

Main Article

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Effect of pre-operative mastoid pneumatisation on tympanoplasty success

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Abstract

Objective. This study aimed to compare the effect of pneumatised and non-pneumatised mastoid on the success of tympanoplasty in terms of rate of graft uptake and air–bone gap improvement.

Method. A comprehensive electronic search of PubMed Medline, Scopus, Web of Science and Cochrane Library was conducted in August 2020 for articles from 1990 to 2020. Selected studies were published in the English language, were conducted on human patients, were concerned with evaluating pre-operative mastoid pneumatisation on tympanoplasty success, were not laboratory studies and were not opinion studies. Five studies were included with 178 patients in the pneumatised group and 97 patients were included in the non-pneumatised group. Comparison between both groups was performed in terms of graft uptake rate and air–bone gap improvement.

Results. Although the pneumatised group showed better graft uptake rate than the non-pneumatised group, there was no statistically significant difference between the two groups in the success rate of tympanoplasty.

Conclusion. Pneumatisation of the mastoid does not significantly affect the success rate of tympanoplasty.

Introduction

Tympanoplasty is the procedure performed for repair of tympanic membrane perforations. Its rate of success differs greatly with many factors.¹ One of these factors is mastoid pneumatisation. The mastoid air cells represent the pneumatisation of the mastoid part of the temporal bone, and they are of variable size and extent. Mastoid air cells are an air reservoir for the middle-ear cavity and are thought to be one of the sources for middle-ear aeration.² A decrease in the mastoid air cells was thought to be related to atelectatic ear diseases.^{3,4} However, the role of mastoid pneumatisation in success of tympanoplasty is a matter of debate and controversy and has not been fully discussed because only a few studies have looked at this issue. Therefore, the objective of our study was to investigate the effect of pre-operative mastoid pneumatisation on the success of tympanoplasty by analysing individual studies.

Materials and methods

Literature search

A comprehensive electronic search of PubMed Medline, Scopus, Web of Science and Cochrane Library was conducted in August 2020 for articles from 1990 to 2020. Only studies in English concerning the effect of mastoid pneumatisation on tympanoplasty success were included using a combination of the following key words: mastoid pneumatisation, tympanoplasty success, chronic suppurative otitis media, drum perforation and middle-ear aeration. Article selection and screening proceeded according to the search strategy based on Preferred Reporting Items for Systematic Reviews and Meta-analysis criteria. Cited references in the screened articles were also assessed for relevance to maximise sensitivity.

Study selection criteria

Over 235 articles were found. After removal of 71 duplicates, they were narrowed to about 164 articles. After exclusion of 61 non-relevant articles, 103 relevant articles were found. By application of inclusion criteria, five articles were found meeting the inclusion criteria and underwent the meta-analysis.

There were five articles (Table 1) that were included for further steps of data collection, analysis and reporting because they fulfilled the following inclusion criteria: they were published in English language, they were conducted on human patients, they were concerned with evaluating pre-operative mastoid pneumatisation on tympanoplasty success, they were not a laboratory study and they were not an opinion study.

Table 1. Included articles

Article	Patients (n)	Age (years)	Gender (male/female)	Type of study
Amer <i>et al.</i> ⁵ 2017	42	26.51	19/23	Prospective
Metin <i>et al.</i> ⁶ 2014	57	29.69	20/37	Prospective
Mohan <i>et al.</i> ⁷ 2015	80	Not available	Not available	Prospective
Sethi <i>et al.</i> ⁸ 2005	50	31.5	Not available	Prospective
Toros <i>et al.</i> ⁹ 2010	92	35	28 /64	Prospective

Table 2. Tympanoplasty success in well pneumatised mastoid

Study	Event (n)	Total (n)	Proportion (%)	95% Confidence interval	Fixed weight (%)
Amer <i>et al.</i> ⁵ 2017	36	42	85.714	71.461 to 94.572	23.5
Metin <i>et al.</i> ⁶ 2014	17	21	80.952	58.093 to 94.554	12.02
Mohan <i>et al.</i> ⁷ 2015	40	45	88.889	75.946 to 96.292	25.14
Sethi <i>et al.</i> ⁸ 2005	18	24	75	53.289 to 90.227	13.66
Toros <i>et al.</i> ⁹ 2010	35	46	76.087	61.233 to 87.414	25.68
Total (Fixed Effects)		178	81.493	75.096 to 86.839	100

Table 3. Heterogeneity tests for well pneumatised mastoid

Test for heterogeneity	Value
Cochran Q chi-square test	3.7685
Degree of freedom	4
Significance level	$p = 0.4382$
I^2 (inconsistency)	0.00%
95% Confidence interval for I^2	0.00 to 79.22

Outcome measures

Information was gathered from each individual study on the effect of pre-operative mastoid pneumatisation on tympanoplasty

success assessed by graft uptake and air–bone gap (ABG) improvement.

