




Is Cartilage Thickness Important in Cartilage Tympanoplasty? A Systematic Review and Meta-analysis

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Abstract Cartilage is used as a grafting material for tympanoplasty. The rigidity of the cartilage is the main concern. There are debates regarding slicing the cartilage when it is used as a graft. Therefore, this systematic review and meta-analysis aimed to compare the hearing results of full vs. partial-thickness cartilages in patients undergoing cartilage tympanoplasty. We systematically searched google scholar, PubMed, Cochrane, Ovid, Scopus, and gray literature including the references of the selected studies, and conference abstracts which were published up to 6 May 2020. The search syntax for identifying studies was: ((Cartilage) AND (tympanoplasty) AND (thickness)). The literature search found 1047 articles. After eliminating duplicates, 908 studies remained; from these, we excluded observational studies, reviews, case reports, and non-randomized trials, and 12 studies remained. Finally, only 5 articles were included for analysis. The pooled standardized mean difference (SMD) for the post-operative gap was -0.87 95% CI: $(-1.66, -0.08)$ ($I^2 = 87.1\%$, $p < 0.001$). The pooled SMD of the reduction in gap in the full-thickness group was 2.84 , 95% CI $(1.39-4.3)$, $I^2 = 93.2\%$, $p < 0.001$. The pooled SMD of the reduction in gap in the partial-thickness group was 4.02 , 95% CI $(1.97-6.02)$, $I^2 = 95.3\%$, $p < 0.001$. The pooled results of this systematic review showed that partial-thickness cartilage graft has better hearing outcomes than full-thickness in patients undergoing cartilage tympanoplasty.

Keywords Tympanoplasty · Cartilage · Fascia · Hearing

Introduction

Traditionally, skin, fascia, vein, perichondrium, and dura mater were used for tympanoplasty[1], while in 1595, tympanoplasty using cartilage as a grafting material was introduced by Utech which is indicated in patients with retraction pockets, recurrent perforations, and atelectatic ears.[2] Cartilage use has excellent results for the reconstruction especially in patients with middle ear pathology, and eustachian tube dysfunction [3]. One critical point in the case of cartilage tympanoplasty is the thickness of the cartilage which could affect hearing results [4]. Based on this point using cartilage, Zahnert et al. recommended the best thickness of the cartilage for tympanoplasty as 0.5 mm compared to the full-thickness[5], while Dornhoffer et al. reported better outcome in patients who underwent tympanoplasty using full-thickness cartilages [3].

There are controversies regarding using different cartilage thicknesses for patients who are candidates for cartilage tympanoplasty. Therefore, we designed this systematic review and meta-analysis to compare the hearing results of full vs. partial-thickness cartilage grafts in patients undergoing cartilage tympanoplasty.

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Methods

Literature Search

We systematically searched google scholar, PubMed, Cochrane, Ovid, Scopus, and gray literature including the references of the selected studies, and conference abstracts which were published up to 6 May 2020.

The inclusion criteria were:

1. Randomized clinical trials
2. The studies that compared the hearing results and the graft take in the type 1 cartilage tympanoplasty between full-thickness cartilage and partial-thickness cartilage

Exclusion criteria were: case reports, cohort studies, and case–control studies.

Search Strategy and Data Extraction

The search syntax for identifying studies was:

((Cartilage) AND (tympanoplasty) AND (thickness)).

Two independent researchers evaluated the studies and extracted the data. Data regarding the name of the first authors, publication year, number of cases in each group of the study, pre-operative and post-operative gap, hearing gain, graft take, surgical technique (endoscopic or micro-scopical), and method of cartilage slicing were extracted.

Risk of Bias Assessment

We evaluated the risk of potential biases using the Cochrane Collaboration for assessing the risk.[6]

Statistical Analysis

All statistical analyses were performed using STATA version 13.0 (Stata Corp LP, College Station, TX, USA). We used the inverse variance with random effects model.

The standardized mean difference (SMD) was calculated for comparisons. For the graft take variable, the pooled prevalence was calculated. Inconsistency (I^2) was calculated to determine heterogeneity.

