

TYMPANIC MEMBRANE ATELECTASIS (SADÉ GRADE I–II): PATHOPHYSIOLOGY, DIAGNOSTIC EVALUATION, AND TREATMENT OUTCOMES A STRUCTURED CLINICAL REVIEW

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ABSTRACT

Objective: To synthesize the published clinical and paraclinical literature on tympanic membrane (TM) atelectasis, with particular attention to early-stage disease (Sadé grade I and II), and to summarize the evidence supporting conservative and surgical management as a basis for a planned prospective cohort study at a regional referral hospital in northern Vietnam.

Methods: A structured search of PubMed/MEDLINE and Vietnamese domestic otorhinolaryngology journals was conducted for studies published between January 2010 and July 2026 addressing the pathogenesis, otoendoscopic and audiometric characteristics, tympanometric and computed-tomographic findings, or treatment outcomes of TM atelectasis or retraction pockets. Systematic reviews, narrative reviews, prospective and retrospective cohorts, and case series were eligible when they reported an extractable clinical, functional, or surgical outcome. Twenty-six clinical studies were retained for structured synthesis, supported by six additional references on pathogenesis, staging, or outcome-instrument validation. Because diagnostic criteria, staging systems, and outcome measures varied across studies, no pooled effect estimate was attempted.

Results: The reviewed literature converged on eustachian tube dysfunction and sustained negative middle-ear pressure, combined with acquired weakness of the TM fibrous layer, as the principal mechanism of progressive retraction. Hearing loss and tinnitus were the most consistently reported symptoms, present in roughly four-fifths to nine-tenths of patients in the largest Vietnamese endoscopic series, while otalgia and otorrhea were less frequent and more often associated with advanced-stage disease. Pure-tone audiometry, tympanometry, the seven-item Eustachian Tube Dysfunction Questionnaire, and temporal-bone computed tomography were the diagnostic tools most consistently used to stage disease and to plan management, with CT reported to identify the site of retraction with 91.9%–97.3% accuracy against surgical findings. For grade I–II atelectasis, watchful waiting and medical treatment directed at eustachian tube dysfunction were favored as first-line management, with surgery reserved for hearing loss exceeding roughly 30 dB or failure of conservative treatment after about six months. Surgical series, most reported for

more advanced disease, showed consistent improvement in the air–bone gap and generally stable anatomic outcomes, although recurrence was concentrated in higher Sadé grades.

Conclusions: Grade I–II tympanic membrane atelectasis is best managed through an evaluation sequence that combines otoendoscopic staging with audiometric, tympanometric, and eustachian tube function assessment, followed by staged escalation from observation and medical therapy to minimally invasive ventilation or reinforcement surgery when disease progresses. Vietnamese data, particularly from referral centres outside major cities, remain limited, and a structured cohort describing the clinical, paraclinical, and treatment-outcome profile of grade I–II disease would address a clear gap in the regional literature.

Keywords: *tympanic membrane atelectasis; retraction pocket; eustachian tube dysfunction; Sadé classification; cartilage tympanoplasty; ventilation tube; air–bone gap.*

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I. INTRODUCTION

Tympanic membrane (TM) atelectasis describes progressive inward retraction of the eardrum toward the middle-ear space, with consequent reduction of tympanic cavity volume. Although the mechanism is not fully resolved, the pathogenesis rests on three interacting factors: sustained negative middle-ear pressure secondary to eustachian tube dysfunction, acquired loss of stiffness in the fibrous layer of the pars tensa, and mucosal inflammation or ulceration of the middle ear [3]. Recurrent otitis media is understood to damage the sub-epithelial fibrous layer, producing thinning, atrophy, and progressive collapse of the membrane, while chronically negative

middle-ear pressure draws the whole drum inward until, in advanced disease, the membrane adheres to the promontory and the floor of the tympanic cavity and the middle-ear space is effectively obliterated.

Based on the extent of involvement, two clinical forms are recognized. Generalized (total) atelectasis affects all four quadrants of the pars tensa, with or without concomitant retraction of the pars flaccida. Localized atelectasis, or retraction pocket, is confined to a single site, most often the pars flaccida or the postero-superior quadrant of the pars tensa. Both forms are conventionally staged using a four-grade system, most widely attributed to Sadé, that tracks the depth of retraction and its relationship to the ossicular chain and medial tympanic

wall; staging is central to treatment planning because the risk of ossicular erosion and secondary cholesteatoma rises sharply from grade III onward, whereas grade I–II disease is, by definition, not yet fixed to the deep structures of the middle ear [25].

