Journal of Medicine in Scientific Research

Volume 4 | Issue 4 Article 15

Subject Area: Otolaryngology

Posterior tympanotomy versus posterior atticotomy in creating well-ventilated middle ear cleft pros and cons

Essam F. Abdelfattah
General Organization for Teaching Hospitals and Institutes

Wael A. Alzami
General Organization for Teaching Hospitals and Institutes, dr_waelzamil25@yahoo.com

Recommended Citation

Abdelfattah, Essam F. and Alzami, Wael A. (2021) "Posterior tympanotomy versus posterior atticotomy in creating well-ventilated middle ear cleft pros and cons," *Journal of Medicine in Scientific Research*: Vol. 4: Iss. 4, Article 15.
DOI: https://doi.org/10.4103/jmisr.jmisr_26_21

Posterior tympanotomy versus posterior atticotomy in creating well-ventilated middle ear cleft pros and cons

Wael A. Alzami, Essam F. Abdelfattah

Department of Ear, Nose and Throat, Hearing and Speech Institute, General Organization for Teaching Hospitals and Institutes, Cairo, Egypt

Abstract

Background

Cortical mastoidectomy is considered a cornerstone step in the surgical management of noncholesteatomatous chronic suppurative otitis media. It comprises the canal wall-up technique, preserving the posterior and superior bony canal walls. The goal of cortical mastoidectomy is mainly to ventilate the middle ear cleft besides eradication of diseased mastoid air cells. The ventilation of the middle ear cleft has no way except through the aditus ad antrum and patent epitympanic diaphragm besides well-functioning Eustachian tube. This way of ventilation is usually affected in chronic infected ears by edematous and polypoid mucosa, leading to its obstruction. Traditional practice used to perform posterior atticotomy to overcome this problem, exposing the incudomalleolar complex and to excise edematous and polypoid mucosa. This technique may be ineffective in many cases owing to multiple factors, so posterior tympanotomy may acts as an alternative pathway to bypass obstructed aditus ad antrum and epitympanic diaphragm.

Aim

The aim was to compare the effectiveness of both posterior tympanotomy and posterior atticotomy in achieving well-ventilated middle ear cleft in noncholesteatomatous chronic suppurative otitis media and to identify advantages and disadvantages of both techniques.

Patients and methods

A prospective, comparative, randomized study was conducted from March 2019 to December 2020. A total of 40 patients experiencing safe non chronic suppurative otitis media CSOM with central perforation were included. Patients have been randomized into two groups of 20 patients each (groups A and B). The patients in group A underwent cortical mastoidectomy and posterior atticotomy, whereas the patients in group B underwent cortical mastoidectomy and posterior tympanotomy. Regular follow-up visits were done every 2 months for at least 6 months for both groups.

Results

In group A, 12 patients were doing well throughout the follow-up period with intact graft and ventilated middle ear, 4 patients had retracted grafts, 2 patients had retraction pockets, and 2 patients had recurrent tympanic perforation and discharge. In group B, 17 patients were doing well with intact grafts and ventilated middle ear, and 3 patients had mild tympanic retraction.

Conclusion

The authors found that posterior tympanotomy is an effective and viable alternative ventilation pathway to middle ear cleft bypassing obstructed aditus ad antrum with better address to the epitympanic diaphragm and less complications in patients with CSOM.

Keywords: Middle ear ventilation, posterior atticotomy, posterior tympanotomy

Introduction

The main function of mastoid air cell system is to buffer the changes in middle ear pressure during the intervals of Eustachian obstruction. So, a well-aerated mastoid system will increase the volume of the middle ear cleft and can compensate pressure changes in the middle ear cavity [1,2].

Access this article online

Quick Response Code:

Website: www.jmsr.eg.net

DOI: 10.4103/jmisr.jmisr_26_21

Correspondence to: Wael A. Alzamil, MD, Assistant consultant of Otorhinolaryngology, Department of Ear, Nose and Throat, Hearing and Speech Institute, General Organization for Teaching Hospitals and Institutes, Cairo 12591, Egypt.
Tel: 01015919029;
E-mail: dr_waelzamil25@yahoo.com

Submitted: 26-Mar-2021 **Revised:** 22-Apr-2021 **Accepted:**20-May-2021 **Published:** 11-Dec-2021

How to cite this article: Alzami WA, Abdelfattah EF. Posterior tympanotomy versus posterior atticotomy in creating well-ventilated middle ear cleft pros and cons. J Med Sci Res 2021;4:369-74.

