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Is Cartilage Tympanoplasty More Effective Than Fascia Tympanoplasty?

A Systematic Review

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Objective: A systematic review to compare the effectiveness of the use of cartilage (with or without perichondrium) with temporalis fascia used in tympanoplasty.
Data Source: The following databases were searched for relevant studies: MEDLINE, Embase, CINAHL, the Cochrane Library including the Cochrane Central Register of Controlled Trials, Google scholar, and the PubMed. There was no restriction as to the design or date of publication.
Study Selections: We selected randomized controlled trials (RCTs) and retrospective studies comparing cartilage and temporalis fascia tympanoplasty in relation to 2 outcomes: morphological and functional success. Initial search identified 2,091 publications. All titles and abstracts were reviewed by 2 of the authors, and 103 relevant articles were studied. However, only 14 studies met the inclusion criteria for this review. These included 3 RCTs, 10 retrospective studies, and 1 literature review.
Results: Three level 1 (RCTs) and 11 level 3 and 4 evidence-based studies were included (n = 1,475 patients). One RCT and 3 retrospective studies showed a statistically significant better morphological success, that is, intact ear drum with cartilage graft with or without perichondrium. There was, however, no statistically significant difference between cartilage and temporalis fascia tympanoplasty regarding function, namely, hearing outcome. The need for revision rates was approximately 10% with cartilage and 19% with fascia tympanoplasty.
Conclusion: Tympanoplasty using cartilage with or without perichondrium has better morphological outcome than tympanoplasty using temporalis fascia. However, there was no statistically significant difference in hearing outcomes between the 2 grafts. **Key Words:** Cartilage—Myringoplasty—Temporalis fascia—Tympanic membrane perforation—Tympanic membrane surgery—Tympanoplasty.
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Since the introduction of tympanoplasty by Wullstein in 1952 (1) and Zoellner in 1955 (2), different types of graft materials have been used to reconstruct the tympanic membrane. These include temporalis fascia, periostia, perichondria, cartilage, vein, and fat (3). Temporalis fascia remains the most commonly used material for tympanic membrane reconstruction, with a success rate of 93% to 97% in primary tympanoplasties (4). However, during the last decade, there has been a renewal of interest in the use of cartilage as an alternative to more traditionally used temporalis fascia graft. The rigidity and stiffness of cartilage play an important role in resistance against retraction, although there have been concerns that these may affect adversely acoustic transfer and the hearing.

There has been an increase in the use of cartilage in tympanoplasty with surgeons reporting improved outcomes when compared with temporalis fascia used alone (5). However, to date, there have been no published systematic reviews in the Cochrane, MEDLINE, and Embase databases to support such a view. This systematic review was performed to address this deficiency.

The aim of this review was to compare the effectiveness of the use of cartilage (with or without perichondrium) and temporalis fascia used on its own in tympanoplasty in relation to 2 outcomes: morphological (intact ear drum) and functional success (improved hearing).

The choice of graft material normally depends on the surgeon's experience and his/her personal choice. There are several factors that affect the type of material used, including the type of procedure, anesthetic requirements, the size of the perforation, the status of the tympanic membrane, and the effect of the eustachian tube on the

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TABLE 1. *Inclusion and exclusion criteria*

Criteria	Inclusion	Exclusion
1. Period	All articles No restriction as to the date MEDLINE/PubMed/ CINAHL/Embase Google scholar/ Cochrane library	None
2. Language	English	Non-English
3. Age of subjects	Adult and children	None
4. Type of article	Randomized controlled trials/retrospective studies	None
5. Characteristics of studies	1. Studies that compare cartilage and fascia tympanoplasty	1. Studies that compare other graft materials in tympanoplasty such as fat, bone, vein, and others
	2. Tympanoplasty with or without mastoid surgery	2. Studies that include obliteration of mastoid cavity with bone or other type of grafts
	3. Sample size: ≥30 patients	3. Revision surgery

graft material. A more resilient material may prevent tympanic membrane retraction.

METHODS

A comprehensive search was conducted using MEDLINE, Embase, CINAHL, the Cochrane Library including the Cochrane Central Register of Controlled Trials, Google scholar, and PubMed (the U.S. National Library of Medicine) database. The key words used were tympanic membrane perforation, tympanic membrane surgery, tympanoplasty, myringoplasty, cartilage, and fascia (and their synonyms). Only English-language literature was included, but there was no restriction as to the design or date of publications. The date of final search was August 1, 2011. The inclusion and exclusion criteria are shown in Table 1.