Diagnosis rests primarily on otoendoscopy with 0° and 30° optics or the operating microscope, which allows the examiner to determine the site and depth of retraction, the mobility of the membrane on Valsalva manoeuvre, and any visible discontinuity of the ossicular chain [9,10]. Pure-tone audiometry and tympanometry are the paraclinical tests most often used to quantify the functional impact of atelectasis on sound conduction and middle-ear status, and standardized questionnaires such as the seven-item Eustachian Tube Dysfunction Questionnaire (ETDQ-7) have been validated to grade the severity of the underlying tubal dysfunction [12,32]. Temporal-bone computed tomography (CT) adds information on the anatomical extent of retraction, mastoid pneumatization, and middle-ear aeration that is difficult to obtain by otoendoscopy alone, and has been reported to correlate closely with intraoperative findings [13,14].

Management options span a continuum from observation, through medical treatment directed at eustachian tube dysfunction, to surgical intervention with ventilation tube insertion, balloon eustachian tuboplasty, or cartilage-reinforcement tympanoplasty, occasionally combined with mastoidectomy in more extensive disease

[2,15,16,17,18,19,24]. These approaches are not interchangeable: their goals, invasiveness, and evidence base differ substantially depending on whether the atelectasis is early and potentially reversible or advanced and structurally destructive.

Because a substantial share of the practical decision-making in early disease concerns grade I and II atelectasis — where the membrane is retracted but not yet fixed to the ossicular chain, and where conservative treatment still has a realistic chance of arresting progression — this review was undertaken to organize the published evidence around questions that arise in routine practice: what is known about the pathogenesis and natural course of early tympanic membrane retraction; which clinical and paraclinical findings characterize grade I–II disease; which diagnostic tools are used to stage it and to plan treatment; and what outcomes have been reported for conservative versus surgical management. The synthesis is intended to support a planned prospective study of the clinical, paraclinical, and treatment-outcome profile of grade I–II tympanic membrane atelectasis at a regional referral hospital in northern Vietnam, a setting for which no such structured description currently exists.

II. METHODS

2.1. Search strategy and study selection

A structured search of PubMed/MEDLINE was conducted for studies published between January 2010 and July 2026. Search terms combined

tympanic membrane atelectasis, retraction pocket, pars tensa retraction, pars flaccida retraction, adhesive otitis media, eustachian tube dysfunction, Sadé classification, cartilage tympanoplasty, ventilation tube, and balloon eustachian tuboplasty. Vietnamese domestic otorhinolaryngology and general medical journals were additionally searched to capture regional cohorts not indexed in international databases, and the reference lists of retrieved articles were screened for further eligible studies.

Studies were eligible when they involved patients with a diagnosed tympanic membrane retraction or atelectasis, described the mechanism of disease, reported at least one clinical, audiometric, tympanometric, or radiological finding, or evaluated a defined treatment. Reports limited to cholesteatoma without staged description of the underlying retraction, isolated case reports of fewer than three patients, and articles without an extractable outcome were excluded.

2.2. Data extraction and synthesis

For each clinical study, the country of the treated cohort, study design, patient population, diagnostic methods, treatment where applicable, and principal reported findings were extracted. Each study was assigned to one primary content category — pathogenesis, clinical/diagnostic characterization, or treatment outcome — to permit descriptive organization, although several studies contributed to more than one category. Given the heterogeneity of staging systems, outcome measures, and follow-up intervals across studies, the synthesis

presented here is descriptive rather than a meta-analysis.

III. RESULTS

Twenty-six clinical studies met the review criteria, supported by six additional references addressing pathogenesis, staging methodology, or the validation of outcome instruments. The geographic distribution of the clinical literature was broad but was weighted toward Vietnamese sources, reflecting the domestic focus of the planned study, together with a substantial body of work from India, Italy, Brazil, and China.

