Impact of site and size of pars tensa tympanic membrane perforation on the success rate of myringoplasty

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Objective
This article is intended to investigate the impact of size and site of tympanic membrane (TM) perforation on the outcome and success rate of myringoplasty.
Patients and methods
This prospective study was conducted at Assiut University Hospital, between September 2015 and November 2017. Video-otoscopy was done to all cases, the images were registered on the computer and analyzed by using Universal Desktop Ruler V.3.5.3364 program, as the area of TM perforation (P) and the entire area of TM (T) were calculated. Thereafter, the percentage area of the perforation ($P/T \times 100\%$) for the perforated ear was revealed. Site of perforation was also authenticated. Preoperative and postoperative A–B gap was carried out through audiogram for hearing results.
Results
The overall success rate of myringoplasty was 78.8%. According to size of TM perforation; the highest success rate of myringoplasty established between small perforations was 93.3% and the lowest found between subtotal perforations was 42.9%; in medium and large perforations, the success rate of myringoplasty was 87.5 and 71.4%, respectively. As regards the site of TM perforation, the success rate of myringoplasty was highest (90%) for posterior perforations and lowest (70%) for anterior perforations; in central and inferior perforations, the success rate of myringoplasty was 79.8 and 75%, respectively. After myringoplasty, the amount of closure of A–B gap was 21.82 dB.
Conclusion
The size of TM perforation has a great influence on the success rate of myringoplasty, while the site of TM perforation has no impact on the success rate of myringoplasty, and myringoplasty is an effective operation for sealing off TM perforations, resulting in improvement of quality of life.

Keywords:
myringoplasty, success rate, tympanic membrane perforation

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Introduction

The tympanic membrane makes the initial adjustment of sound from the ear canal to the cochlea. The peerless anatomical framework and material properties of the TM have a share in its motion [1]. TM perforation is one of the most prevalent issues of hearing weakness and is at most caused by infection and may have possibly been caused by various types of trauma: blunt trauma, penetrating trauma, and surgical trauma [2]. Tympanoplasty is known as any surgical procedure including patching up the TM and/or the ossicular chain. Myringoplasty is a tympanoplasty without ossicular rebuilding [3,4]. It purposes to plug the TM perforation to stop recurrent otorrhea, and to generate a sound conducting mechanism in a well-aerated mucosa-lined middle ear cleft, and preserve these fulfillments for a long time [5,6]. The recorded incidence of successful rate of myringoplasty in adults ranges from 60 to 99% [7]. Rating size, site, duration, state and etiology of TM perforation is significant when looking for management [8]. The evolution of computer-based video-otoscopy systems that accurately calculate the size of a perforation relative to the size of the TM has precluded many of these obstacles [9,10].

Patients and methods

Study participants

This is a prospective cohort study of 52 patients who attended the Otolaryngology Department, Assiut University Hospitals, with dry perforations and were operated upon for the TM defect between September 2015 and September 2017. The patients were followed up for 6 months postoperatively. Ethical clearance for

the study was obtained from the Medical Research Ethics Committee at Assiut University on 15 September 2015 before commencing the data collection. Patients were assigned to the study randomly from those patients fulfilling the inclusion criteria. Consent (informed, written and well understood) was obtained from each patient.

Inclusion criteria

(1) Patients belonging to both sexes, with ages ranging from 16 to 50 years.
(2) Patients with dry perforation.
(3) Patients with good cochlear reserve.

Exclusion criteria

(1) Age up to 16 years and of at least 50 years.
(2) Patients with previous failed myringoplasty.
(3) Patients with cholesteatoma, retraction pockets or associated mastoiditis.
(4) Known eustachian tube dysfunction (diagnosed by Valsalva test and tympanogram).
(5) Patients with upper respiratory tract pathologies.
(6) Patients with deformity of the external auditory canal.
(7) Patients with malignancy, diabetes, and other debilitating diseases.
(8) Patients with wet or attic perforations.

Methods

Preoperative otoscopic and video-otoscopic examination to document the size and site of TM perforation by means of video-otoscopy (Endoscope ShenDa 'J0200G SN 300.0096, 0° 4-175-A-W') was carried out. The images of perforated TMs by means of video-otoscopy were recorded on a computer, 'Acer Lap – PC' (Photo 1), and analyzed by Universal Desktop Ruler V.3.5.3364 Program (http://avpsoft.com/products/udruler/).

The area of TM perforation (P) and the entire area of TM (T) were calculated. Thereafter, the percentage area of the perforation ($P/T \times 100\%$) for the perforated ear was obtained (Photos 2 and 3) [11].

