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Research Article

Modified Technique Endaural Approach: Comparison with Endoscopic and Postauriculer Approach

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Abstract

Objectives: To introduce and evaluate a modified endaural approach for type 1 tympanoplasty by comparing its anatomical and functional outcomes with those of the classical postauricular and endoscopic transcanal approaches.

Methods: We retrospectively analyzed 86 patients (≥16 years) with subtotal tympanic membrane perforations who underwent type 1 tympanoplasty between 2015 and 2021. Patients were grouped based on surgical approach: endoscopic transcanal (Group A, n=28), postauricular (Group B, n=31), and modified endaural (Group C, n=27). Pre- and postoperative air-bone gap (ABG), graft success rates, complications, and operation durations were compared.

Results: The mean operation duration was significantly shorter in Groups A (40.3±0.9 min) and C (45.1±1.4 min) than in Group B (61.3±1.6 min) ($p<0.0001$). Graft success rates were similar across groups: 85.8% in Group A, 83.9% in Group B, and 85.2% in Group C. Pre- and postoperative ABG improvements did not differ significantly among groups. No major complications were observed in Group C, while minor complications occurred in Groups A and B.

Conclusion: The modified endaural approach offers comparable anatomical and functional outcomes to classical techniques while reducing operation time and bleeding. This technique is especially advantageous for patients with narrow external auditory canals or posterior perforations and allows the comfortable use of both microscope and endoscope.

Keywords: Tympanoplasty, endaural approach, postauricular approach, endoscopic ear surgery

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Tympanoplasty is the most commonly performed middle ear surgery in otorhinolaryngology clinics worldwide. Gaining access to the middle ear is an important step during tympanoplasty. Various approaches have been described to gain access to the middle ear.[1,2] Although most surgeons prefer the postauricular approach, endaural and transcanal approaches are also frequently used. Each technique has advantages and limitations. Factors that should be considered when deciding on the surgical approach include the size and area of the tympanic membrane perforation, ear canal size, and surgeon's preference. Surgical approaches to the middle ear are used less frequently due to the increase in number of endoscopic ear surgeries, which have become popular in recent years. However, surgical access to the middle ear is not possible without an external auditory canal incision.[3,4]

The transcanal approach is the only one which does not involve external incisions; therefore, this approach is frequently used during endoscopic surgeries. Post-auricular incisions are required in all ear surgeries, and have been modified by many surgeons.[5,6] The endaural approach is another approach used to gain middle ear access. This ap-

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proach was first described more than 100 years ago and has been used for mastoid and middle ear surgeries.[1]

In this study, we aimed to introduce a new endaural technique by modifying the classical endaural approach. We compared the outcomes of tympanoplasty between the modified endaural approach and endoscopic and postauricular approaches.

Methods

The study was approved by the Non-invasive Clinical Studies Ethics Committee of Bilecik Seyh Edebali University Faculty of Medicine, Turkey (02.07.2021-33471, M2S1). The study was conducted in accordance with the Declaration of Helsinki.[7]

Patients

We retrospectively analyzed the records of 86 out of the 112 patients with chronic otitis media who underwent type 1 tympanoplasty at our hospital between January 2015 and January 2021. Patients were selected on the basis of age, revision surgery status, tympanic membrane perforation size, and the need for mastoidectomy. Patients were grouped on the basis of the surgical approach used to access the middle ear.

Group A patients underwent surgery using the endoscopic, transcanal approach. In this approach, a Rosen's incision is made in the direction of the ear membrane, in the superior and inferior parts of the ear. The tympanomeatal flap is lifted and the middle ear accessed.

Group B patients underwent surgery using the post-auricular approach. In this approach, a skin incision is made in the postauricular groove and the auricle is retracted anteriorly. A crescent-shaped incision is made in the external auditory canal, and the tympanomeatal flap is elevated to access the middle ear. Group C patients underwent surgery using the modified endaural approach described below.

Modified Endaural Approach

We prefer the endaural approach for primary or revision tympanoplasty and inside-out mastoidectomy. We modified the number of incisions used in this approach. As per anecdotal experience, this modified endaural approach is associated with reduced surgical time and bleeding. We used two incisions: a skin incision from the junction of the outer ear canal cartilage and bone at the 6–12 o'clock position, extending into the helicotragal groove (Fig. 1); and another skin incision from the superior end of the first incision to the annulus, extending up to the level of the lateral process of the manubrium mallei (Fig. 2, 3).

