 6.1% lower success rate than those less than 50% in size (≤50% perforation size: 85.56%, >50% perforation size: 79.44%). Anterior perforations had lower closure rates than central or posterior perforations by 0.6% and 3.3% respectively (anterior: 85.42%, central: 85.42%, posterior 88.72%). The postaural approach had an increased closure rate of 2.0% compared to endaural approach, but the difference was not statistically significant. The underlay technique was the most commonly used graft technique (used in 75.5% of patients: 13,359 of 17,697 total patients where surgical technique was specified). The overlay technique was only 0.1% better in achieving successful closure compared to the underlay technique, and the inlay technique was the least common and successful (underlay: usage 75.5%, success 86.71%, overlay: usage 15.5%, success 86.83%, inlay: usage 9.0%, 85.39%). Cartilage had superior closure rates compared to temporalis fascia, fat, and 'other' materials such as paper, alloderm, perichondrium, other synthetic materials (cartilage: 90.80%, fascia 88.00%, fat: 86.52%, other 85.39%). Pairwise comparisons of graft materials showed that cartilage compared to fascia as the only significant pair comparison with a $p$ value of 0.048. When cartilage was compared to fat or to 'other' materials, there was no significant advantage ($p$ value 0.366 and 0.110 respectively). Likewise, fascia compared to fat and to 'other' materials was not significant ($p$ value 0.581 and 0.560 respectively). Lastly, fat compared to 'other' materials was not significant ($p$ value 0.4692). Audiometry data was inconsistently reported, and a mean improvement in ABG post operatively could not be ascertained. However, data at the 10dB, 20dB and 30dB postoperative ABG thresholds was available in 29, 32 and 30 studies respectively. Looking at the postoperative ABG within these studies, 42.5% of cases (n = 1380/3247) were within 10dB, 68.6% (n = 2428/3540) within 20dB and 95.5% (n = 2797/2928) within 30dB.

## DISCUSSION

The overall closure rate for this meta-analysis was 86.6%, with an adult population success rate of 89.2% and a pediatric population success rate of 83.4%, which is the same success rate identified in a 2015 meta-analysis of pediatric tympanoplasty. (9)

*Follow-up period does not correlate to graft success rate*

Through linear regression analysis, this study demonstrates that there is no correlation between follow-up period and success rate. In some series, the follow-up period is as little as two months while in others it was as high as 12 years. (12-15) Some authors have suggested that late graft failure is relatively rare, therefore stating that a graft follow-up period of six months is sufficient. (16,17) However, others have compared short and long-term follow-up periods and demonstrated that a significant number of failures occur after one year. (18,19) It has been observed that regardless of any factors that can be controlled, a 10% deterioration in closure rate occurs within the first two years post-operatively. (13) These late re-perforations are attributed to either underlying Eustachian tube dysfunction or to avascularity and inappropriate thickness of the graft. (20) Future studies should aim to follow-up graft success for a minimum of 12 months.

*Adult populations have superior closure rates*

In our analysis, it was demonstrated that adults had a better closure rate than the overall pediatric population. Interestingly, the teenage subgroup (13 to 17 years of age) had the highest success rate (92.81%), 9.7% higher than for children ≤12 years (83.11%) and 9.4% higher than success rate for children ≤ 17 years (83.42%) suggesting within children, better outcomes are found in older children. However, direct comparison of age groups above and below 12 years was not significant, and no comparative analysis could be made between <12 years and 13 to 17 years. Our findings are consistent with a meta-analysis of pediatric tympanoplasty performed in 1997, which identified that age was a significant factor, and that in children better outcomes are found with increasing age. (8) However, a more recent meta-analysis of pediatric tympanoplasty has found through subgroup analysis that age was not a significant factor affecting the closure rate. (9) The lower success rate of tympanoplasty in children is thought to be related to Eustachian tube function and its relationship with otitis media. (21-25) There remains debate as to whether there should be a minimum age for tympanoplasty or not, with some studies suggesting it should be performed after the Eustachian tube is at adult development after seven years of age. (22,26-31) The decision to perform tympanoplasty in children remains a balance of the risks and benefits within the individual patient with the additional added risk of an increased rate of failure. In order to determine a recommended minimum age for tympanoplasty, future studies should aim to report age-specific closure rates.

*Discharging ears and perforations due to otitis media do not significantly affect closure rates*

Closure rates in tympanoplasty performed in perforations due to otitis media and in those perforations that were still discharging were not significantly affected. It is important to recognize that discharging ears may not necessarily be infected, with multiple factors including tympanomastoid space mucosa, ventilation and Eustachian tube dysfunction influencing the occurrence and presentation of infection. (28) Individual studies looking at this specific issue have reported mixed results. (15,17,22,26,32-36) Given that this meta-analysis and no individual study claims that perforations that are wet have a higher success rate for closure, it would seem reasonable to attempt to create a dry perforation but not make this a necessary condition for surgery.

*Perforation size matters, but location does not*

This meta-analysis indicates that perforations greater than 50% have a lower success rate, while the location of the perforation had no significant effect on success rate. Several individual studies also found a significantly higher rate of failures in larger perforations. (9,17,20,26,32,34,37,38) There are also individual studies where perforation size was not observed to affect overall results. (16,22,24,36,39-46) The major reasons thought to be responsible for graft failure in larger perforations are increased technical difficulty, reduced visibility, reduced graft overlap with the residual TM, a poor vascular bed for the graft and poor graft support or fixation. (16,34) Some studies have claimed that anteriorly placed perforations are associated with a poorer outcome, possibly due to reduced vascularity or exposure of the anterior TM. (13,15,47,48) While our meta-analysis did not demonstrate statistical significance with the location of the perforation, it is important to acknowledge that large-sized perforations often include the anterior segment, as anterior-only perforations are uncommon. (49) Anteriorly located perforations also had the lowest success rate (85.42% vs. 86.03% for central and 88.72% for posterior) and so the site of the perforation while not proving to be significant for success rate remains an important factor.

*No surgical approach has an advantage*

The type of surgical approach did not have an impact on outcomes. Surgical approach depends on many factors including the perforation size, location, visualization and the individual surgeon's preference. Typically an endaural or transcanal approach is used for smaller, more posterior perforations in wider canals. Because there are a number of variables that contribute to the decision of approach and these are biased by the individual surgeon's preferences it is not surprising that this meta-analysis did not detect a difference.

*There is no superior graft placement technique*

This meta-analysis demonstrates that there is no significant difference between the grafting techniques used (underlay, overlay and inlay). While the underlay technique was the most commonly used graft technique (75.5% of patients in this meta-analysis), there was no significant benefit of any individual technique. Some individual studies have claimed superiority in closure rates for the overlay technique. (50,51) Others have reported no difference; however, there is an identified increased risk of blunting of the anterior tympanomeatal angle and lateralization of the TM are more common when utilizing the overlay technique. (52-54) Blunting may result in a persistent conductive hearing loss. (16) The inlay technique was initially used for small perforations utilizing a plug of adipose tissue. (4,55) More recently, this technique has been applied using cartilage. (56-58) There does not appear to be a definitive indication for each technique, so to a large extent the choice usually depends on the surgeon's view of each technique's relative advantages or disadvantages. (59,60) As each surgeon has personal preferences, it is almost impossible to compare grafting techniques performed by the same surgeon and excellent outcomes are achieved with all techniques. (16,51,61-64)

*Cartilage has superior closure rates*

The most commonly used graft materials are temporalis fascia, cartilage and fat, which are all readily accessible at the surgical site. Over the years many other natural and synthetic materials have been trialed, but there are very few published studies on outcomes. Our meta-analysis shows that cartilage (90.80%) has a small but significant superior closure rate to temporalis fascia (88.00%), with pairwise comparisons of other material choices demonstrating no significance. A small randomized prospective clinical trial comparing fascia (20 ears) to cartilage (18 ears) found the graft uptake rates and hearing outcomes were not significantly different at 24 months (84.2% and 80% respectively). (65) Since the literature review date of this meta-analysis one other randomized control trial showed a benefit for cartilage in closure rate at 12 months, while another reported a reduced post-operative infection rate with cartilage. (57,66,67) One possible suggested explanation of this difference in cartilage success, between these two trials, is that poorer results may occur with cartilage thickness over 500 micrometers. (67) While graft choice ultimately depends on the perforation type, size and surgeon preference, our meta-analysis has shown that cartilage, as an independent variable, is a superior graft choice compared to temporalis fascia in both the pediatric and adult populations in terms of perforation closure. Cartilage is also often used as a graft material for smaller sized perforations, which innately have higher healing rates, and this may account for the increased closure rate with cartilage compared to other graft material. Different graft materials can also be used in different situations and the superiority of cartilage must still be balance for an individual patient's situation and the surgeon's experience with a particular material.

*Hearing outcomes were inconsistently reported*

Hearing outcomes following tympanoplasty are inconsistently reported which limits the conclusions that are able to be made. In this meta-analysis 39% (83 of 214 studies) of the studies recorded post-operative hearing results. Due to inconsistency in reporting the overall mean hearing gain could not be calculated. The range of mean postoperative air-bone gap (ABG) closures in individual studies was 1.2dB to 25.5dB. A total of 32 studies in this meta-analysis contributed data with complete reporting of postoperative ABG. (20,24,43,48,56,57,61,64,68-91) Data at the 10dB, 20dB and 30dB postoperative ABG thresholds was available in 29, 32 and 30 studies respectively. Looking at the postoperative ABG within these studies, 42.5% of cases (n = 1380/3247) were within 10dB, 68.6% (n = 2428/3540) within 20dB and 95.5% (n = 2797/2928) within 30dB, demonstrating that only a minority of patients achieved the best postoperative ABG (<10dB). While the ideal outcome in Tympanoplasty is the complete closure of the postoperative ABG to 0 dB (indicating no hearing loss), achieving a postoperative ABG

<10dB should be considered good clinical outcome as an ABG greater than 10dB indicates a conductive hearing loss. Though data was collected on pure-tone air conduction thresholds, very few studies documented findings in adequate detail for a meaningful analysis. When examining other individual studies' ability to achieve a postoperative ABG within 20dB there are reports ranging from 60% to 90%, consistent with our finding of 69%. (12,35,48,51,70,72,92,93) The impact of variables on hearing outcomes could not be determined due to the poor quality of reporting. Future studies should report audiometric outcomes in accordance to the American Academy of Otolaryngology, Head and Neck Surgery's Hearing Committee and with audiometry test results before and after surgery. (94)

*Secondary outcomes and complications*

The complications detected in this meta-analysis are reported in Table 2. Complication rates were reported in only 21% of studies (44 of 214 studies). The most commonly reported complications were reperforation (11.9%), revision surgery (11.4%), blunting (6.7%) and lateralization (4.2%). Re-operation or revision surgery was defined as any operation caused by an event requiring return to theatre, or as defined by the individual study. Future studies should aim to report complications in greater details to help future analysis of specific complications.

*The effect of mastoidectomy*

Mastoidectomy or other surgical adjunctive procedures were not included as a variable as the majority of studies did not discriminate between cholesteatoma and non cholesteatoma etiology when considering mastoidectomy. The current body of literature has been unable to demonstrate a clear benefit for TM healing when mastoidectomy is performed concurrently with tympanoplasty. Several studies retrospectively compared tympanoplasty alone to

**Table 2:** Complication rates as reported by individual studies included in this meta-analysis.

| Complication | Number of studies | Mean (%) | Range (%) | SD |
|---|---|---|---|---|
| Reperforation | 22 | 11.88 | 2.25 - 31 | 7.72 |
| Reoperation | 14 | 11.43 | 1 - 87% | 23.25 |
| Blunting | 17 | 6.65 | 1 - 54% | 12.36 |
| Lateralization | 17 | 4.24 | 1 - 13% | 3.75 |

tympanoplasty with mastoidectomy for TM perforation repair and did not find any statistical difference in repair success or hearing outcomes for adults or children. (95-98) A large prospective randomized study of adults with CSOM compared graft success rate and mean postoperative-ABG between tympanoplasty only to tympanoplasty with cortical mastoidectomy and concluded there was no significant difference. (99) Regarding non-cholesteatomata CSOM perforations, a literature review examining 26 articles concluded that there was no additional benefit to performing mastoidectomy with tympanoplasty for uncomplicated TM perforations. (100)

*Limitations*

Any meta-analysis is limited by the quality of the primary data. In the 214 included studies, there were only three experimental studies, with the majority of studies being retrospective cohort studies. Most studies did not report hearing outcomes adequately, or were inconsistent with outcome reporting. We relied on individual studies to determine the chronicity of perforations, as well as their definition of a 'chronic traumatic' perforation. Differences in surgical technique were not accounted for as these are highly variable between individual surgeons, difficult to define and mostly unreported.