Table 1. Geographic origin and design of the reviewed clinical literature (n = 26)

Reg ion	Count ry	Stu dies , n (%)	Design mix	Typical focus
Viet nam	Vietna m	9 (34. 6)	3 prospect ive / 6 retrospe ctive, descripti ve	Clinical , endosco pic, CT, and surgical - outcom e series from tertiary ENT centres

Reg ion	Count ry	Stu dies , n (%)	Design mix	Typical focus
Sout h Asia	India	5 (19.2)	2 prospective / 3 retrospective	Retracti on pocket and attic pocket characte rization and surgical outcom e
Sout hern Europe	Italy	3 (11.5)	1 systemat ic review / 2 surgical cohorts	Endosc opic and cartilag e tympan oplasty for atelectat ic otitis media
Sout h America	Brazil	2 (7.7)	1 prospective / 1 retrospective	Compar ative pars tensa vs pars flaccida retraction, children and adults

Reg ion	Count ry	Stu dies , n (%)	Design mix	Typical focus
East Asia	China	2 (7.7)	1 prospective / 1 imaging-based	Eustach ian tuboplas ty and AI-assisted otoscopi c diagnosi s
Other	Nethe rlands, Denmark, Hunga ry, Tunisi a	5 (19.2)	2 prospective/RCT / 3 retrospective	Watchf ul waiting, balloon eustachi an tube dilation, paediatr ic excision series
Tota l	-	26 (100)	10 prospective or RCT / 16 retrospective or other	-

Regional groupings reflect the site of patient recruitment. "Other" comprises single studies from the Netherlands, Denmark, Hungary, and Tunisia, spanning a watchful-waiting cohort, a randomized trial of balloon eustachian

tube dilation, and paediatric retraction-pocket excision series.

3.1. Staging of tympanic membrane atelectasis

The Sadé system, applied separately to generalized and localized atelectasis, remains the staging framework most consistently used across the reviewed literature to describe severity and to guide the threshold for surgery [25].

Table 2. Sadé grading of generalized (total) and localized tympanic membrane atelectasis

Grade	Generalized (total) atelectasis	Localized atelectasis (retraction pocket)
I	Membrane retracted inward; not in contact with any middle-ear structure	Pars flaccida retracted; not in contact with any ossicular structure
II	Membrane retracted and fixed in contact with the long process of the incus; the fibrous layer is lost at this stage	Membrane retraction reaches the neck of the malleus (pars flaccida) or the long process of the incus (postero-superior pars tensa)
III	Membrane in contact with the promontory but not	Membrane adherent to the malleus neck and the lateral epitympanic

Grade	Generalized (total) atelectasis	Localized atelectasis (retraction pocket)
	adherent; may distend on Valsalva manoeuvre	(scutum) wall, with progressive erosion of the scutum
IV	Membrane adherent to the promontory and medial tympanic wall, invaginated into the facial recess, sinus tympani, and hypotympanum; the epithelium erodes the long process of the incus and the stapes suprastructure	Membrane retracted deep into the attic, adherent to and eroding the ossicles; the pocket contains infected keratin debris, representing an early stage of cholesteatoma

3.2. Clinical and paraclinical characteristics

Across the Vietnamese endoscopic series, hearing loss and tinnitus were consistently the two dominant complaints. Thuy reported hearing loss and tinnitus in 87.8% and 79.7% of patients respectively, otalgia in only 16.3%, and no functional symptom at all in 11.2%, underscoring the frequently silent course of early disease [5]. In a more recent cohort of localized atelectasis, Chhoa and colleagues reported hearing loss in 93.3% of patients,

tinnitus in 70.0%, otorrhea in 66.7%, otalgia in 23.3%, and vertigo in 6.7%, with a mean air-conduction threshold of 41.2 ± 12.7 dB and a mean air–bone gap (ABG) of 23.7 ± 12.1 dB on pure-tone audiometry [6]. Audiometric configuration was reported to track Sadé grade, ranging from near-normal thresholds in grade I to a mixed-loss pattern once the membrane became fixed to the medial tympanic wall in grade IV disease.

Temporal-bone CT added anatomical detail beyond otoendoscopy. Tuan found that the retracted membrane most often contacted the promontory (82.4% of ears), followed by the incus and incudostapedial joint (64.9%), the neck of the malleus (24.3%), and the facial recess (13.5%); against surgical findings, CT identified the site of retraction with an accuracy of 91.9%–97.3%, with the highest accuracy for contact with the promontory [13]. Lai and colleagues further showed that the pattern of mastoid pneumatization on CT — sclerotic, hypopneumatized, or well-pneumatized — correlated with middle-ear ventilation status, supporting the use of mastoid aeration as an ancillary marker of disease activity and prognosis [14]. In a surgical cohort with more advanced disease, Pisy reported a mean patient age of 46.8 ± 14.9 years with a female predominance, and CT evidence of epitympanic extension in 85.8% of ears and incudal involvement in 77.8% [21].