Results

The literature search found 1047 articles that were assessed. After eliminating duplicates, 908 studies remained; from these, we excluded observational studies, reviews, case reports, and non-randomized trials. Finally, 12 studies remained. After the full-text evaluation, only 5 articles

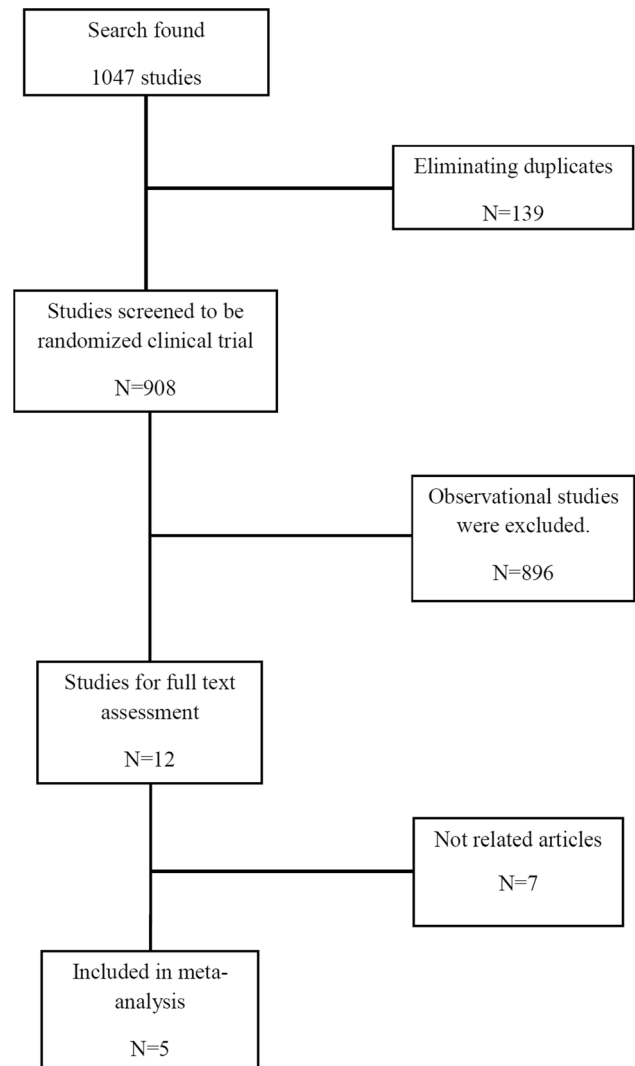


Fig. 1 Flow diagram summarizing the selection of the studies

were included for analysis (Fig. 1). The other 7 articles didn't compare full-thickness with partial-thickness and only used one type of cartilage in those clinical trials.

Included articles were published between 2007 and 2020 and the follow-up duration varied between 2 and 9 months (Table 1). Totally, 113 patients were evaluated in the full-thickness group (group A) and 114 in the partial-thickness group (group B).

Characteristics of the included articles are summarized in Table 1. Pre-operative and post-operative gap and reduction in the gap are shown in Table 2. The quality assessment of the included studies is also shown in Table 3.

The pooled SMD for the post-operative gap (group B–group A) was -0.87 95% CI: $(-1.66, -0.08)$ ($I^2 = 87.1\%$, $p < 0.001$) (Fig. 2).

The pooled frequency of graft take in group A (full-thickness) was 97%, 95% CI: $(94–100\%)$ ($I^2: 25\%$, $p = 0.25$) (Fig. 3).

Table 1 Characteristics of the included articles

First author	Publication year	Study duration	Follow up duration	Method of cartilage slicing	Surgical technique
Guindi ¹	2016	July 2014 and February 2015	6 months	Slicing the tragal cartilage with a surgical scalpel blade No. 11 while held between two glass slides	Not mentioned
Atef ⁴	2007	January 2003 and March 2004	8–9 months	The tragal cartilage disk was bisected to half of its thickness using a No. 15 scalpel under microscopic magnification	Microscopic
Sadek ⁷	2019	February 2017 to November 2017	3 months	Kurz® Precise Cartilage Splitter 0.5 mm thickness tragal cartilage obtained	Microscopic
Mokbel ⁸	2013	July 2004 to July 2010	Not mentioned	Partial thickness (0.2 mm) where thinning of the cartilage was done by a special instrument called Conchotome (Kurz Co. Germany)	Microscopic
Parelkar ⁹	2020	February 2014 to September 2015	2 months	The tragal cartilage was sliced to a partial thickness (~0.4 mm)	Endoscopic

The pooled frequency of graft take in group B (partial-thickness) was 94%, 95% CI: (87–100%) (I2:70.2%, $p = 0.01$) (Fig. 4).

