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Comparative study of tympanoplasty type I using periosteum versus tragal cartilage with perichondrium

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Abstract

Background: Various grafting materials and different techniques have been used for myringoplasty. The aim of the study was to compare the result of tympanoplasty in patients with safe-type chronic suppurative otitis media using periosteum versus tragal cartilage with perichondrium grafts through pre- and postoperative clinical and audiological evaluation.

Results: There was statistically significant difference for mean air-bone gap for group A ($23.4 \text{ dB} \pm 0.03 \text{ SD}$) when compared to group B ($19.4 \text{ dB} \pm 4.2 \text{ SD}$) with P value 0.103. Also, there was statistically significant difference in the hearing gain in group A after 6 months ($25.53 \text{ dB} \pm 6.26 \text{ SD}$) when compared to group B ($19.63 \text{ dB} \pm 9.76 \text{ SD}$) and the P value was 0.003. Graft taken was superior in the periosteal group (95%), compared to the cartilage grafts (90%).

Conclusion: Tympanoplasty with periosteal graft showed better hearing results and high rates of graft taken than tragal cartilage grafts.

Keywords: Cartilage graft, Periosteal graft, Tympanoplasty, Clinical and audiological assessment

Background

Perforations in the tympanic membrane are commonly due to middle ear infections or trauma. Surgical management of perforation and hearing restoration by myringoplasty is needed if the perforation fails to heal by conservative therapy. Biological graft materials act as a scaffold of tissue matrix when applied to seal the perforation. Autologous graft materials used in myringoplasty include vein, fat, fascia lata, temporalis fascia, periosteum, perichondrium, and cartilage. Materials vary regarding their ease of harvesting, preparation time, placement ease, viability, graft uptake, and hearing improvement [1].

Hearing loss in chronic suppurative otitis media (CSOM) with inactive mucosal disease with central perforation has been challenging to the otologist for many

years because of its morbidity, which needs early surgical intervention [2].

Since the first description of tympanoplasty, clinicians had attempted to reduce the frequency of complication. The selection of surgical techniques is directed by the pathology encountered in case of severe tympanic membrane retraction, atelectasis, or perforation [3].

Periosteum grafts have advantages over both temporalis fascia and cartilage grafts in that it is thinner than cartilage and thicker than fascia, allowing it to be used in cases of eustachian tube dysfunction, active ear discharge, or revision surgery with better hearing gain than thick cartilage [4].

The use of cartilage in middle ear surgery is not a new concept, but the last decade has shown a renewed interest in this material as an alternative to more traditional grafting materials for tympanic membrane reconstruction. Previously, cartilage was used in the management of retraction pockets and recently for the reconstruction of the tympanic membrane perforations [5].

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Aim of work

The aim of the study was to compare the outcomes of tympanoplasty type I using periosteum and tragal cartilage with perichondrium grafts in safe type chronic suppurative otitis media through clinical and audiological assessment pre- and postoperative.

Methods

The study was done on 80 patients with safe type CSOM, selected from ENT outpatient clinic in the period from October 2017 to December 2019. All patients had been fully investigated and followed up. Forty patients operated with periosteum grafting, while the other 40 patients operated with tragal cartilage with perichondrium grafting. Peri- and postoperative audiological assessments were done 2 and 6 months.

Inclusion criteria

Patients' ages ranged from 14 to 45 years. Both males and females are equally distributed. Safe type of chronic suppurative otitis media with small, medium, and large dry perforations were included in the study.

Exclusion criteria

Unsafe type of chronic suppurative otitis media, conductive hearing loss greater than expected for the size of perforation. Small perforation (16–25 dB), medium perforation (26–40dB), and large perforation (40–50dB); previous ear surgery; ossicular chain pathology; diabetes mellitus; superimposed otomycosis; hematologic disorders; associated otitis externa; considerable nasal pathology, e.g., nasal polypi, deviated septum, and chronic nasopharyngitis; and poor general condition.