3.3. Treatment approaches and outcomes

For grade I–II disease, most reviewed protocols favored observation or medical treatment directed at eustachian tube dysfunction as first-line management, reserving surgery for hearing loss exceeding roughly 30 dB or failure of a conservative trial of about six months. Reported medical measures included intranasal corticosteroids, second-generation antihistamines when allergic rhinitis was present, short-course nasal decongestants, and eustachian tube auto-insufflation techniques such as the Valsalva manoeuvre or an Otovent balloon, aimed at restoring middle-ear ventilation rather than acting directly on the retraction pocket.

Table 3. Reported treatment approaches and outcomes in the reviewed literature

Study	Design / setting	Intervention	Principal reported outcome
Bayoumy et al., 2021 [8]	Prospective watchful waiting; posterosuperior pars tensa retraction	Observation, median follow-up 64 months	Mean ABG 17.9→15.5 dB ($p=0.08$); 12% of ears worsened ≥ 10 dB; grade I outcome better than grade III
Thanh, 2024 [7]	Retrospective, 55 ears with	Ventilation tube (Shepard vs	Atelectasis after tube extrusion in 23.6% overall (22.2%

Study	Design / setting	Intervention	Principal reported outcome
	otitis media with effusion	T-tube)	Shepard vs 25.0% T-tube; p=0.808)
Ráth et al., 2011 [15]	Prospective, children	Trans meatal pocket excision + simultaneous ventilation tube	Effective, minimally invasive control of pars tensa retraction pockets
Kalra et al., 2018 [16]	Prospective	Excision + cartilage tympanoplasty	Favorable anatomical and functional (hearing) outcome
Immodino et al., 2022 [17]	Systematic review	Cartilage / cartilage-perichondrium tympanoplasty	Effective in preventing recurrence of retraction
Dinh, 2013 [20]	Retrospective, Bach Mai	Middle-ear reconstruction	92.4% stable anatomic result at 5.8 months;

Study	Design / setting	Intervention	Principal reported outcome
	Hospital	ear surgery	recurrence limited to grade III-IV; PTA≤30dB in 45.4%, ABG≤20dB in 51.5%
Pisy, 2023 [21]	Retrospective, Thai Nguyen	Endoscopic atticotomy + tympanoplasty	Air conduction 56.9→20.1 dB; ABG 39.5→13.5 dB; dry ear 95.2% at 3 months
Pham et al., 2023 [22]	Retrospective, stage-4 atelectasis	Endoscopic middle-ear surgery	ABG (500/1000/2000 Hz) 48.5/47.8/49.3 →26.1/25.5/24.3 dB at 3 months
Kjær Krogh et al., 2022 [24]	Randomized controlled trial	Balloon dilation of the eustachian tube	Improved tubal function scores vs medical treatment at 6 months
Lou et al., 2021 [19]	Preliminary cohort, China	Micro wave ablation eustachian	Sustained improvement in tubal function on long-term follow-up

Study	Design / setting	Intervention	Principal reported outcome
		tuboplasty	

The longest natural-history data came from Bayoumy and colleagues, who followed posterosuperior pars tensa retractions with a watchful-waiting policy for a median of 64 months; the mean ABG changed from 17.9 dB (SD 11.3) at first visit to 15.5 dB (SD 12.9) at last visit, a modest mean improvement of 2.4 dB that did not reach significance ($p = 0.08$), while hearing worsened by 10 dB or more in 12% of ears. Patients with Sadé grade I retraction at baseline had significantly better final audiometric outcomes than those with grade III, supporting a strategy of active observation in early-stage disease rather than early surgery [8]. Where surgery was performed for early or moderate disease, Ráth and colleagues described transmeatal excision of pars tensa retraction pockets combined with simultaneous ventilation tube insertion as an effective, minimally invasive option in children [15], while Kalra and colleagues reported favorable anatomical and functional results after excision of the retraction pocket with cartilage tympanoplasty [16]; a subsequent systematic review by Immordino and colleagues supported cartilage or cartilage-perichondrium grafting as an effective means of preventing recurrence in retraction-prone ears, while noting that mastoidectomy is reserved for more extensive disease with poor mastoid aeration or attic extension [17,18].