The pooled SMD of the reduction in gap in group A (full-thickness) was 2.84, 95% CI (1.39–4.3), I2 = 93.2%, $p < 0.001$) (Fig. 5).

The pooled SMD of the reduction in gap in group B (partial-thickness) was 4.02, 95% CI (1.97–6.02), I2 = 95.3%, $p < 0.001$) (Fig. 6).

Discussion

To our knowledge, this is the first systematic review and meta-analysis evaluating the hearing results of full vs. partial-thickness cartilage in patients undergoing cartilage tympanoplasty type I.

The results showed that hearing results (post-operative gap) after implanting partial-thickness cartilage improved more significantly than the full-thickness group (The pooled SMD for the post-operative gap was -0.87 95% CI: ($-1.66, -0.08$)).

Two authors Guindi et al. and Mokbel et al.[1, 7] reported significantly better hearing outcomes in patients who had partial-thickness cartilage grafts than the full-thickness group, while the other three individual studies did not find significant difference regarding the hearing outcome (post-operative gap) [4, 8, 9]. The pooled results of this systematic review showed that partial-thickness cartilage graft has better outcomes than full-thickness.

The results also showed that the pooled frequency of graft-take in the full-thickness group was 97% and in the partial-thickness group was 94% which is indicative of good graft take in both groups. The frequency of graft-take in group A ranged between 88–100% in included studies

Table 2 Main findings of the included studies

	Group A Full thickness	Group B Partial thickness
<i>Guindi¹</i>		
Number	15	15
Pre-operative gap	30.15 ± 5.42	30.22 ± 6.49
Post-operative gap	20.44 ± 5.34	10.74 ± 4.29
Reduction in gap	9.71	19.48
Graft take	14 (93.33%)	14 (93.33%)
<i>Atef⁴</i>		
Number	28	29
Pre-operative gap	21.3 ± 3.72	22.07 ± 2.62
Post-operative gap	10.44 ± 2.21	10.28 ± 1.65
Reduction in gap	10.85	11.79
Graft take	27 (96.4%)	28 (96.5%)
<i>Sadek⁷</i>		
Number	15	15
Pre-operative gap	43.6 ± 11.8	40.5 ± 8.8
Post-operative gap	31.9 ± 8.9	27.3 ± 4.9
Reduction in gap	11.7	13.2
Graft take	14 (93.8%)	14 (93.8%)
<i>Mokbel⁸</i>		
Number	30	30
Pre-operative gap	29.3 ± 2.55	29.7 ± 2.74
Post-operative gap	13.8 ± 2.40	9.9 ± 2.08
Reduction in gap	15.5	19.8
Graft take	30 (100%)	30 (100%)
<i>Parelkar⁹</i>		
Number	25	25
Pre-operative gap	40.80 ± 7.46	39.40 ± 7.95
Post-operative gap	26.72 ± 8.08	26.40 ± 8.6
Reduction in gap	14.08	13
Graft take	22 (88%)	17 (68%)

Table 3 Quality assessment of the included studies

First author	Sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessor	Incomplete outcome data	Selective outcome reporting	Others
Guindi ¹	Yes	unclear	No	No	Unclear	Yes	Yes
Atef ⁴	Yes	unclear	Yes	Yes	Unclear	Yes	Yes
Sadek ⁷	Yes	unclear	No	No	Unclear	Yes	Yes
Mokbel ⁸	Yes	unclear	No	No	Unclear	Yes	Yes
Parelkar ⁹	Yes	unclear	No	No	Unclear	Yes	Yes