After these incisions, the periosteum is elevated, and an inferior-based, superior pedicled tympanomeatal flap is prepared. After the middle ear is accessed from under the annulus, the flap is advanced by visualizing the annulus inferiorly, and superiorly from the established middle ear access point.

We aimed to categorize the patients into homogeneous groups to compare the outcomes of different surgical approaches.

Inclusion Criteria

We included patients aged ≥16 years with subtotal tympanic membrane perforation (≥50% of the total tympanic membrane area) who underwent type 1 tympanoplasty. These patients did not have ear discharge for >2 months, and had a normal ossicular system and stable disease for ≥6 months prior to the surgery. We measured the perforation size during surgery using an otomicroscope.

Exclusion Criteria

We excluded patients if they were younger than 16 years of age, had cholesteatoma, or underwent mastoidectomy, ossicular chain reconstruction, or revision surgery.

Records of the preoperative otolaryngological, radiological (temporal bone computed tomography), and otomicroscopic examinations were reviewed. Results of audiological pure tone thresholds measured preoperatively were recorded. The operating room notes of the patients were reviewed and the operation duration was calculated. Medical records of the patients at 1, 6, and 12 months, and of controls at 24 months, were evaluated. We calculated the operation duration, pre- and post-operative air-bone gap (ABG), complication rates, and postoperative graft success rates.

Pre- and post-operative audiograms were evaluated using the American Academy of Otolaryngology-Head and Neck Surgery Committee on Hearing and Equilibrium guidelines. Air and bone conduction hearing thresholds were determined by pure tone audiometry tests (0.25–8.0 kHz). Mean hearing thresholds and ABGs were calculated at 0.5, 1.0, and 2.0 kHz.

The patients were operated on under general anesthesia. All surgeries were performed by the same surgeon (R.D.) using a microscope and endoscopic system. Group A patients were operated on using an endoscopic system and a 0-degree rigid endoscope (4.0 mm, 16.0 cm; Karl Storz SE & Co., Tuttlingen, Germany). Group B and C patients were operated on using a microscope (Opmi Vario S88; Carl Zeiss AG, Oberkochen, Germany). No special tools were used during the operations.

The postauricular approach was preferred for patients with anterior tympanic membrane perforation, and the modified endaural approach for patients with posterior perfora-

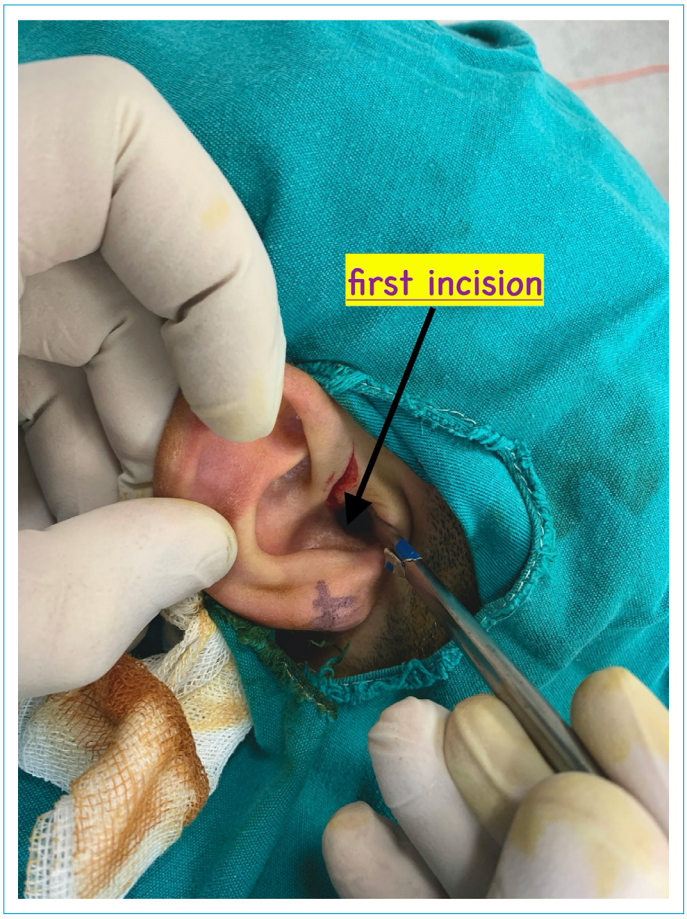

Figure 1. First incision of modified endaural approach.

tion. The endoscopic approach was preferred for patients who requested endoscopic surgery.

