

# Comparison of anterior tab flap and underlay tympanoplasty techniques in anterior tympanic membrane perforations

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**Ethics Committee Approval**

Kocaeli University Ethics Committee of Non-  
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All procedures in this study involving human  
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**Conflict of Interest**

No conflict of interest was declared by the  
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**Abstract**

**Background/Aim:** Closure of anterior tympanic membrane perforation is surgically demanding with high rates of graft failure. The anterior tab flap (ATF) technique is a modification of underlay tympanoplasty which claims higher success rates for repairing anterior and subtotal perforations. Our main aim was to compare graft take rates of ATF and underlay techniques in anterior tympanic membrane perforations.

**Method:** In this retrospective cohort study, 41 patients with anterior tympanic membrane perforations who underwent tympanoplasty at a tertiary referral center were analyzed. The patients were grouped according to the technique used. Demographic, clinical, and follow-up information as well as preoperative and postoperative 6<sup>th</sup>-month audiometric data were collected and compared between the groups.

**Results:** Four patients were lost to follow-up. Eighteen patients in the ATF arm and 19 patients in the underlay arm were compared. Graft take rates were 94.4% in the ATF group and 73.7% in the underlay group ( $P=0.180$ ). An air conduction threshold average of <30 dB was observed in 76.5% in the ATF group and 63.1% in the underlay tympanoplasty group ( $P>0.05$ ). The postoperative ABG of the ATF and underlay group patients were less than 20 dB in 76.5% and 78.9%, respectively ( $P>0.05$ ). No graft lateralization, anterior blunting, or cholesteatoma were observed.

**Conclusion:** ATF is a safe and effective technique with a higher success rate for repairing anterior tympanic membrane perforation.

**Keywords:** Anterior tab flap, Tympanoplasty, Anterior pull-through, Kerr flap, Underlay

## Introduction

Tympanoplasty is one of the widely performed and understood otologic procedures over the years [1]. Maintaining a healthy middle ear cleft and restoration of hearing are its main goals. Although graft take rates are high for posterior and central perforations, anterior tympanic membrane perforation is clinically challenging for surgeons. The absence of medial support mechanism for grafts, relatively less vascularity of the region, scarcity of anterior epithelial reserve, and poor exposure are the main reasons for graft failure in anterior tympanic membrane perforations [2-3].

Several different tympanoplasty techniques and modifications were described to establish an intact tympanic membrane for anterior perforations. The underlay technique is an easy to perform and less time-consuming method that is commonly used throughout the world. The absence of reliable support and resulting graft medialization is the main drawback of the underlay technique [4-5]. To prevent anterior re-perforations and decrease graft medialization, the anterior tab flap (ATF) method, a modification of the underlay technique was advocated with higher success rates. In this modification, the tip of the graft is anchored to a 1-2 mm tunnel created lateral to the anterior fibrous annulus and external auditory canal wall skin [5-7].

This study aimed to compare graft take rates of the ATF and underlay techniques in anterior tympanic membrane perforations.

## Materials and methods

The patients with anterior tympanic membrane perforations operated on between 2015-2019 in a tertiary referral center were the subjects of this study. After institutional review board approval was granted from the Kocaeli University Ethics Committee of Non-invasive Clinical Research on 11/12/2019 with the number of GOKAEK 2019/349, a retrospective chart review was performed. Data regarding the preoperative and the postoperative 6<sup>th</sup>-month air conduction thresholds (ACT), bone conduction thresholds (BCT), air-bone gaps (ABG), the postoperative 6<sup>th</sup>-month tympanic membrane status, surgical technique, operative details, and follow-up information were collected.

We included the patients with perforations affecting more than 30% of the whole tympanic membrane, with a perforation margin to the anterior fibrous annulus of less than 1 mm. All procedures were performed under general anesthesia using an operating microscope through a retroauricular approach. Temporalis muscle fascia and conchal cartilage with one-sided perichondrium were used as graft materials. Patients with cholesteatoma or retraction pockets were excluded, but those with ossicular chain discontinuity were included in the study.

The decision of the technique to be used was made intraoperatively. The underlay technique was used in patients with a clear view and access to the anterior tympanic membrane remnant. The ATF technique was preferred in patients with less than 1 mm anterior tympanic membrane remnant after disepitelization or anterior marginal perforations with an unhindered view of the anterior tympanomeatal angle.