## CONCLUSION

Based on this meta-analysis, the weighted average success rate of tympanic closure was 86.6%. Pediatric surgery has a larger failure rate than adults. Poorer outcomes are found in those perforations with a size over 50% of the total area. Perforations discharging around the time of surgery and those perforations of different locations of the pars tensa did not have significantly different outcomes. The length of follow-up period does not correlate to graft success. Surgical factors that led to improved closure rates include the use of cartilage whilst other factors such as surgical approach or technique of graft placement did not influence the closure rate overall. Future studies should, at a minimum, report closure rates, hearing outcomes, complications and report follow-up of at least 12 months.

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**REFERENCES**


1. Banzer M. Disputatio de Auditione Laesa. Wittenbergae: Johannis Rohrerei, 1651.
2. Chu EA, Jackler RK. The artificial tympanic membrane (1840-1910): from brilliant innovation to quack device. *Otol Neurotol* 2003;24:507-18.
3. Sarkar S. A Review on the History of Tympanoplasty. *Indian Journal of Otolaryngology and Head & Neck Surgery* 2013;65:455-60.
4. Ringenberg JC. Closure of tympanic membrane perforations by the use of fat. *Laryngoscope* 1978;88:982-93.
5. Storrs L. Myringoplasty. *Laryngoscope* 1966;76:185-95.
6. Wullstein H. Theory and practice of tympanoplasty. *The Laryngoscope* 1956;66:1076-93.
7. Mudry A. History of myringoplasty and tympanoplasty type I. *Otolaryngology - Head and Neck Surgery* 2008;139:613-4.
8. Vrabec JT, Deskin RW, Grady JJ. Meta-analysis of pediatric tympanoplasty. *Arch Otolaryngol Head Neck Surg* 1999;125:530-4.
9. Hardman J, Muzaffar J, Nankivell Pet al. Tympanoplasty for Chronic Tympanic Membrane Perforation in Children: Systematic Review and Meta-analysis. *Otol Neurotol* 2015;36:796-804.
10. Moher D, Liberati A, Tetzlaff Jet al. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *International Journal of Surgery* 2010;8:336-41.
11. Einarson TR. Pharmacoeconomic applications of meta-analysis for single groups using antifungal onychomycosis lacquers as an example. *Clin Ther* 1997;19:559-69; discussion 38-9.
12. Friedberg J, Gillis T. Tympanoplasty in childhood. *J Otolaryngol* 1980;9:165-8.
13. Sade J, Berco E, Brown Met al. Myringoplasty: short and long-term results in a training program. *J Laryngol Otol* 1981;95:653-65.

14. Velepic M, Starcevic R, Ticac Ret al. Cartilage palisade tympanoplasty in children and adults: long term results. *Int J Pediatr Otorhinolaryngol* 2012;76:663-6.

15. Jurovitzki I, Sade J. Myringoplasty: long-term followup. *The American journal of otology* 1988;9:52-5.

16. Gibb AG, Chang SK. Myringoplasty (A review of 365 operations). *J Laryngol Otol* 1982;96:915-30.

17. Adkins WY, White B. Type I tympanoplasty: influencing factors. *Laryngoscope* 1984;94:916-8.

18. Berger G, Shapira A, Marshak G. Myringoplasty in children. *J Otolaryngol* 1983;12:228-30.

19. Raine CH, Singh SD. Tympanoplasty in children. A review of 114 cases. *J Laryngol Otol* 1983;97:217-21.

20. Puhakka H, Virolainen E, Rahko T. Long-term results of myringoplasty with temporalis fascia. *J Laryngol Otol* 1979;93:1081-6.

21. Buchwach KA, Birck HG. Serous otitis media and type 1 tympanoplasties in children. A retrospective study. *Ann Otol Rhinol Laryngol Suppl* 1980;89:324-5.

22. Koch WM, Friedman EM, McGill TJet al. Tympanoplasty in children. The Boston Children's Hospital experience. *Arch Otolaryngol Head Neck Surg* 1990;116:35-40.

23. Shih L, de Tar T, Crabtree JA. Myringoplasty in children. *Otolaryngol Head Neck Surg* 1991;105:74-7.

24. Black JH, Hickey SA, Wormald PJ. An analysis of the results of myringoplasty in children. *Int J Pediatr Otorhinolaryngol* 1995;31:95-100.

25. Gersdorff M, Garin P, Decat Met al. Myringoplasty: long-term results in adults and children. *Am J Otol* 1995;16:532-5.

26. Ophir D, Porat M, Marshak G. Myringoplasty in the pediatric population. *Arch Otolaryngol Head Neck Surg* 1987;113:1288-90.

27. Crabtree JA, Maceri DR. Tympanoplasty and ossicular reconstruction: an update. *Am J Otol* 1988;9:334-9.

28. Bluestone CD, Paradise JL, Beery QC. Physiology of the eustachian tube in the pathogenesis and management of middle ear effusions. *Laryngoscope* 1972;82:1654-70.

29. Strong MS. The eustachian tube: basic considerations. *Otolaryngol Clin North Am* 1972;5:19-27.
30. Singh GB, Sidhu TS, Sharma Aet al. Tympanoplasty type I in children—an evaluative study. *International Journal of Pediatric Otorhinolaryngology* 2005;69:1071-6.
31. Ribeiro JC, Rui C, Natercia Set al. Tympanoplasty in children: A review of 91 cases. *Auris Nasus Larynx* 2011;38:21-5.
32. Lee P, Kelly G, Mills RP. Myringoplasty: does the size of the perforation matter? *Clinical otolaryngology and allied sciences* 2002;27:331-4.
33. Westerberg J, Harder H, Magnuson Bet al. Ten-year myringoplasty series: does the cause of perforation affect the success rate? *J Laryngol Otol* 2011;125:126-32.
34. Vartiainen E, Karja J, Karjalainen Set al. Failures in myringoplasty. *Arch Otorhinolaryngol* 1985;242:27-33.
35. Lau T, Tos M. Tympanoplasty in children. An analysis of late results. *Am J Otol* 1986;7:55-9.
36. Chandrasekhar SS, House JW, Devgan U. Pediatric tympanoplasty. A 10-year experience. *Arch Otolaryngol Head Neck Surg* 1995;121:873-8.
37. Smyth GD, Hassard TH. Tympanoplasty in children. *Am J Otol* 1980;1:199-205.
38. Onal K, Uguz MZ, Kazikdas KCet al. A multivariate analysis of otological, surgical and patient-related factors in determining success in myringoplasty. *Clin Otolaryngol* 2005;30:115-20.
39. Glasscock ME, 3rd, Jackson CG, Nissen AJet al. Postauricular undersurface tympanic membrane grafting: a follow-up report. *Laryngoscope* 1982;92:718-27.
40. Packer P, Mackendrick A, Solar M. What's best in myringoplasty: underly or overlay, dura or fascia? *J Laryngol Otol* 1982;96:25-41.
41. Yung MW. Myringoplasty for subtotal perforation. *Clin Otolaryngol* 1995;20:241-5.

42. Vartiainen E, Vartiainen J. Tympanoplasty in young patients: the role of adenoidectomy. *Otolaryngol Head Neck Surg* 1997;117:583-5.

43. Denoyelle F, Roger G, Chauvin Pet al. Myringoplasty in children: predictive factors of outcome. *Laryngoscope* 1999;109:47-51.

44. Salviz M, Bayram O, Bayram AAet al. Prognostic factors in type I tympanoplasty. *Auris Nasus Larynx* 2015;42:20-3.

45. Kim DK, Park SN, Yeo SWet al. Clinical efficacy of fat-graft myringoplasty for perforations of different sizes and locations. *Acta oto-laryngologica* 2011;131:22-6.

46. Wasson JD, Papadimitriou CE, Pau H. Myringoplasty: impact of perforation size on closure and audiological improvement. *J Laryngol Otol* 2009;123:973-7.

47. Halik JJ, Smyth GD. Long-term results of tympanic membrane repair. *Otolaryngol Head Neck Surg* 1988;98:162-9.

48. Bhat NA, De R. Retrospective analysis of surgical outcome, symptom changes, and hearing improvement following myringoplasty. *J Otolaryngol* 2000;29:229-32.

49. Schraff S, Dash N, Strasnick B. “Window Shade” Tympanoplasty for Anterior Marginal Perforations. *The Laryngoscope* 2005;115:1655-9.

50. Strahan RW, Acquarelli M, Ward PHet al. Tympanic membrane grafting. Analysis of materials and techniques. *Ann Otol Rhinol Laryngol* 1971;80:854-60.

51. Rizer FM. Overlay versus underlay tympanoplasty. Part II: the study. *The Laryngoscope* 1997;107:26-36.

52. Rizer FM. Overlay versus underlay tympanoplasty. Part I: historical review of the literature. *Laryngoscope* 1997;107:1-25.

53. Doyle PJ, Schleuning AJ, Echevarria J. Tympanoplasty: should grafts be placed medial or lateral to the tympanic membrane. *Laryngoscope* 1972;82:1425-30.

54. Glasscock ME, 3rd. Tympanic membrane grafting with fascia: overlay vs. undersurface technique. *Laryngoscope* 1973;83:754-70.

55. Gross CW, Bassila M, Lazar RHet al. Adipose plug myringoplasty: an alternative to formal myringoplasty techniques in children. *Otolaryngol Head Neck Surg* 1989;101:617-20.

56. Eavey RD. Inlay tympanoplasty: cartilage butterfly technique. *Laryngoscope* 1998;108:657-61.

57. Mauri M, Lubianca Neto JF, Fuchs SC. Evaluation of inlay butterfly cartilage tympanoplasty: a randomized clinical trial. *Laryngoscope* 2001;111:1479-85.

58. Couloigner V, Baculard F, El Bakkouri Wet al. Inlay butterfly cartilage tympanoplasty in children. *Otol Neurotol* 2005;26:247-51.

59. Smyth GD. Tympanic reconstruction. *Otolaryngol Clin North Am* 1972;5:111-25.

60. Sergi B, Galli J, De Corso Eet al. Overlay versus underlay myringoplasty. *Acta Otorhinolaryngologica Italica* 2011;31:366-71.

61. Pignataro L, Grillo Della Berta L, Capaccio Pet al. Myringoplasty in children: anatomical and functional results. *J Laryngol Otol* 2001;115:369-73.

62. Gersdorff M, Gerard JM, Thill MP. Overlay versus underlay tympanoplasty. Comparative study of 122 cases. *Rev Laryngol Otol Rhinol (Bord)* 2003;124:15-22.

63. Singh M, Rai A, Bandyopadhyay Set al. Comparative study of the underlay and overlay techniques of myringoplasty in large and subtotal perforations of the tympanic membrane. *J Laryngol Otol* 2003;117:444-8.

64. Wang WH, Lin YC. Minimally invasive inlay and underlay tympanoplasty. *American journal of otolaryngology* 2008;29:363-6.

65. Yung M, Vivekanandan S, Smith P. Randomized study comparing fascia and cartilage grafts in myringoplasty. *Ann Otol Rhinol Laryngol* 2011;120:535-41.

66. Cabra J, Monux A. Efficacy of cartilage palisade tympanoplasty: randomized controlled trial. *Otol Neurotol* 2010;31:589-95.

67. Jiang H, Zhang Z. Cartilage Tends To Be a Better Choice than Temporalis Fascia for Tympanoplasty under the Circumstance of Eustachian Tube Dysfunction. *Ann Otol Rhinol Laryngol* 2014;1:1013.

68. Ajulo SO, Myatt HM, Alusi G. Peri-umbilical superficial fascial graft myringoplasty--a simple alternative. *Clinical otolaryngology and allied sciences* 1993;18:433-5.