Statistical Analysis

GraphPad Prism 6.01 (GraphPad Software, Inc., San Diego, CA, USA) was used for the statistical analysis and plotting of the graphs. The results are expressed as means ± standard error of the mean (SEM). Data were analyzed using Tukey's multiple comparisons test and one-way analysis of variance. P-values ≤0.05 and ≤0.0001 were considered significant.

Results

Group A

Endoscopic tympanoplasty was performed in Group A patients (n=28, 32.5%). Twelve patients were male and sixteen were female. The mean age of the patients was 36.67 years, and the mean control duration was 25.5 months. The mean operation duration was 40.320±0.980 min. Mean pre- and postoperative ABG values were 21.860±1.119 and 9.536±0.7910 dB, respectively. Perforation was found in four (14.2%) postoperative controls. The graft success rate was 85.8%.

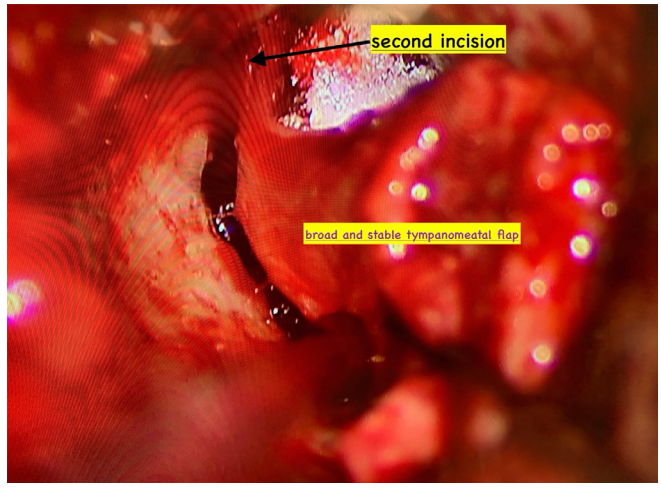

Figure 2. Second incision and tympanomeatal flap view.

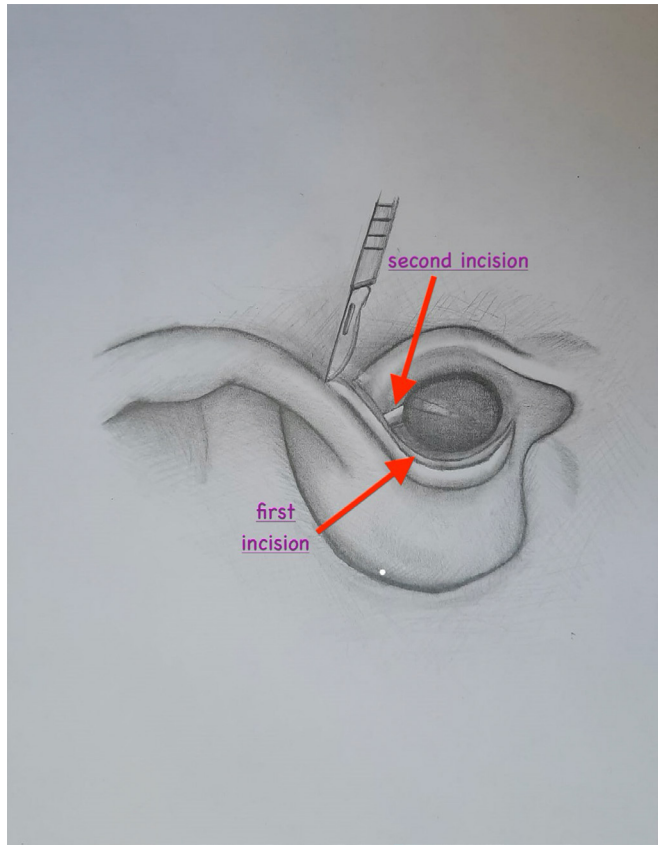

Figure 3. Incisions of modified endaural approach.