For more advanced disease, Vietnamese surgical series consistently reported meaningful audiometric gains. Dinh found ossicular chain involvement, most often of the incus, in nearly half of operated ears; after a mean follow-up of 5.8 months, 92.4% of ears maintained a stable anatomical result, with recurrence confined to total atelectasis of Sadé grade III–IV, and 45.4% of patients achieved a postoperative pure-tone average of 30 dB or better while 51.5% achieved an ABG of 20 dB or better [20]. Pisy reported an improvement in mean air-conduction threshold from 56.9 ± 11.5 dB preoperatively to 20.1 ± 1.4 dB postoperatively, with the ABG falling from 39.5 ± 8.5 dB to 13.5 ± 1.2 dB and a dry-ear rate of 95.2% at three months [21]. Pham and colleagues, studying endoscopic surgery for stage-4 atelectasis, found ossicular damage concentrated in the incus (70% of ears), with the malleus and combined incudostapedial involvement less common (17% and 13% respectively); the mean ABG at 500, 1000, and 2000 Hz fell from 48.5, 47.8, and 49.3 dB preoperatively to 26.1, 25.5, and 24.3 dB at three months [22]. Although these series described predominantly advanced-stage disease, their consistent direction of effect — meaningful ABG closure with generally low recurrence outside the most severe grades — supports the rationale for earlier surgical escalation once grade I–II disease fails to respond to conservative treatment.

Non-surgical interventions on the eustachian tube itself have also been studied specifically as an alternative to

reinforcement or excisional surgery. In a randomized controlled trial with six months of follow-up, balloon dilation of the eustachian tube improved tubal function scores relative to medical treatment alone, although the durability of effect on established retraction was less well characterized [24]; Lou and colleagues reported that microwave ablation eustachian tuboplasty produced sustained improvement in tubal function on longer-term follow-up in a preliminary Chinese cohort [19]. Ventilation tube insertion, the most widely used minimally invasive procedure, was itself associated with a non-trivial risk of recurrent atelectasis after tube extrusion in one Vietnamese cohort of ears treated for otitis media with effusion: atelectasis was observed in 23.6% of ears overall after tube extrusion (13/55), with similar rates for Shepard tubes (22.2%, 6/27) and T-tubes (25.0%, 7/28), a difference that was not statistically significant ($p = 0.808$) [7].

IV. DISCUSSION

4.1. What the evidence supports most clearly

The reviewed literature converges on a consistent physiological narrative: chronically negative middle-ear pressure from eustachian tube dysfunction, acting on a fibrous layer already weakened by prior inflammation, drives progressive retraction that is initially reversible but becomes structurally fixed once the membrane adheres to the ossicular chain and medial tympanic wall [3]. This mechanism explains why grade I–II disease — retracted but not yet adherent — is the stage at which conservative

measures directed at eustachian tube function have the greatest plausible benefit, and why the natural-history data from watchful-waiting cohorts show that a meaningful proportion of early retractions remain stable or even improve without surgery [8].

4.2. Matching evaluation and treatment to stage

A credible evaluation of suspected atelectasis should combine otoendoscopic staging with an objective assessment of hearing (pure-tone audiometry), middle-ear status (tympanometry), and eustachian tube function (a validated instrument such as the ETDQ-7), reserving CT for cases where surgical planning or clarification of ossicular or attic involvement is required [9,12,13,32]. For grade I–II disease specifically, the evidence supports an initial period of observation combined with treatment of upstream causes of eustachian tube dysfunction — allergic rhinitis, chronic rhinosinusitis, adenoid hypertrophy — with surgery reserved for audiometric deterioration beyond roughly 30 dB or failure of conservative management after about six months. This staged approach avoids exposing patients whose retraction may remain stable to the risks of surgery, while still identifying, through periodic endoscopic and audiometric follow-up, the subset whose disease is progressing toward the ossicular chain.