69. Black JH, Wormald PJ. Myringoplasty--effects on hearing and contributing factors. *South African medical journal = Suid-Afrikaanse tydskrif vir geneeskunde* 1995;85:41-3.

70. Blanshard JD, Robson AK, Smith Iet al. A long term view of myringoplasty in children. *J Laryngol Otol* 1990;104:758-62.

71. Caye-Thomasen P, Nielsen TR, Tos M. Bilateral myringoplasty in chronic otitis media. *The Laryngoscope* 2007;117:903-6.

72. Claes J, Van de Heyning PH, Creten Wet al. Allograft tympanoplasty: predictive value of preoperative status. *Laryngoscope* 1990;100:1313-8.

73. Cody DT, Taylor WF. Tympanoplasty: long-term results. *The Annals of otology, rhinology, and laryngology* 1973;82:538-46.

74. el-Guindy A. Endoscopic transcanal myringoplasty. *The Journal of laryngology and otology* 1992;106:493-5.

75. Fernandes SV. Composite chondroperichondrial clip tympanoplasty: the triple "C" technique. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery* 2003;128:267-72.

76. Goyal N, Kakkar V, Goyal Pet al. Myringoplasty for chronic otitis media. *Indian journal of pediatrics* 2002;69:223-4.

77. Haksever M, Akduman D, Solmaz Fet al. Inlay butterfly cartilage tympanoplasty in the treatment of dry central perforated chronic otitis media as an effective and time-saving procedure. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2015;272:867-72.

78. Harugop AS, Mudhol RS, Godhi RA. A comparative study of endoscope assisted myringoplasty and micrsoscope assisted myringoplasty. *Indian journal of otolaryngology and head and neck surgery : official publication of the Association of Otolaryngologists of India* 2008;60:298-302.

79. Kim HJ, Kim MJ, Jeon JHet al. Functional and practical outcomes of inlay butterfly cartilage tympanoplasty. *Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2014;35:1458-62.

80. Mak D, MacKendrick A, Bulsara Met al. Outcomes of myringoplasty in Australian Aboriginal children and factors associated with success: a prospective case series. *Clinical otolaryngology and allied sciences* 2004;29:606-11.

81. Naganuma H, Okamoto M, Shitara Tet al. Myringoplasty in the outpatient clinic. *Acta oto-rhino-laryngologica Belgica* 1994;48:59-65.

82. Onal K, Arslanoglu S, Oncel Set al. Perichondrium/Cartilage island flap and temporalis muscle fascia in type I tympanoplasty. *Journal of otolaryngology - head & neck surgery = Le Journal d'oto-rhino-laryngologie et de chirurgie cervico-faciale* 2011;40:295-9.

83. Onal K, Arslanoglu S, Songu Met al. Functional results of temporalis fascia versus cartilage tympanoplasty in patients with bilateral chronic otitis media. *The Journal of laryngology and otology* 2012;126:22-5.

84. Potsic WP, Winawer MR, Marsh RR. Tympanoplasty for the anterior-superior perforation in children. *The American journal of otology* 1996;17:115-8.

85. Rourke T, Snelling JD, Aldren C. Cartilage graft butterfly myringoplasty: how we do it. *Clinical otolaryngology : official journal of ENT-UK ; official journal of Netherlands Society for Oto-Rhino-Laryngology & Cervico-Facial Surgery* 2010;35:135-8.

86. Sakagami M, Yuasa R, Yuasa Y. Simple underlay myringoplasty. *The Journal of laryngology and otology* 2007;121:840-4.

87. Singh BJ, Sengupta A, Das SKet al. A comparative study of different graft materials used in myringoplasty. *Indian journal of otolaryngology and head and neck surgery : official publication of the Association of Otolaryngologists of India* 2009;61:131-4.

88. Singh GB, Sharma A, Singh N. Role of transtympanic myringoplasty in modern otology. *The Journal of otolaryngology* 2006;35:408-12.

89. Srinivasan V, Toynton SC, Mangat KS. Transtympanic myringoplasty in children. *International journal of pediatric otorhinolaryngology* 1997;39:199-204.

90. Ulku CH. Cartilage tympanoplasty with island technique for reconstruction of tympanic membrane perforation: anatomic and audiologic results. *Kulak burun bogaz ihtisas dergisi : KBB = Journal of ear, nose, and throat* 2010;20:7-12.

91. Yadav SP, Aggarwal N, Julaha Met al. Endoscope-assisted myringoplasty. *Singapore medical journal* 2009;50:510-2.

92. Perkins R, Bui HT. Tympanic membrane reconstruction using formaldehyde-formed autogenous temporalis fascia: twenty years' experience. *Otolaryngol Head Neck Surg* 1996;114:366-79.

93. Podoshin L, Fradis M, Malatskey Set al. Type I tympanoplasty in children. *Am J Otol* 1996;17:293-6.

94. Committee on Hearing and Equilibrium guidelines for the evaluation of results of treatment of conductive hearing loss. AmericanAcademy of Otolaryngology-Head and Neck Surgery Foundation, Inc. *Otolaryngol Head Neck Surg* 1995;113:186-7.

95. Balyan FR, Celikkanat S, Asian Aet al. Mastoidectomy in Noncholesteatomatous Chronic Suppurative Otitis Media: Is it Necessary? *Otolaryngology -- Head and Neck Surgery* 1997;117:592-5.

96. McGrew BM, Jackson CG, Glasscock ME. Impact of Mastoidectomy on Simple Tympanic Membrane Perforation Repair. *The Laryngoscope* 2004;114:506-11.

97. Rickers J, Petersen CG, Pedersen CBet al. Long-term follow-up evaluation of mastoidectomy in children with non-cholesteatomatous chronic suppurative otitis media. *Int J Pediatr Otorhinolaryngol* 2006;70:711-5.

98. Mishiro Y, Sakagami M, Takahashi Yet al. Tympanoplasty with and without mastoidectomy for non-cholesteatomatous chronic otitis media. *European Archives of Oto-Rhino-Laryngology*;258:13-5.

99. Albu S, Trabalzini F, Amadori M. Usefulness of cortical mastoidectomy in myringoplasty. *Otol Neurotol* 2012;33:604-9.

100. Eliades SJ, Limb CJ. The role of mastoidectomy in outcomes following tympanic membrane repair: A review. *The Laryngoscope* 2013;123:1787-802.

**SUPPPLEMENTARY TABLE – INCLUDED STUDIES**

| Reference | Author(s) | Year | Title |
|---|---|---|---|
| 1 | Abdelghany, A.M. | 2013 | The button graft technique for perforations affecting less than 25% of the tympanic membrane: a non-randomised comparison of a new modification to cartilage tympanoplasty with underlay and overlay grafts |
| 2 | Acar, M., et al. | 2015 | Fat-plug myringoplasty of ear lobule vs abdominal donor sites |
| 3 | Adkins, W.Y., et al. | 1984 | Type I tympanoplasty: influencing factors |
| 4 | Ahmed, S., et al. | 2013 | Chondroperichondrial clip myringoplasty: a new technique for closure of tympanic membrane perforations |
| 5 | Ahmed, Z., et al. | 2005 | Over-under myringoplasty |
| 6 | Ajulo, S.O., et al. | 1993 | Peri-umbilical superficial fascial graft myringoplasty--a simple alternative |
| 7 | Al-Khtoum, N., et al. | 2009 | Myringoplasty in children: retrospective analysis of 35 cases |
| 8 | al-Shaikh, A.M., et al. | 1998 | Underlay tympanoplasty with anterior and posterior flaps for subtotal perforations |
| 9 | Albera, R., et al. | 2009 | Equine versus bovine pericardium in transmeatal underlay myringoplasty |
| 10 | Albera, R., et al. | 2006 | Tympanic reperforation in myringoplasty: evaluation of prognostic factors |
| 11 | Albera, R., et al. | 1998 | [Myringoplasty in children: a comparison with an adult population] |
| 12 | Albirmawy, O.A. | 2010 | Comparison between cartilage-perichondrium composite 'ring' graft and temporalis fascia in type one tympanoplasty in children |
| 13 | Alkan, S., et al. | 2009 | Effect of the use of dry (rigid) or wet (soft) temporal fascia graft on tympanoplasty |
| 14 | Altuna, X., et al. | 2010 | [Island cartilage myringoplasty. Anatomical and functional results in 122 cases] |
| 15 | Alzahrani, M., et al. | 2015 | Hyaluronic acid fat graft myringoplasty vs fat patch fat graft myringoplasty |
| 16 | Alzoubi, F.Q., et al. | 2010 | Comparison between transtympanic and elevation of tympanomeatal flap approaches in tympanoplasty |
| 17 | Anderson, O., et al. | 2007 | Tri-adcortyl ointment ear dressing in myringoplasty: an analysis of outcome |
| 18 | Attallah, M.S., et al. | 1996 | Hearing results in tympanoplasty in Riyadh |
| 19 | Aviles Jurado, F.J., et al. | 2009 | [Myringoplasty: auditory follow-up and study of prognostic factors] |
| 20 | Ayache, S. | 2013 | Cartilaginous myringoplasty: the endoscopic transcanal procedure |
| 21 | Ayache, S., et al. | 2003 | Adipose graft: an original option in myringoplasty |
| 22 | Bajaj, Y., et al. | 1998 | Tympanoplasty in children--a prospective study |
| 23 | Balaguer Garcia, R., et al. | 2011 | [Myringoplasties. A retrospective analysis of our surgical outcomes] |
| 24 | Becker, J., et al. | 2011 | Success rate of myringoplasty at Groote Schuur Hospital |
| 25 | Benson-Mitchell, R., et al. | 1996 | Day-stay myringoplasty |

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|---|---|---|---|
| 26 | Berger, G., et al. | 1983 | Myringoplasty in children |
| 27 | Bhat, N.A., et al. | 2000 | Retrospective analysis of surgical outcome, symptom changes, and hearing improvement following myringoplasty |
| 28 | Black, J.H., et al. | 1995 | An analysis of the results of myringoplasty in children |
| 29 | Black, J.H., et al. | 1995 | Myringoplasty--effects on hearing and contributing factors |
| 30 | Blanshard, J.D., et al. | 1990 | A long term view of myringoplasty in children |
| 31 | Borkowski, G., et al. | 1999 | [Autologous perichondrium-cartilage graft in the treatment of total or subtotal perforations of the tympanic membrane] |
| 32 | Boronat-Echeverria, N.E., et al. | 2012 | Prognostic factors of successful tympanoplasty in pediatric patients: a cohort study |
| 33 | Brandow, E.C., Jr. | 1976 | Homograft tympanic membrane myringoplasty |
| 34 | Buchwach, K.A., et al. | 1980 | Serous otitis media and type 1 tympanoplasties in children. A retrospective study |
| 35 | Callanan, V.P., et al. | 1993 | Xenograft versus autograft in tympanoplasty |
| 36 | Castro, O., et al. | 2013 | Myringoplasties in children: our results |
| 37 | Caye-Thomasen, P., et al. | 2007 | Bilateral myringoplasty in chronic otitis media |
| 38 | Caylan, R., et al. | 1998 | Myringoplasty in children: factors influencing surgical outcome |
| 39 | Chanvimalueng, W. | 2000 | A clinical comparison of outpatient and standard myringoplasty |
| 40 | Claes, J., et al. | 1990 | Allograft tympanoplasty: predictive value of preoperative status |
| 41 | Cody, D.T., et al. | 1973 | Tympanoplasty: long-term results |
| 42 | Coskun, B.U., et al. | 2006 | The effects of the incision types in myringoplasty operations on cosmesis |
| 43 | Couloigner, V., et al. | 2005 | Inlay butterfly cartilage tympanoplasty in children |
| 44 | D'Eredita, R., et al. | 2009 | Anterior tab flap versus standard underlay myringoplasty in children |
| 45 | Dabholkar, J.P., et al. | 2007 | Comparative study of underlay tympanoplasty with temporalis fascia and tragal perichondrium |
| 46 | De, S., et al. | 2004 | Myringoplasty using a subcutaneous soft tissue graft |
| 47 | De Seta, E., et al. | 2013 | Type I tympanoplasty with island chondro-perichondral tragal graft: the preferred technique? |
| 48 | Deddens, A.E., et al. | 1993 | Adipose myringoplasty in children |
| 49 | Deenadayal, D.S., et al. | 2011 | Graft uptake rates with isoamyl-2-cyanoacrylate in myringoplasty procedures: a 10-year retrospective study |
| 50 | Demirpehlivan, I.A., et al. | 2011 | Comparison of different tympanic membrane reconstruction techniques in type I tympanoplasty |
| 51 | Denoyelle, F., et al. | 1999 | Myringoplasty in children: predictive factors of outcome |
| 52 | Dursun, E., et al. | 2008 | Comparison of paper-patch, fat, and perichondrium myringoplasty in repair of small tympanic membrane perforations |