## ATF Technique

The ATF technique is well described in the literature [6-8]. The retroauricular approach is preferred in our clinic to increase the exposure of the anterior tympanomeatal angle and the anterior extent of the perforation. Temporalis muscle fascia and conchal cartilage with the perichondrium are harvested routinely. The edges of the perforation are refreshed. During tympanomeatal flap elevation, the manubrium of the malleus is carefully freed from the membrane. Sclerotic plaques which are close to the perforation and the larger ones causing hearing impairment are removed. Ossicular movement is controlled at this step and ossiculoplasty is performed if required. A 2-mm anterior stab incision 2 mm lateral to the annulus is made on the anterior meatal skin usually at the 2 to 4 o'clock position in right ears and the 8 to 10 o'clock position in the left ears. An anterior meatal tunnel is created deep into the annulus, carefully preserving the fibrous annulus, and the middle ear is entered. Temporalis fascia graft is fashioned according to the perforation, leaving an anterior tab, or pointed tip to be delivered through the meatal tunnel. Temporalis fascia graft is then positioned under the tympanomeatal flap over the manubrium of the malleus. The anterior tab portion is placed near the anterior meatal tunnel and pulled through the tunnel with micro-suction tubes, alligator forceps, or right-angled hooks. This maneuver anchors the fascia graft anteriorly. To further support the temporalis fascia medially, a thinned cartilage perichondrium composite graft of 5 mm is positioned on the malleus handle under the fascia graft and dry gel foam is placed into the anterior mesotympanum to further support the grafts medially. The tympanomeatal flap is then placed back into the anatomic position and stabilized laterally with gel foam soaked in antibiotic solution. The incision is closed in layers, antibiotic-coated ribbon gauze is inserted in the ear canal, and a standard pressure dressing is applied.

## Underlay Technique

The underlay technique used in our clinic for anterior perforations is similar to the classical underlay technique [6]. The difference is the release of the malleus handle from the tympanic membrane to use for medial support. Temporalis fascia graft is placed over the manubrium of the malleus under the tympanomeatal flap. In this approach, a larger (~6-8 mm) cartilage perichondrium composite graft is positioned onto the malleus handle to support the fascia graft anteriorly. Also, dry gel foam is inserted into the anterior mesotympanum to support both grafts medially. The rest of the procedure is the same in both techniques.

Patients are called for routine control visits on the 2<sup>nd</sup> postoperative day, first week, 3<sup>rd</sup> week, 2<sup>nd</sup> month, and 6<sup>th</sup> month. Ribbon gauze in the ear canal is removed on the 2<sup>nd</sup> day and the patients start using 0.3% ciprofloxacin and 0.1% dexamethasone ear drops three times a day for 3 weeks. Stitches are removed at 1 week postoperatively. Tympanic membrane repair is expected at the 3<sup>rd</sup> week but hearing status is evaluated at 2<sup>nd</sup> and 6<sup>th</sup>-month postoperative controls.

## Audiologic Assessment

Patients' audiometry tests were performed per the ISO standards within a maximum of one month before the surgery, and at the last control after surgery (Audiometer: Interacoustic, AC40, Denmark). ACT, BCT, and ABG are evaluated at 500,

1000, 2000, and 4000 Hz. An ABG within 20 dB, or a hearing level within 30 dB considering the average pure tone thresholds of 500, 1000, 2000 Hz, 4000 Hz, are considered functional hearing success [1].

**Statistical analysis**

IBM SPSS statistics 21 (IBM Corp, Armonk, NY) software was used for data analysis. The chi-square test was used to compare graft take rates and hearing improvement. Odds ratio (OR) and 95% confidence intervals (CI) were given in parenthesis. Shapiro-Wilk test was used for the analysis of normality. ABG closure rates were evaluated using related samples Wilcoxon signed-rank test. P-values of less than 0.05 were considered significant.

**Results**

Forty-one patients with anterior tympanic membrane perforations were operated on between 2015-2019 in our tertiary referral center. All patients had chronic tubotympanic otitis media with anterior tympanic membrane perforation. Of these patients, four were lost to follow-up, so 37 patients were included in the study. Nineteen patients underwent underlay tympanoplasty, and 18 patients underwent ATF modification of underlay tympanoplasty.