4.3. Surgical options and their evidence base

Where surgery is indicated, the reviewed evidence favors minimally invasive approaches for early and moderate disease — transmeatal excision of the retraction pocket with or without simultaneous ventilation tube placement, or cartilage or cartilage-perichondrium reinforcement tympanoplasty — with mastoidectomy reserved for more extensive attic disease or poorly pneumatized mastoids [15,16,17,18]. Newer eustachian-tube-directed procedures such as balloon dilation and microwave tuboplasty are promising for the underlying tubal dysfunction but remain less established as primary treatment for an already-formed retraction pocket [19,24]. Across the more advanced surgical series, audiometric improvement was consistent — closure of the ABG by roughly 15–25 dB and dry-ear rates above 90% at short-term follow-up — but recurrence was concentrated in the most severe Sadé grades, reinforcing that earlier intervention, when conservative treatment fails, is likely to carry a more favorable prognosis than delayed surgery for advanced disease [20,21,22].

4.4. Gaps in the literature

Despite a reasonably active Vietnamese literature on tympanic membrane atelectasis, most published domestic series have come from major national or provincial-capital hospitals in Hanoi, Can Tho, and, more recently, Vinh and Thai Nguyen, and few have focused specifically on grade I–II disease as a distinct clinical and paraclinical entity rather than as an early stage within a broader surgical cohort dominated by

advanced disease [5,6,20,21,22,27]. No structured description of the clinical presentation, audiometric and tympanometric profile, eustachian tube function, and treatment outcome of grade I–II atelectasis has been reported for the referral hospital population of a northern mountainous province, where case mix, time to presentation, and access to specialized otoendoscopic and audiological services may differ from those of major urban centres. A prospective cohort describing these characteristics, and the outcomes of a staged conservative-to-surgical treatment protocol, would directly address this gap and provide regionally relevant data to inform management of early tympanic membrane atelectasis in similar settings.

V. CONCLUSIONS

Tympanic membrane atelectasis of Sadé grade I–II is a functionally significant but often clinically silent condition driven principally by eustachian tube dysfunction and negative middle-ear pressure acting on a weakened fibrous layer of the drum. Its evaluation should combine otoendoscopic staging with audiometric, tympanometric, and eustachian tube function assessment, reserving computed tomography for surgical planning. The published evidence supports an initial strategy of observation and medical treatment of eustachian tube dysfunction for early-stage disease, with escalation to minimally invasive ventilation or reinforcement surgery when hearing deteriorates or conservative treatment fails, and supports generally favorable audiometric and anatomical outcomes

when surgery is undertaken before disease progresses to higher Sadé grades.

Regional Vietnamese data on grade I–II disease specifically, and on the outcome of a staged treatment protocol in a northern mountainous referral-hospital population, remain limited. A structured prospective study addressing this gap would both consolidate the existing evidence base and provide practical guidance for the diagnosis and staged management of early tympanic membrane atelectasis in comparable clinical settings.

REFERENCES

1. Iannella G, Pace A, Greco A, et al. Endoscopic ear surgery in the treatment of chronic otitis media with atelectasis. *Eur Arch Otorhinolaryngol*. 2024;281(12):6283-6291. doi:10.1007/s00405-024-08845-0.
2. Bayoumy AB, Veugen CCAF, van der Veen EL, Bok JM, de Ru JA, Thomeer HGXM. Management of tympanic membrane retractions: a systematic review. *Eur Arch Otorhinolaryngol*. 2022;279(2):723-737. doi:10.1007/s00405-021-06719-3.
3. Urík M, Tedla M, Hurník P. Pathogenesis of retraction pocket of the tympanic membrane - a narrative review. *Medicina (Kaunas)*. 2021;57(5):425. doi:10.3390/medicina57050425.
4. Canali I, Rosito LPS, Elias CCL. Retraction pockets and adhesive otitis media. In: Goycoolea MV, da Costa SS, de Souza C, Paparella MM, eds. *Textbook of Otitis Media: The Basics and Beyond*. Springer International Publishing; 2023:395-406.
5. Thuy NL. Endoscopic clinical forms of tympanic membrane atelectasis at Thai Nguyen University of Medicine Hospital. *J Sci Technol (Thai Nguyen Univ)*. 2014;134:163-168 [in Vietnamese].
6. Chhoa KH, Ho LHN, Pham TT. Clinical and paraclinical characteristics and endoscopic surgical outcomes of localized tympanic membrane atelectasis at Can Tho ENT Hospital, 2022-2024. *Can Tho J Pharm Med Sci*. 2024;275-280. doi:10.58490/ctump.2024i77.2744 [in Vietnamese].
7. Thanh DD. Tympanic membrane status after ventilation tube extrusion in patients treated for otitis media with effusion at the National ENT Hospital. *Vietnam Med J*. 2024;1:183-187 [in Vietnamese].
8. Bayoumy AB, Veugen C, van Rijssen LB, Yung M, Bok JM. The natural course of tympanic membrane retractions in the posterosuperior quadrant of pars tensa: a watchful waiting policy. *Otol Neurotol*. 2021;42(9):e50-e59. doi:10.1097/mao.0000000000002834.
9. Zeng J, et al. A deep learning approach to the diagnosis of atelectasis and attic retraction pocket in otitis media with effusion using otoscopic images. *Eur Arch Otorhinolaryngol*. 2023;280(4):1621-1627. doi:10.1007/s00405-022-07632-z.
10. Monga U. Role of otoendoscopy in evaluation of tympanic membrane retraction - a new perspective. *Online J Health Allied Sci*. 2024;23:1-4.