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|---|---|---|---|
| 53 | Eavey, R.D. | 1998 | Inlay tympanoplasty: cartilage butterfly technique |
| 54 | Effat, K.G. | 2005 | Results of inlay cartilage myringoplasty in terms of closure of central tympanic membrane perforations |
| 55 | Eisenbeis, J.F., et al. | 2004 | Areolar connective tissue grafts in pediatric tympanoplasty: a pilot study |
| 56 | el-Guindy, A. | 1992 | Endoscopic transcanal myringoplasty |
| 57 | Emir, H., et al. | 2007 | Success is a matter of experience: type 1 tympanoplasty : influencing factors on type 1 tympanoplasty |
| 58 | Emmett, J.R. | 1999 | Age as a factor in the success of tympanoplasty: a comparison of outcomes in the young and old |
| 59 | Eren, S.B., et al. | 2014 | A randomized prospective trial of a novel device for measuring perforation size during inlay 'butterfly' myringoplasty |
| 60 | Fadl, F.A. | 2003 | Outcome of type-1 tympanoplasty |
| 61 | Feilen, S.E., et al. | 1996 | [Long-term outcome of tympanoplasty in chronic suppurative middle ear infection in childhood] |
| 62 | Fernandes, S.V. | 2003 | Composite chondroperichondrial clip tympanoplasty: the triple "C" technique |
| 63 | Fouad, T., et al. | 2010 | Utilization of amniotic membrane graft for repair of the tympanic membrane perforation |
| 64 | Francois, M., et al. | 1985 | [Myringoplasty in children] |
| 65 | Fukuchi, I., et al. | 2006 | Tympanoplasty: surgical results and a comparison of the factors that may interfere in their success |
| 66 | Gamra, O.B., et al. | 2008 | Cartilage graft in type I tympanoplasty: audiological and otological outcome |
| 67 | Gavriel, H., et al. | 2013 | Inferior flap tympanoplasty: a novel technique for anterior perforation closure |
| 68 | Gedikli, O., et al. | 2011 | Efficacy of octyl-2-cyanoacrylate in type I tympanoplasty |
| 69 | Gersdorff, M., et al. | 1995 | Myringoplasty: long-term results in adults and children |
| 70 | Ghosh, L.M., et al. | 1991 | Paediatric myringoplasty in India |
| 71 | Gibb, A.G., et al. | 1982 | Myringoplasty (A review of 365 operations) |
| 72 | Golz, A., et al. | 2003 | Paper patching for chronic tympanic membrane perforations |
| 73 | Goyal, N., et al. | 2002 | Myringoplasty for chronic otitis media |
| 74 | Gross, C.W., et al. | 1989 | Adipose plug myringoplasty: an alternative to formal myringoplasty techniques in children |
| 75 | Gupta, S.C. | 2000 | Myringoplasty with a single flap |
| 76 | Habesoglu, T.E., et al. | 2011 | Effect of type I tympanoplasty on the quality of life of children |
| 77 | Habib-ur-Rehman, et al. | 2011 | Otitis Media: Comparison of outcome of underlay versus overlay myringoplasty |
| 78 | Hagemann, M., et al. | 2003 | [Tympanoplasty with adipose tissue] |
| 79 | Haksever, M., et al. | 2015 | Inlay butterfly cartilage tympanoplasty in the treatment of dry central perforated chronic otitis media as an effective and time-saving procedure |
| 80 | Halim, A., et al. | 2009 | Pediatric myringoplasty: postaural versus transmeatal approach |
| 81 | Hamans, E.P., et al. | 1996 | Allograft tympanoplasty type 1 in the childhood population |

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|---|---|---|---|
| 82 | Harterink, E., et al. | 2014 | Results of myringoplasty in children with cleft palate: a patient-matched study |
| 83 | Harugop, A.S., et al. | 2008 | A comparative study of endoscope assisted myringoplasty and micrsoscope assisted myringoplasty |
| 84 | Harvinder, S., et al. | 2005 | Underlay myringoplasty: comparison of human amniotic membrane to temporalis fascia graft |
| 85 | Hicks, G.W., et al. | 1988 | A review of 925 cases of tympanoplasty using formaldehyde-formed-fascia grafts |
| 86 | Hod, R., et al. | 2013 | Inlay "butterfly" cartilage tympanoplasty |
| 87 | Hung, T., et al. | 2004 | Anterosuperior anchoring myringoplasty technique for anterior and subtotal perforations |
| 88 | Iacovou, E., et al. | 2012 | Effect of type I tympanoplasty on the resonant frequency of the middle ear: comparison between chondrotympanoplasty and temporalis fascia grafting |
| 89 | Jung, T., et al. | 2009 | Medial or medio-lateral graft tympanoplasty for repair of tympanic membrane perforation |
| 90 | Jung, T.T., et al. | 2005 | Mediolateral graft tympanoplasty for anterior or subtotal tympanic membrane perforation |
| 91 | Jurovitzki, I., et al. | 1988 | Myringoplasty: long-term followup |
| 92 | Kaddour, H.S. | 1992 | Myringoplasty under local anaesthesia: day case surgery |
| 93 | Kane, R.J., et al. | 1980 | Out-patient myringoplasty |
| 94 | Karela, M., et al. | 2008 | Myringoplasty: surgical outcomes and hearing improvement: is it worth performing to improve hearing? |
| 95 | Karkanevatos, A., et al. | 2003 | Day-case myringoplasty: five years' experience |
| 96 | Kartush, J.M. | 2000 | Tympanic membrane Patcher: a new device to close tympanic membrane perforations in an office setting |
| 97 | Kazikdas, K.C., et al. | 2007 | Palisade cartilage tympanoplasty for management of subtotal perforations: a comparison with the temporalis fascia technique |
| 98 | Kessler, A., et al. | 1994 | Type 1 tympanoplasty in children |
| 99 | Khan, M.M., et al. | 2011 | Primary cartilage tympanoplasty: our technique and results |
| 100 | Kim, D.K., et al. | 2011 | Clinical efficacy of fat-graft myringoplasty for perforations of different sizes and locations |
| 101 | Kim, H.J., et al. | 2014 | Functional and practical outcomes of inlay butterfly cartilage tympanoplasty |
| 102 | Knapik, M., et al. | 2011 | Pediatric myringoplasty: a study of factors affecting outcome |
| 103 | Koch, W.M., et al. | 1990 | Tympanoplasty in children. The Boston Children's Hospital experience |
| 104 | Komune, S., et al. | 1992 | Interlay method for myringoplasty |
| 105 | Konstantinidis, I., et al. | 2013 | Fat myringoplasty outcome analysis with otoendoscopy: who is the suitable patient? |
| 106 | Kumar, S., et al. | 2010 | Pediatric myringoplasty: definition of "success" and factors affecting outcome |
| 107 | Kwong, K.M., et al. | 2012 | Fat graft myringoplasty using umbilical fat |
| 108 | Kyrodimos, E., et al. | 2014 | Cartilage tympanoplasty: a reliable technique for smokers |
| 109 | Lai, P., et al. | 2006 | Lateral graft type 1 tympanoplasty using AlloDerm for tympanic membrane reconstruction in children |
| 110 | Landsberg, R., et al. | 2006 | Fat graft myringoplasty: results of a long-term follow-up |

| | | | |
|---|---|---|---|
| 111 | Lee, P., et al. | 2002 | Myringoplasty: does the size of the perforation matter? |
| 112 | Lee, S.H., et al. | 2008 | Paper-patch myringoplasty with CO2 laser for chronic TM perforation |
| 113 | Li, P., et al. | 2010 | The selection and strategy in otoendoscopic myringoplasty with autogenous adipose tissue |
| 114 | Lima, J.C., et al. | 2011 | Evaluation of the organic and functional results of tympanoplasties through a retro-auricular approach at a medical residency unit |
| 115 | Lin, Y.C., et al. | 2011 | Predictors of surgical and hearing long-term results for inlay cartilage tympanoplasty |
| 116 | Loock, J.W., et al. | 2008 | A randomised controlled trial comparing fresh, dried, and dried-then-rehydrated temporalis fascia in myringoplasty |
| 117 | Lou, Z.C., et al. | 2011 | Prognosis and outcome of the tympanic membrane flap at traumatic tympanic membrane perforation edge |
| 118 | Lubianca-Neto, J.F. | 2000 | Inlay butterfly cartilage tympanoplasty (Eavey technique) modified for adults |
| 119 | MacDonald, R.R., 3rd, et al. | 1994 | Fasciaform myringoplasty in children |
| 120 | Maeta, M., et al. | 1998 | [A clinical comparison of orthodox myringoplasty and a simple method with fibrin glue] |
| 121 | Mak, D., et al. | 2004 | Outcomes of myringoplasty in Australian Aboriginal children and factors associated with success: a prospective case series |
| 122 | Mauri, M., et al. | 2001 | Evaluation of inlay butterfly cartilage tympanoplasty: a randomized clinical trial |
| 123 | Mendel, L., et al. | 1985 | A clinical comparison of the results of two different methods of closing tympanic membrane perforations |
| 124 | Migirov, L., et al. | 2014 | Efficacy of myringoplasty in older people |
| 125 | Migirov, L., et al. | 2013 | Does smoking influence the surgical outcome of a myringoplasty? |
| 126 | Mills, N. | 2013 | Early healing and hearing improvement following type one tympanoplasty using the 'drum sandwich' technique |
| 127 | Mills, R., et al. | 2013 | Results of myringoplasty operations in active and inactive ears in adults |
| 128 | Mishra, P., et al. | 2007 | Prospective study of 100 cases of underlay tympanoplasty with superiorly based circumferential flap for subtotal perforations |
| 129 | Mitchell, R.B., et al. | 1997 | Fat graft myringoplasty in children--a safe and successful day-stay procedure |
| 130 | Mitchell, R.B., et al. | 1996 | Bilateral fat graft myringoplasty in children |
| 131 | Mompo Romero, L., et al. | 1996 | [Survey of 80 myringoplasty] |
| 132 | Monfared, A., et al. | 2008 | Bivalve cartilage inlay myringoplasty: an office-based procedure for closing small to medium-sized tympanic membrane perforations |
| 133 | Morant Ventura, A., et al. | 1993 | [Myringoplasty using formaldehyde formed fascia (Perkins' foot) in 188 cases: anatomical and functional results at 5 years] |
| 134 | Naganuma, H., et al. | 1994 | Myringoplasty in the outpatient clinic |