One of four grades of TM perforation was classified according to Niculescu *et al.* [11]: group I: small for perforation less than 25% of TM, group II: medium for perforation between 25 and 50% of TM, group III: large for perforation between 50 and 75% of TM and group IV: subtotal for perforations more than 75% of TM.

Photo 1

shows tympanic membrane perforation by means of video-otoscopy.

Photo 2

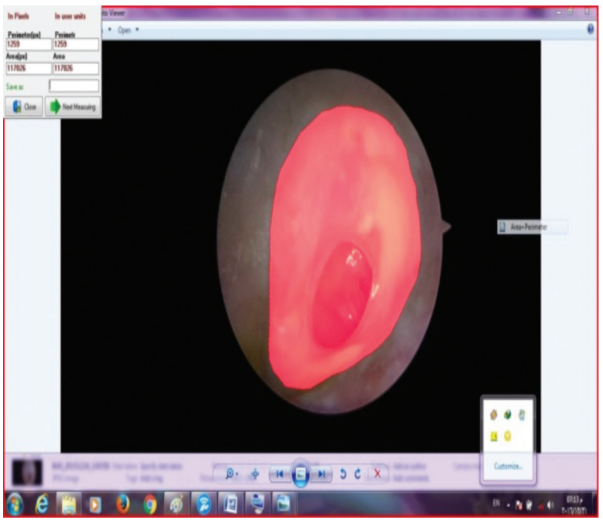
Measuring the area of tympanic membrane perforation using Universal Desktop Ruler.

The TM perforations were categorized according to the site into 4 types: anterior, posterior, inferior, and central (1–3 represents the three quadrants and four represents the involvement of more than one quadrant): (a) anterior; (b) posterior; (c) inferior and (d) central for localization of the site of perforation [2].

Audiological evaluation

(1) A pure tone air and bone conduction audiogram before surgery were recorded at the frequencies of 250, 500, 1000, 2000, 4000, and 8000 Hz by using a Madsen Orbiter 922 (Madsen Electronics, Taastrup, Denmark) diagnostic audiometer by the audiologist.

Photo 3



Measuring the entire tympanic membrane area including the perforation using Universal Desktop Ruler.

(2) Preoperative A–B gap was calculated by taking the averages of bone conduction and air conduction at frequencies of 500, 1000, and 2000 Hz.
(3) During follow-up, postoperative audiograms were obtained at the 12th week following surgery. Postoperative A–B gap was calculated by taking the averages of bone conduction and air conduction at frequencies of 500, 1000, and 2000 Hz.
(4) Hearing results after myringoplasty through preoperative and postoperative A–B gap were calculated by taking the averages of bone conduction and air conduction at frequencies of 500, 1000, and 2000 Hz.
(5) Committee on hearing and equilibrium recommends that when the A–B gap is used, they should be constructed as follows: 0–10, 11–20, 21–30, and more than 30 dB [12].
(6) Comparison of preoperative and postoperative A–B gap was carried out for successful cases only.
(7) Hearing results after myringoplasty for successful cases based on A–B gap were calculated, and A–B gap within 20 dB or less was considered as a successful result.

Statistics

We used a personal database obtained by means of statistical package for the social sciences version 23 (SPSS, IBM, Chicago, USA) to evaluate the results. *P* value smaller than 0.05 was considered as significant. For statistical analysis, we divided 52 patients into four groups according to their size of perforation: small (>25%), medium (25–50%), large (50–75%) and subtotal (<75%), and into four groups according to their site of perforation: anterior, posterior, inferior and central. The result was analyzed according to these groups.

Table 1 The success rate in cases that undergo myringoplasty according to size of tympanic membrane perforation

Size	Success [*N* (%)]	Failure [*N* (%)]
Small (<25%)	14 (93.3)	1 (6.7)
Medium (25–50%)	14 (87.5)	2 (12.5)
Large (50–75%)	10 (71.4)	4 (28.6)
Subtotal (>75%)	3 (42.9)	4 (57.1)
Overall success rate	41 (78.8)	11 (21.2)

P=0.027 (<0.05).

Result

Fifty-two patients meeting the inclusion criteria underwent myringoplasty between September 2015 and September 2017. In this study, the age ranges from 16 to 45 years, although most patients were within 16–25 years of age (48.1%). The number of female patients was more than that of male patients, and the female : male ratio was 1.4 : 1. Right-sided TM perforations were predominant, and left : right ratio was 1 : 1.1. Diminution of hearing and ear discharge were found to be the most common symptoms in our study.

