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Evaluation of Hearing in Patients Undergoing Type 1 Tympanoplasty

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Abstract

Background/Objectives: This study evaluated the clinical results of type 1 tympanoplasty performed in our clinic.

Methods: This retrospective analysis included eighty patients who underwent type I tympanoplasty for tympanic membrane perforation in the otorhinolaryngology department of between January 2019 and December 2022. We determined the mean hearing levels by averaging the hearing thresholds at 500, 1,000, 2,000, and 4,000 Hz. Researchers examined the differences in air-bone gaps before and after tympanoplasty between the groups. Researchers evaluated pre- and postoperative air conduction (AC), bone conduction (BC), and air-bone gap (ABG) between groups using paired t-tests.

Results: This study involved 80 patients, comprising 45 males and 35 females. The mean age was 33.8 ± 15.3 years. Out of 80 patients, 38 (47.5%) exhibited disease in the right ear, 33 (41.25%) had disease solely in the left ear, and nine patients (11.25%) were affected in both ears. The existence of central perforation was the most ordinary observation (43.75%). In the present investigation, we noticed that 100% of patients had hearing thresholds of more than 30 dB. The preoperative air-bone tract gap ratio was 38.3. The postoperative air-bone tract gap ratio was 22.8. 74 of 80 patients (92.5%) showed remarkable surgical success with graft harvesting, with just four patients having residual tympanic membrane perforation and two with graft medialisation. Out of 80 patients, 71 (88.75%) have restored to normal hearing, while only 9 (11.25%) remain in the category of mild deafness. The mean of the preoperative air-bone gap is 38.3 Db; however, postoperatively, the air-bone gap is 23.98 Db. Improvement in the air-bone gap is 14.32 Db.

Conclusions: Type 1 tympanoplasty employing temporalis fascia is a reliable method for mending tympanic membrane perforations and boosting hearing results. The procedure achieves great air bone gap closure and enhances patients' auditory function. However, individual variables such as age, perforation size, and surgical procedure must be acknowledged when quantifying postoperative hearing improvement.

Keywords: Type 1 tympanoplasty; hearing loss; chronic otitis media; air bone gap; temporalis fascia

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Tip 1 Timpanoplasti Uygulanan Hastalarda İşitmenin Değerlendirilmesi

Öz

Amaç: Bu çalışmada kliniğimizde uygulanan tip 1 timpanoplastinin klinik sonuçları değerlendirildi.

Yöntem: Bu retrospektif analiz, Ocak 2019 ile Aralık 2022 tarihleri arasında Kulak Burun Boğaz kliniğinde tip I timpanoplasti uygulanan hastaları kapsamaktadır. Ortalama işitme seviyelerini elde etmek için 500, 1.000, 2.000 ve 4.000 Hz eşiklerinin ortalaması alındı. Gruplar arasında timpanoplasti öncesi ve sonrasında hava-kemik aralığındaki değişimleri incelendi. Eşleştirilmiş t-testleri kullanarak gruplar arasında ameliyat öncesi ve sonrası hava iletimi, kemik iletimi ve hava-kemik aralığı incelendi.

Bulgular: Bu çalışmaya 45 erkek ve 35 kadından oluşan 80 hasta katıldı. Ortalama yaş 33.8 ± 15.3 yıldı. Seksen hastanın otuz üçünde (%41,25) sadece sol kulakta, dokuzunda (%11,25) her iki kulakta ve 38'inde (%47,5) sağ kulakta hastalık vardı. En yaygın bulgu (%43,75) santral perforasyon varlığı idi. Bu çalışmadaki tüm hastaların işitme eşiklerinin 30 dB'den yüksek olduğunu tespit ettik. Ameliyat öncesi hava-kemik yolu boşluk oranı 38,3 idi. Ameliyat sonrası hava-kemik yolu boşluk oranı 22,8 idi. 80 hastanın 74'ünde (%92,5) greft alımında kayda değer bir cerrahi başarı elde edilmiş, sadece dört hastada rezidüel timpanik membran perforasyonu ve iki hastada greft medializasyonu görülmüştür. 80 hastanın 71'i (%88,75) normal işitmeye geri dönerken, sadece 9'u (%11,25) hafif sağırlık kategorisinde kalmıştır. Hava-kemik aralığındaki iyileşme 14.32 Db'dir.

Sonuçlar: Bu prosedür, hava kemik aralığını etkili şekilde kapatmakta ve hastaların işitme fonksiyonu postoperatif düzeltmenin yanısıra yaş, perforasyon boyutu ve cerrahi prosedür gibi bireysel değişkenler göz önünde bulundurulmalıdır.