The patients were subjected to the following:

1. History:

- Personal history (name, age, sex, occupation, special habits as smoking).
- Patient complaint including onset, course, and duration of the complaint.
- Present history, considering ear symptoms: earache, discharge, HL, tinnitus, vertigo, headache, facial nerve paralysis, nasal complaints.
- History of ear disease, trauma, operations, ototoxic drugs, and general disease as diabetes mellitus and fever. History of allergy, heart disease, facial nerve paralysis.

2. Complete otorhinolaryngological examination:

A- Otologic examination:

- Auricle and external auditory canal examination.
- Otoscopic examination of TM (site, size, and shape of perforation).

B- Microscopic examination of remnants of TM, ossicular chain, and mucosa of middle ear.

C- Nasal examination:

- Nasal speculum for any nasal problems.
- Nasal endoscopy to exclude nasal or nasopharyngeal pathology.

D- Oral examination for postnasal discharge or any oropharyngeal problems.

3. Investigations:

A- Basic audiological assessment:

- *Pure tone audiometry* for air conduction thresholds at octave frequencies between 250 and 8000 Hz, also for bone conduction thresholds at frequencies 500–4000 Hz.
- *Speech audiometry*, with speech reception threshold (SRT) using Arabic Spondee words for adults [6] and word discrimination scores (WDS %), using Arabic phonetically balanced words for adults [7].
- *Immittancemetry* using single frequency tympanometry (226 Hz) to assess the ME function, volume of external canal, and Eustachian tube function.

Pre- and postoperative audiological evaluations were done in local manufactured sound-treated booth using Interacoustic AD 40 for pure tone audiometry and Interacoustic AT235 for tympanometry, both equipment's from Denmark.

B- Routine laboratory investigations: complete blood count, blood urea and serum creatinine, blood sugar, prothrombin time and concentration, and liver function tests.

4. Medical treatment: to control infection and get satisfactory dry perforation.

5. Surgical intervention: 80 patients were subjected to tympanoplasty type I through postauricular approach and classified into 2 groups according to the type of grafting materials used during surgery

❖ Group A (periosteum graft group): included 40 patients, 12 males and 28 females.

❖ Group B (tragal cartilage with perichondrium graft group): included 40 patients, 16 males and 24 females.

Surgical technique

General anesthesia was used for all patients. The ear canal must be viewed throughout its length while the surgeon is sitting comfortably. The skin was cleaned and degreased using povidone-iodine and allowed to dry. The postauricular region is injected with 1:200,000 epinephrine solution. The external auditory canal is flushed with isopropyl alcohol or povidone-iodine solution and then sterile saline. Sterile sponges are used to dry the auricle [8].

Postauricular approach was used to access the tympanic membrane and middle ear. The grafting procedure was performed by over underlay fashion by placing the graft over the malleus and under the annulus. Gel foam was used to support the graft and packed gel foam at external auditory canal at the end of the operation. Postauricular incision 0.5 cm behind the postauricular crease is done; a fine dissector is used to dissect the skin from the bony wall of the posterior canal. The dissector is directed toward the bony canal wall to avoid laceration of the skin of the canal [8].

Group A (periosteum graft group)

After postauricular incision was made, the muscular tissue and the aponeurotic tissue were elevated in the conventional manner to expose the periosteum over mastoid bone (Fig. 1) [8].

After exposure of periosteum, the remnants of muscle fibers were removed using a blunt dissector until a thin layer of periosteum appear. Periosteum (about 15 mm ×

20 mm) is harvested from mastoid cortex below linea temporalis to tip of mastoid. Then, incision was taken at the posterior edge of periosteal flap and dissected from mastoid bone using sharp dissector or periosteal elevator. The graft was sufficiently extensive to cover all the tympanic membrane perforation area and entered partially in contact with the bony wall of the external auditory meatus. The edges were trimmed, and the most appropriate shape was given to it before application of the graft over the middle ear [8].