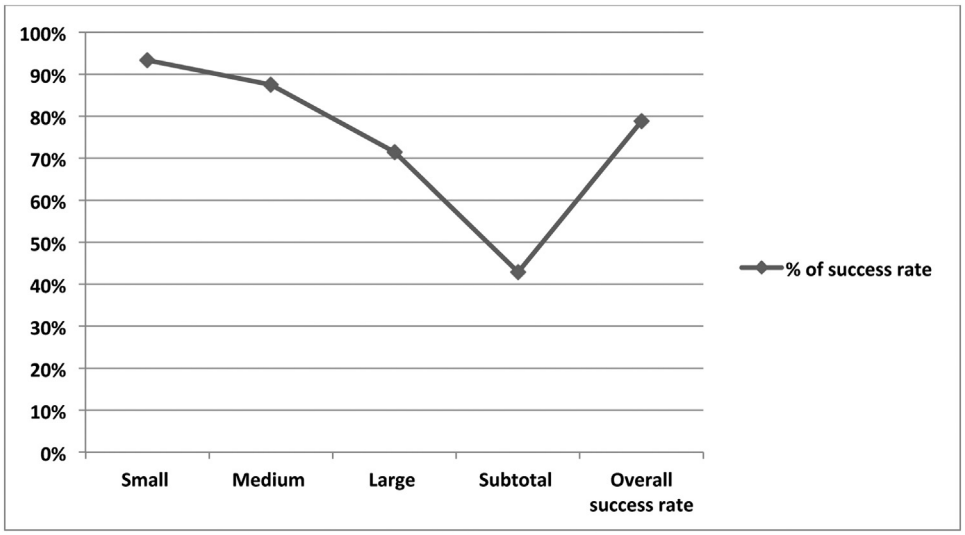
Of 52 cases undergoing myringoplasty, the overall success rate was 78.8% (*n*=41), and the failure rate was 21.2% (*n*=11) (Table 1 and Fig. 1).

With regard to size groups of TM perforation, the success rate of myringoplasty was established to be highest between small perforations (93.3%) and lowest between subtotal perforations (42.9%); in medium and large perforations, the success rate was 87.5 and 71.4%, respectively. Success rate correlates significantly with the size of TM perforations (*P*=0.027). The smaller-sized perforations were associated with higher success rate (Table 1 and Fig. 2).

With regard to site of TM perforation, the success rate of myringoplasty was found to be highest between posterior perforations (90%) and lowest between anterior perforations (70%); in central and inferior perforations,the success rate was 79.8 and 75%, respectively (*P*=0.593), which implies that site of perforation is a statistically insignificant factor in success of myringoplasty (Table 2 and Fig. 2).

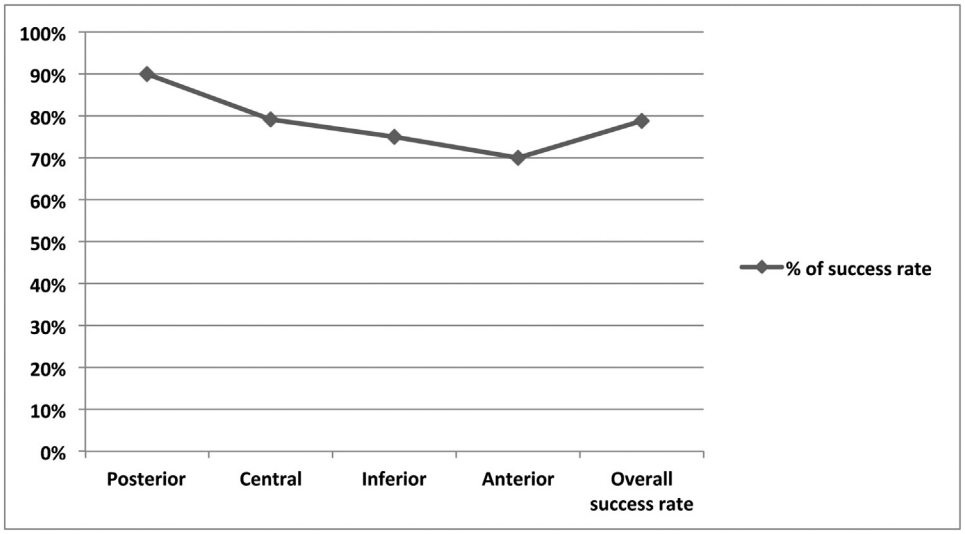
Preoperative A–B gap in small perforations was found to be between 20 and 30 dB; in medium perforations,

Figure 1



Line showing success rate of myringoplasty according to size of tympanic membrane perforation.