The titles and abstracts were screened independently by 2 researchers (M. H. S. and I. K.) to identify potentially relevant articles. The full-text article was then obtained. The bibliography was also searched for other potentially relevant articles. All articles that met the inclusion criteria were reviewed for data extraction and quality assessment. Data extracted from each article included patient demographics, study design, type of surgical intervention performed, length of follow-up, and outcomes measured. Literature was appraised using the critical appraisal tools, and evidence was based on the levels of evidence as defined by the Oxford Centre of Evidence-Based Medicine (6).

The outcome measures include morphological (graft take), that is, complete closure of tympanic membrane after surgery with no evidence of perforation, atelectasis, atrophy, lateralization, and otorrhea and functional success or improvement of hearing after surgery using pure-tone audiometry.

RESULTS

The literature search results are shown in Figure 1. A total of 2,091 articles were obtained from the initial literature search. After reviewing the citations and abstracts, 103 were deemed to be potentially relevant, and the full texts of these articles were reviewed. A further 63 articles were excluded; of these, 52 studies did not meet the inclusion criteria, 5 were in a foreign language (Turkish, Polish, and Chinese), and 6 studies had a sample size fewer than 30 patients. All excluded articles were retrospective studies. After further review of the remaining articles (n = 40), 26 articles were found to be duplicate and therefore removed. A total of 14 studies were available for final review and analysis; of these, 3 were randomized controlled trials (RCTs), 10 were retrospective studies, and 1 was a literature review. The summary of the results of the literature is shown in Table 2.

The most recent RCT by Yung et al. (7) published in 2011 compared medium-term results of cartilage and temporalis fascia myringoplasty using underlay technique. Their study included 38 patients with tympanic membrane perforations of more than 50%. The mean follow-up period for both groups was 24 months. In addition to myringoplasty, 15 patients had coexisting middle ear disease and underwent additional procedures such as mastoidectomy. In 18 patients, ossiculoplasty was performed for ossicular erosion; thus, various grades of tympanoplasty were performed in this study.

In this study, the graft take rates of fascia and cartilage grafts at 24 months were 84.2% and 80%, respectively. The postoperative air-bone gaps and hearing gains at 24 months were 16.97 and 13.63 dB, respectively, in the fascia group and 20.63 and 12.60 dB, respectively, in the cartilage group. However, the authors did not find any statistical significant difference between cartilage and temporalis fascia with regard to graft take rate and postoperative hearing improvement.

Cabra and Monoux' (8), in 2010, reported the results of their RCT comparing the efficacy of cartilage palisade tympanoplasty and temporalis fascia graft using the underlay technique. Their study included 123 patients with perforations of more than 25%, and the mean follow-up for both groups was 24 months. The primary outcome measure was morphological success including the absence of perforation, atelectasis, atrophy, lateralization, otorrhea, and blunting. The secondary outcome measure was the functional (hearing) result. They detected better morphological success in the cartilage tympanoplasty group (82.26%) than in the fascia group (64.4%) at 24 months, which was statistically significant. However, this study showed no statistically significant difference in functional outcomes (hearing) in both groups.

The RCT by Mauri et al. (9) was published in 2001. Their study evaluated the efficacy of a modified inlay cartilage myringoplasty with a conventional underlay fascia myringoplasty. A total of 70 adult patients having tympanoplasty with tympanic membrane perforation of less than 50% were included. Patients with coexisting middle ear disease were excluded in their study. They compared the short-term results of inlay cartilage and fascia grafts by studying the graft take rates at 1 month and the hearing outcomes at 2 months. The authors found no statistically