In the ATF group, the median age of 18 patients was 30.4 (20.8, 43.8) years. The female to male ratio was 8/10. Tympanoplasty was performed on the right ear in 11 cases and on the left ear in 7 patients. Four patients were revision cases, previously operated with other techniques, but perforation persisted. The ossicular chain was mobile in 16 patients and immobile in 2. In one of these immobile ossicular chain patients, the incus was removed, and a partial ossicular replacement prosthesis was inserted between the cartilage composite graft and stapes head for hearing restoration. The incus lenticular process and stapes suprastructure were eroded in the remaining patient, and a total ossicular replacement prosthesis was positioned on the mobile footplate.

In the underlay group, the female to male ratio was 12/7, and the median age of 19 patients was 35.0 (26.0-48.0) years. The right to left ear ratio was 8/11. Three cases were revision surgeries. The ossicular chain was mobile in 17 patients. The lenticular process was eroded and incudostapedial conduction was ensured with glass-ionomer bone cement in one patient. In the other one, the incus was removed and malleostapedopexy was performed. Malleostapedial connection was established with the glass-ionomer bone cement. The clinical data of both groups are given in Table 1.

Table 1: Clinical summary of both groups

	Anterior tab flap group	Underlay group	P-value
Number of patients	18	19	
Age	30.4 (20.8,43.8)	35.0 (26.0,48.0)	0.461
Female to Male Ratio	8/10	12/7	0.343
Right Ear/Left Ear	11/7	8/11	
Revision Surgery	4	3	
Ossiculoplasty	2	2	
Graft take rate	17/18 (94.4%)	14/19 (73.7%)	

Age is presented as median (25-75%).

The average follow-up time was 18 months in the ATF group and 9 months in the underlay group. Graft take rates were 17/18 (94.4%) in the ATF group and 14/19 (73.7%) in the underlay group. No statistical difference was found between the two groups in terms of graft success rate (P=0.180). One of the

graft failure patients in the ATF group was re-operated for slit-like re-perforations, and complete tympanic membrane closure was achieved afterward. One of five patients with postoperative defective graft in the underlay group was re-operated, but the perforation persisted. None of the patients exhibited graft lateralization or anterior blunting. Two patients in the ATF group and one patient in the underlay group had a postoperative purulent discharge. These infections had resolved with appropriate care and antibiotics. After the treatment, complete tympanic membrane closure was achieved in all 2 patients in the ATF group, however, perforation persisted in the infected ear in the underlay group. The patient in the underlay group did not agree to a revision.

One cochlear implant candidate patient was not evaluated for hearing statistics. In terms of hearing status, the median of the average of 500-1000-2000-4000 Hz preoperative ACT and BCT values were 32.5 dB and 10.0 dB, respectively, in the ATF group, versus 42.5 dB and 15.0 dB, respectively, in the underlay group (Table 2). The median of sixth-month postoperative air and bone conduction thresholds were 22.5 dB and 11.3 dB, respectively, in the ATF group versus 23.8 dB and 16.3 dB, respectively, in the underlay group. The differences in the ACT were significantly better in both groups. The BCT levels did not deteriorate statistically. The preoperative and postoperative median of the ABG in the ATF group were 22.5 and 12.5, respectively (P=0.023). The preoperative and postoperative median of the ABG in the underlay group were 25.0 and 12.5, respectively (P=0.003). One patient in the ATF group was operated on to prepare for cochlear implantation, so she was excluded from hearing assessment.

Table 2: Audiological outcomes of both groups

		Pre-operative	Post-operative	p value
Anterior Tab Flap Group (N=17)	ACT	32.5 (30.0-40.0)	22.5 (18.1-30.0)	0.031
	BCT	10.0 (8.1-16.3)	11.3 (7.5-17.5)	0.118
	ABG	22.5 (18.1-29.4)	12.5 (3.8-18.8)	0.023
Underlay Group (N=19)	ACT	42.5 (26.3-50.0)	23.8 (18.8-40.0)	0.004
	BCT	15.0 (8.8-25.0)	16.3 (8.8-23.8)	0.135
	ABG	25.0 (17.5-32.5)	12.5 (3.8-18.8)	0.003

Median and range values of 500-1000-2000-4000 Hz pure tone audiometry and air-bone gap results are presented in the table (Unit: dB). ACT: Air-Conduction Threshold, BCT: Bone-Conduction Threshold, ABG: Air-Bone Gap

Air conduction threshold of under 30 dB was reached in 76.5% in the ATF group, and 63.1% in the underlay tympanoplasty group (P>0.05). The ATF and underlay group patients had postoperative ABGs less than 20 dB in 76.5% and 78.9% (P>0.05). No difference for functional hearing success was detected among the groups (P=0.586, OR: 1.15, 95% CI: 0.24-5.56).