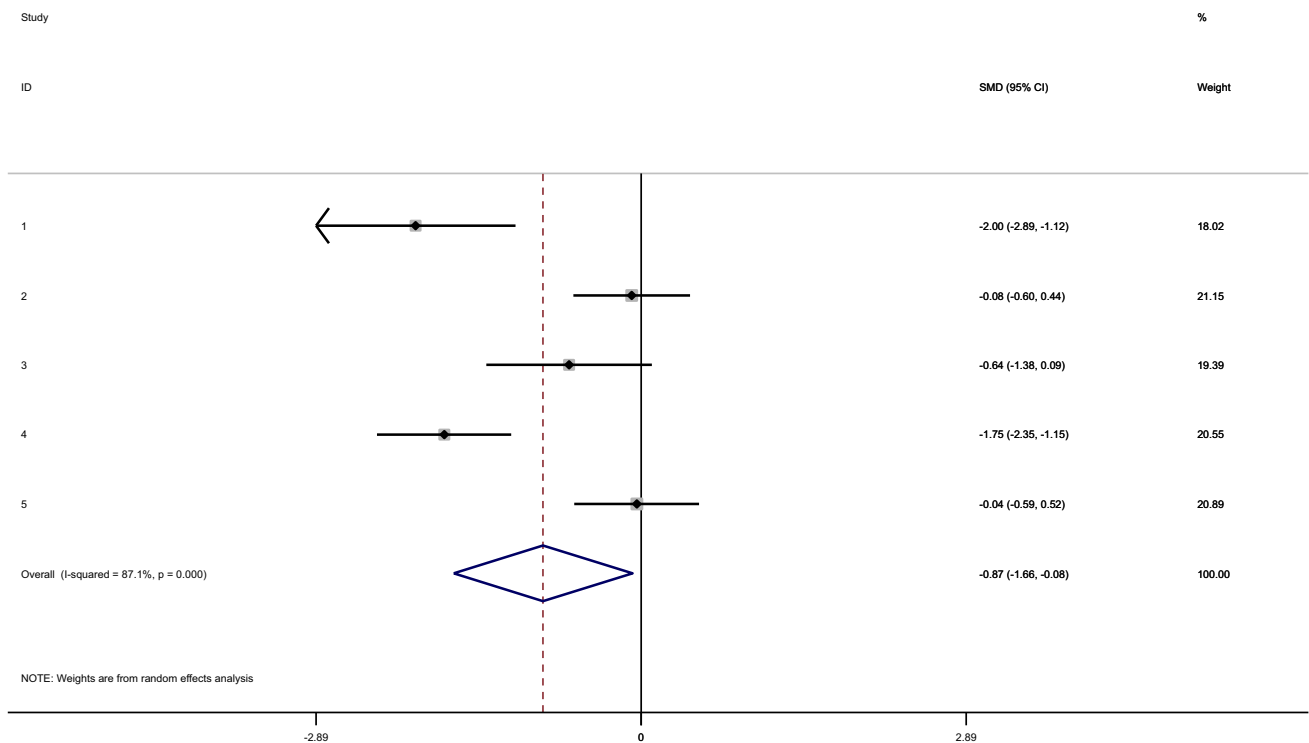


Fig. 2 The pooled SMD of the post-operative gap

and 68–100% in group B. This finding could be based on the rigid quality of the cartilage that prevents infection or middle ear pressure change [7].

Atef et al.[4] reported that most patients had subtotal perforation (20 in full-thickness and 19 in partial-thickness groups). In the full-thickness group, 6 patients had posterior perforation, and 2 patients had anterior perforation. Also, in the partial-thickness group, 9 patients had posterior perforation, and 1 patient had anterior perforation. The average size of the perforation was not exactly mentioned in the other studies.

One of the cautions in interpreting the results of this systematic review is the method of slicing and the thickness of the slices in the partial-thickness group. In previous

studies, some authors believed that applying a cartilage graft of 0.5 mm had better outcomes [5].

All included studies used tragal cartilage for full-thickness, and partial-thickness graft except for Mokbel et al.[7] that did not report where the cartilage graft was harvested from.

By comparing the hearing results of the fascia graft, full-thickness graft, and partial-thickness graft (0.5 mm), Nemade and Dabhokar found that the best balance between stability and acoustic sensitivity is observed in the partial-thickness graft group [10].

In another study, Murbe et al. reported better sound transmission properties in patients with partial-thickness cartilage grafts [11]. On the other hand, Atef et al. found