Figure 2



Line showing success rate of myringoplasty according to site of tympanic membrane perforation

Table 2 Success rate of myringoplasty according to site of tympanic membrane perforation

Site	Success [*N* (%)]	Failure [*N* (%)]
Posterior	9 (90)	1 (10)
Central	19 (79.2)	5 (20.8)
Inferior	6 (75)	2 (25)
Anterior	7 (70)	3 (30)
Overall success rate	41 (78.8)	11 (21.2)

P=0.593(>0.05).

between 31 and 40 dB; in large perforations, between 41 and 50 dB and in subtotal perforations, it was 49.8 dB (*P*=0.04); The size of TM perforation is a statistically significant factor in preoperative hearing loss (Table 3).

Although the hearing loss detected in the posterior and central perforations was worse than that in the anterior and inferior perforations (*P*=0.147), it indicated that preoperative A–B gap among the site groups was statistically insignificant (Table 4).

The amount of closure of A–B gap established after myringoplasty was 21.82 dB, which indicates an average improvement in hearing (Table 5).

For successful cases of myringoplasty; comparison between preoperative and postoperative A–B gap was carried out by using postoperative A–B gap within 20 dB as the criterion; preoperatively, A–B

Table 3 The mean preoperative and postoperative A–B gap in relation to size groups in successful cases of myringoplasty (*n*=41)

Size	Patients [*N* (%)]	Air-bone gap (mean) (dB)	
		Preoperatively	Postoperatively
Small (<25%)	14 (34.1)	23.6	3.3
Medium (25–50%)	14 (34.1)	33.3	10.7
Large (50–75%)	10 (24.4)	43.5	21.1
Subtotal (>75%)	3 (7.4)	49.6	27.6
Average of all patients	41 (100)	37.5	15.68

P=0.043 (<0.05).

Table 4 The mean preoperative and postoperative A–B gap in relation to site groups in successful cases of myringoplasty (*n*=41)

Site	Patients [*N* (%)]	Air-bone gap (mean) (dB)	
		Preoperative	Postoperative
Posterior	9 (22)	44.5	17.8
Central	19 (46.3)	41.7	17.5
Inferior	6 (14.6)	34.3	13.6
Anterior	7 (17.1)	29.9	13.8
Average all patients	41 (100)	37.5	15.68

P=0.147 (>0.05).

Table 5 The mean improvement in air conduction in successful cases of myringoplasty

N	Air-bone gap	dB
1	Average A–B gap preoperatively	37.5
2	Average A–B gap postoperatively	15.68
3	Average improvement (amount of closure of A–B gap)	21.82

Table 6 Comparison of preoperative and postoperative cases for A–B gap in successful cases of myringoplasty

A–B gap (dB)	Preoperatively [*N* (%)]	Postoperatively [*N* (%)]
0–20	0	38 (92.7)
21–30	6 (14.6)	3 (7.3)
≥31	35 (85.4)	0
Total	41 (100)	41 (100)

P=0.019 (<0.05).

gap of 30 dB or more was observed in 35 patients, representing 85.4%; postoperatively, 38 patients representing 92.7% had their A–B gap within 20 dB. *P* value was found to be 0.019, which indicates that hearing is statistically improved with successful myringoplasty, and myringoplasty is a beneficial operation for hearing and improving quality of life (Table 6 and Figs 3 and 4).