In a well-aerated mastoid, marked changes in the middle ear pressure may have little effect on the middle ear and tympanic membrane [3]. During mastoidectomy, if we connect the mastoid cavity to the middle ear cleft properly, this will result in mastoid aeration, so the sequelae of repeated negative pressure, including atelectasis and cholesteatoma, can be minimized. However, the aeration of the mastoid system after a canal wall up mastoidectomy may be not achieved in many patients [3,4]. Vrabec *et al*.[4] found that only 46% of 35 patients with canal wall-up mastoidectomies showed good mastoid aeration. They concluded from the review of several previous reports that the prevalence of mastoid aeration following a canal wall-up mastoidectomy was no greater than 50% [4]. Ventilation of the middle ear cleft is mainly dependent on the Eustachian tube function, patent isthmus tympanicum, patent aditus ad antrum, pneumatization of the mastoid cavity, and status of the middle ear cleft mucosa. The mesotympanum and protympanum are aerated directly from the Eustachian tube, whereas the epitympanum is separated from the mesotympanum by the epitympanic diaphragm and ventilated through the isthmus tympanicum and sometimes through the incomplete tensor fold [5,6]. The mastoid system is separated from the epitympanum by the aditus ad antrum and needs for aeration patent aditus, patent tympanic isthmus plus or minus incomplete tensor fold in case of good Eustachian function and intact tympanic membrane [6].

The epitympanic diaphragm forms the floor of the epitympanum and separates it from the mesotympanum. This diaphragm consists of the malleus, incus, and their attached ligaments and membranous folds [7]. Aeration of the epitympanic space comes from the Eustachian tube to the protympanum and then through the isthmus tympanicum crossing the diaphragm [8]. In a study, the isthmus tympanicum was blocked in most patients with attic disease, whereas the prevalence of blocked isthmus was low in the control group [9].

In 1964, Proctor[10] described the isthmus tympanicum as a tiny opening between the mesotympanum and the attic and located between the stapes posteriorly and the tensor tympani tendon anteriorly, with its primary function being ventilation of the atticomastoid compartment as mentioned before [10]. Even in the presence of a well-functioning Eustachian tube, a blocked isthmus tympanicum may hinder ventilation and pneumatization of the atticomastoid compartment of the middle ear cleft, resulting in hypopneumatized mastoid and possible formation of attic retraction and cholesteatoma [11]. Thick edematous mucosa, adhesions, granulation tissue, polyps, and cholesteatoma may block the isthmus tympanicum and interfere with the ventilation of the atticoantral compartment [12].

Posterior tympanotomy is a technique in which we address the middle ear cavity through the facial recess in a canal wall-up mastoidectomy. Originally this technique was described mainly as a management of limited situations, mainly limited facial recess cholesteatoma and cochlear implantation surgery [13]. This route has the advantage of proper wide connection between the middle ear cleft and the mastoid cavity with bony boundaries not lined by mucosa and permanent patency with subsequent minimal narrowing [13]. Moreover, it can be widened safely anterosuperiorly toward the incus buttress with minimal risk to the facial nerve, chorda tympani, or the annulus [13].

However, in nonexperienced hands, there may be risks of complications involving the facial nerve, the chorda tympani nerve, the annulus, and the posterior bony wall. Moreover, the incus and incudostapedial joint may be at risk, especially in chronically inflamed mastoid with altered anatomy [14].

Regarding the posterior atticotomy (Fig. 1), it is the traditional technique done as an extension of cortical mastoidectomy in the anterosuperior direction to address the attic between the tegmen tympani and the superior bony wall. This procedure is meticulous, demanding a highly skilled surgeon [15]. The aim of posterior atticotomy is good exposure of the incudomalleolar complex to excise thick edematous mucosa [16]. Low dural plate may interfere with good exposure with a risk of ossicular chain injury (Fig. 2), and also the length of the procedure and its proximity to the incudomalleolar heads has the risk of noise-induced sensorineural high-frequency hearing loss even with experienced hands [16]. It was found also that a good connection between the mastoid and the mesotympanum was not universally achieved after long meticulous procedure owing to difficult control of the tympanic isthmus and the tensor fold [4,17]. In our study, we have conducted a comparison between posterior atticotomy and posterior tympanotomy regarding the surgical steps, difficulties, complications, and the outcomes (Tables 1–3).