Anahtar kelimeler: Tip 1 timpanoplasti, işitme kaybı, kronik otitis media, hava kemik aralığı, temporal fasya.

INTRODUCTION

The assessment of auditory results in patients receiving Type 1 tympanoplasty is a crucial study domain in otolaryngology, especially given the widespread occurrence of chronic otitis media (COM) and its related consequences. Type 1 tympanoplasty, a surgical procedure for repairing the tympanic membrane, seeks to restore ear integrity and enhance hearing function. Type 1 tympanoplasty, according to Wullstein's classification, refers to a surgical procedure performed only in cases where the tympanic membrane perforation is repaired and the ossicular chain is intact. During this surgical procedure, the ossicular chain is not interfered with; the aim is only to restore the anatomical and functional integrity of the eardrum[1]. Researchers frequently evaluate the efficacy of this operation using several audiometric evaluations, emphasizing the air-bone gap (ABG) and overall hearing thresholds. Hearing restoration is vital since it directly influences the quality of life for individuals with hearing loss from tympanic membrane perforations.

Tympanoplasty has historically evolved substantially, with enhancements in surgical methodologies and graft materials leading to better outcomes. The application of temporalis fascia as a graft material has established itself as the norm in tympanoplasty, offering a dependable solution for tympanic membrane repair[2]. Recent research has investigated other graft materials, including cartilage, which may provide improved structural stability and superior auditory results, especially in bigger perforations or recurring illnesses[3]. The selection of graft material and the surgical method are crucial factors influencing the procedure's success and the resulting enhancement in hearing.

The parameters for assessing the success of tympanoplasty include not just graft uptake but also functional hearing results. An intact graft

characterizes a successful tympanoplasty after a set follow-up period, often 12 months, and a stable or improved hearing threshold, with a minimum hearing gain of 10 dB being a frequent benchmark[4]. This multimodal approach to evaluating results underlines the importance of both morphological and functional success in determining the efficacy of tympanoplasty.

Factors impacting postoperative hearing outcomes are numerous and varied. Patient demographics, especially age and the existence of concomitant diseases can considerably alter the success of tympanoplasty. For instance, younger patients often display superior hearing outcomes compared to older adults, presumably because of changes in the healing process and the physiological reaction to surgery[5]. Type I Tympanoplasty is primarily concerned with healing the tympanic membrane without modifying the ossicular chain. This type is recommended for individuals with isolated tympanic membrane perforations and is the most prevalent form of tympanoplasty conducted. The process typically involves using graft materials like temporalis fascia or cartilage to mend the tympanic membrane[6]. Recent studies have indicated that the success rates of Type 1 tympanoplasty might vary based on numerous factors, including the surgical technique performed, the graft material used, and the patient's age. For instance, Eom et al. showed that older patients exhibit hearing results following Type 1 tympanoplasty equivalent to younger populations, suggesting that age may not be a substantial obstacle to achieving acceptable auditory outcomes post-surgery[7]. Batni and Goyal verified that the underlay approach using temporalis fascia leads to fewer complications and better functional results. They emphasize that the surgical technique significantly influences postoperative hearing outcomes[8]. Additionally, the status of the contralateral ear has been proven to affect hearing results, with healthy contralateral ears corresponding with improved surgical outcomes[9]. Moreover, the timing of the surgical surgery is critical. Early tympanoplasty during chronic otitis media is connected with improved hearing outcomes, as more extended periods of conductive hearing loss can lead to irreversible abnormalities in the auditory system[10].

The postoperative examination of hearing often comprises pure tone audiometry, which offers a quantitative measure of hearing thresholds across multiple frequencies. Studies have consistently demonstrated that patients enjoy considerable decreases in ABG following Type 1 tympanoplasty, with average gains reported in the range of 6 to 15 dB[11]. Such gains indicate the procedure's success in restoring conductive hearing and underscore the significance of careful audiometric examinations in the postoperative period. The choice of graft material is another crucial aspect impacting hearing results. Studies have revealed that cartilage grafts may yield improved outcomes compared to temporalis fascia, particularly in juvenile populations. Yilmaz et al. showed that the success rate for cartilage transplants was much higher than that for fascia grafts, with reported rates of 95% versus 76.2%, respectively[4]. The structural properties of cartilage may improve the stability and efficiency of tympanic membrane repair, thus enhancing auditory function.

This study aimed to evaluate the clinical results of type 1 tympanoplasty performed in our clinic.