Discussion

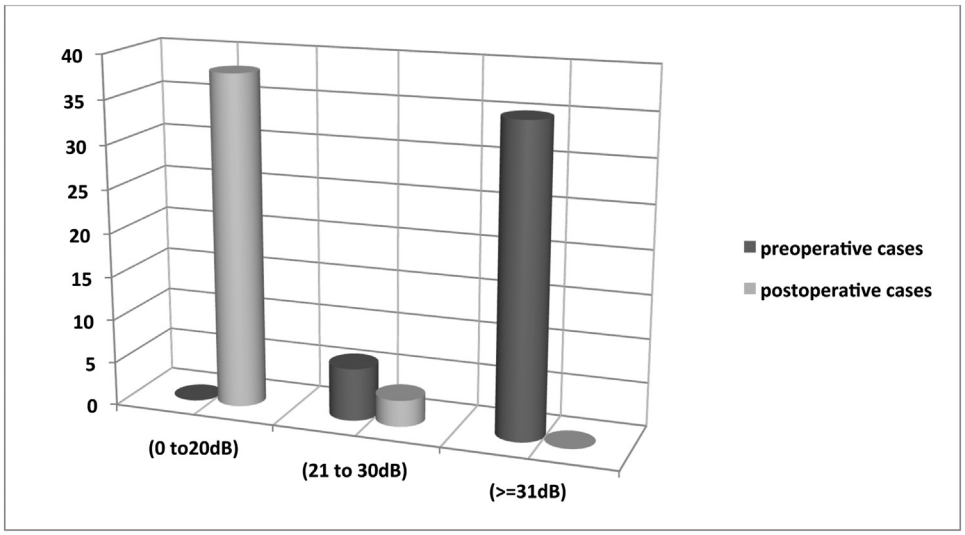
Numerous published articles have assigned myringoplasty as an effective operation for plugging off TM perforations and changing air conduction for the better. However, the impact of size and site of TM perforation upon myringoplasty success rate is poorly authenicated [2]. This study attempted to probe the impact of size and site of TM perforation on the outcome and success rate of myringoplasty.

The age of patients varied from 16 to 45 years, and their average age at the time of operation was about 27.8 years, which can be comparable with Sangavi [13], who stated that the average age of patients at the time of operation was about 23.4 years, which implies that all age groups were operated upon, except for very young and very old patients, because very young children by the time seek for specialist advice, and very old people are unwilling to get operated.

In previous literature, myringoplasty success rate differed excessively, because it is hard to observe all variables that have an important role in the consequence of myringoplasty [14]. Among 52 myringoplasties, the overall success rate was 78.8%. This is in agreement with the opinion of Das *et al.* [2] who stated that, among 60 myringoplasties, the success rate was 80%. This is also in agreement with Feroze *et al.* [15] who reported that, among 113 myringoplasties, 84.1% had successful graft uptake and with Wasson *et al.* [16] who mentioned that the overall success rate of myringoplasty was 80.8%.

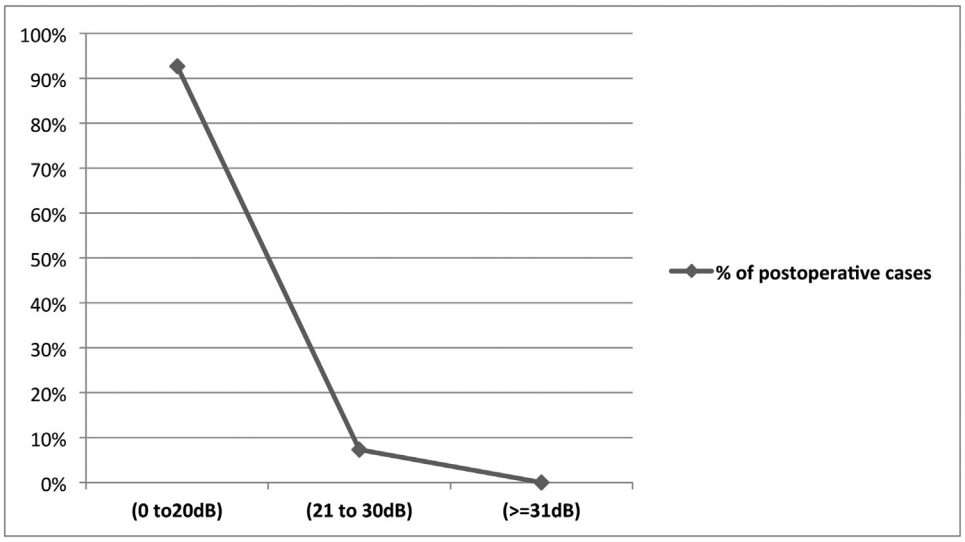
The size of TM perforation is a significant factor that affects myringoplasty success rate, and the success rate was highest for small perforations (93.3%) and lowest

Figure 3



Histogram showing the number of preoperative and postoperative successful cases of myringoplasty according to A–B gap.

Figure 4



Line showing hearing results in successful cases of myringoplasty according to A–B gap.

for subtotal perforations (42.9%), while for medium and large perforations, the success rate was 87.5 and 71.4%, respectively, and the results were statistically significant. This is probably because of the the larger bed that is provided for the graft, and there was a good opportunity for the graft to be taken in cases of small and moderate-sized perforations [13].