Patients and methods

A prospective, comparative, randomized study was conducted from March 2019 to December 2020. In all, 40 patients experiencing safe noncholesteatomatous CSOM with central perforation were included. Patients have been randomized into two groups of 20 patients each (groups A and B). The patients in group A underwent cortical mastoidectomy and posterior atticotomy, whereas the patients in group B underwent cortical

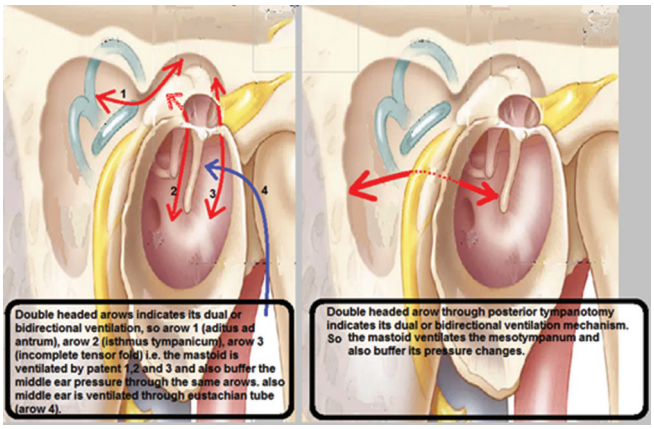

Figure 1: Comparison between routs of ventilation in both groups, group A on the right and group B on the left.

Table 1: Comparison between groups according to operative time, blood loss, complications, hospitalization, and return to normal life activities

Patient groups		Item				
		Operative time (h)	Blood loss	Intraoperative complications	Hospitalization	Return to normal life
Group A	Range	1.5 to 2.4 h	105-130 ml	No complications in both groups	1 day	7 days
	Mean	1.8 h	123 ml			
Group B	Range	1.2 to 1.9 h	107-125 ml		1 day	7 days
	Mean	1.5 h	117 ml			

Table 2: Comparison between groups regarding intraoperative difficulties and postoperative complications

Patient groups	Operative difficulties			Postoperative complications
	Exposure of the epitympanum	Communication between the mastoid and the mesotympanum		
Group A	Inadequate in 6 patients (15%)	Proper	11 patients (55%)	High-frequency sensor neural hearing loss in 2 patients (10%)
		Inadequate	4 patients (20%)	
		Absent	5 patients (25%)	
Group B	-	Proper	20 patients (100%)	-

Table 3: Final Outcome

Patient groups	Conducive gap closure [*n* (%)]			Intact graft [*n* (%)]	Retracted graft [*n* (%)]	Retraction pocket [*n* (%)]	Residual perforation [*n* (%)]
	Gap closure	Minimal gap closure	Persistent conductive gap				
Group A	8 (40)	2 (10)	10 (50)	12 (60)	4 (20)	2 (10)	2 (10)
Group B	12 (60)	3 (15)	5 (25)	17 (85	3 (15)	-	-

mastoidectomy and posterior tympanotomy. Regular follow-up visits were done every 2 months for at least 6 months for both groups.

Ethics

The Ethics Committee of our institution approved this work according to the Declaration of Helsinki. A detailed informed consent was obtained from each patient.

Methods

All patients were assessed based on a thorough history, otologic examination, and full audiological evaluation. High-resolution computed tomography scan of the temporal bone was performed for each patient to assess the middle ear cavity and mastoid pneumatization.

Operative technique

Under general anesthesia, we performed cortical mastoidectomy via a postauricular approach, raising a periosteal flap, exposing the spine of Henle to start drilling in the Mc Ewen's triangle proceeding in the three main directions, the dural plate, the sinus plate, and the line parallel to the posterior canal wall. After exenteration of the diseased mastoid air cells and good identification of the antrum and lateral semicircular canal, the patients were divided into two equal groups of 20 patients each (group A and group B) according to the following steps.

