

Middle ear ventilation function in patients with myringoplasty alone and myringoplasty plus mastoidectomy

Miringoplasti ve miringoplastiyle birlikte mastoidektomi uygulanmış olgularda orta kulak ventilasyon fonksiyonu

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Objectives: In this study we investigated the correlation between middle ear pressure changes in patients with myringoplasty alone and together with intact canal wall mastoidectomy.

Patients and Methods: The tympanometric values of 102 patients with myringoplasty alone and 78 patients with myringoplasty plus intact canal wall mastoidectomy were examined by tympanometric analysis in this retro-prospective study. The study population consisted of 130 male and 50 female patients (mean age 25.3±7.7). All patients underwent myringoplasty with or without mastoidectomy due to chronic otitis without cholesteatoma. Patients with a value of less than -100 daPa during the postoperative follow-up were considered having normal middle ear ventilation. Independent-samples t-test was used for comparison of the analyses results of groups.

Results: Sixty patients with myringoplasty (58.8%) and 55 patients with intact canal wall mastoidectomy (70.5%) had middle ear pressures less than -100 daPa at three months after surgery. The percentage of recovery over the first three years was 70.5% and 76.9% in the myringoplasty and intact canal wall mastoidectomy groups, respectively. The rate of persistent negative pressure is 21.6% and 14.1% in the myringoplasty and intact canal wall mastoidectomy groups, respectively. The number of patients who had negative middle ear pressure in myringoplasty group was higher than the number of those in intact canal wall mastoidectomy group at all intervals. However, when the rate of normalization over time was compared between two groups, no significant difference was found ($p>0.05$).

Conclusion: In first three months, the significantly higher number of patients achieving normal middle ear ventilation in mastoidectomy group compared to the patients without mastoidectomy is a finding which supports the additional effect of mastoidectomy on the pressure normalization function. However, the rate of normalization over time is not different between two groups. Middle ear pressure normalization is a continuous dynamic process and improvements may be seen for up to one year.

Key Words: Myringoplasty; tympanometry; tympanoplasty; ventilation.

Amaç: Bu çalışmada tek başına ve intakt kanal duvar mastoidektomisiyle birlikte miringoplasti uygulanan hastalarda orta kulak basınç değişimleri arasındaki ilişki araştırıldı.

Hastalar ve Yöntemler: Miringoplasti yapılan 102 ve intakt kanal duvar mastoidektomisi ile birlikte miringoplasti yapılan 78 hastanın timpanometrik değerleri bu retrospektif çalışmada timpanometrik analizle incelendi. Çalışma grubu 130 erkek ve 50 kadın hastadan (ort. yaş 25.3±7.7) oluşmaktaydı. Hastalara kolesteatomla seyretmeyen kronik otit nedeniyle mastoidektomili ya da mastoidektomisiz miringoplasti uygulandı. Ameliyat sonrası takipte -100 daPa'dan düşük bir değere sahip olan hastaların normal orta kulak ventilasyonuna sahip olduğu kabul edildi. Grupların analiz sonuçlarının karşılaştırılmasında bağımsız örnekler t-testi kullanıldı.

Bulgular: Ameliyattan sonraki 3. ayda miringoplastili 60 hasta (%58.8) ile intakt kanal duvar mastoidektomili 55 hastada (%70.5) orta kulak basıncı -100 daPa'nın altında idi. Miringoplasti ve intakt kanal duvar mastoidektomisi grubunda ilk üç yılda orta kulak basıncındaki toparlanma oranı sırasıyla %70.5 ve %76.9 idi. Persistan negatif basınç oranı miringoplasti ve intakt kanal duvar mastoidektomisi grubunda sırasıyla %21.6 ve %14.1 idi. Her bir zaman aralığında iki grup karşılaştırıldığında miringoplasti grubunda negatif basınçlı hasta sayısı tüm zamanlarda intakt kanal duvar mastoidektomisi grubundakinden daha fazlaydı. Ancak iki grup zaman içindeki normalizasyon oranı açısından karşılaştırıldığında anlamlı fark bulunamadı ($p>0.05$).

Sonuç: İlk üç ayda orta kulak ventilasyonunun normale ulaştığı hasta sayısının mastoidektomi yapılan hasta grubunda anlamlı bir şekilde daha yüksek olması, mastoidektominin basınç normalizasyonu fonksiyonu üzerindeki ilave etkisini destekler bir bulgudur. Ancak zaman içindeki normalizasyon oranı gruplar arasında farklı değildi. Orta kulak basıncı normalizasyonu devam eden dinamik bir süreç olup bir yıla kadar düzelmeler görülebilir.

Anahtar Sözcükler: Miringoplasti; timpanometri; tympanoplasti; ventilasyon.