| | | | |
|---|---|---|---|
| 135 | Nagle, S.K., et al. | 2009 | Comparative study of outcome of type I tympanoplasty in dry and wet ear |
| 136 | Nakhla, V., et al. | 2007 | Myringoplasty: a comparison of bismuth iodoform paraffin paste gauze pack and tri-adcortyl ointment ear dressing |
| 137 | Nardone, M., et al. | 2012 | Myringoplasty in simple chronic otitis media: critical analysis of long-term results in a 1,000-adult patient series |
| 138 | Noh, H., et al. | 2012 | Vascularisation of myringo-/tympanoplastic grafts in active and inactive chronic mucosal otitis media: a prospective cohort study |
| 139 | Ogisi, F.O., et al. | 2004 | Type 1 Tympanoplasty in Benin: a 10- year review |
| 140 | Onal, K., et al. | 2011 | Perichondrium/Cartilage island flap and temporalis muscle fascia in type I tympanoplasty |
| 141 | Onal, K., et al. | 2012 | Functional results of temporalis fascia versus cartilage tympanoplasty in patients with bilateral chronic otitis media |
| 142 | Ophir, D., et al. | 1987 | Myringoplasty in the pediatric population |
| 143 | Ozbek, C., et al. | 2008 | A comparison of cartilage palisades and fascia in type 1 tympanoplasty in children: anatomic and functional results |
| 144 | Park, S.N., et al. | 2015 | Predictors for outcome of paper patch myringoplasty in patients with chronic tympanic membrane perforations |
| 145 | Peng, R., et al. | 2013 | Efficacy of "hammock" tympanoplasty in the treatment of anterior perforations |
| 146 | Piedrola Maroto, D., et al. | 2010 | [Functional results in myringoplasties] |
| 147 | Pignataro, L., et al. | 2001 | Myringoplasty in children: anatomical and functional results |
| 148 | Podoshin, L., et al. | 1996 | Type I tympanoplasty in children |
| 149 | Potsic, W.P., et al. | 1996 | Tympanoplasty for the anterior-superior perforation in children |
| 150 | Puhakka, H., et al. | 1979 | Long-term results of myringoplasty with temporalis fascia |
| 151 | Puls, T. | 1996 | Myringoplasty: is molded collagen xenograft a valid alternative for fresh temporalis fascia? |
| 152 | Quraishi, M.S., et al. | 1995 | Day case myringoplasty using tragal perichondrium |
| 153 | Raghavan, U., et al. | 2000 | Myringoplasty: update on onlay pedicle skin flap and temporalis fascia sandwich graft |
| 154 | Raine, C.H., et al. | 1983 | Tympanoplasty in children. A review of 114 cases |
| 155 | Ribeiro, J.C., et al. | 2011 | Tympanoplasty in children: A review of 91 cases |
| 156 | Ringenberg, J.C. | 1978 | Closure of tympanic membrane perforations by the use of fat |
| 157 | Rizer, F.M. | 1997 | Overlay versus underlay tympanoplasty. Part II: the study |
| 158 | Rogha, M., et al. | 2014 | Comparison of tympanic membrane grafting medial or lateral to malleus handle |
| 159 | Rourke, T., et al. | 2010 | Cartilage graft butterfly myringoplasty: how we do it |

| | | | |
|---|---|---|---|
| 160 | Ryan, C., et al. | 2002 | Paediatric day-stay myringoplasty: a review of 74 consecutive cases |
| 161 | Saadat, D., et al. | 2001 | Office myringoplasty with alloderm |
| 162 | Sade, J., et al. | 1981 | Myringoplasty: short and long-term results in a training program |
| 163 | Sakagami, M., et al. | 2007 | Simple underlay myringoplasty |
| 164 | Sakai, N., et al. | 1997 | Simple in-office closure of small intractable tympanic membrane perforations after myringoplasty |
| 165 | Saliba, I., et al. | 2012 | Advantages of hyaluronic acid fat graft myringoplasty over fat graft myringoplasty |
| 166 | Saliba, I., et al. | 2011 | Hyaluronic acid fat graft myringoplasty: a minimally invasive technique |
| 167 | Salman, S.D. | 1977 | Myringoplasty as an office procedure: a new technique |
| 168 | Sarac, S., et al. | 2002 | Use of homograft dehydrated temporal fascia in tympanoplasty |
| 169 | Sauvage, J.P., et al. | 1996 | [Hammock myringoplasty (technique, results)] |
| 170 | Scaramella, L.F., et al. | 2002 | Effectiveness of nonsurgical office closure of tympanic membrane pars tensa perforations |
| 171 | Schraff, S.A., et al. | 2006 | Outcomes in children with perforated tympanic membranes after tympanostomy tube placement: results using a pilot treatment algorithm |
| 172 | Sckolnick, J.S., et al. | 2008 | Pediatric myringoplasty: factors that affect success-a retrospective study |
| 173 | Seidman, M.D. | 2008 | Anterior transcanal tympanoplasty: a novel technique to repair anterior perforations |
| 174 | Sergi, B., et al. | 2011 | Overlay versus underlay myringoplasty: report of outcomes considering closure of perforation and hearing function |
| 175 | Shaikh, A.A., et al. | 2009 | Outcome of Tympanoplasty Type - I by Underlay Technique |
| 176 | Sharma, D.K., et al. | 2009 | Prospective study of myringoplasty using different approaches |
| 177 | Sharp, J.F., et al. | 1992 | Myringoplasty for the anterior perforation: experience with the Kerr flap |
| 178 | Sheahan, P., et al. | 2002 | Results of type 1 tympanoplasty in children and parental perceptions of outcome of surgery |
| 179 | Sheehy, J.L., et al. | 1980 | Myringoplasty. A review of 472 cases |
| 180 | Shih, L., et al. | 1991 | Myringoplasty in children |
| 181 | Shrestha, S., et al. | 2006 | Hearing results after myringoplasty |
| 182 | Singh, B.J., et al. | 2009 | A comparative study of different graft materials used in myringoplasty |
| 183 | Singh, G.B., et al. | 2006 | Role of transtympanic myringoplasty in modern otology |
| 184 | Singh, G.B., et al. | 2005 | Tympanoplasty type I in children--an evaluative study |
| 185 | Singh, M., et al. | 2003 | Comparative study of the underlay and overlay techniques of myringoplasty in large and subtotal perforations of the tympanic membrane |
| 186 | Sozen, E., et al. | 2012 | Is the tragal cartilage necessary for type 1 tympanoplasties? |
| 187 | Sridhara, S.K., et al. | 2013 | Tympanoplasty for blast-induced perforations: the Walter Reed experience |

| | | | |
|---|---|---|---|
| 188 | Srinivasan, V., et al. | 1997 | Transtympanic myringoplasty in children |
| 189 | Supiyaphun, P., et al. | 1999 | Myringoplasty: a simple procedure for out-patients |
| 190 | Takahashi-Tatsumi, E., et al. | 2014 | Longitudinal follow-up after pediatric myringoplasty: long-term outcome is defined at 12 months |
| 191 | Tek, A., et al. | 2012 | Audiological and graft take results of cartilage reinforcement tympanoplasty (a new technique) versus fascia |
| 192 | Terry, R.M., et al. | 1988 | Fat graft myringoplasty--a prospective trial |
| 193 | Thomassin, J.M., et al. | 2004 | [The effectiveness of otoendoscopy in myringoplasty using adipose graft] |
| 194 | Trotoux, J., et al. | 1986 | [Tympanic reconstruction by molded grafts. Value and results. Apropos of experience in 158 cases] |
| 195 | Tuzuner, A., et al. | 2015 | Does glubran 2 improve the graft uptake in tympanoplasty? A retrospective study |
| 196 | Ulku, C.H. | 2010 | Cartilage tympanoplasty with island technique for reconstruction of tympanic membrane perforation: anatomic and audiologic results |
| 197 | Ullah, N., et al. | 2011 | Tympanoplasty in young patients |
| 198 | Umapathy, N., et al. | 2003 | Myringoplasty: is it worth performing in children? |
| 199 | Vartiainen, E., et al. | 1993 | Success and pitfalls in myringoplasty: follow-up study of 404 cases |
| 200 | Vartiainen, E., et al. | 1997 | Tympanoplasty in young patients: the role of adenoidectomy |
| 201 | Velepic, M., et al. | 2012 | Cartilage palisade tympanoplasty in children and adults: long term results |
| 202 | Vos, J.D., et al. | 2005 | Use of AlloDerm in type I tympanoplasty: a comparison with native tissue grafts |
| 203 | Wang, W.H., et al. | 2008 | Minimally invasive inlay and underlay tympanoplasty |
| 204 | Webb, B.D., et al. | 2008 | Efficacy of tympanoplasty without mastoidectomy for chronic suppurative otitis media |
| 205 | Weider, D.J. | 1977 | Tympanoplasty: medial grafting using Williams' microclips |
| 206 | Williams, J.D. | 1977 | Microclip application in tympanoplasty |
| 207 | Yadav, S.P., et al. | 2009 | Endoscope-assisted myringoplasty |
| 208 | Yang, H.C., et al. | 2014 | Efficacy of tympanoplasty without mastoidectomy on MRSA-infected chronic otitis media |
| 209 | Yigit, O., et al. | 2005 | Short-term evaluation of over-under myringoplasty technique |
| 210 | Yilmaz, M.S., et al. | 2015 | Comparison of the anatomic and hearing outcomes of cartilage type 1 tympanoplasty in pediatric and adult patients |
| 211 | Yuasa, Y., et al. | 2008 | Postoperative results of simple underlay myringoplasty in better hearing ears |
| 212 | Yung, M., et al. | 2007 | A longitudinal study on pediatric myringoplasty |
| 213 | Zhang, Z., et al. | 2010 | Combined tympanic epithelial layer avulsion and overlay myringoplasty for diffuse granular myringitis |
| 214 | Zhang, Z.G., et al. | 2011 | Three autologous substitutes for myringoplasty: a comparative study |

**References:**


1. Abdelghany AM. The button graft technique for perforations affecting less than 25% of the tympanic membrane: a non-randomised comparison of a new modification to cartilage tympanoplasty with underlay and overlay grafts. *Clinical otolaryngology : official journal of ENT-UK ; official journal of Netherlands Society for Oto-Rhino-Laryngology & Cervico-Facial Surgery* 2013;38:208-16.
2. Acar M, Yazici D, San Tet al. Fat-plug myringoplasty of ear lobule vs abdominal donor sites. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2015;272:861-6.
3. Adkins WY, White B. Type I tympanoplasty: influencing factors. *The Laryngoscope* 1984;94:916-8.
4. Ahmed S, Raza N, Ullah Set al. Chondroperichondrial clip myringoplasty: a new technique for closure of tympanic membrane perforations. *The Journal of laryngology and otology* 2013;127:562-7.
5. Ahmed Z, Aslam MA, Aslam MJet al. Over-under myringoplasty. *Journal of the College of Physicians and Surgeons--Pakistan : JCPSP* 2005;15:768-70.
6. Ajulo SO, Myatt HM, Alusi G. Peri-umbilical superficial fascial graft myringoplasty--a simple alternative. *Clinical otolaryngology and allied sciences* 1993;18:433-5.
7. Al-Khtoum N, Hiari MA. Myringoplasty in children: retrospective analysis of 35 cases. *Brazilian journal of otorhinolaryngology* 2009;75:371-4.
8. al-Shaikh AM, Reddy PV, Bizrah MB. Underlay tympanoplasty with anterior and posterior flaps for subtotal perforations. *Otolaryngologia polska. The Polish otolaryngology* 1998;52:137-40.
9. Albera R, Dagna F, Lacilla Met al. Equine versus bovine pericardium in transmeatal underlay myringoplasty. *The Annals of otology, rhinology, and laryngology* 2009;118:287-91.
10. Albera R, Ferrero V, Lacilla Met al. Tympanic reperforation in myringoplasty: evaluation of prognostic factors. *The Annals of otology, rhinology, and laryngology* 2006;115:875-9.
11. Albera R, Milan F, Riontino Eet al. [Myringoplasty in children: a comparison with an adult population]. *Acta otorhinolaryngologica Italica : organo ufficiale della Societa italiana di otorinolaringologia e chirurgia cervico-facciale* 1998;18:295-9.
12. Albirmawy OA. Comparison between cartilage-perichondrium composite 'ring' graft and temporalis fascia in type one tympanoplasty in children. *The Journal of laryngology and otology* 2010;124:967-74.
13. Alkan S, Baylancicek S, Sozen Eet al. Effect of the use of dry (rigid) or wet (soft) temporal fascia graft on tympanoplasty. *Journal of otolaryngology - head & neck surgery = Le Journal d'oto-rhino-laryngologie et de chirurgie cervico-faciale* 2009;38:126-32.
14. Altuna X, Navarro JJ, Martinez Zet al. [Island cartilage myringoplasty. Anatomical and functional results in 122 cases]. *Acta otorrinolaringologica espanola* 2010;61:100-5.
15. Alzahrani M, Saliba I. Hyaluronic acid fat graft myringoplasty vs fat patch fat graft myringoplasty. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2015;272:1873-7.
16. Alzoubi FQ, Tarifi AA, Khader Yet al. Comparison between transtympanic and elevation of tympanomeatal flap approaches in tympanoplasty. *Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2010;31:773-5.