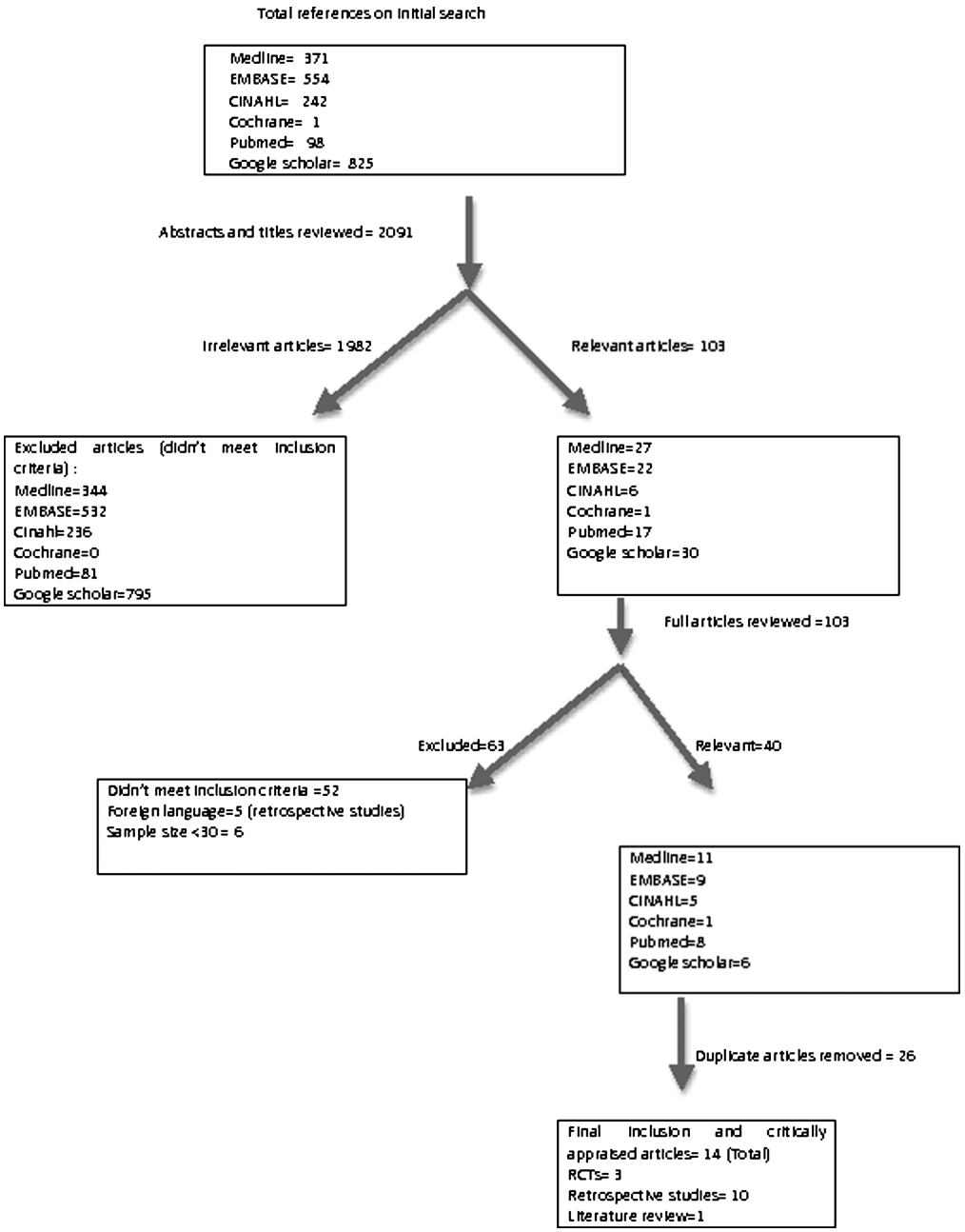

FIG. 1. Summary of the literature search.

significant difference in either the graft take rates or the hearing outcomes.

Of the 10 retrospective studies, 3 (2 studies in pediatric-age groups) showed statistically significant better morphological success with cartilage tympanoplasty (11,13,16). As to the hearing outcomes, these studies did not show any statistically significant difference in hearing gain with either of the graft materials, and the results were considered as comparable.

Nicholas and O'Reilly (10) published in 2010 a literature review addressing the question, ''Is cartilage preferable to fascia myringoplasty in children?'' Their review included 4 retrospective studies on the pediatric-age group. Their review reported a higher success rate of cartilage tympanoplasty in comparison of fascia tympanoplasty, based on 4 studies of level 3 and 4 of evidence. They suggest that the use of cartilage graft in pediatric myringoplasty has an additional advantage of improvement in long-term closure of the tympanic membrane in comparison with the fascia tympanoplasty despite the paucity of high level of evidence to support their views.

TABLE 2. *Summary of articles comparing the outcomes of cartilage and temporalis fascia tympanoplasty*