Data analysis

Statistical analysis was done using MedCalc® (version 19.1) statistical software. Studies included in the meta-analysis were tested for heterogeneity of the estimates using the following tests: Cochran Q chi-square test (a statistically significant test ($p < 0.1$) denoted heterogeneity among the studies) and I-square (I^2) index. Event rates were calculated for each study along with its 95 per cent confidence interval (95 per cent CI). Estimates from the included studies were pooled using both the DerSimonian Laird random-effects method and the Mantel–Haenszel fixed-effects method. Owing to the

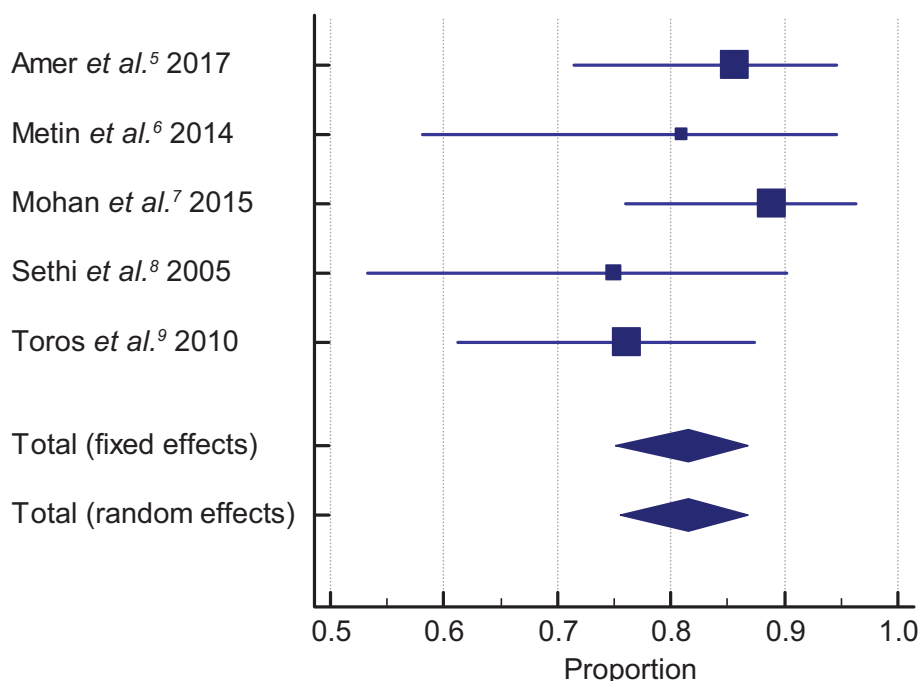


Fig. 1. Forest plot for tympanoplasty success in the well pneumatised mastoid group.