Special care was taken that its periphery stayed in close contact with the edges of the skin in the external auditory canal as far as the dissection was conducted when removing the outer cutaneous layer of the drum. In this way the epithelium will rapidly cover the surface of the graft. Small pieces of gel foam soaked in saline were used to support the graft and for hemostasis [8].

Evaluation of the periosteum graft

The first week after its placement, the graft was covered with a thin whitish coat of fibrin which must not be disturbed when removing the pack. One month later, the graft appeared opaque, reddish, and completely adapted to the region and covered with epithelium. Two months later, it was slightly thinner, the reddish color has disappeared, and the graft acquired the characteristic shine of a normal tympanic membrane [9].

Group B (tragal cartilage with perichondrium group)

Tragal cartilage with perichondrium was used in all cases. It was harvested through a skin incision on the medial side of the tragus. The lateral 2-mm portion of the tragal cartilage was left intact in the dome of the tragus for cosmetic appearance. The cartilage with attached perichondrium was dissected medially from the overlying skin and soft tissue by spreading a pair of sharp scissors in a plane that was easily developed superficial to the perichondrium on both sides. At this point, in order to maximize the length of harvested cartilage, it is necessary to make an inferior cut as low as possible. The



Fig. 1 Postauricular incision, dissection of periosteum graft over mastoid wall, and periosteum graft was prepared

cartilage was then grasped and retracted inferiorly, which delivered the superior portion from the incisura area. The superior portion was then dissected out while retracting, which produces a large piece of cartilage [10] (Fig. 2).

The cartilage was widely exposed on both its lateral and medial surfaces and harvested with its attached perichondrium, then the donor site closed. The cartilage-perichondrium graft was prepared by elevating the perichondrium over the convex surface of the tragal cartilage graft while maintaining its attachment to the concave surface. The cartilage-perichondrium graft was placed as a medial graft with the elevated perichondrium draping onto the posterior external canal wall for stabilization. The cartilage was trimmed to fit the size and shape of the tympanic membrane defect. A triangular notch was removed from the middle of the superior half of the cartilage graft to accommodate the handle of malleus. The final shape of the cartilage included a notch for manubrium mallei [10].

This cartilage, when compared with conchal cartilage, tends to be thinner and flatter, making it more suitable for tympanic membrane reconstruction.

The entire graft was placed in an underlay fashion, with the malleus fitting in the groove and actually pressing down into and confirming to the perichondrium. The cartilage was placed toward the promontory, with the perichondrium immediately adjacent to the tympanic membrane remnant (its edge was tucked under the tympanic membrane remnant); both of which are medial to the malleus. Gel foam was packed in the middle ear space underneath the anterior annulus to support the graft in this area, and the posterior apron of perichondrium was draped over the posterior canal wall. Middle ear packing was avoided on the promontory and in the area of the ossicular chain. One piece of gel foam was placed lateral to the reconstructed tympanic membrane, and antibiotic ointment was placed in the ear canal [10].

Postoperative management

Amoxicillin clavulanic acid antibiotic and ceftriaxone injection were prescribed for all patients for 1 week. The first postoperative visit occurred after 1 week, at which the ear dressing, packing, and skin sutures were removed. In cartilage tympanoplasty, the ointment and gel foam were suctioned from the ear canal 2 weeks after surgery. After removal of the dressing, the patient might have shower but was instructed to keep the ear dry. Bacitracin was applied to the postauricular incision twice a day for 1 week. All patients were followed up postoperatively on a regular basis. Examination of the operated ear was performed using the examining microscope every 1 week to evaluate the rate of graft taking for 6 weeks and then every 2 weeks for another 6 weeks to evaluate the hearing results. Audiological evaluation was performed 2 and 6 months after surgery. The difference between preoperative and postoperative air-bone gap was calculated [8].

Statistical analysis

The results of the current study were analyzed using the SPSS version 22 software (Chicago, IL). The quantitative variables of the study are presented as the mean \pm SD. The qualitative variables are presented as a percentage. Analyses of the differences between the groups were by Mann-Whitney test. P value \leq 0.05 was considered significant.