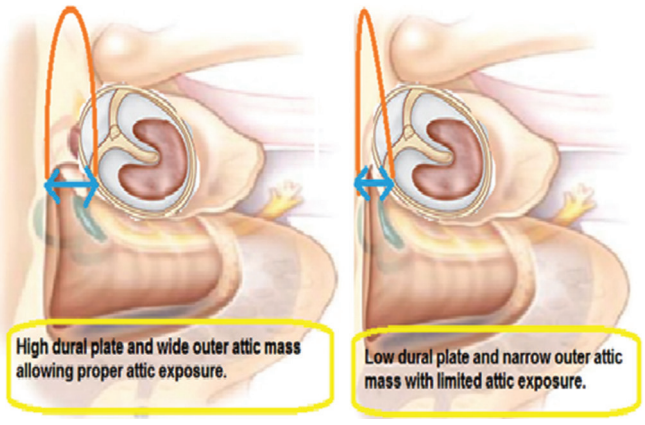

Figure 2: Two different situation regarding the dural level showing low level in the right side and high level in the left.

In group A (Fig. 3), we have completed the cortical mastoidectomy in the anterosuperior direction performing posterior atticotomy or the superior canal wall-up atticotomy. We started by exposing the incus body and short process followed by careful drilling between the dural plate superiorly and the superior canal wall inferiorly to expose the rest of incus body, the incudomalleolar joint, and head of malleus correspondingly. In case of high dural

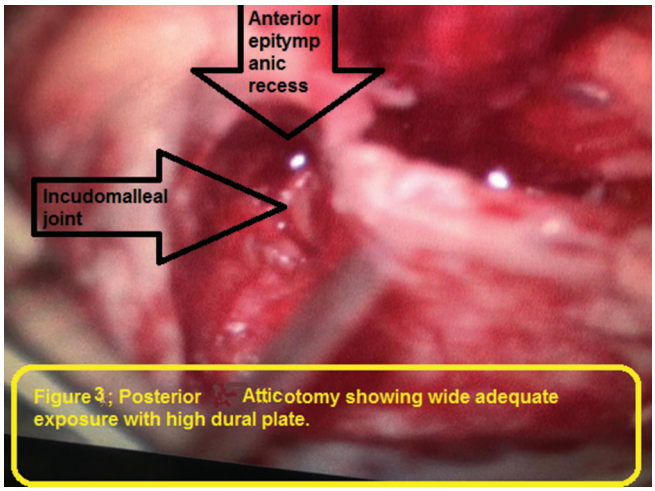

Figure 3: Posterior atticotomy.

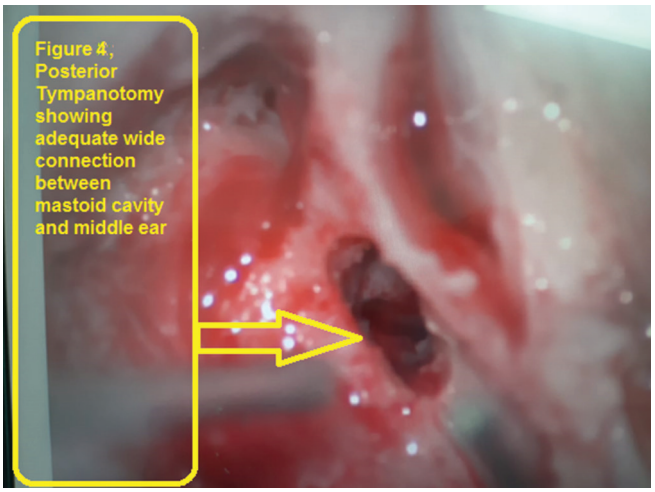

Figure 4: Posterior tympanotomy.

plate with optimal circumstances, we proceeded anteriorly to open the anterior epitympanic recess beyond the cog. Careful drilling not to touch the ossicular chain is crucial. In this group of patients, we have excised edematous polypoid mucosa in the attic and around ossicles by using different instruments to reach hidden areas in the epitympanic diaphragm (the tympanic isthmus and the tensor fold) to establish good connection between the epitympanum and the mesotympanum. This connection is marked by the free passage of saline between these two compartments.