Analyses of the preoperative and postoperative ABG closure rates alone demonstrated a significant difference in the underlay group (pre-op ABG: Median: 25, interquartile range: 19 vs post-op ABG: Median: 15, interquartile range: 12) (P=0.031). However, the decrease in ABG was not significant in the ATF group (pre-op ABG: Median: 23, interquartile range: 9 vs post-op ABG: Median: 13, interquartile range: 14) (P=0.083).

**Discussion**

Tympanoplasties for anterior tympanic membrane perforations are surgically demanding, thus, surgical approaches have lower closure rates compared to other perforations [1-2]. Reasons for graft failure include scarcity of vascular supply,

difficulty in access, and lack of medial support for the graft [2]. Many different techniques and modifications of underlay and overlay tympanoplasties have been described with increased graft survival in anterior tympanic membrane perforations [2-3]. The ATF technique is one of the modifications of the underlay technique described to solve this problem. In this technique, a small tab of fascia is anchored to the anterior wall to provide durability for the graft while preserving the anterior acute tympanomeatal angle.

The proposed technique was first introduced by Bailey in 1976 [6]. In his underlay fixation technique, small tongues of the fascia graft were drawn under the fibrous annulus both superiorly and anteriorly through 2-4 mm tunnels on the anterior bony canal wall. In 1986, Primrose and Kerr defined the anterior hitch method for anterior marginal perforations [7]. This method was a modification of the underlay fixation technique using only one anterosuperior tunnel. Sharp et al. exercised the Kerr flap in 47 patients with a 97.5% graft take rate [8]. Later in 1996, Kerr published his series with a 100% success rate in 20 patients [9]. Instead of creating an anterior tunnel, Harris et al. [5] made the anterior incision just lateral to the annulus. With their anterior pull-through technique, they reported an 84.6% perforation closure rate in 13 patients. They proposed that performing this modification was easier and less time-consuming than the anterior hitch method.

Our experience with the ATF method was similar to the previous reports [5,8,9]. In contrast to overlay techniques, creating a small tunnel on the anterior wall did not cause anterior blunting. The decision to do underlay or ATF can be made intraoperatively, just before trimming the fascia. Indeed, the ATF method requires more time and experience [5,7]. We believe creating a 2 mm tunnel provides more support for the graft and pulling the anterior tab through the tunnel is not very difficult. However, in cases with obstructed views of the anterior tympanic annulus due to anterior bony overhang or anatomical reasons, the ATF method may not be feasible. Although this technique can be used in the transcanal, endaural, and postauricular approaches, the postauricular route provides a better view of the anterior wall and more mobility to the surgeon [6].

In the literature, 84.6% to 100% graft take rates were published with the ATF method [5, 7-11]. However, there is only one study comparing the ATF method with the underlay techniques. In this random prospective clinical trial, D'Eredità and Lens [11] compared the ATF technique with standard underlay myringoplasty in children. The closure rate at 2 years of follow-up was 93.2% in the ATF technique and 84.6% in the underlay technique. Although they achieved insignificantly better results with the ATF technique, their results were not limited to anterior perforations. In anterior perforations, they still achieved better results with the ATF technique (91.3% vs 78.9%) [11]. Our results were consistent with this study (94.4% in the ATF arm and 73.7% in the underlay tympanoplasty arm).

The most common graft failure in our underlay group was medialization of the anterior border of the cartilage. If this medialization occurs without fascia or perichondrium on the free margin, it is difficult to restore.

The main drawbacks of our study were the small sample size, lack of randomization, and non-homogeneity of the groups in terms of ABG and ossicular problems.

### Conclusion

ATF is a safe and effective technique for repairing anterior tympanic membrane perforations. None of the patients had anterior blunting or graft lateralization at 18 months follow-up. Although insignificant, higher graft take rates were achieved with the ATF technique compared to underlay tympanoplasty.

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