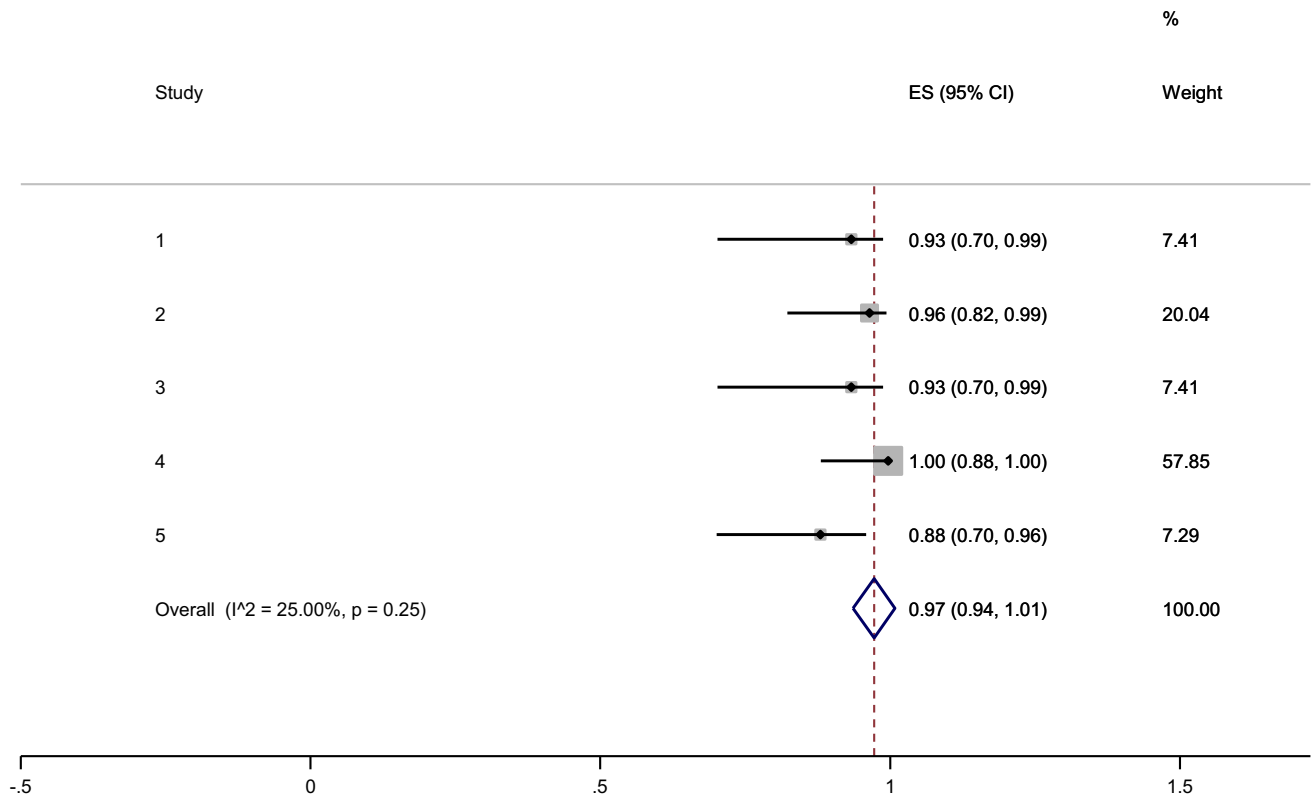


Fig. 3 The pooled frequency of graft take in group A (full thickness)