In group B (Fig. 4), we performed posterior tympanotomy or the facial recess approach. At first, we exposed the incus short process, which points to the fossa incudis in the incus buttress, as it represents the base of the inverted pyramid of the facial recess. By a coarse diamond burr, we drilled carefully parallel to the facial nerve and the chorda tympani nerve along an axis from the incus buttress to the chordofacial angle besides thinning of the posterior canal wall. After establishing proper connection between the mastoid and the mesotympanum, we widened it in the anterosuperior direction safely. Additionally, through this approach, we assessed the tensor fold and the tympanic isthmus clearly and excised edematous polypoid mucosa to ventilate the attic region.

In both groups, the procedures were continued in the same steps, such as grafting the tympanic membrane perforation by temporalis fascia, periosteal closure, and skin closure by interrupted silk or vicryl sutures.

Postoperative management was the same in both groups. Parenteral antibiotics and analgesia were given for the first 5 days followed by oral antibiotics for 5 days.

Follow-up visits were done every week for the first month and then monthly for 6 months recording data about healing, recurrence, and complications.

Statistical analysis

Data management and analysis were performed by using the statistical analysis systems. Numerical data were summarized using means and SDs or mean and ranges and Fisher's exact test, with statistical significance at P less than or equal to 0.05. Categorical data were summarized as percentages. The χ^2-test was used to compare between the groups concerning categorical data. All P values are two sided. P values less than 0.05 were considered significant.

Results

The average age of the patients in group A was 32.0 ± 5.5 years, whereas that in group B was 29.5 ± 7.75 years. The difference was statistically not significant (P = 0.5). The study population comprised 22 male patients (55%) and 18 female patients (45%). Both groups were comparable (P = 0.6).

Operative results

In group A, the operative time ranged from 1.5 to 2.4 h, with a mean of 1.8 h. Blood loss ranged from 105 to 130 ml, with a mean of 123 ml. Hospitalization was 1 day in all patients of this group, with discharge on the second postoperative day. Regarding complications, there were no complications in the form of injury to adjacent critical structures, including ossicles, dura, sinus, and facial nerve. Exposure of the epitympanum was inadequate in six patients due to low dural plate and narrow outer attic mass with relatively long procedure. Communication between the mastoid and the mesotympanum was proper in 11 patients (55%), inadequate or slow saline passage in four patients (20%), and absent in five patients (25%). Return to regular normal life activity or work was possible in all patients after 7 days.

Regarding the final outcome, all patients were subjected to periodic regular monthly assessment after the first month. In group A, 12 patients were doing well throughout the follow-up period with intact graft and ventilated middle ear, four patients had retracted grafts, two patients had posterosuperior retraction pockets, and two patients had recurrent tympanic membrane perforation and discharge.

Pure tune audiometry revealed conductive gap closure in eight patients (40%), minimal gap closure in two patients (10%), and persistent conductive gap in 10 patients (50%). High-frequency sensorineural hearing loss affecting 6 and 8 KHz was found in two patients (10%) in whom the procedure was lengthy.

In group B, the operative time ranged from 1.2 to 1.9 h, with a mean of 1.5 h. Blood loss ranged from 107 to 125 ml, with a mean of 117 ml. Hospitalization was 1 day in all patients of this group, with discharge on the second postoperative day. Regarding complications, there were no complications in the form of injury to adjacent critical structure, mainly the facial nerve, the lateral canal, and the posterior canal wall. Exposure of the facial recess area was adequate in all patients, except in two patients owing to anteriorly placed sinus plate with relatively long procedure. Communication between the mastoid and the mesotympanum was proper in all patients (100%). Return to regular normal life activity or work was possible in all patients after 7 days.

Regarding the final outcome, all patients were subjected to periodic regular monthly assessment after the first month. In group B, 17 patients were doing well throughout the follow-up period with intact graft and ventilated middle ear, and three patients had mild tympanic retraction.

Pure tune audiometry revealed conductive gap closure in 12 patients (60%), minimal gap closure in three patients (15%), and persistent conductive gap in five patients (25%). No high-frequency sensorineural hearing loss affection was noted.

Return to regular life activity or work was possible in all patients after 7 days.