Ethics

The present study was approved by the Medical Research Ethics Committee at Al-Azhar University (Assiut branch) and was carried out following the code of Ethics 143/5\9. Written consent was taken from all patients who participated in the study, and all data were kept confidential.

Results

The study consisted of 80 patients with CSOM with dry perforation divided into two groups:



Fig. 2 Tragal cartilage harvested through skin incision on medial side of tragus, cartilage with attached perichondrium dissected medially, and cartilage-perichondrium graft was prepared by elevating the perichondrium over convex surface of the cartilage

Table 1 Demographic data of both groups of patients

	Group A (n=40) Periosteum	Group B (n=40) Cartilage	P value
Age			
Mean \pm SD	28.73 \pm 11.15	28.38 \pm 9.25	0.879
Sex			
Male	12 (30%)	16 (40%)	0.348
Female	28 (70%)	24 (60%)	
Ear			
Lt	24 (60%)	17 (42.5%)	0.117
Rt	16 (40%)	23 (57.5%)	

Group A where tympanoplasty was done using the periosteum graft.

Group B where tympanoplasty was done using tragal cartilage with perichondrium graft.

The mean age group for group A was 28.73 \pm 11.15 years while for group B was 28.38 \pm 9.25 years. In both

Table 2 Preoperative audiometry and 2 and 6 months follow-up PTA

AIR	Group A Periosteum Mean \pm SD	Group B Cartilage Mean \pm SD	P value
Preoperative			
250	57 \pm 8.53	47.63 \pm 9.87	0.000**
500	50.88 \pm 6.97	44.75 \pm 9.87	0.003**
1000	45.63 \pm 9.82	42.63 \pm 10.86	0.276
2000	40.38 \pm 9.36	39.75 \pm 10.12	0.770
4000	43.75 \pm 7.99	42.25 \pm 8.62	0.418
8000	47.63 \pm 10.44	42.5 \pm 11.09	0.031*
Postoperative after 2 months			
250	33.13 \pm 8.06	33.25 \pm 10.16	0.884
500	26.5 \pm 6.62	24.5 \pm 8.38	0.065
1000	23.75 \pm 6.77	21.75 \pm 7.56	0.046
2000	23.38 \pm 8.43	21.5 \pm 7.18	0.160
4000	22.13 \pm 8.46	24 \pm 7.7	0.421
8000	22.63 \pm 8.99	25.63 \pm 8.02	0.220
Postoperative after 6 months			
250	27.13 \pm 9.53	32.13 \pm 10.12	0.012*
500	20.75 \pm 7.64	24.13 \pm 10.55	0.211
1000	20 \pm 7.84	22.38 \pm 10.62	0.491
2000	20.38 \pm 8.2	21.75 \pm 8.59	0.620
4000	18.63 \pm 8.24	23.75 \pm 8.6	0.002**
8000	18.75 \pm 9.04	25.13 \pm 9.77	0.001**

Used Mann-Whitney test

*Statistically significant: ($p < 0.05$), **High statistically significant: ($p < 0.01$)

groups, the perforation was more in female, 70% in group A and 60% in group B (Table 1).

Regarding the pure tone audiometry, the average preoperative PTA was 45.16 \pm 7.09 for group A while group B was 42.34 \pm 7.95, both showed no statistically significant differences, and both groups showed moderate degrees of HL.

Two months postoperative audiograms, there were improvements in hearing acuity; the average PTA for group A was 23.94 \pm 6.41 while group B average was 22.94 \pm 6.89.

Six months postoperative audiograms, there were much improvements in hearing acuity; the average PTA for group A was 19.94 \pm 6.98 while group B average was 23 \pm 9.

Although there was statistical insignificance, there were significant improvements in PTA average reflecting improvement in hearing acuity after tympanoplasty with periosteum grafts (Table 2).