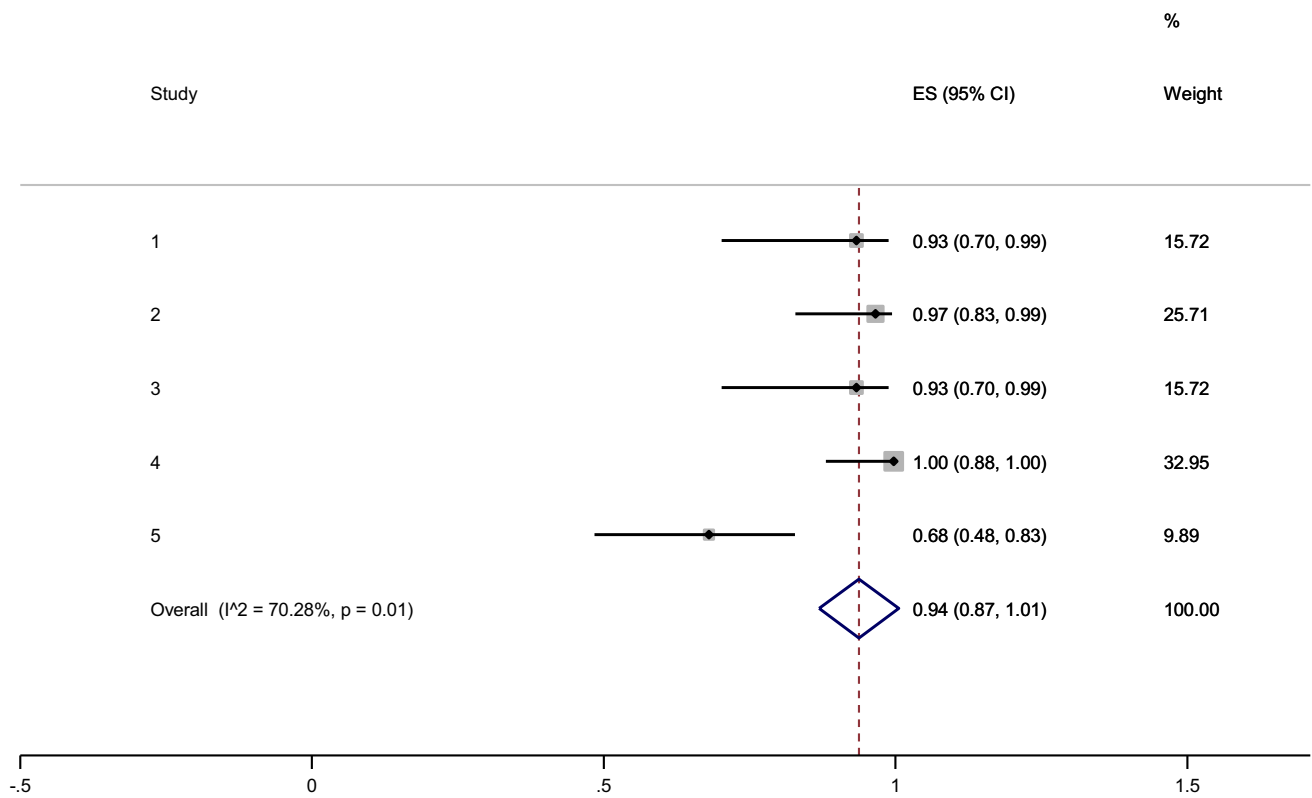


Fig. 4 The pooled frequency of graft take in group B (partial thickness)

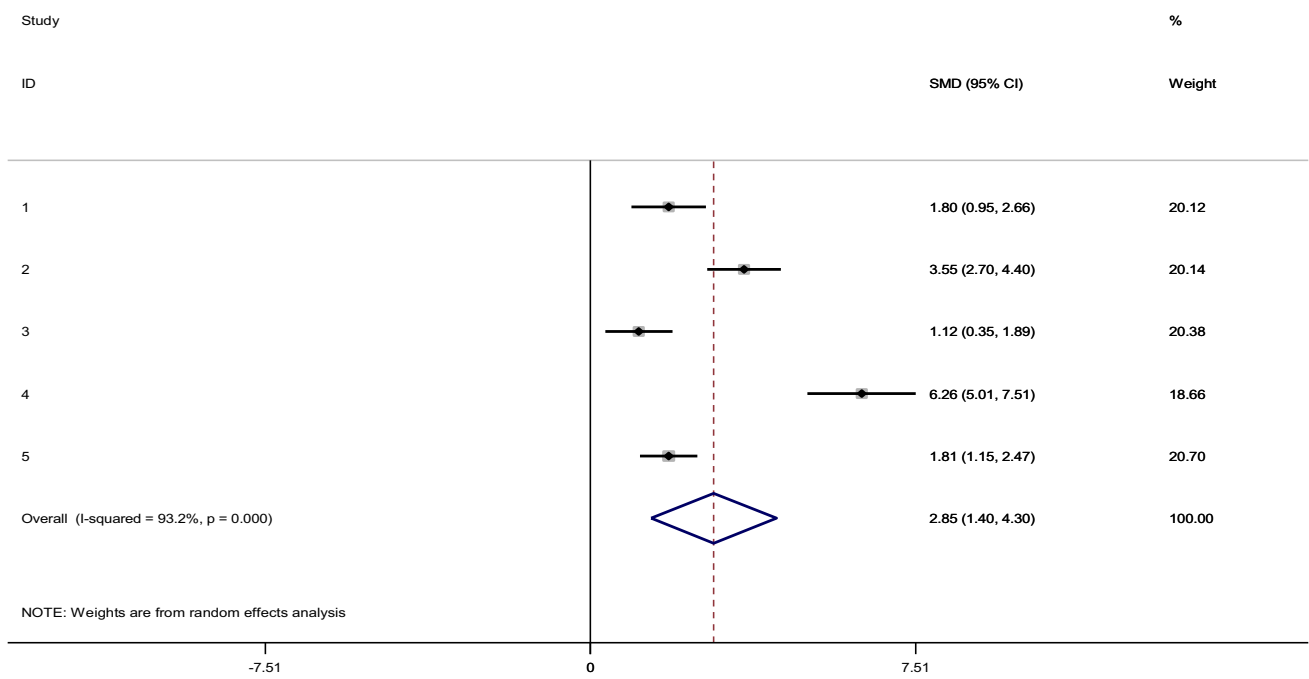


Fig. 5 The pooled SMD of the reduction in gap in group A (full thickness)