METHODS

This retrospective analysis encompasses all patients who received type I tympanoplasty for tympanic membrane perforation at the ENT department of xxxxx University Hospital from January 2019 to December 2022. Ethical approval and was obtained from the xxx local ethics commetee (dated 20.11.2024, numbered 338) and informed concent was obtained from

participants. The study was carried out in accordance with the ethical rules for medical research that recommended in the Declaration of Helsinki. This study comprised only 80 patients. All patients exhibiting problems underwent a comprehensive evaluation process, including history gathering, targeted physical examination (otoscopy and rhinoscopy), audiogram, and microscopic inspection to validate otoscopic findings. During the medical history assessment, we inquired about when the disease began, how long the asymptomatic periods lasted, the annual frequency of otological infections, and any prior otological procedures the patients had undergone. In each case, the team conducted routine examinations, including evaluating perforation size and location, checking for tympanosclerosis, and assessing the presence or absence of inflammatory mucosa in the middle ear, alongside microscopic inspection. All patients had a diagnostic nasal endoscopy to examine nasal problems and rule out diseases that prevented the Eustachian tube from working correctly. All patients received a routine preoperative assessment, including temporal bone CT and pure tone audiometry. The surgeon administered general anaesthesia during the surgery. All patients received type 1 tympanoplasty. A single senior surgeon performed all procedures utilizing general anaesthesia. Patients with Dry Central Perforation The study included cases of Pure Conductive Hearing Loss and Inactive Mucosal Chronic Otitis Media Type. We excluded patients with marginal or attic perforation, mixed or sensorineural type hearing loss, active ear discharge, attico-antral or squamosal type chronic otitis media, and complications from chronic otitis media.

The temporalis muscle fascia was used to repair the tympanic membrane (TM) perforation using a graft placed under the postauricular route and a microscope. The temporal fascia graft was put simultaneously with the middle ear filling utilizing the underlay approach. The team used dexamethasone-impregnated gel foam to reduce the incidence of fibrosis caused by the gel foam in the middle ear. Postoperative pure tone audiometry was performed at an average follow-up of 12.3 ± 2.2 months. This time frame is clinically accepted for evaluating functional hearing gain after the anatomical integrity of the tympanic membrane has been restored with the graft. To compare the results, we determined the mean hearing levels by averaging the hearing thresholds at 500, 1,000, 2,000, and 4,000 Hz. The study examined how air-bone gaps differed before and after tympanoplasty between the groups. The study evaluated the pre-and postoperative air conduction (AC), bone conduction (BC), and air-bone gap (ABG) between groups using paired t-tests. We obtained significance when the p-value was less than 0.05.

RESULTS

This study involved 80 patients, 45 males and 35 females. The mean age was 33.8 ± 15.3 years. The average follow-up length was 12.3 ± 2.2 months. Table 1 shows that most cases (59%) belong to the age group of 10 to 30, with a mean age of 24.2 years.

Table I: Age distribution (n=80)

Age group (years)	No. of cases	Percentage
0-10	0	0
10-20	10	13
20-30	37	46
30-40	25	31
40-50	8	10

In the current study, female patients constitute 36 (45%), whereas male patients account for 44 (55%). Out of 80 patients, 38 (47.5%) exhibited disease in the right ear, 33 (41.25%) had disease solely in the left ear, and nine patients (11.25%) were affected in both ears. The surgical team prioritized the ear with more significant hearing loss and extensive pathology among the nine patients with bilateral illness.

Ear discharge and hearing loss are the most common complaints in all (100%) individuals. Tinnitus is detected in 15%, pain in the ear in 81.25%, and vertigo in 3% of patients, as shown in Table 2.

Table II: Symptom distribution (n = 80)

Symptoms	No. of patients	Percentage
Otorrhoea	80	100
Hearing loss	80	100
Earache	65	81.25
Vertigo	3	3.75
Tinnitus	12	15

On microscopic examination of the operative ears, central perforation was the most common observation (n=48, 60%). Subtotal perforation was detected in n=32 40% of patients (detailed in Table 3).

Table III: Location of perforations (n = 80)

Location of perforations	No. of patients	Percentage
Central	48	60
Subtotal	32	40

In the present investigation, we noticed that 100% of patients had hearing thresholds of more than 30 dB. The preoperative air-bone tract gap ratio was 38.3. Most patients presented with mild to moderate hearing loss ranging from 35.1 to 50 dB, i.e., 41 out of 59 (73.75%), as indicated in Table 4.

Table IV: Preoperative hearing threshold (n = 80)

Air bone gap (in dBs.)	Number of patients	Percentage
30-35	21	26.25
35.1-40	33	41.25
40.1-45	16	20
45.1-50	10	12.50

The postoperative air-bone tract gap ratio was 22.8. Most patients gained 15.1–30 dB of hearing, with 55 out of 80 patients (68.75%) benefiting, as indicated in Table 5.