ABG was calculated for both groups, and there was much improvement postoperative mainly for the periosteum group 6 months postoperative where the ABG was 6.94 \pm 6.4 in comparable to 30.38 \pm 6.01 preoperative (Table 3).

The hearing gain (improvement in hearing acuity postoperative) was more prominent in the periosteum group reaching about 25.53 \pm 6.26 in comparison to 19.63 \pm 9.76 in the cartilage group, and it was statistically significant, reflecting that the periosteum graft was more superior as grafting techniques (Table 4).

Table 3 Air-bone gap preoperative and 2 and 6 months follow-up

ABG (air bone gap)	Group A Periosteum Mean \pm SD	Group B Cartilage Mean \pm SD	P value
Preoperative			
500	35.25 \pm 6.98	32 \pm 7.99	0.035*
1000	31 \pm 9	29.63 \pm 8.43	0.648
2000	26.13 \pm 8.36	27.38 \pm 9.34	0.505
4000	29.13 \pm 7.67	28.88 \pm 8.12	1.000
Postoperative after 2 months			
500	12.5 \pm 6.3	11.63 \pm 8.65	0.163
1000	9.63 \pm 5.82	8.75 \pm 8.45	0.183
2000	9.25 \pm 6.56	8.75 \pm 8.3	0.435
4000	8.63 \pm 8.09	11 \pm 9.14	0.199
Postoperative after 6 months			
500	7.75 \pm 7.84	11.25 \pm 10.79	0.145
1000	6.75 \pm 6.56	9.63 \pm 11.23	0.397
2000	7.25 \pm 7.16	9.63 \pm 10.4	0.368
4000	6 \pm 7.44	11 \pm 9.69	0.003**

Used Mann-Whitney test

*Statistically significant: ($p < 0.05$), **High statistically significant: ($p < 0.01$)

Table 4 Two- and six-months hearing gain

Gain	Group A Periosteum Mean ± SD	Group B Cartilage Mean ± SD	P value
2 months			
500	21.13±6.45	19.88±9.37	0.996
1000	18.25±6.46	20.5±11.25	0.105
2000	17.88±6.19	17.63±10.5	0.980
4000	19.13±7.92	18.63±8.99	1.000
6 months			
500	30.25±7.25	20.75±11.07	0.000**
1000	25.63±8.78	20.63±12.41	0.053
2000	20.88±8.69	17.75±11.21	0.180
4000	25.38±8.8	19.38±9.75	0.007**

Used Mann-Whitney test

*Statistically significant: ($p < 0.05$), **High statistically significant: ($p < 0.01$)

Broken graft was observed in two patients (5%) in the periosteum group while 4 patients had broken grafts (10%) (Table 5).

Discussion

The success rate of tympanoplasty in general is quite high, irrespective of the graft material. A variety of graft materials have been used over time for repairing tympanic membrane perforation [11].

Mortiz reported the first closure of tympanic membrane perforation using the pedicled skin flap in 1950. Fat, conchal or septal cartilage, vein, fascia lata, and, after that, the periosteum were used as autologous graft materials, as were temporalis fascia, tragal cartilage, and perichondrium [12]. However, there is no consensus on the selection of graft material for tympanoplasties; it depends entirely on the surgeon's experience and preferences [13].

Certain criteria which an ideal grafting material used for tympanic membrane repair should meet include easy availability, good tensile strength, sufficient quantity, low rejection rate, and functionally similar to the tympanic membrane [14].

The rigidity of the periosteum graft has benefits in reducing retraction of the tympanic membrane. Periosteum is

an excellent grafting material as it is easily accessible, easy to adapt, resistant to negative middle ear pressures, stable, elastic, well tolerated by the middle ear, resistant to resorption, and with high graft take rate. Furthermore, periosteum graft thickness offers the best balance between the stability and the acoustic sensitivity [1].

Regarding the tragal cartilage with perichondrium achieved high success rate and healed well in 6 weeks' time. Overall, the tragal cartilage and perichondrium proved to be one of the best graft materials in reconstructive tympanoplasty which is universally accepted. The main reason being the cartilage is easily available at the site of operation, is nontoxic, and causes less extrusion, minimum shrinkage, and lateralization [15].