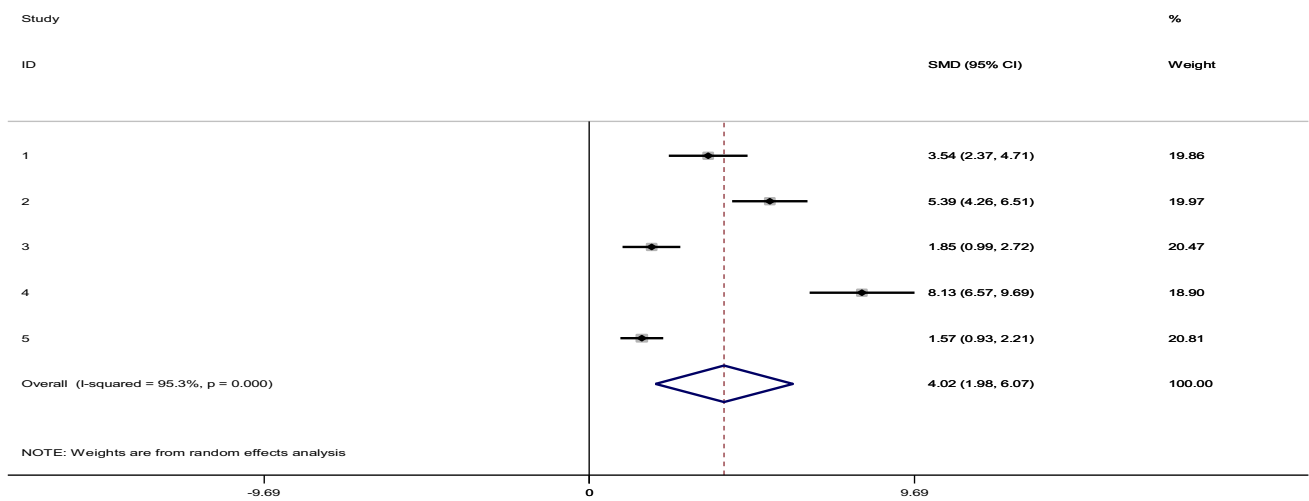


Fig. 6 The pooled SMD of the reduction in gap in group B (partial thickness)

that partial-thickness cartilages are not superior to full-thickness cartilages graft [4].

By following one thousand patients, Dornhoffer preferred the application of full-thickness of cartilages instead of partial-thickness as cartilage thinning will cause curves which would be difficult to use [3].

After the introduction of tympanoplasty by Wullstein and Zöllner, a wide range of grafts were used while temporalis fascia was the most acceptable graft [12, 13].

Previously, the beliefs about conductive hearing loss in patients who underwent cartilage tympanoplasty made its

usage difficult but the comparison of different grafts showed better hearing results or no inferiority [4].

Gerber et al. reported no superiority regarding the hearing results of cartilage versus fascia graft, while others reported superiority of cartilage grafts to other types of grafts in tympanoplasty [14–16].

The suggestion about slicing the cartilage due to hearing loss based on thick rigid cartilage use, makes the application of thinned cartilage grafts possible. In 2000, Zahnert et al. found that the best cartilage thickness was 0.5 mm

compared to 0.7–1 mm[5] while Lee et al. suggested cartilage thickness of 0.1–0.2 mm.[17]

This systematic review and meta-analysis have some limitations. The cartilage thickness was not the same in the partial-thickness group. Furthermore, the duration of the follow-up period was not the same in all studies and was sometimes too short. Also, the number of included studies was not too much.

Conclusion

The pooled results of this systematic review showed that partial-thickness cartilage graft has better hearing outcomes than full-thickness cartilage graft in patients undergoing cartilage tympanoplasty.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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