In the literature, there was a varied result with regard to this view. Lee *et al.* [17] reported that the success rate was 74.1% for small perforations and 56% for large perforations, with a significant difference in results. Wasson *et al.* [16] observed that there was a lower success rate for patients with larger perforations, but a statistically insignificant difference. Jurado *et al.* [18] declared that the success rate was 90 and 54.54% for small and large perforations, respectively. Biswas *et al.* [19] and Awan [20] also found that small perforations had a better success rate, and Gersdorff *et al.* [21] achieved the best results with subtotal perforations. In contrast, Vartianinen and Nuutinen [22], Yung [23], Black *et al.* [24] and Denoyelle *et al.* [25] stated that the success rate of myringoplasty does not depend on the size of TM perforation.

With regard to the site of TM perforation, the graft uptake rate for posterior perforations, central perforations, inferior perforations and anterior

perforations was 90, 79.8, 75, and 70%, respectively. There was less success with anterior perforations probably because the anterior portion of TM is the least vascular area [15]. Moreover, Das *et al.* [2] noted that anterior perforations are technically more difficult to access, and the blood supply is also poorer. Feroze *et al.* [15] noted that the success rate of myringoplasty was best in posterior perforations (93.3%) and central perforations (87.7%), and it was worse for anterior perforations (66.7%). Singh *et al.* [26] showed that the success rate was 34% in anterior perforations and 91 and 100% in inferior and posterior perforations, respectively. These results were in agreement with our results.

Success rate among the site groups was statistically insignificant, which indicates that the TM perforation site was not a prognostic factor for myringoplasty success rate. These results coincided with Das *et al.* [2] and Lima *et al.* [27]. Merenda *et al.* [28] and Ordóñez-Ordóñez *et al.* [29] reported in their studies that success rate does not depend on perforation site. In contrast, Bhat and De [30] and Gersdorff *et al.* [21] reported that the success rate of myringoplasty was dependent on TM perforation site.

Preoperative A–B gap in small perforations was between 20 and 30 dB; in medium perforations, it was between 31 and 40 dB and, in large and subtotal perforations, it was between 41 and 50 dB; it was statistically significant, and it indicated that the severity of hearing loss increases with the increase in the size of perforation. These results were in agreement with the results reported in Alsarhana *et al.* [31], Rafique *et al.* [32], Park *et al.* [33] and Kumar *et al.* [34]. However, Ribeiro *et al.* [35] and Malik *et al.* [36] concluded that there was no correlation between the size of TM perforation and hearing loss.Hearing loss was more in posterior perforations, followed by central perforations and anterior perforations, but it was insignificant statistically. These observations coincided with the results obtained by Nahata *et al.* [37] and Malik *et al.* [36]; they attributed this effect to the direct exposure of the round window to the sound waves, resulting in cancellation of the phase difference between the two windows and resultant nonmovement of the perilymph. However, Pannu *et al.* [38] and Kumar *et al.* [34] reported that site of TM perforation does not affect the degree of hearing loss.

With regard to hearing assessment, most stated that an improvement in hearing, when closure of A–B gap was within 20 dB or less, was considered a successful result, and, in cases where there was no improvement in hearing following surgery, the result was considered a failure.

In successful cases of myringoplasty (A–B gap within 20 dB), the preoperative A–B gap of 30 dB or more was observed in 85.4% cases, while postoperatively A–B gap of 30 dB or more was not observed. However, postoperatively, 92.7% of cases had their A–B gap within 20 dB, and hearing was statistically improved with successful myringoplasty. These results of success in our study (92.7%) are comparable to the results of Shrestha and Sinha [39] who found that by using the proportion of patients with a postoperative A–B gap of 30 dB as the criterion. Preoperatively A–B gap of 30 dB or more was observed in 76%, whereas, postoperatively, A–B gap of 30 dB or more was observed in only one patient.

A computerized system using video-otoscopy rightly calculates TM perforation size and site, which is in agreement with Hsu *et al.* [10]; they reported that the percentage of TM perforation can be estimated quite precisely by using a computer program, because the differences in estimations can be very big, and the variances can be large for different individuals.

Conclusion

(1) Myringoplasty was a successful procedure in plugging of TM perforations.
(2) The size of TM perforation was a significant factor affecting the success rate of myringoplasty.
(3) The site of TM perforation had no effect on success rate of myringoplasty.
(4) Postoperatively, most patients had their A–B gap within 20 dB, and hearing was improved with successful myringoplasty.

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Conflicts of interest
There are no conflicts of interest.

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