A dry, functional middle ear space with an acoustically effective sound conduction mechanism is the goal of tympanoplastic reconstruction. Infection and poor surgical technique are causes of early unpleasant outcomes. Residual inflammatory disease and Eustachian tube dysfunction are responsible for late failure even though the graft take after surgery seems satisfactory. One of the parameters for long-term success of middle ear reconstructive surgery is adequate middle ear ventilation. However, the correlation between the rate of successful graft take in the long run and middle ear pressure changes is not clear and the predictive value of pressure variations is not apparent.

On the other hand, some studies support the adjunctive use of mastoidectomy in an effort to improve the success rate regardless of the grafting material. Physiological relationship between mastoid pneumatization and middle ear pressure alterations are previously well documented.^[1] The arguments in favor of mastoidectomy state that the open mastoid cavity provides an improved volume and pressure buffer, excludes the mastoid of diseased mucosa and ensures adequate patency of the aditus.^[2,3] Failure to surgically create a pneumatized air cell system in a patient with non-cholesteatomatous chronic otitis media may increase the risk of surgical failure. However, the correlation between middle ear pressure changes in patients with myringoplasty alone and intact canal wall mastoidectomy (ICWM) in the long-term is not clear. This study analyzes longitudinal tympanometric follow-up of patients who have intact ear drum after myringoplasty with or without mastoidectomy operation.

PATIENTS AND METHODS

The study included 180 patients (130 males, 50 females, mean age 25.3 ± 7.7 years; range 18 to 52 years) who had been operated for myringoplasty alone ($n=102$) or myringoplasty plus mastoidectomy ($n=78$) and who had an intact restored ear drum during the follow-up period. All patients underwent primary surgery. There were draining or non-draining ears at repair. The criteria for separating the patients into myringoplasty or myringoplasty with mastoidectomy groups were based on the disease status. Non-draining, dry ears were selected for myringoplasty only. However, mastoidectomy was included for patients with draining ears, hyperplastic mucosa, polypoid and/or granulation

tissue of the middle ear cleft. Diseased granulation tissue of the middle ear and mastoid was always cleaned but the healthy middle ear mucosa was never removed. Patients with unsuccessful eardrum repair or late failure were excluded. Patients who had ossicular reconstruction, prosthesis or ossicular replacement, were not included. All patients had a history of chronic discharging ears for a variable duration. Written and informed consent was obtained from all patients. Patients who did not respond during follow-up were excluded. Intact canal wall mastoidectomy was basically done for patients with chronic otitis media without cholesteatoma. All patients received temporalis muscle fascia for tympanic membrane repair. Audiometric and tympanometric tests were reviewed three or four times a year for more than three years. The test battery consisted of an acoustic impedance chamber (AZ-26, IAC, Denmark), a clinical audiometer (AC-30, IAC, Denmark) with standard earphones (Telephonics TDH 39P, IAC, Denmark) and with standard vibrator (Radio ear B-71, IAC, Denmark) for measurement of bone conduction. Tests included air and bone conduction thresholds for pure tones, tests of speech reception and speech discrimination, acoustic reflex threshold and middle ear impedance. A pure-tone hearing threshold was obtained at 250, 500, 1000, 2000, 4000 and 6000 Hz frequencies. Acoustic reflex thresholds were measured at 500, 1000, 2000 and 4000 Hz frequencies. Acoustic impedance measurements were repeated twice. Patients with a value of less than -100 daPa were considered having normal middle ear ventilation. All acoustic measurements were conducted under closed sound-field conditions with the patient sitting inside a standard, sound proof, electrically shielded chamber (Industrial Acoustic Corp., Bronx, NY, USA). Tests were done at the same center with the same group of audiometrists who were unaware of the study groups.

All the results are processed by SPSS (Statistical Package for Social Sciences) software for Windows 10.0 version (SPSS Inc., Chicago IL, USA). Independent-samples t-test is used for comparison of two groups. Results were evaluated in 95% safety margin and at the level of $p < 0.05$ significance.

RESULTS

Postoperative average middle ear pressures of 102 patients from the myringoplasty group was -60.8 ± 43.3 daPa (0-216 daPa) and it was -59.5 ± 34.5