Group B

The post-auricular approach and a microscope were used in Group B (n=31, 36%). Eighteen patients were male and thirteen were female. The mean age was 31.3 years, and the mean control duration was 24.51 months. The mean operation duration was 61.320±1.602 minutes. The mean pre- and postoperative ABG values were 20.390±1.031 and 10.480±1.345

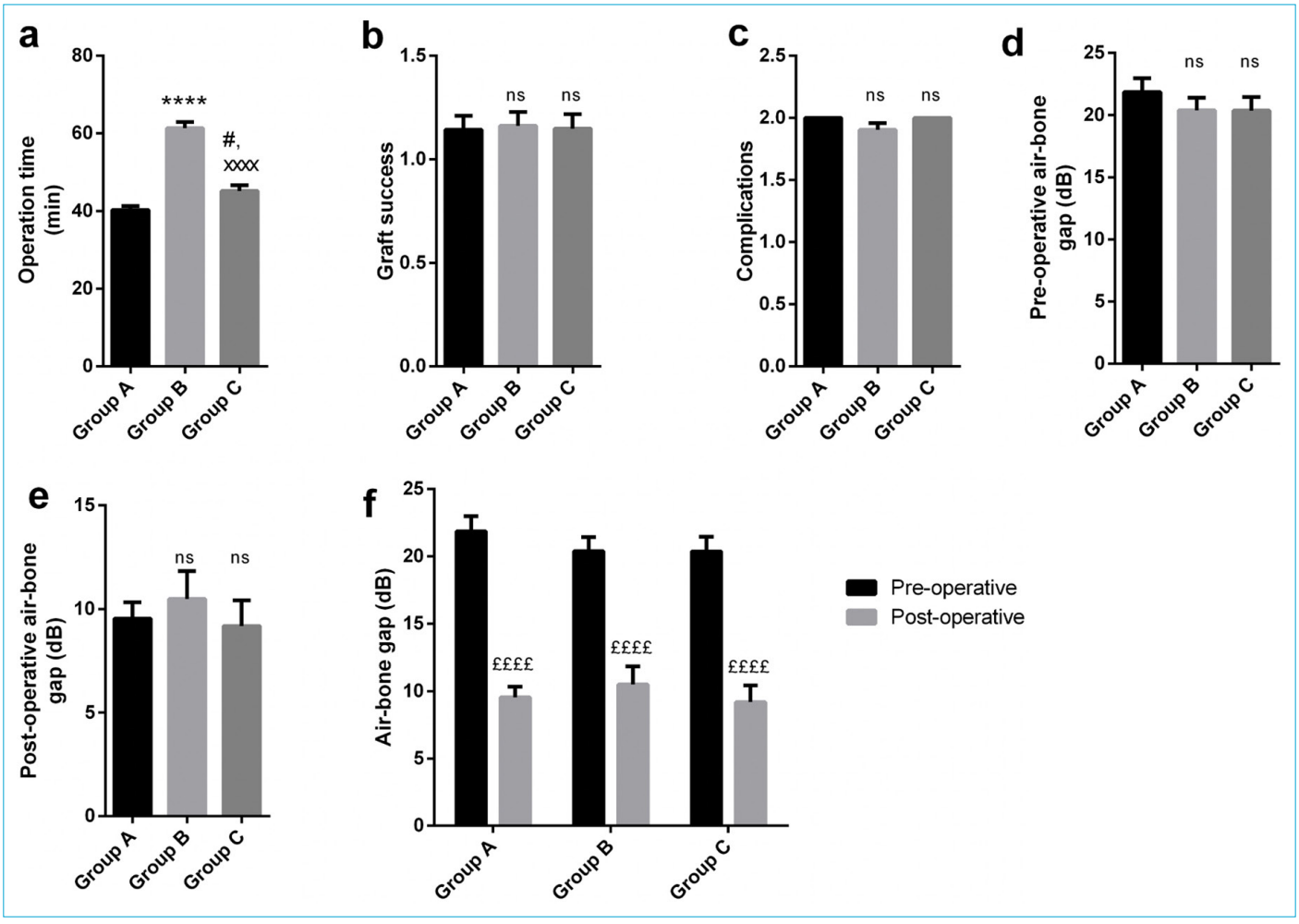

Figure 4. Graphical representation of anatomical and functional results of the groups. (a) Operation time, (b) Graft success, (c) complications, (d) pre-operative air-bone gaps, (e) post-operative air-bone gaps, and (f) comparison of air-bone gaps between pre-operative and post-operative patients.