Authors	Cartilage (n; intervention)	Fascia (n; control)	Age (yr), mean/range	Follow-up (mo)	Case mix	Level of evidence	Outcomes (cartilage versus fascia)
Yung et al. (7)	18 cartilage	20	7–72 (42)	24	Perforations >50% Underlay technique Myringoplasty +/− (mastoidectomy, ossiculoplasty)	1	Graft take rate, cartilage (80%) versus fascia (84.2%) Mean hearing gain, cartilage (912.60 dB) versus fascia (13.63 dB) Postoperative air-bone gap of ≤20 dB, cartilage (41.6%) versus fascia (64.4%) No statistically significant difference in graft take or hearing
Cabra et al. (8)	64 cartilage palisade	59	39	24	Perforations >25% Underlay technique +/− mastoid surgery, ossiculoplasty	1	Higher morphological success in cartilage (82.3%) than fascia (64.4%) i.e., absence of retraction, atrophy, lateralization, anterior blunting, and otorrhea ($p = 0.03$) Postoperative air-bone gap of ≤20 dB, cartilage (62.5%) versus fascia (73.9%) No significant difference in hearing
Mauri et al. (9)	34 butterfly cartilage	36	15–65	1 (graft take) 2 (hearing)	Perforations <50% Type 1 tympanoplasty Inlay technique	1	Graft take rate, 88.2% cartilage versus 86.1% fascia Postoperative air-bone gap of ≤20 dB, 94.1% cartilage versus 97.2% fascia No significant difference in graft take or hearing between 2 groups
Onal et al. (5)	44 cartilage perichondrium	48	>15	12	Type 1 tympanoplasty	3	Graft take rate, cartilage 93.2% versus fascia 89.6% ($p = 0.173$) Better postoperative air-bone gap in cartilage ($p = 0.027$)
Demirpehlivan et al. (11)	Cartilage = 19 Perichondrium + cartilage = 34	67	>15	12	Subtotal perforations Type 1 tympanoplasty Underlay technique	4	Higher graft take rate in perichondrium cartilage (97.6%), cartilage only (78.95%), and fascia (80.6%), statistically significant ($p = 0.006$) No difference in hearing among 3 groups
Ulku (12)	23 Perichondrium + cartilage	17	39.7 (cartilage) 32.4 (fascia)	14.2 21.6	Type 1 tympanoplasty	4	Graft take, cartilage 91.3% versus fascia 88.2% Hearing gain postoperatively, cartilage 12.3 versus fascia 12.7 No significance difference between 2 groups
Albirmawy (13)	40 Perichondrium + cartilage (ring graft)	42	<16	12	Type 1 tympanoplasty All perforations	3	Higher morphological success rate in cartilage (95%) than fascia (76.2%), $p < 0.01$ Mean postoperative air-bone gap, 10.95 ± 2.12 dB in cartilage versus 12.73 ± 8.97 in fascia No significant difference in hearing between 2 groups

Yetiser and Hidir (14)	47 cartilage	66	25.6 (fascia) 26.6 (cartilage)	36	Myringoplasty +/− mastoidectomy Perforations >50%	3	Graft take not measured Postoperative air-bone gap, 14.2 ± 7.7 dB cartilage versus 19.7 ± 12.0 dB fascia Air-bone gap significantly better in cartilage group
Gamra et al. (15)	90 cartilage	290	10–72	24	Type 1 tympanoplasty	4	Anatomic success 97.7% in cartilage versus 96.9% in fascia Closure of air-bone gap to within 10 db was seen in 48.8% the cartilage group, whereas in the fascia group. this was only in 16.2% No significance difference between 2 groups
Ozbek et al. (16)	28 cartilage palisade	31	<16	12	Type 1 tympanoplasty Perforations <25%	4	Higher graft take rate in cartilage (100%) than fascia (70.2%), $p = 0.008$ Postoperative air-bone was 10.33 ± 1.87 dB in cartilage and 11.25 ± 9.5 dB No significant difference in hearing
Kazikdas et al. (17)	23 cartilage palisade	28	27.6	18.7	Type 1 tympanoplasty Perforations >50% Intact ossicles	3	Graft take rate, 95.7% cartilage versus 75% fascia Mean postoperative air-bone gap, 17.3 dB cartilage versus 20.2 dB fascia No significant difference in graft take or hearing between 2 groups
Couloigner et al. (18)	59 inlay butterfly cartilage	29	<16	12	Type 1 tympanoplasty Nonmarginal perforations	4	Graft take rate, 71% cartilage versus 83% fascia Postoperative hearing at 2 kHz, 14 ± 10 dB cartilage versus 13 ± 6 dB fascia No difference in graft take rate or hearing between 2 groups
Al lackany and Sarkis (19)	Tragal perichondrium = 50 Cartilage + perichondrium composite = 90	110	10–60	6	Type 1 tympanoplasty Intact ossicular chain central, subtotal, and total perforations	4	Graft success rate, 92.3% composite graft, 88% perichondrium. and 80% fascia, statistically significant only for total perforations Better postoperative air-bone gap with perichondrium and composite graft in total and subtotal perforations Whereas fascia was better in central perforations (no p value available)

DISCUSSION

This systematic review highlights the interesting and sometimes conflicting evidence in the use of the 2 commonly used graft materials, that is, temporalis fascia and cartilage with or without perichondrium in tympanoplasty. The limitations of this literature review were the exclusion of a few articles, which were in a foreign language, owing to the lack of interpreter expertise. However, the authors believe that sufficient evidence has been accumulated in providing adequate evidence to compare the 2 graft materials used in tympanoplasty. The review included 3 RCTs, 10 retrospective studies (of which 7 were predominantly for adults whereas 3 were for children), and 1 literature review.