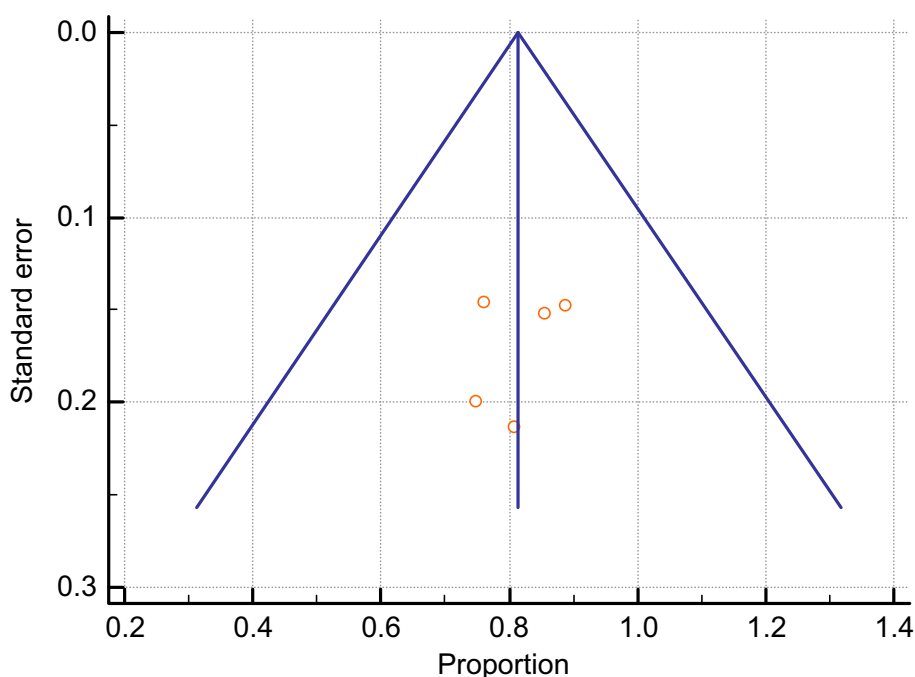


Fig. 2. Funnel plot for publication bias in the studies included for tympanoplasty success in the well pneumatised mastoid group.

Table 4. Tympanoplasty success in sclerotic mastoid

Study	Event	Total	Proportion (%)	95% Confidence interval	Fixed weight (%)
Metin <i>et al.</i> ⁶ 2014	23	36	63.889	46.221 to 79.178	37
Mohan <i>et al.</i> ⁷ 2015	25	35	71.429	53.696 to 85.365	36
Sethi <i>et al.</i> ⁸ 2005	20	26	76.923	56.352 to 91.026	27
Total (fixed effects)		97	69.629	59.628 to 78.430	100

Table 5. Heterogeneity tests for sclerotic mastoid

Test for Heterogeneity	Value
Cochran Q chi-square test	1.1937
Degree of freedom	2
Significance level	$p = 0.5505$
I^2 (inconsistency)	0.00%
95% confidence interval for I^2	0.00 to 94.38

presence of significant heterogeneity among the studies, the random-effects estimates were considered. Publication bias was examined. Two-sided p -value less than 0.05 denoted statistical significance.

Results

Meta-analysis for the graft success was performed using these 5 studies with a total number of patients (178) in the well pneumatised mastoid group (Table 2 and 3, Figures 1 and 2) and 3 studies in the sclerotic mastoid group with 97 patients (Table 4 and 5, Figures 3 and 4). Results showed no significant difference between the two groups: well pneumatised or sclerotic mastoid in the success rate of tympanoplasty (Figure 5).

Meta-analysis for improvement of ABG was not possible because of the small number of included studies, study heterogeneity and lack of clarity of patient follow up. As such, it was not possible to combine data from the different studies to gain

any meaningful aggregate descriptive statistics. Sethi *et al.* found that in the well pneumatised group 66 per cent had an ABG of 20 dB or less while in the poorly pneumatised mastoid group 80 per cent had an ABG of 20 dB or less, so there was no statistically significant difference between the two groups after eight weeks.⁸ Also, according to Metin *et al.*, there was no statistically significant difference between the well and poorly pneumatised groups in terms of audiometry results after one year of follow up.⁶

Discussion

Mastoid air cells are important in middle-ear physiology because they act as an air reservoir and regulator for middle-ear pressure.^{10,11} Their volume ranges between 5.8 and 12.2 ml as measured by computed tomography scan on healthy ears.¹² Mastoid air cell pneumatisation is associated with various factors involving overall growth of the skull, height of the individual, genetic factors and Eustachian tube function.¹³ There are many studies on the association of otological disorders such as congenital cholesteatoma and Ménière's disease with the degree of mastoid pneumatisation.^{14,15} However, a limited number of studies were available for the relationship between mastoid pneumatisation and the success rate of tympanoplasty.

Factors associated with the success of tympanoplasty are a matter of debate and controversy. Mastoid pneumatisation is one of these factors.¹⁶ To date, our study is the first meta-analysis study to look at this important issue in the literature.