17. Anderson O, Takwoingi YM. Tri-adcortyl ointment ear dressing in myringoplasty: an analysis of outcome. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2007;264:873-7.
18. Attallah MS, al-Essa A. Hearing results in tympanoplasty in Riyadh. *Otolaryngologia polska. The Polish otolaryngology* 1996;50:145-51.
19. Aviles Jurado FJ, Meran Gil JL, Tobed Secall Met al. [Myringoplasty: auditory follow-up and study of prognostic factors]. *Acta otorrinolaringologica espanola* 2009;60:169-75.
20. Ayache S. Cartilaginous myringoplasty: the endoscopic transcanal procedure. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2013;270:853-60.
21. Ayache S, Braccini F, Facon Fet al. Adipose graft: an original option in myringoplasty. *Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2003;24:158-64.
22. Bajaj Y, Bais AS, Mukherjee B. Tympanoplasty in children--a prospective study. *The Journal of laryngology and otology* 1998;112:1147-9.
23. Balaguer Garcia R, Morales Suarez-Varela MM, Tamarit Conejeros JMet al. [Myringoplasties. A retrospective analysis of our surgical outcomes]. *Acta otorrinolaringologica espanola* 2011;62:213-9.
24. Becker J, Lubbe D. Success rate of myringoplasty at Groote Schuur Hospital. *South African medical journal = Suid-Afrikaanse tydskrif vir geneeskunde* 2011;101:740.
25. Benson-Mitchell R, Kenyon GS, Gardiner Q. Day-stay myringoplasty. *The Journal of laryngology and otology* 1996;110:421-4.
26. Berger G, Shapira A, Marshak G. Myringoplasty in children. *The Journal of otolaryngology* 1983;12:228-30.
27. Bhat NA, De R. Retrospective analysis of surgical outcome, symptom changes, and hearing improvement following myringoplasty. *The Journal of otolaryngology* 2000;29:229-32.
28. Black JH, Hickey SA, Wormald PJ. An analysis of the results of myringoplasty in children. *International journal of pediatric otorhinolaryngology* 1995;31:95-100.
29. Black JH, Wormald PJ. Myringoplasty--effects on hearing and contributing factors. *South African medical journal = Suid-Afrikaanse tydskrif vir geneeskunde* 1995;85:41-3.
30. Blanshard JD, Robson AK, Smith Iet al. A long term view of myringoplasty in children. *The Journal of laryngology and otology* 1990;104:758-62.
31. Borkowski G, Sudhoff H, Luckhaupt H. [Autologous perichondrium-cartilage graft in the treatment of total or subtotal perforations of the tympanic membrane]. *Laryngo- rhino- otologie* 1999;78:68-72.
32. Boronat-Echeverria NE, Reyes-Garcia E, Sevilla-Delgado Yet al. Prognostic factors of successful tympanoplasty in pediatric patients: a cohort study. *BMC pediatrics* 2012;12:67.
33. Brandow EC, Jr. Homograft tympanic membrane myringoplasty. *Archives of otolaryngology (Chicago, Ill. : 1960)* 1976;102:473-7.
34. Buchwach KA, Birck HG. Serous otitis media and type 1 tympanoplasties in children. A retrospective study. *The Annals of otology, rhinology & laryngology. Supplement* 1980;89:324-5.
35. Callanan VP, Curran AJ, Gormley PK. Xenograft versus autograft in tympanoplasty. *The Journal of laryngology and otology* 1993;107:892-4.
36. Castro O, Perez-Carro AM, Ibarra Iet al. Myringoplasties in children: our results. *Acta otorrinolaringologica espanola* 2013;64:87-91.
37. Caye-Thomasen P, Nielsen TR, Tos M. Bilateral myringoplasty in chronic otitis media. *The Laryngoscope* 2007;117:903-6.
38. Caylan R, Titiz A, Falcioni Met al. Myringoplasty in children: factors influencing surgical outcome. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery* 1998;118:709-13.

39. Chanvimalueng W. A clinical comparison of outpatient and standard myringoplasty. *Ear, nose, & throat journal* 2000;79:113-4, 7.
40. Claes J, Van de Heyning PH, Creten Wet al. Allograft tympanoplasty: predictive value of preoperative status. *The Laryngoscope* 1990;100:1313-8.
41. Cody DT, Taylor WF. Tympanoplasty: long-term results. *The Annals of otology, rhinology, and laryngology* 1973;82:538-46.
42. Coskun BU, Cinar U, Seven Het al. The effects of the incision types in myringoplasty operations on cosmesis. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2006;263:820-2.
43. Couloigner V, Baculard F, El Bakkouri Wet al. Inlay butterfly cartilage tympanoplasty in children. *Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2005;26:247-51.
44. D'Eredita R, Lens MB. Anterior tab flap versus standard underlay myringoplasty in children. *Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2009;30:777-81.
45. Dabholkar JP, Vora K, Sikdar A. Comparative study of underlay tympanoplasty with temporalis fascia and tragal perichondrium. *Indian journal of otolaryngology and head and neck surgery : official publication of the Association of Otolaryngologists of India* 2007;59:116-9.
46. De S, Karkanevatos A, Srinivasan VRet al. Myringoplasty using a subcutaneous soft tissue graft. *Clinical otolaryngology and allied sciences* 2004;29:314-7.
47. De Seta E, De Seta D, Covelli Eet al. Type I tympanoplasty with island chondro-perichondral tragal graft: the preferred technique? *The Journal of laryngology and otology* 2013;127:354-8.
48. Deddens AE, Muntz HR, Lusk RP. Adipose myringoplasty in children. *The Laryngoscope* 1993;103:216-9.
49. Deenadayal DS, Neeli AK, Patel SH. Graft uptake rates with isoamyl-2-cyanoacrylate in myringoplasty procedures: a 10-year retrospective study. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery* 2011;145:442-5.
50. Demirpehlivan IA, Onal K, Arslanoglu Set al. Comparison of different tympanic membrane reconstruction techniques in type I tympanoplasty. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2011;268:471-4.
51. Denoyelle F, Roger G, Chauvin Pet al. Myringoplasty in children: predictive factors of outcome. *The Laryngoscope* 1999;109:47-51.
52. Dursun E, Dogru S, Gungor Aet al. Comparison of paper-patch, fat, and perichondrium myringoplasty in repair of small tympanic membrane perforations. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery* 2008;138:353-6.
53. Eavey RD. Inlay tympanoplasty: cartilage butterfly technique. *The Laryngoscope* 1998;108:657-61.
54. Effat KG. Results of inlay cartilage myringoplasty in terms of closure of central tympanic membrane perforations. *The Journal of laryngology and otology* 2005;119:611-3.
55. Eisenbeis JF, Herrmann BW. Areolar connective tissue grafts in pediatric tympanoplasty: a pilot study. *American journal of otolaryngology* 2004;25:79-83.
56. el-Guindy A. Endoscopic transcanal myringoplasty. *The Journal of laryngology and otology* 1992;106:493-5.
57. Emir H, Ceylan K, Kizilkaya Zet al. Success is a matter of experience: type 1 tympanoplasty : influencing factors on type 1 tympanoplasty. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2007;264:595-9.
58. Emmett JR. Age as a factor in the success of tympanoplasty: a comparison of outcomes in the young and old. *Ear, nose, & throat journal* 1999;78:480, 3.

59. Eren SB, Tugrul S, Ozucer Bet al. A randomized prospective trial of a novel device for measuring perforation size during inlay 'butterfly' myringoplasty. *American journal of otolaryngology* 2014;35:305-8.
60. Fadl FA. Outcome of type-1 tympanoplasty. *Saudi medical journal* 2003;24:58-61.
61. Feilen SE, Federspil P. [Long-term outcome of tympanoplasty in chronic suppurative middle ear infection in childhood]. *Hno* 1996;44:143-7.
62. Fernandes SV. Composite chondroperichondrial clip tympanoplasty: the triple "C" technique. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery* 2003;128:267-72.
63. Fouad T, Rifaat M, Buhaibeh Q. Utilization of amniotic membrane graft for repair of the tympanic membrane perforation. *Egyptian Journal of ear, nose, throat and Allied Sciences* 2010;11:31-4.
64. Francois M, Juvanon JM, Contencin Pet al. [Myringoplasty in children]. *Annales d'oto-laryngologie et de chirurgie cervico faciale : bulletin de la Societe d'oto-laryngologie des hopitaux de Paris* 1985;102:321-7.
65. Fukuchi I, Cerchiari DP, Garcia Eet al. Tympanoplasty: surgical results and a comparison of the factors that may interfere in their success. *Brazilian journal of otorhinolaryngology* 2006;72:267-71.
66. Gamra OB, Mbarek C, Khammassi Ket al. Cartilage graft in type I tympanoplasty: audiological and otological outcome. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2008;265:739-42.
67. Gavriel H, Eviatar E. Inferior flap tympanoplasty: a novel technique for anterior perforation closure. *BioMed research international* 2013;2013:758598.
68. Gedikli O, Eren SB, Kahya Vet al. Efficacy of octyl-2-cyanoacrylate in type I tympanoplasty. *The Journal of craniofacial surgery* 2011;22:1039-41.
69. Gersdorff M, Garin P, Decat Met al. Myringoplasty: long-term results in adults and children. *The American journal of otology* 1995;16:532-5.
70. Ghosh LM, Dubey SP. Paediatric myringoplasty in India. *Auris, nasus, larynx* 1991;18:209-13.
71. Gibb AG, Chang SK. Myringoplasty (A review of 365 operations). *The Journal of laryngology and otology* 1982;96:915-30.
72. Golz A, Goldenberg D, Netzer Aet al. Paper patching for chronic tympanic membrane perforations. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery* 2003;128:565-70.
73. Goyal N, Kakkar V, Goyal Pet al. Myringoplasty for chronic otitis media. *Indian journal of pediatrics* 2002;69:223-4.
74. Gross CW, Bassila M, Lazar RHet al. Adipose plug myringoplasty: an alternative to formal myringoplasty techniques in children. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery* 1989;101:617-20.
75. Gupta SC. Myringoplasty with a single flap. *Ear, nose, & throat journal* 2000;79:946-8, 50-1.
76. Habesoglu TE, Habesoglu M, Deveci Iet al. Effect of type I tympanoplasty on the quality of life of children. *The Annals of otology, rhinology, and laryngology* 2011;120:326-30.
77. Habib-ur-Rehman, Fazal-I-Wahid, Javaid Met al. Otitis Media: Comparison of outcome of underlay versus overlay myringoplasty. *Pakistan Journal of Medical Sciences* 2011;27:1076.
78. Hagemann M, Hausler R. [Tympanoplasty with adipose tissue]. *Laryngo- rhino- otologie* 2003;82:393-6.
79. Haksever M, Akduman D, Solmaz Fet al. Inlay butterfly cartilage tympanoplasty in the treatment of dry central perforated chronic otitis media as an effective and time-saving procedure. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2015;272:867-72.
80. Halim A, Borgstein J. Pediatric myringoplasty: postaural versus transmeatal approach. *International journal of pediatric otorhinolaryngology* 2009;73:1580-3.