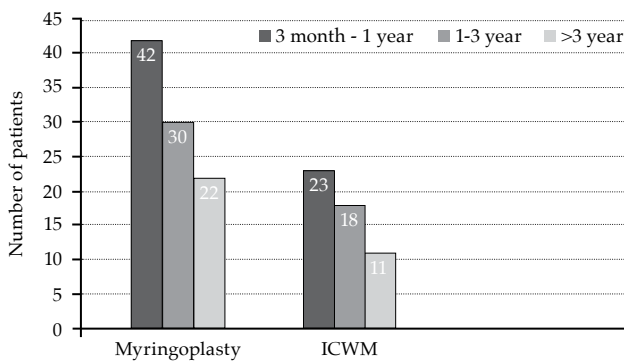


Figure 1. Follow-up of recovery in patients with negative middle ear pressure. 2nd and 3rd columns in each group represent the number of patients with recovery at the following intervals; 12 out of 42 (28.5%) for 1-3 years and 8 out of 30 (26%) for more than 3 years in the myringoplasty and 5 out of 23 (21.7%) for 1-3 years and 7 out of 18 (30.8%) more than 3 years in CWM group have recovery of the middle ear ventilation. ICWM: Intact canal wall mastoidectomy.

daPa in 78 patients from the mastoidectomy group (-4-200 daPa) in the early period after surgery. There was no significant difference between the average values ($p > 0.05$). Sixty patients (60/102; 58.8%) with myringoplasty (mean; -42.83 daPa) and 55 patients (55/78; 70.5%) with ICWM had middle ear pressures less than -100 daPa (mean: -50.89 daPa) at three months after surgery. Those with normal middle ear ventilation at three months were not included in further follow-up. The average middle ear pressure of 42 patients from the myringoplasty group was -130 ± 31.6 daPa at three months after surgery and it was -128.4 ± 33.7 daPa in 23 patients from the ICWM group. In the myringoplasty group, middle ear pressure recovered within 1-3 years in 12 patients (62.2 ± 40.7 daPa). After three years, eight more patients in this group had pressure normalization (-61.7 ± 41.8 daPa) (Figure 1). In the myringoplasty group, in patients with negative middle pressures at the first clinical test, the rate of recovery from the first to the final test was 52.3% (42/22). The overall rate of patients having normal middle ear pressures in this group

was 78.4% in the long-term. Twenty-two patients still had high negative pressures. Therefore, the rate of persistent negative pressure in this group during planned follow-up was 21.5% (102/22). In the ICWM group, middle ear pressures recovered within 1-3 years in five patients (-63.6 ± 41.5 daPa). After three years, seven more patients had pressure recovery (-60.8 ± 42.4 daPa). In this group, recovery of middle ear pressure in patients with negative middle pressure at the first clinical test is 47.8% (23/11). The total number of patients having normal middle ear pressure in this group was 85.9% in the long-term. Eleven patients in this group still had negative pressures. The rate of persistent negative pressure in this group was 14.1% (78/11).

The rate of patients with negative middle ear pressures in both groups during different time intervals is seen on table 1. When the number of patients with negative middle pressures in two groups was separately evaluated at each time interval, the number of patients who had negative middle ear pressures in the myringoplasty group was higher than the number of those patients in the ICWM group at all intervals. However, as seen in figure 2, when the rate of normalization over time was plotted on the same diagram and the data were compared between two groups, no difference was found ($p > 0.05$).

DISCUSSION

Almost 10% of patients with successful tympanic membrane repair had re-perforations.^[4] Retraction, atelectasis, granulation tissue formation of the ear drum, epithelial thinning are the late problems and can be seen within two years after tympanic membrane grafting in 2-7% of patients.^[5] Those patients who experience a poor outcome have ongoing environmental factors predisposing them to the failure which is basically attributed to Eustachian tube dysfunction.^[4] It has been the subject of various discussions, whether reconstruction of the tympanic membrane with mastoidectomy may provide additional stability

Table 1. The overall rate of patients with negative middle ear pressure in both groups during different time intervals

Surgery	3 month - 1 year (n)		1-3 year (n)		>3 year (n)	
	n	%	n	%	n	%
Myringoplasty	42/102	41.2	30/102	29.7	22/102	21.5
ICW mastoidectomy	23/78	24.9	18/78	17.6	11/78	14.1

ICW: Canal wall mastoidectomy.

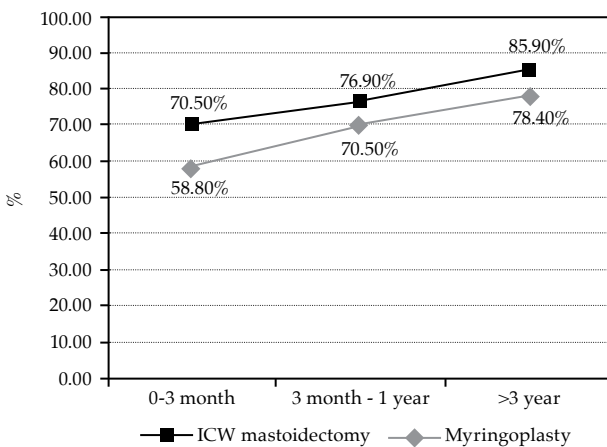


Figure 2. The rate of normalization of the middle ear pressure over time in two groups. ICW: Canal wall mastoidectomy.