Our study showed no significance difference between the two groups (well pneumatised group *vs* sclerotic mastoid

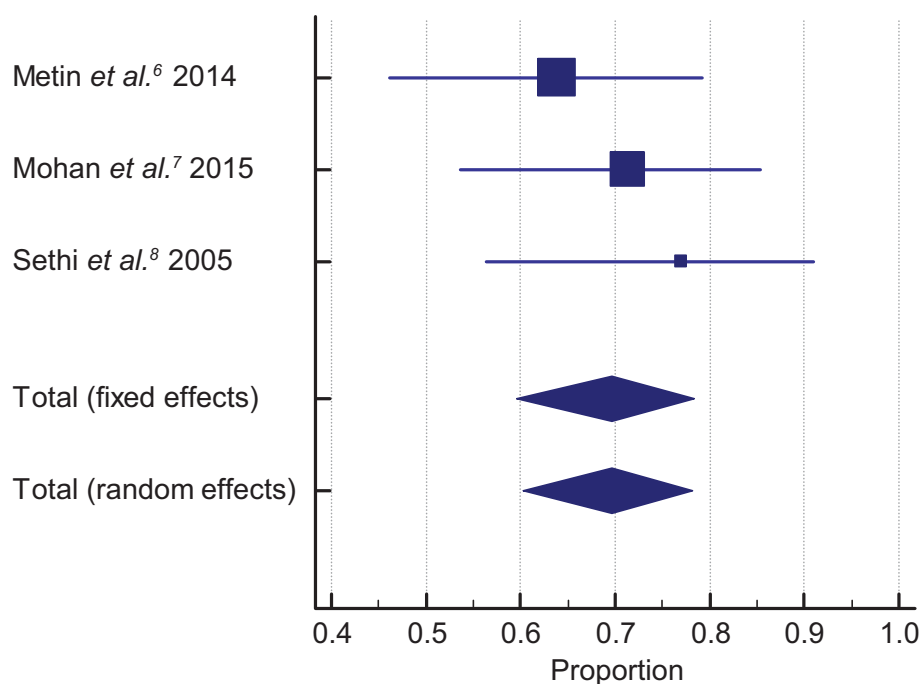


Fig. 3. Forest plot for tympanoplasty success in the sclerotic mastoid group.

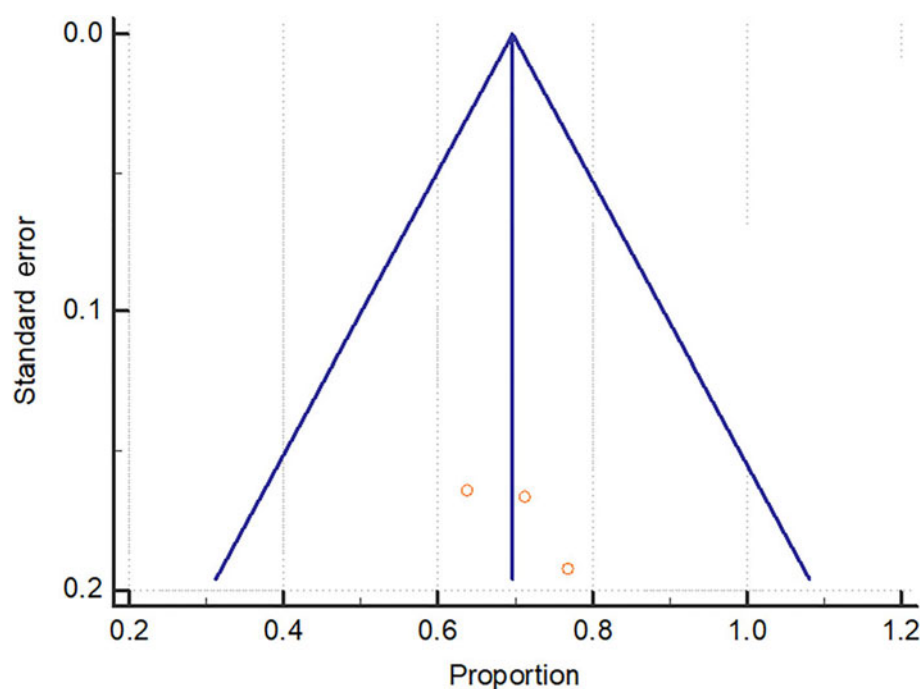


Fig. 4. Funnel plot for publication bias of tympanoplasty success in the sclerotic mastoid group.

group) in the graft uptake rate in tympanoplasty, although the well pneumatised group had a higher success rate. Our result agreed with Amer *et al.*⁵ (2017), Metin *et al.*⁶ (2014), Sethi *et al.*⁸ (2005), Toros *et al.*⁹ (2010) and Yegin *et al.*²⁴ (2016). However, Mohan *et al.*⁷ (2015) found that graft uptake rate in cases of tubotympanic chronic suppurative otitis media was better and statistically significant in well pneumatised mastoids when compared with sclerotic mastoids.