81. Hamans EP, Govaerts PJ, Somers Tet al. Allograft tympanoplasty type 1 in the childhood population. *The Annals of otology, rhinology, and laryngology* 1996;105:871-6.
82. Harterink E, Leboulanger N, Kotti Set al. Results of myringoplasty in children with cleft palate: a patient-matched study. *Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2014;35:838-43.
83. Harugop AS, Mudhol RS, Godhi RA. A comparative study of endoscope assisted myringoplasty and micrsoscope assisted myringoplasty. *Indian journal of otolaryngology and head and neck surgery : official publication of the Association of Otolaryngologists of India* 2008;60:298-302.
84. Harvinder S, Hassan S, Sidek DSet al. Underlay myringoplasty: comparison of human amniotic membrane to temporalis fascia graft. *The Medical journal of Malaysia* 2005;60:585-9.
85. Hicks GW, Wright JW, 3rd. A review of 925 cases of tympanoplasty using formaldehyde-formed-fascia grafts. *The Laryngoscope* 1988;98:150-3.
86. Hod R, Buda I, Hazan Aet al. Inlay "butterfly" cartilage tympanoplasty. *American journal of otolaryngology* 2013;34:41-3.
87. Hung T, Knight JR, Sankar V. Anterosuperior anchoring myringoplasty technique for anterior and subtotal perforations. *Clinical otolaryngology and allied sciences* 2004;29:210-4.
88. Iacovou E, Vlastarakos PV, Panagiotakopoulou Aet al. Effect of type I tympanoplasty on the resonant frequency of the middle ear: comparison between chondrotympanoplasty and temporalis fascia grafting. *Journal of otolaryngology - head & neck surgery = Le Journal d'oto-rhino-laryngologie et de chirurgie cervico-faciale* 2012;41:14-9.
89. Jung T, Kim YH, Kim YHet al. Medial or medio-lateral graft tympanoplasty for repair of tympanic membrane perforation. *International journal of pediatric otorhinolaryngology* 2009;73:941-3.
90. Jung TT, Park SK. Mediolateral graft tympanoplasty for anterior or subtotal tympanic membrane perforation. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery* 2005;132:532-6.
91. Jurovitzki I, Sade J. Myringoplasty: long-term followup. *The American journal of otology* 1988;9:52-5.
92. Kaddour HS. Myringoplasty under local anaesthesia: day case surgery. *Clinical otolaryngology and allied sciences* 1992;17:567-8.
93. Kane RJ, Moffat DA, O'Connor AF. Out-patient myringoplasty. *The Journal of laryngology and otology* 1980;94:1387-93.
94. Karela M, Berry S, Watkins Aet al. Myringoplasty: surgical outcomes and hearing improvement: is it worth performing to improve hearing? *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2008;265:1039-42.
95. Karkanevatos A, De S, Srinivasan VRet al. Day-case myringoplasty: five years' experience. *The Journal of laryngology and otology* 2003;117:763-5.
96. Kartush JM. Tympanic membrane Patcher: a new device to close tympanic membrane perforations in an office setting. *The American journal of otology* 2000;21:615-20.
97. Kazikdas KC, Onal K, Boyraz Iet al. Palisade cartilage tympanoplasty for management of subtotal perforations: a comparison with the temporalis fascia technique. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2007;264:985-9.
98. Kessler A, Potsic WP, Marsh RR. Type 1 tympanoplasty in children. *Archives of otolaryngology--head & neck surgery* 1994;120:487-90.
99. Khan MM, Parab SR. Primary cartilage tympanoplasty: our technique and results. *American journal of otolaryngology* 2011;32:381-7.
100. Kim DK, Park SN, Yeo SWet al. Clinical efficacy of fat-graft myringoplasty for perforations of different sizes and locations. *Acta oto-laryngologica* 2011;131:22-6.

101. Kim HJ, Kim MJ, Jeon JHet al. Functional and practical outcomes of inlay butterfly cartilage tympanoplasty. *Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2014;35:1458-62.
102. Knapik M, Saliba I. Pediatric myringoplasty: a study of factors affecting outcome. *International journal of pediatric otorhinolaryngology* 2011;75:818-23.
103. Koch WM, Friedman EM, McGill TJet al. Tympanoplasty in children. The Boston Children's Hospital experience. *Archives of otolaryngology--head & neck surgery* 1990;116:35-40.
104. Komune S, Wakizono S, Hisashi Ket al. Interlay method for myringoplasty. *Auris, nasus, larynx* 1992;19:17-22.
105. Konstantinidis I, Malliari H, Tsakiropoulou Eet al. Fat myringoplasty outcome analysis with otoendoscopy: who is the suitable patient? *Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2013;34:95-9.
106. Kumar S, Acharya A, Hadjihannas Eet al. Pediatric myringoplasty: definition of "success" and factors affecting outcome. *Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2010;31:1417-20.
107. Kwong KM, Smith MM, Coticchia JM. Fat graft myringoplasty using umbilical fat. *International journal of pediatric otorhinolaryngology* 2012;76:1098-101.
108. Kyrodimos E, Stamatiou GA, Margaritis Eet al. Cartilage tympanoplasty: a reliable technique for smokers. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2014;271:255-60.
109. Lai P, Propst EJ, Papsin BC. Lateral graft type 1 tympanoplasty using AlloDerm for tympanic membrane reconstruction in children. *International journal of pediatric otorhinolaryngology* 2006;70:1423-9.
110. Landsberg R, Fishman G, DeRowe Aet al. Fat graft myringoplasty: results of a long-term follow-up. *The Journal of otolaryngology* 2006;35:44-7.
111. Lee P, Kelly G, Mills RP. Myringoplasty: does the size of the perforation matter? *Clinical otolaryngology and allied sciences* 2002;27:331-4.
112. Lee SH, Jin SM, Lee KCet al. Paper-patch myringoplasty with CO2 laser for chronic TM perforation. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2008;265:1161-4.
113. Li P, Yang QT, Li YQet al. The selection and strategy in otoendoscopic myringoplasty with autogenous adipose tissue. *Indian journal of otolaryngology and head and neck surgery : official publication of the Association of Otolaryngologists of India* 2010;62:25-8.
114. Lima JC, Marone SA, Martucci Oet al. Evaluation of the organic and functional results of tympanoplasties through a retro-auricular approach at a medical residency unit. *Brazilian journal of otorhinolaryngology* 2011;77:229-36.
115. Lin YC, Wang WH, Weng HHet al. Predictors of surgical and hearing long-term results for inlay cartilage tympanoplasty. *Archives of otolaryngology--head & neck surgery* 2011;137:215-9.
116. Loock JW, Naude N. A randomised controlled trial comparing fresh, dried, and dried-then-rehydrated temporalis fascia in myringoplasty. *Clinical otolaryngology : official journal of ENT-UK ; official journal of Netherlands Society for Oto-Rhino-Laryngology & Cervico-Facial Surgery* 2008;33:97-101.
117. Lou ZC, Hu YX, Tang YM. Prognosis and outcome of the tympanic membrane flap at traumatic tympanic membrane perforation edge. *ORL; journal for oto-rhino-laryngology and its related specialties* 2011;73:212-8.

118. Lubianca-Neto JF. Inlay butterfly cartilage tympanoplasty (Eavey technique) modified for adults. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery* 2000;123:492-4.
119. MacDonald RR, 3rd, Lusk RP, Muntz HR. Fasciaform myringoplasty in children. *Archives of otolaryngology--head & neck surgery* 1994;120:138-43.
120. Maeta M, Saito R, Nakagawa Fet al. [A clinical comparison of orthodox myringoplasty and a simple method with fibrin glue]. *Nihon Jibiinkoka Gakkai kaiho* 1998;101:1062-8.
121. Mak D, MacKendrick A, Bulsara Met al. Outcomes of myringoplasty in Australian Aboriginal children and factors associated with success: a prospective case series. *Clinical otolaryngology and allied sciences* 2004;29:606-11.
122. Mauri M, Lubianca Neto JF, Fuchs SC. Evaluation of inlay butterfly cartilage tympanoplasty: a randomized clinical trial. *The Laryngoscope* 2001;111:1479-85.
123. Mendel L, Kuylenstierna R. A clinical comparison of the results of two different methods of closing tympanic membrane perforations. *The Journal of laryngology and otology* 1985;99:339-42.
124. Migirov L, Lipschitz N, Slonimsky Get al. Efficacy of myringoplasty in older people. *Aging clinical and experimental research* 2014;26:661-4.
125. Migirov L, Lipschitz N, Wolf M. Does smoking influence the surgical outcome of a myringoplasty? *ORL; journal for oto-rhino-laryngology and its related specialties* 2013;75:207-10.
126. Mills N. Early healing and hearing improvement following type one tympanoplasty using the 'drum sandwich' technique. *The Journal of laryngology and otology* 2013;127:957-61.
127. Mills R, Thiel G, Mills N. Results of myringoplasty operations in active and inactive ears in adults. *The Laryngoscope* 2013;123:2245-9.
128. Mishra P, Sonkhya N, Mathur N. Prospective study of 100 cases of underlay tympanoplasty with superiorly based circumferential flap for subtotal perforations. *Indian journal of otolaryngology and head and neck surgery : official publication of the Association of Otolaryngologists of India* 2007;59:225-8.
129. Mitchell RB, Pereira KD, Lazar RH. Fat graft myringoplasty in children--a safe and successful day-stay procedure. *The Journal of laryngology and otology* 1997;111:106-8.
130. Mitchell RB, Pereira KD, Younis RTet al. Bilateral fat graft myringoplasty in children. *Ear, nose, & throat journal* 1996;75:652, 5-6.
131. Mompo Romero L, Dalmau Galofre J, Pons Rocher Fet al. [Survey of 80 myringoplasty]. *Anales otorrinolaringologicos ibero-americanos* 1996;23:565-76.
132. Monfared A, Bergeron CM, Ortiz Jet al. Bivalve cartilage inlay myringoplasty: an office-based procedure for closing small to medium-sized tympanic membrane perforations. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery* 2008;139:630-4.
133. Morant Ventura A, Marco Algarra J, Mallea Canizares Iet al. [Myringoplasty using formaldehyde formed fascia (Perkins' foot) in 188 cases: anatomical and functional results at 5 years]. *Acta otorrinolaringologica espanola* 1993;44:425-30.
134. Naganuma H, Okamoto M, Shitara Tet al. Myringoplasty in the outpatient clinic. *Acta oto-rhino-laryngologica Belgica* 1994;48:59-65.
135. Nagle SK, Jagade MV, Gandhi SRet al. Comparative study of outcome of type I tympanoplasty in dry and wet ear. *Indian journal of otolaryngology and head and neck surgery : official publication of the Association of Otolaryngologists of India* 2009;61:138-40.
136. Nakhla V, Takwoingi YM, Sinha A. Myringoplasty: a comparison of bismuth iodoform paraffin paste gauze pack and tri-adcortyl ointment ear dressing. *The Journal of laryngology and otology* 2007;121:329-32.

137. Nardone M, Sommerville R, Bowman Jet al. Myringoplasty in simple chronic otitis media: critical analysis of long-term results in a 1,000-adult patient series. *Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2012;33:48-53.
138. Noh H, Lee DH. Vascularisation of myringo-/tympanoplastic grafts in active and inactive chronic mucosal otitis media: a prospective cohort study. *Clinical otolaryngology : official journal of ENT-UK ; official journal of Netherlands Society for Oto-Rhino-Laryngology & Cervico-Facial Surgery* 2012;37:355-61.
139. Ogisi FO, Adobamen P. Type 1 Tympanoplasty in Benin: a 10- year review. *The Nigerian postgraduate medical journal* 2004;11:84-7.
140. Onal K, Arslanoglu S, Oncel Set al. Perichondrium/Cartilage island flap and temporalis muscle fascia in type I tympanoplasty. *Journal of otolaryngology - head & neck surgery = Le Journal d'oto-rhino-laryngologie et de chirurgie cervico-faciale* 2011;40:295-9.
141. Onal K, Arslanoglu S, Songu Met al. Functional results of temporalis fascia versus cartilage tympanoplasty in patients with bilateral chronic otitis media. *The Journal of laryngology and otology* 2012;126:22-5.
142. Ophir D, Porat M, Marshak G. Myringoplasty in the pediatric population. *Archives of otolaryngology--head & neck surgery* 1987;113:1288-90.
143. Ozbek C, Ciftci O, Tuna EEet al. A comparison of cartilage palisades and fascia in type 1 tympanoplasty in children: anatomic and functional results. *Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2008;29:679-83.
144. Park SN, Kim HM, Jin KSet al. Predictors for outcome of paper patch myringoplasty in patients with chronic tympanic membrane perforations. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2015;272:297-301.
145. Peng R, Lalwani AK. Efficacy of "hammock" tympanoplasty in the treatment of anterior perforations. *The Laryngoscope* 2013;123:1236-40.
146. Piedrola Maroto D, Escalona Gutierrez JJ, Conde Jimenez Met al. [Functional results in myringoplasties]. *Acta otorrinolaringologica espanola* 2010;61:94-9.
147. Pignataro L, Grillo Della Berta L, Capaccio Pet al. Myringoplasty in children: anatomical and functional results. *The Journal of laryngology and otology* 2001;115:369-73.
148. Podoshin L, Fradis M, Malatskey Set al. Type I tympanoplasty in children. *The American journal of otology* 1996;17:293-6.
149. Potsic WP, Winawer MR, Marsh RR. Tympanoplasty for the anterior-superior perforation in children. *The American journal of otology* 1996;17:115-8.
150. Puhakka H, Virolainen E, Rahko T. Long-term results of myringoplasty with temporalis fascia. *The Journal of laryngology and otology* 1979;93:1081-6.
151. Puls T. Myringoplasty: is molded collagen xenograft a valid alternative for fresh temporalis fascia? *Acta oto-rhino-laryngologica Belgica* 1996;50:111-4.
152. Quraishi MS, Jones NS. Day case myringoplasty using tragal perichondrium. *Clinical otolaryngology and allied sciences* 1995;20:12-4.
153. Raghavan U, Malki DS, Mahmoud NA. Myringoplasty: update on onlay pedicle skin flap and temporalis fascia sandwich graft. *The Journal of laryngology and otology* 2000;114:174-7.
154. Raine CH, Singh SD. Tympanoplasty in children. A review of 114 cases. *The Journal of laryngology and otology* 1983;97:217-21.
155. Ribeiro JC, Rui C, Natercia Set al. Tympanoplasty in children: A review of 91 cases. *Auris, nasus, larynx* 2011;38:21-5.
156. Ringenberg JC. Closure of tympanic membrane perforations by the use of fat. *The Laryngoscope* 1978;88:982-93.
157. Rizer FM. Overlay versus underlay tympanoplasty. Part II: the study. *The Laryngoscope* 1997;107:26-36.