Table V: Hearing gain in dB postoperatively

Hearing loss in dB	Number of patients (%)
0-10	15
10.1-15	10
15.1-20	24
20.1-25	18
25.1-30	13

Table 6 shows that 74 of 80 patients (92.5%) had great surgical success with graft harvesting, with just four patients having residual tympanic membrane perforation and two having graft medialisation.

Table VI: Surgical success rate (n = 80)

Surgical success rate	Number of patients	Percentage
Perforation closure	74	92.50
Residual perforation	4	5
Medialization of graft	2	2.50
Complete Graft Failure	0	0

Out of 80 patients, 71 (88.75%) have returned to normal hearing, while only 9 (11.25%) remain in the category of mild deafness, as indicated in Table 7.

Table VII: Overall hearing improvement of the patients postoperatively (n = 80)

Hearing improvement in dB	Number of patients	Percentage
0–25 (normal range)	71	88.75
26–40 (mild deafness range)	9	11.25

Table 8 presents the mean preoperative hearing loss and the mean postoperative hearing levels in type 1 Tympanoplasty. The mean of the preoperative air-bone gap is 38.3 Db, while postoperatively, the air-bone gap is 23.98 Db. Improvement in the air-bone gap is 14.32 Db, as reported in Table 8. Statistical analysis revealed a significant improvement in ABG ($p < 0.001$) between preoperative and postoperative measurements. This confirms that the hearing improvement observed following the surgery is statistically significant.

Table VIII: Air Bone Gap In Pure Tone Audiometry

Air Bone Gap(ABG)	Mean (in Db)
Pre op ABG	38.3
Post op ABG	23.98
Changes in ABG	14.32

Statistical significance: p < 0.001

DISCUSSION

Tympanoplasty is a prevalent surgical technique employed in managing middle ear disorders, particularly in cases of eardrum perforation. The age distribution of this procedure is crucial for comprehending the demographic characteristics of the patients and the surgery's efficacy. Studies show that patients undergoing tympanoplasty age demographics range from children to young adults. Boronat-Echeverría et al. investigated the outcomes of tympanoplasty in pediatric patients and found that younger individuals had better success rates[12]. Hasegawa et al. analyzed instances of chronic perforating otitis media across various age groups and determined that younger patients had superior outcomes[13].

Nevertheless, the results of tympanoplasty in geriatric patients are frequently more intricate. Sevil and Doblan underscore that the decision to undertake tympanoplasty in older patients is complex since this demographic frequently presents with comorbidities such as diminished bone conduction thresholds and tympanosclerosis[14]. Younger patients often exhibit superior postoperative outcomes, while the existence of comorbidities in older patients may elevate surgical risks. It shows that age's effect on surgical outcomes and patients' general health status[15] should be analyzed[14]. Our study's mean age was 33.8 years, which we consider to be in the young patient category. Researchers project a high success rate in the young patient group. Our surgical success rate was 92.5%.

A prominent symptom observed in people with tympanic membrane perforations is auditory impairment. Olusesi et al. conducted a study that emphasized the relationship between preoperative hearing scores and tympanoplasty outcomes, observing that patients often exhibited various degrees of conductive hearing loss, a principal rationale for surgical intervention[16]. Eom et al. highlighted that hearing impairment is a common symptom in older patients following tympanoplasty, with several individuals exhibiting substantial air-bone gaps prior to the procedure[7]. This is consistent with the findings of Ramalingam et al., who found that patients typically had hearing impairments that required surgical intervention[17]. We observed hearing loss in all patients in our study. Otorrhea is a prevalent symptom in individuals with chronic otitis media, typically marked by continuous ear discharge that may be purulent or serous. Gamra et al. observed that intermittent otorrhea is a primary symptom in patients with chronic otitis media, which considerably affects the choice to have tympanoplasty[18]. All patients in our study had ear discharge. Otalgia is a prominent symptom of chronic otitis media, frequently described by patients as a considerable source of distress. Shrestha et al. found that tympanic membrane perforation often causes earache, and its intensity can vary depending on the underlying middle ear pathology.