Discussion

With intact tympanic membrane, the middle ear cleft has a dual ventilation system, composed of direct and indirect routes. The direct route occurs through the Eustachian tube, which ventilates the mesotympanum during its momentary opening equalizing its pressure with the atmospheric pressure [18]. The second route is the pneumatized cellular mastoid system, which acts as a standby buffer system to compensate the intervals of Eustachian blockage. However, the second route needs patent aditus ad antrum to ventilate the epitympanum and needs in addition a patent epitympanic diaphragm to further ventilate the mesotympanum [19]. Proper Eustachian tube function besides its direct effect on the mesotympanum also has an indirect effect on the mastoid system in the form of good pneumatization [20]. Moreover, this indirect effect requires a patent epitympanic diaphragm and a patent aditus ad antrum. So, hypopneumatized mastoid may be a result of chronic Eustachian dysfunction, obstructed aditus ad antrum, or blocked epitympanic diaphragm as a single factor or in combinations [20,21]. A vicious circle aggravates the middle ear condition, which may start by long-standing poor Eustachian tube function, leading to poorly pneumatized mastoid system, which in turn may adversely affect the middle ear buffer system. This circle may continue by chronic inflammatory mucosal edema leading again to more Eustachian obstruction [22]. Breaking this circle may be achieved by proper connection of the mesotympanum with the mastoid system. This connection has its physiological route through two steps, the aditus ad antrum and epitympanic diaphragm, which may be occluded by inflammatory mucosal edema or granulation. In this case, we practice posterior atticotomy to excise the obstructing element in its steps (aditus ad antrum and epitympanic diaphragm) [23]. There are many factors that may interfere with successful posterior atticotomy, including low dural plate, marked mucosal edema, and the time factor with long procedure of drilling near by the ossicular heads adding the risk of sensorineural hearing loss [24]. In these situations, posterior tympanotomy can establish proper wide connection between the mesotympanum and the mastoid cavity, bypassing the natural route, which is full of ossicles, membranous folds, and ligaments [24].

In our study, we compared both procedures (posterior atticotomy and posterior tympanotomy) regarding operative details and postoperative outcome. We found significant intraoperative difference between both groups regarding the length of the procedure, which was more in group A of posterior atticotomy owing to some anatomical issues in some patients, like as low dural plate and marked polypoid thick mucosal changes mandating careful meticulous drilling. Moreover, achieving proper connection between the mastoid cavity and the middle ear was significantly less in group A, with proper connection in 11 patients only (55%), inadequate or slow saline passage in four patients (20%), and absent in five patients (25%). However, it was proper in all patients of group B of posterior tympanotomy. Unfortunately, high-frequency sensorineural hearing loss was a complication in two patients of group A, which was explained as a noise trauma by the prolonged drilling near to the ossicular heads. Although the facial nerve was at a higher risk of injury in group B, it was not affected in all patients. Postoperatively, we found a significant deference in the outcome of patients, who showed higher graft taking in group B, as well as less retraction, better conductive gap closure, and no high-frequency hearing loss.

Conclusion

We found that posterior tympanotomy is an effective and viable alternative ventilation pathway to middle ear cleft bypassing obstructed aditus ad antrum with better address to the epitympanic diaphragm with less complications in patients with chronic supportive otitis media.

Conflicts of interest

There are no conflicts of interest.

References

1. Ars B, Dirckx J. Eustachian tube function. Otolaryngol Clin North Am 2016; 49:1121–1133.
2. Alicandri-Ciufelli M, Gioacchini FM, Marchioni D, Genovese E, Monzani D, Presutti L. Mastoid: a vestigial function in humans?. Med