In this study, the mean patient age was 28.5 years with a female predominance (65%) while male patients constitute about 35% of the study. This agreed with Mostafa et al., Dawood, El-Khatib et al., and Rasha and Ahmed who reviewed that females constituted about 65% of CSOM patients [16–19]. However, Gupta et al. found that the majority of patients were males [20]. Also, in a study done by Konstantinidis et al., male preponderance in the subjects was noticed [21]. The debate in the gender difference can be explained by the social, behavioral, and educational level of patients and their families.

Regarding the pure tone audiometry, there was improvement in the postoperative PTA evaluation, reaching maximum at 6 months for the periosteum group than the cartilage with perichondrium. Although there was statistical insignificance, but from the audiological and clinical views, there were much improvements in PTA (Table 2). ABG was calculated for both groups, and there was much improvement postoperative mainly for the periosteum group 6 months postoperative where the ABG was 6.94 ± 6.4 in comparable to 30.38 ± 6.01 preoperative (Table 3). This agreed with the study of ElBatawi et al. They reported that the preoperative mean ABG of periosteum group was $18 \text{ dB} \pm 5 \text{ SD}$ while 6 months postoperative mean ABG was $7 \text{ dB} \pm 5 \text{ SD}$ [22]. The results of the study did not agree with Yang et al., retrospective study through 1 year follow-up of patients who underwent full thickness type I tympanoplasty had better hearing than others who underwent tympanoplasty using temporalis fascia and showed that long term of hearing results of cartilage tympanoplasty which seems to be better on the long run [23].

The hearing gain (improvement in hearing acuity postoperative) was more prominent in the periosteum group reaching about 25.53 ± 6.26 in comparison to 19.63 ± 9.76 in the cartilage group, and it was statistically significant, reflecting that the periosteum graft was more superior as grafting techniques (Table 4). This agreed with ElBatawi et al. in which the hearing gain was the best for the periosteal grafts than the perichondrial grafts [22].

Table 5 Complication that occurred in both groups

	Group A (n=40) Periosteum	Group B (n=40) Cartilage	P value
Complication			
Broken graft	2 (5%)	4 (10%)	0.396
No	38 (95%)	36 (90%)	
Satisfaction			
Satisfied	33 (82.5%)	30 (75%)	0.412
Unsatisfied	7 (17.5%)	10 (25%)	

Graft taken was better in the periosteal graft (95%), while it reached 90% in cartilage graft, and it showed statistically insignificant differences where the *P* value is 0.396 (Table 5). These results are quite similar to ElBatawi et al., where the periosteal graft taken was about 93% and cartilage graft taken was 92% [22]. Also, the patient's satisfaction was 82.5% for the periosteal grafts versus 75% in the cartilage with perichondrium grafts.

Conclusion

From the current study, we can conclude that the periosteum and the cartilage with perichondrium provide viable autograft materials. The results of hearing restoration with the periosteum were noted to be better than that of the cartilage grafts. Also, the graft taken was to some extent better in the periosteum group.

Abbreviations

CSOM: Chronic suppurative otitis media; PTA: Pure tone audiometry; SRT: Speech reception threshold; WRS: Word recognition scores; ME: Middle ear; ABG: Air-bone gap; HL: Hearing loss

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None

Authors' contributions

Each author took part in the design and the work of the study. MM Elbahrawy is the surgeon who performed all the surgical work and followed up the patients. MM Elmoursy is the audiovestibular physician, performing the audiological evaluation, and followed up the patients. Both authors wrote and analyzed the results and collected data for this study. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The present study was approved by the Medical Research Ethics Committee at Al-Azhar University (Assuit branch) and was carried out following the code of Ethics 143/5 and the number of paper 9. Informed and written consent was taken from all participants as well as from their parents or legal guardians in the case of children under 16 years old.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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