158. Rogha M, Berjis N, Taherinia Aet al. Comparison of tympanic membrane grafting medial or lateral to malleus handle. *Advanced biomedical research* 2014;3:56.
159. Rourke T, Snelling JD, Aldren C. Cartilage graft butterfly myringoplasty: how we do it. *Clinical otolaryngology : official journal of ENT-UK ; official journal of Netherlands Society for Oto-Rhino-Laryngology & Cervico-Facial Surgery* 2010;35:135-8.
160. Ryan C, Harris R, Hung Tet al. Paediatric day-stay myringoplasty: a review of 74 consecutive cases. *The Journal of laryngology and otology* 2002;116:899-902.
161. Saadat D, Ng M, Vadapalli Set al. Office myringoplasty with alloderm. *The Laryngoscope* 2001;111:181-4.
162. Sade J, Berco E, Brown Met al. Myringoplasty: short and long-term results in a training program. *The Journal of laryngology and otology* 1981;95:653-65.
163. Sakagami M, Yuasa R, Yuasa Y. Simple underlay myringoplasty. *The Journal of laryngology and otology* 2007;121:840-4.
164. Sakai N, Kokubun T, Asai Tet al. Simple in-office closure of small intractable tympanic membrane perforations after myringoplasty. *Auris, nasus, larynx* 1997;24:43-6.
165. Saliba I, Knapik M, Froehlich Pet al. Advantages of hyaluronic acid fat graft myringoplasty over fat graft myringoplasty. *Archives of otolaryngology--head & neck surgery* 2012;138:950-5.
166. Saliba I, Woods O. Hyaluronic acid fat graft myringoplasty: a minimally invasive technique. *The Laryngoscope* 2011;121:375-80.
167. Salman SD. Myringoplasty as an office procedure: a new technique. *Archives of otolaryngology (Chicago, Ill. : 1960)* 1977;103:459-60.
168. Sarac S, Gursel B. Use of homograft dehydrated temporal fascia in tympanoplasty. *Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2002;23:416-21.
169. Sauvage JP, Heurtebise F, Puyraud S. [Hammock myringoplasty (technique, results)]. *Revue de laryngologie - otologie - rhinologie* 1996;117:247-51.
170. Scaramella LF, Farrell BP, Kooiker PDet al. Effectiveness of nonsurgical office closure of tympanic membrane pars tensa perforations. *Ear, nose, & throat journal* 2002;81:556-8, 60.
171. Schraff SA, Markham J, Welch Cet al. Outcomes in children with perforated tympanic membranes after tympanostomy tube placement: results using a pilot treatment algorithm. *American journal of otolaryngology* 2006;27:238-43.
172. Sckolnick JS, Mantle B, Li Jet al. Pediatric myringoplasty: factors that affect success-a retrospective study. *The Laryngoscope* 2008;118:723-9.
173. Seidman MD. Anterior transcanal tympanoplasty: a novel technique to repair anterior perforations. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery* 2008;138:242-5.
174. Sergi B, Galli J, De Corso Eet al. Overlay versus underlay myringoplasty: report of outcomes considering closure of perforation and hearing function. *Acta otorhinolaryngologica Italica : organo ufficiale della Societa italiana di otorinolaringologia e chirurgia cervico-facciale* 2011;31:366-71.
175. Shaikh AA, Onali MAS, Shaikh SMet al. Outcome of Tympanoplasty Type - I by Underlay Technique. *Journal of Liaquat University of Medical and Health Sciences* 2009;8:80-4.
176. Sharma DK, Singh S, Sohal BSet al. Prospective study of myringoplasty using different approaches. *Indian journal of otolaryngology and head and neck surgery : official publication of the Association of Otolaryngologists of India* 2009;61:297-300.
177. Sharp JF, Terzis TF, Robinson J. Myringoplasty for the anterior perforation: experience with the Kerr flap. *The Journal of laryngology and otology* 1992;106:14-6.
178. Sheahan P, O'Dwyer T, Blayney A. Results of type 1 tympanoplasty in children and parental perceptions of outcome of surgery. *The Journal of laryngology and otology* 2002;116:430-4.
179. Sheehy JL, Anderson RG. Myringoplasty. A review of 472 cases. *The Annals of otology, rhinology, and laryngology* 1980;89:331-4.

180. Shih L, de Tar T, Crabtree JA. Myringoplasty in children. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery* 1991;105:74-7.
181. Shrestha S, Sinha BK. Hearing results after myringoplasty. *Kathmandu University medical journal (KUMJ)* 2006;4:455-9.
182. Singh BJ, Sengupta A, Das SKet al. A comparative study of different graft materials used in myringoplasty. *Indian journal of otolaryngology and head and neck surgery : official publication of the Association of Otolaryngologists of India* 2009;61:131-4.
183. Singh GB, Sharma A, Singh N. Role of transtympanic myringoplasty in modern otology. *The Journal of otolaryngology* 2006;35:408-12.
184. Singh GB, Sidhu TS, Sharma Aet al. Tympanoplasty type I in children--an evaluative study. *International journal of pediatric otorhinolaryngology* 2005;69:1071-6.
185. Singh M, Rai A, Bandyopadhyay Set al. Comparative study of the underlay and overlay techniques of myringoplasty in large and subtotal perforations of the tympanic membrane. *The Journal of laryngology and otology* 2003;117:444-8.
186. Sozen E, Orhan Ucal Y, Tansuker HDet al. Is the tragal cartilage necessary for type 1 tympanoplasties? *The Journal of craniofacial surgery* 2012;23:e280-3.
187. Sridhara SK, Rivera A, Littlefield P. Tympanoplasty for blast-induced perforations: the Walter Reed experience. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery* 2013;148:103-7.
188. Srinivasan V, Toynton SC, Mangat KS. Transtympanic myringoplasty in children. *International journal of pediatric otorhinolaryngology* 1997;39:199-204.
189. Supiyaphun P, Kerekhanjanarong V. Myringoplasty: a simple procedure for out-patients. *Journal of the Medical Association of Thailand = Chotmaihet thangphaet* 1999;82:1220-5.
190. Takahashi-Tatsumi E, Mishiro Y, Katsura Het al. Longitudinal follow-up after pediatric myringoplasty: long-term outcome is defined at 12 months. *Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2014;35:126-8.
191. Tek A, Karaman M, Uslu Cet al. Audiological and graft take results of cartilage reinforcement tympanoplasty (a new technique) versus fascia. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2012;269:1117-26.
192. Terry RM, Bellini MJ, Clayton MIet al. Fat graft myringoplasty--a prospective trial. *Clinical otolaryngology and allied sciences* 1988;13:227-9.
193. Thomassin JM, Facon F, Gabert K. [The effectiveness of otoendoscopy in myringoplasty using adipose graft]. *Annales d'oto-laryngologie et de chirurgie cervico faciale : bulletin de la Societe d'oto-laryngologie des hopitaux de Paris* 2004;121:346-9.
194. Trotoux J, Geoffray B, Deffrennes Det al. [Tympanic reconstruction by molded grafts. Value and results. Apropos of experience in 158 cases]. *Annales d'oto-laryngologie et de chirurgie cervico faciale : bulletin de la Societe d'oto-laryngologie des hopitaux de Paris* 1986;103:437-42.
195. Tuzuner A, Demirci S, Kuran Get al. Does glubran 2 improve the graft uptake in tympanoplasty? A retrospective study. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2015;272:3-8.
196. Ulku CH. Cartilage tympanoplasty with island technique for reconstruction of tympanic membrane perforation: anatomic and audiologic results. *Kulak burun bogaz ihtisas dergisi : KBB = Journal of ear, nose, and throat* 2010;20:7-12.
197. Ullah N, Khan Q, Said Met al. Tympanoplasty in young patients. *Journal of Postgraduate Medical Institute* 2011;22.
198. Umapathy N, Dekker PJ. Myringoplasty: is it worth performing in children? *Archives of otolaryngology--head & neck surgery* 2003;129:1053-5.
199. Vartiainen E, Nuutinen J. Success and pitfalls in myringoplasty: follow-up study of 404 cases. *The American journal of otology* 1993;14:301-5.

200. Vartiainen E, Vartiainen J. Tympanoplasty in young patients: the role of adenoidectomy. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery* 1997;117:583-5.
201. Velepic M, Starcevic R, Ticac Ret al. Cartilage palisade tympanoplasty in children and adults: long term results. *International journal of pediatric otorhinolaryngology* 2012;76:663-6.
202. Vos JD, Latev MD, Labadie RFet al. Use of AlloDerm in type I tympanoplasty: a comparison with native tissue grafts. *The Laryngoscope* 2005;115:1599-602.
203. Wang WH, Lin YC. Minimally invasive inlay and underlay tympanoplasty. *American journal of otolaryngology* 2008;29:363-6.
204. Webb BD, Chang CY. Efficacy of tympanoplasty without mastoidectomy for chronic suppurative otitis media. *Archives of otolaryngology--head & neck surgery* 2008;134:1155-8.
205. Weider DJ. Tympanoplasty: medial grafting using Williams' microclips. *Archives of otolaryngology (Chicago, Ill. : 1960)* 1977;103:468-72.
206. Williams JD. Microclip application in tympanoplasty. *The Annals of otology, rhinology, and laryngology* 1977;86:223-6.
207. Yadav SP, Aggarwal N, Julaha Met al. Endoscope-assisted myringoplasty. *Singapore medical journal* 2009;50:510-2.
208. Yang HC, Cho YB, Jang CH. Efficacy of tympanoplasty without mastoidectomy on MRSA-infected chronic otitis media. *Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2014;35:976-80.
209. Yigit O, Alkan S, Topuz Eet al. Short-term evaluation of over-under myringoplasty technique. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2005;262:400-3.
210. Yilmaz MS, Guven M, Kayabasoglu Get al. Comparison of the anatomic and hearing outcomes of cartilage type 1 tympanoplasty in pediatric and adult patients. *European archives of oto-rhino-laryngology : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 2015;272:557-62.
211. Yuasa Y, Yuasa R. Postoperative results of simple underlay myringoplasty in better hearing ears. *Acta oto-laryngologica* 2008;128:139-43.
212. Yung M, Neumann C, Vowler SL. A longitudinal study on pediatric myringoplasty. *Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2007;28:353-5.
213. Zhang Z, Liu X, Chen Set al. Combined tympanic epithelial layer avulsion and overlay myringoplasty for diffuse granular myringitis. *The Journal of laryngology and otology* 2010;124:842-5.
214. Zhang ZG, Huang QH, Zheng YQet al. Three autologous substitutes for myringoplasty: a comparative study. *Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology* 2011;32:1234-8.