Hypotheses 2012; 78:364–366.
3. Shirai K, Schachern PA, Schachern MG, Paparella MM, Cureoglu S. Volume of the epitympanum and blockage of the tympanic isthmus in chronic otitis media: a human temporal bone study. Otol Neurotol 2015; 36:254–259.
4. Vrabec JT, Champion SW, Johnson RFJr, Chaljub G. Aeration following intact canal wall mastoidectomy. Ann Otol Rhinol Laryngol 2003; 112(Pt 1):801–806.
5. Marchioni D, Alicandri-Ciufelli M, Molteni G, Artioli FL, Genovese E, Presutti L. Selective epitympanic dysventilation syndrome. Laryngoscope 2010; 120:1028–1033.
6. Marchioni D, Grammatica A, Alicandri-Ciufelli M, Aggazzotti-Cavazza E, Genovese E, Presutti L. The contribution of selective dysventilation to attical middle ear pathology. Med Hypotheses 2011; 77:116–120.
7. Marchioni D, Molteni G, Presutti L. Endoscopic anatomy of the middle ear. Indian J Otolaryngol Head Neck Surg 2011; 63:101–113.
8. Palva T, Ramsay H, Böhling T. Tensor fold and anterior epitympanum. Otol Neurotol 1997; 18:307–316.
9. Kwon OJ, Sung JM, Jung HK, Kim CW. Postoperative mastoid aeration following canal wall up mastoidectomy according to preoperative middle ear disease. J Audiol Otol 2017; 21:140–145.
10. Proctor B. The development of the middle ear spaces and their surgical significance. J Laryngol Otol 1964; 78:631–645.
11. Padurariu S, Roosli C, Roge R, Stensballe A, Vyberg M, Huber A, *et al*. On the functional compartmentalization of the normal middle ear. Morphohistological modelling parameters of its mucosa. Hear Res 2019; 378:176–184.
12. Marchioni D, Mattioli F, Alicandri-Ciufelli M, Presutti L. Endoscopic approach to tensor fold in patients with attic cholesteatoma. Acta Otolaryngol 2009; 129:946–954.
13. Karchier EB, Niemczyk K, Morawski KF, Bartoszewicz R, Orłowski A. Intraoperative endoscopy of the anterior epitympanum recess through the posterior tympanotomy. Wideochir Inne Tech Maloinwazyjne 2016; 11:208–213.
14. Sheehy JL. The facial nerve in surgery of chronic otitis media. Otolaryngol Clin North Am 1974; 7:483–503.
15. Gorur K, Ozcan C, Talas DU. The computed tomographical and tympanometrical evaluation of mastoid pneumatization and attic blockage in patients with chronic otitis media with effusion. Int J Pediatr Otorhinolaryngol 2006; 70:481–485.
16. Marchioni D, Mattioli F, Alicandri-Ciufelli M, Presutti L. Prevalence of ventilation blockages in patients affected by attic pathology: a case-control study. Laryngoscope 2013; 123:2845–2853.
17. Pereira AR, Diogenes JS, Vierradecastro JD, Filho JA, Freitas M. Matoidectomy: anatomical parametersxsurgical difficulty. Int Arch Otorhinolaryngol 2012; 16:828.
18. Lee DH, Jung MK, Yoo YH. Analysis of unilateral sclerotic temporal bone: how does the sclerotic change the mastoid pneumatization morphologicall in the temporal bone. Surg Radio Anat 2008; 30:221–227.
19. Marchioni D, Mattioli F, Alicandri-Ciufelli M, Molteni G, Masoni F, Presutti L. Endoscopic evaluation of middle ear ventilation route blockage. Am J Otolaryngol 2010; 31:453–466.
20. Shinnabe A, Hara M, Hasegawa M, Matsuzawa S, Kanazawa H, Kanaza-wa T, *et al*. Differences in middle ear ventilation disorders between pars flaccida and pars tensa cholesteatoma in sonotubometry and patterns of tympanic and mastoid pneumatization. Otol Neurotol 2012; 33:765–768.
21. Monsanto RD, Pauna HF, Kaya S, Hızlı Ö, Kwon G, Paparella MM, *et al*. Epitympanum volume and tympanic isthmus area in temporal bones with retraction pockets. Laryngoscope 2016; 126:E369–E374.
22. Li B, Doan P, Gruhl RR, Rubini A, Marchioni D, Fina M. Endoscopic anatomy of the tensor fold and anterior attic. Otolaryngol Head Neck Surg 2018; 158:358–363.
23. Shewel Y, Bassiouny M, Ebrahim M. Endoscopic assessment of the isthmus tympanicum and tensor tympani fold and their relationship with mastoid pneumatization in chronic otitis media. J Int Adv Otol 2020; 16:227–233.
24. Hashemi J, Rajati M, Rezayani L, Bahadori A. Temporal bone measurements.a comparison between rendered spiral CT and surgery. Iran J Radiol 2014; 11:e9400.