In general, the overall success rate of tympanoplasty has been approximately 80%. Two of the 3 RCTs show similar results between cartilage and fascia tympanoplasty both morphologically and audiologically (7,9). However, Cabra and Monoux' (8), in their RCT, did show better morphological results with cartilage tympanoplasty, which is statistically significant. However, there was statistically no significant difference seen in the hearing levels after surgery in either group. As far as the retrospective case series were concerned, 3 studies (1 in adult and 2 in children) show better morphological success with cartilage tympanoplasty. These results were statistically significant (11,13,16). The morphological success seemed to be more consistent with the use of cartilage and perichondrium composite grafts. The case series did not show any statistical difference in hearing outcome with either of the graft materials.

Three articles compared the 2 graft materials in children alone. This differentiation is important because, in the pediatric group, the eustachian tube has a significant role on the success of myringoplasty. Two of these studies (13,16) show better morphological outcome with the use of cartilage when compared with fascia grafts. This would make a strong argument because one of effects of the eustachian tube dysfunction in the pediatric population is the negative pressure in the middle ear cavity, which can cause retraction of the tympanic membrane with resultant failure of myringoplasty. The effect of this negative pressure can be counteracted by the use of cartilage, which, because of its size and thickness, is more stiff and resilient when compared with temporalis fascia. The main concern that has been raised by clinicians in the past is that cartilage can have a negative impact on the hearing mechanism reducing hearing levels post operatively. However, studies performed in pediatric and adults do not support this claim. Thus, it would seem a sensible option to use cartilage in the pediatric population.

In an experimental study, Zahnert et al. (20) looked at the acoustic transfer characteristics of cartilage of varying thickness and its mechanical deformation when exposed to fluctuations of atmospheric pressure. Cartilage specimens from cadavers with various thickness levels were tested for acoustic transfer. Tragal and conchal cartilage were compared to see which was better; however, there was no statistical difference between these 2 types of cartilage. Their study also showed that reducing the thickness of cartilage to a thickness of 500 μm or less resulted in an acceptable acoustic transfer loss when compared with the tympanic membrane. The authors concluded that both tragal and conchal cartilage materials are useful for the reconstruction of tympanic membrane from the perspective of their acoustic properties. Reducing the cartilage size to 500 micrometer is regarded by the authors as a good compromise between sufficient mechanical stability and providing adequate and comparable hearing levels when compared with normal tympanic membrane.

This argument is supported by a clinical study conducted by Kazikdas et al. (17). The authors compared palisade cartilage with temporalis muscle fascia tympanoplasty in a comparative study in a homogenous group of patients. They compared medium-term outcomes for patients with large perforations (>50%). The cartilage strip thickness used was as thin as 0.5 mm. They detected a higher morphological success in the cartilage group (95.7%) than in the fascia group (75%). This was statistically not significant but close to the significant level ($p = 0.059$).

Interestingly in their RCT, Mauri et al. (9) used local anesthetic for transcanal cartilage tympanoplasty. This was found to be as effective as temporalis fascia tympanoplasty under general anesthesia. This showed a significant reduction in operative costs, operating times, and hospital stay. In their review, a meta-analysis has not been conducted owing to the presence of heterogeneity in the included studies.

This review has shown that cartilage graft is more successful in morphological or anatomical outcomes. We postulate that rigidity and stiffness of cartilage may have a role in resistance against retraction and provide stability and a reduced failure rate. That there is no statistically significant difference in hearing outcomes between the 2 grafts may be explained by the fact that a perforation on the tympanic membrane reduces the surface area of the membrane available for sound pressure transmission. This results in impaired sound transmission to the ossicular chain and a conductive hearing loss. After successful repair of the perforated tympanic membrane with either cartilage or fascia, the hearing mechanism will regain sound transmission equally, provided that care is taken in the use of cartilage.

CONCLUSION

This systematic review of the available literature has shown that both cartilage and temporalis fascia grafts used in tympanoplasty give equal and comparable functional results (hearing improvement). However, there is level 1 and level 3 and 4 evidence to show better morphological results (intact ear drum) with the use of cartilage graft with or without perichondrium.

On the basis of the evidence evaluated, cartilage tympanoplasty can be safely used in the reconstruction of

tympanic membrane perforations in both adult and pediatric patients.

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