Graft success: 2-perforation, 1-no perforation. Complications: 1-yes, 2-no. The air-bone gaps ≤10dB, 11–20dB, and ≥20dB was normalized to 1, 2, and 3, respectively. The number of patients: Group A (N=28), Group B (N=31), Group C (N=27), Total (N=86). Average age of patients: Group A (36,67), Group B (31,23), Group C (28,3). Average follow-up time (month) of patients: Group A (25.5), Group B (24.5), Group C (27). The unpaired t test with Welch's correction was used to compare the groups (p≤0.05 *, p≤0.0001 ****. *Group A vs. Group B, #Group A vs. Group C, xGroup B vs. Group C, nsnon-significant, £Pre-operative vs. Post-operative).

dB, respectively. The graft success rate was 83.9%, and postoperative graft perforation was observed in five (16.1%) patients. Postoperative wound complications occurred in two patients. Infections and hematoma developed in the postauricular suture area in one patient each in Groups A and B.

Group C

Group C patients underwent surgery using the aforementioned modified endaural approach and a microscope (n=27). Thirteen patients were male and fourteen were female. The mean age was 28.3 years, and the mean operation duration was 45.190±1.449 minutes. The graft success rate was 85.2%, and postoperative graft perforation occurred in four patients. The pre- and post-operative ABG values were 20.370±1.090 and 9.179±1.247 dB, respectively. No postoperative wound complications were detected in any patients.

No statistically significant differences were found in the graft success rate or pre- or post-operative ABG values between the groups. The operation duration was significantly shorter for Groups A and C compared to Group B ($p<0.0001$) (Fig. 4; Table 1). However, there was no difference in operation duration between Groups A and C. No statistically significant difference was observed in demographic or disease-related data between the groups. The endoscopic approach was preferred for revision surgery in patients with postoperative graft perforation.

Discussion

Tympanoplasty is the most frequently performed surgery worldwide in the field of otology. Several approaches have been described to gain middle ear access during tympa-

Table 1. Anatomical and functional results of the groups

Parameters	Study groups (n=86)		
	Group A (n=28)	Group B (n=31)	Group C (n=27)
Operation time (min)	40.320±0.980	61.320±1.602****	45.190±1.449$^{\#,xxxx}$
Graft success	1.143±0.067	1.161±0.067^{ns}	1.148±0.069^{ns}
Complications	2.000±0.000	1.903±0.0539^{ns}	2.000±0.000^{ns}
Pre-operative air-bone gap (dB)	21.860±1.119	20.390±1.031^{ns}	20.370±1.090^{ns}
Post-operative air-bone gap (dB)	9.536±0.7910$^{££££}$	10.480±1.345$^{ns,££££}$	9.179±1.247$^{ns,££££}$

Graft success: 2-perforation, 1-no perforation. Complications: 1-yes, 2-no. The air-bone gaps ≤10dB, 11–20dB, and ≥20dB was normalized to 1, 2, and 3, respectively. The number of patients: Group A (N=28), Group B (N=31), Group C (N=27), Total (N=86). Average age of patients: Group A (36,67), Group B (31,23), Group C (28,3). Average follow-up time (month) of patients: Group A (25.5), Group B (24.5), Group C (27). The unpaired t test with Welch's correction was used to compare the groups (p≤0.05 *, p≤0.0001 ****. *Group A vs. Group B, $^{\#}$Group A vs. Group C, ^{x}Group B vs. Group C, $^{£}$Pre-operative vs. Post-operative, ^{ns}Non-significant).

noplasty, including transcanal, post-auricular, and endaural approaches. These well-defined approaches provide access to the middle ear for tympanoplasty, as well as mastoid surgery. Each approach has its own advantages and disadvantages. The approach used for middle ear surgery depends on the external auditory canal anatomy and surgeon's preference, especially in the cases of tympanoplasty, stapedectomy, and myringoplasty.