The study showed that patients with active mucosal disease report more severe earache than those with inactive disease, demonstrating a correlation between the illness's activity level and the amount of pain experienced[19]. In our study, 65 patients complained of ear pain. Patients with chronic otitis media often describe experiencing vertigo, as research shows that inflammation in the middle ear can lead to vestibular dysfunction. Monsanto et al. did a systematic evaluation that almost 40% of individuals with chronic otitis media report dizziness or vertigo during their disease. This finding underlines the importance of detecting

vestibular symptoms in the clinical assessment of COM since they can significantly impact patient management and treatment success[20]. In our study, three patients complained of vertigo. Studies on the prevalence of tinnitus in patients with chronic otitis media vary. Tailor et al., for example, carried out a thorough analysis using the Chronic Otitis Media Questionnaire-12 research and found that a considerable percentage of patients reported having tinnitus, with severity ratings ranging from mild to moderate[21]. Our study detected that 15 per cent of the patients had complaints.

Doctors categorize tympanic membrane perforations into three essential locations: central, marginal, and subtotal. Central perforations occur in the pars tensa, the more significant, more rigid region of the tympanic membrane, while marginal perforations are located near the borders, often affecting the annulus. Subtotal perforations encompass a considerable section of the tympanic membrane but do not entirely rupture it. Studies have shown that central perforations are the most common form in patients with chronic otitis media. For instance, Karakuş et al. observed that central perforations accounted for roughly 87.2% of cases in their study, underscoring their prevalence in surgical settings[22]. In our study, central perforation was observed in 60% of all patients.

Research shows a substantial association between preoperative hearing thresholds and surgical outcomes. For example, Kolo and Ramalingam reported that the preoperative hearing threshold was 38.3 dB, and the postoperative threshold fell to 22.8 dB, resulting in an average hearing gain of 15.5 dB. These data imply that the preoperative hearing threshold is a key element impacting the hearing gain following surgery[23]. Vidiyanti et al. found that 52.7% of patients improved their hearing threshold by more than 10 decibels after surgery[3]. The preoperative hearing threshold is an important metric that impacts the success of surgery in individuals undergoing tympanoplasty. The link between preoperative hearing threshold and postoperative outcomes plays a key role in evaluating the efficacy of surgery and improving the treatment of patients.

The success rates of tympanoplasty treatments utilizing temporal muscle fascia range from 75% to 90%. A study by Yurttaş et al. indicated that the success rate of temporal muscle fascia grafts is approximately 90%[24]. The results indicate that temporal muscle fascia graft is an efficacious material for eardrum closure. Success rates are not just contingent upon the graft material. Sahan et al. indicated that the site and dimensions of the perforation are significant factors influencing the efficacy of tympanoplasty. The success rate for anterior perforations is as low as 67%, whereas it can go up to 90% for posterior and inferior perforations[25]. The characteristics of the perforation play a crucial role in the success of the surgery. Our study's perforation closure rate was 92.5%, similar to earlier studies.

Many studies have investigated hearing gain after tympanoplasty with temporalis fascia transplantation. In the study of Kütük and Özdaş, The study reported that in patients using a temporalis fascia graft, the preoperative air-bone difference (ABG) decreased from 20.40 dB to 8.12 dB, resulting in a mean hearing gain of 12.4 dB[26]. These findings confirm the beneficial benefits of tympanoplasty with temporalis fascia graft on hearing. In addition, in Ahmed and Panchami's study, patients' hearing levels were assessed at 3 and 6 months postoperatively. Researchers observed that individuals experienced the most significant hearing improvement in the first 3 months[27]. In Kumaraswamy's study, a mean air-bone difference reduction of 11.94 dB was recorded following tympanoplasty with temporalis fascia graft (5). Type 1 tympanoplasty with a

temporalis fascia graft significantly improves patients' hearing. Several studies have proved the usefulness of this operation in delivering hearing gains. In our study, the preoperative and postoperative air-bone gap difference was 14.32 Db.

CONCLUSIONS

Type 1 tympanoplasty employing temporalis fascia is reliable for healing tympanic membrane perforations and enhancing hearing results. The technique has achieved considerable ABG closure and boosted patients' auditory function. However, individual characteristics such as age, perforation size, and When measuring postoperative hearing improvement, we must address the surgical method. Future studies should continue to study these aspects to optimize surgical methods and enhance patient outcomes.

Limitations

Its single-centre and retrospective design may limit patient selection and the generalisability of results to other settings.

Surgical interventions were performed by a single surgeon, which increases the likelihood of operator bias in the results.

Only objective (audiometric) measurements were considered in audiological evaluations; subjective patient satisfaction scores or quality of life measures were not evaluated.

The pre-op and post-op evaluation period was kept fixed (12 weeks), and long-term hearing gains and graft durability were not monitored.

Ethics Committee Approval: The study was approved by the Ethics Committee of Dicle University Hospital with approval number 395 on March 28, 2025.

Conflict of Interest: The authors declared no conflicts of interest.

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