necessary to allow the middle ear and mastoid to revert naturally to a normalized environment. The primary argument in favor of mastoidectomy has been an improvement in the middle ear and mastoid conditions through clearance of disease, secretions and ventilatory mechanisms of an open mastoid system. An increase in the volume of the middle ear space through a surgically opened mastoid would be protective for tympanic membrane to middle ear pressure changes and would help the tube to restore the already existing dysfunction. The mastoid cavity is thought to maintain middle ear pressure.^[6] McGrew et al.^[7] compared the hearing result and graft take rate of 144 patients with tympanoplasty combined with mastoidectomy and 320 patients with tympanic membrane repair only. They reported that mastoidectomy is not necessary for successful results but it has a certain impact on the clinical course in patients by reducing the number of patients requiring future procedures.

However, there are conflicting reports which make it difficult to address the additional restorative effect of the mastoidectomy. Ruhl and Pensak^[8] presented 135 revision tympanoplasty surgeries performed in conjunction with mastoidectomy and reported grafting success over 90% of patients, even in those with draining ears. However, there were no controls without mastoidectomy. Balyan et al.^[9] reported similar results of graft take rate and hearing results with or without mastoidectomy in their series of 323 tympanoplasties. Graft take rate and functional hearing gain was not different whether mastoidectomy was included or not. Mishiro et al.^[10] supported the use of tympanoplasty without mastoidectomy in chronic non-cholesteatomous

otitis media with an equivalent rate of grafting success and hearing results regardless of the state of the ear at repair (draining or non-draining) or addition of mastoidectomy. A long-term follow-up study by Mishiro et al.^[11] presented similar results. Recent studies demonstrated no difference in surgery of patients whether they had draining or dry ears or whether mastoidectomy was included or not.^[12,13]

Some controversy remains about the mastoidectomy procedure combined with intact canal wall technique in patients with non-cholesteatomas chronic otitis media. Holmquist was one of the pioneers who concluded that there is continuous gas absorption through the mucosal lining of the middle ear depending on the volume of the middle ear cavity in such a way that the rate of decline in air pressure increases as the volume decreases. Holmquist and Bergström^[14] suggested that it is necessary to have an air reservoir in the form of an open mastoidectomy cavity connected with the middle ear when treating patients with poor tubal function. In contrast Palva and Virtanen^[15] suggested that such an air reservoir serves no purpose and recommended obliteration of the mastoid cavity by means of a musculo-periosteal flap to prevent retraction. Vartiainen and Härmä^[16] reported that hearing and mobility of the intact tympanic membrane is as good as the open cavity technique if mastoid obliteration is used. Minoda et al.^[17] offered a new approach by closing the mastoid cortex only with bone paté having an access between the middle ear and the mastoid cavity through the epitympanium and reported less recurrence.

The purpose of this study was simply to compare the recovery of middle ventilation function in patients with or without mastoidectomy by means of tympanometry. In an effort to examine the effect of mastoidectomy on patients treated surgically for otitis media, objective analysis is difficult since subjective assessments are frequently required to consider many factors that effect surgical outcomes such as severity of infection, degree of mucosal disease etc. Restoration of middle ear ventilation function over time, regardless of presence or absence of associated mastoidectomy, suggests that closure of a perforation may prevent irritation of the middle ear mucosa which may encourage a return of normal tubal function. Not only the patency but also the mucociliary function

of the tube would have been restored after healing of the middle ear mucosa. Jonathan^[18] using sonotubometry demonstrated successful recovery of tubal function after myringoplasty. However, even if the repaired tympanic membrane seems normal after surgery healing and maturation of the middle ear takes some time.^[19] By using computed tomography, Tono et al.^[20] reported that an average time for the return of middle ear aeration after intact canal wall mastoidectomy is eight months. However, individual discrepancies indicate that several parameters play some role in this process. For some, it takes years to gain normal ventilating function. According to the study by Vartiainen, who used otoscopy only, the number of ears with permanent Eustachian tube insufficiency long after successful tympanic membrane repair is low at about 3%.^[4] However, if tympanometric analysis is included, the rate of persistent high pressure in patients can be higher. Residual negative pressure three years after surgery in the present study was 14.1% in patients with mastoidectomy and 21.5% in patients with myringoplasty alone.

Conclusively, in the first three months, the number of patients with normal middle ear ventilation in the mastoidectomy group was significantly more than those without mastoidectomy which may support the additional effect of mastoidectomy on the pressure normalization function. However, the rate of normalization over time was not different between both groups. Middle ear pressure normalization is a dynamic process and lasts up to a year.

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