The transcanal approach is frequently used in combination with endoscopic systems. This approach does not involve an external incision, which leads to better cosmetic appearance, reduced recovery and hospitalization durations, and better tolerability. The use of the transcanal approach with an endoscopic system further reduces the operation duration.[3,6]

The post-auricular approach can be used for almost all otologic surgeries. The disadvantages of this approach are the long recovery duration of the post-auricular incision, cosmetic problems due to risk of displacement of the auricle, and long operation duration. However, it has the advantage of being commonly used.[1,5]

The endaural approach is the main subject of this paper, and is another preferred approach for middle ear access during middle ear surgery. The endaural approach, which may be used for exploratory tympanotomy, tympanoplasty, and mastoidectomy, was first described by Kessel in 1885. Lempert popularized the use of this approach in 1929, and Heermann modified it in 1930 to its current form. The classical endaural approach involves four incisions.[1] First, a skin incision is made at the junction of the outer ear canal cartilage and bone at the 6–12 o'clock position; an incision extending along the inferior wall of the external auditory canal to the annulus is then made, perpendicular to the first incision and parallel to the external auditory canal; then, an incision extending along the superior wall of the external auditory canal to the annulus, perpendicular to the first incision and parallel to the external auditory canal, is made; and finally, an incision is made between the helix and tragus, starting from the upper end of the first incision and lateral to the external auditory canal.

The endaural approach has some advantages and disadvantages. It is difficult to use in cases of protruding anterior ear wall, and scars may occur in the helicotragal groove, which lead to cosmetic problems. Perforations may also occur in the anterior part of the tympanic membrane.

However, the modified endaural approach was associated with shorter surgery duration and less bleeding due to the use of two incisions.

Sharma et al. compared the surgical approaches of myringoplasty (i.e., the transcanal, endaural, and postauricular approaches). The audiological and anatomical results of the approaches were similar.[8] In our study, although the functional and anatomical results were similar, the operation time was significantly shorter for the modified endaural approach.

Man et al. described a cavum turbinate modification of the endaural approach, which involved an additional incision extending from the superior incision to the cavum concha, after the classical endaural incisions. The outcomes of this approach were satisfactory, and it may be a good alternative for gaining middle ear access.[9] In our study, however, the approach was different compared to that described in the previous study. Instead of the cavum concha incision, an incision was made in the helicotragal groove, which was kept as small as possible to prevent scar formation.

Kamalova et al. compared the anatomical and functional outcomes of different tympanoplasty approaches, including the transcanal, endaural, and postauricular approaches. The endaural and postauricular approaches had better outcomes than the transcanal approach.[10]

In our study, the incisions used in the classical endaural approach were modified, and fewer incisions were made. In addition to reduced operation duration, this method was associated with less bleeding and a more stable and wide tympanomeatal flap. Compared to other approaches, the anatomical and functional outcomes are similar for the modified endaural approach. The operation duration with the endaural approach was also similar to that associated with the endoscopic approach. The graft success rate for the modified endaural approach was 85.2%, versus 83.9% and 85.8% for the endoscopic and postauricular approaches, respectively. No difference was found in the pre- or post-operative ABG values between the groups. A statistically insignificant difference was seen in operation duration between Groups A and C. However, the operation duration was significantly shorter in Groups A and B compared to Group B ($p<0.0001$) (Fig. 4; Table 1). With this approach, we aimed to minimize the length of the helicotragal groove to reduce the need for sutures, cosmetic deformity, and the healing time. Additionally, only the first helicotragal groove incision was sutured.

Conclusion

In conclusion, tympanoplasty performed with the modified endaural approach has satisfactory anatomical and functional outcomes. In addition, it was associated with reduced bleeding, fewer incisions, and shorter operation duration. In the modified endaural approach, the microscope and endoscope can be comfortably used. Additionally, more than one instrument can be simultaneously used in the external auditory canal, especially when using the endoscope. The endaural approach is a viable alternative for patients with a narrow external auditory canal entrance and posterior tympanic membrane perforation.

The limitations of our study included the small sample size and lack of objective measurement of bleeding.

Disclosures

Ethics Committee Approval: The study was approved by the Bilecik Seyh Edebali University Faculty of Medicine Non-invasive Clinical Studies Ethics Committee (date: 02.07.2021, no: 33471).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – T.Y., R.D.; Design – T.Y., R.D.; Supervision – R.D.; Materials – T.Y., R.D.; Data collection and/or processing – T.Y., R.D.; Analysis and/or interpretation – T.Y., R.D.; Literature search – T.Y., R.D.; Writing – T.Y., R.D.; Critical review – R.D.

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