- There was no significant effect of mastoid pneumatisation on graft uptake rate
- There was no significant effect of mastoid pneumatisation on air–bone gap change post-operatively
- Further studies are needed to assess the relationship between mastoid pneumatisation and the success rate of tympanoplasty

In terms of ABG change, there was no significant difference between the well pneumatised group and the sclerotic mastoid group concerning ABG improvement in studies performed by Metin *et al.*, Sethi *et al.* and Toros *et al.*^{6,8,9}

Holmquist and Bergström preferred not to intervene with well pneumatised mastoid during surgery.¹⁷ Bonding advocated that problems with the mastoid cell system might be the cause of unsuccessful tympanomastoidectomy in children.¹⁸ However, Palva and Virtanen, Siedentop *et al.* and Gimenez *et al.* did not agree with that in their studies.^{19–21} Holmquist reported a success rate of 70 per cent with well pneumatised mastoid air cells as compared with a 57 per cent success rate with poorly pneumatised mastoid air cells.²² McGrew *et al.* supported performing mastoidectomy with tympanoplasty over performing tympanoplasty alone to

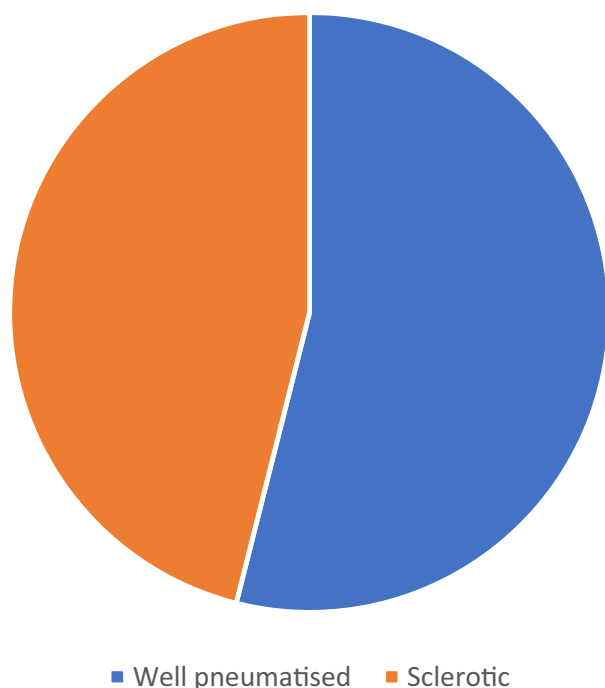


Fig. 5. Success rate in both the well pneumatised mastoid group and sclerotic mastoid group.

decrease the progression of disease and the need for surgical revision.⁴ Jackler and Schindler strongly supported mastoidectomy with myringoplasty in sclerosed mastoids.²³

Metin *et al.* observed that graft success in tympanoplasty was greater with diploic mastoiditis than pneumatic mastoids, so they suggested that there was no relationship between tympanoplasty success and the degree of mastoid pneumatisation.⁶ Balyan *et al.* concluded that mastoidectomy was not necessary for treatment of patients with non-cholesteatomatous chronic otitis media and that it added extra effort and risk, without giving better chance for graft success or functional hearing results.²⁵ Gimenez *et al.*²¹ found no relationship between myringoplasty results and the degree of mastoid pneumatisation. Recent data showed that a cavity would be of no benefit at all as it does not form a reliable pressure buffer.^{26,27} Yegin *et al.* concluded that the degree of mastoid pneumatisation did not affect the success rate of type 1 tympanoplasty.²⁴

Conclusion

Although the pneumatised group showed better graft uptake rate than the non-pneumatised group, there was no statistically significant difference between the two groups in the success rate of tympanoplasty.

Competing interests. None declared

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