11. Canali I, Schmidt Rosito LP, Longo VD, de Andrade Águas JV, da Costa SS. Comparative analysis of moderate and severe tympanic membrane retractions in children and adults. *Int J Pediatr Otorhinolaryngol.* 2021;147:110784. doi:10.1016/j.ijporl.2021.110784.
12. Bright T, et al. Evaluating the inclusion of tympanometry in population-based surveys of hearing loss. *J Laryngol Otol.* 2022;136(9):839-847. doi:10.1017/S0022215122001190.
13. Tuan TA. Value of temporal-bone computed tomography in the evaluation of the tympanic membrane in atelectatic ears. *Vietnam Med J.* 2021;500. doi:10.51298/vmj.v500i2.393 [in Vietnamese].
14. Lai TH, Vu DL, Le VK. Correlation between mastoid pneumatization pattern and middle-ear ventilation status on computed tomography in atelectatic ears. *Vietnam J Radiol Nucl Med.* 2020;4-10. doi:10.55046/vjrm.40.178.2020 [in Vietnamese].
15. Ráth G, et al. Transmeatal excision of pars tensa retraction pockets with simultaneous ventilation tube insertion in children: a prospective study. *Eur Arch Otorhinolaryngol.* 2011;268(11):1549-1556. doi:10.1007/s00405-011-1521-2.
16. Kalra VK, Yadav SPS, Verma M, Singh B, Goel A. Treatment of tympanic membrane retraction pockets by excision and cartilage tympanoplasty: a prospective study. *Indian J Otolaryngol Head Neck Surg.* 2018;70(3):392-394. doi:10.1007/s12070-018-1388-2.
17. Immordino A, Sireci F, Lorusso F, Martines F, Dispenza F. The role of cartilage-perichondrium tympanoplasty in the treatment of tympanic membrane retractions: systematic review of the literature. *Int Arch Otorhinolaryngol.* 2022;26(3):e499-e504. doi:10.1055/s-0042-1742349.
18. Immordino A, et al. Mastoidectomy in surgical procedures to treat retraction pockets: a single-center experience and review of the literature. *Eur Arch Otorhinolaryngol.* 2023;280(3):1081-1087. doi:10.1007/s00405-022-07573-7.
19. Lou Z, Lou Z, Sun J, Chen Z, Yin S. Microwave ablation eustachian tuboplasty: a preliminary investigation with long-term follow-up. *J Otolaryngol Head Neck Surg.* 2021;50:39. doi:10.1186/s40463-021-00520-2.
20. Dinh LC. Surgical treatment outcomes of tympanic membrane atelectasis at the ENT Department, Bach Mai Hospital. *J Med Res (Hanoi Med Univ).* 2013;82(2):71-77 [in Vietnamese].
21. Pisy S. Outcomes of endoscopic attico-antrostomy combined with transcanal middle-ear reconstruction in Thai Nguyen. *Vietnam J Otorhinolaryngol.* 2023;68-59:19-26 [in Vietnamese].
22. Pham TT, Ho MP, Ho LHN. Efficacy of endoscopic surgery in the treatment of stage-4 tympanic membrane atelectasis. *Vietnam Med J.* 2023;529. doi:10.51298/vmj.v529i1.6239 [in Vietnamese].
23. American Speech-Language-Hearing Association. Type, Degree, and

Configuration of Hearing Loss. ASHA; 2023.

24. Kjær Krogshede S, Kirchmann M, Jørkov APS, Glad H. Balloon dilation of the eustachian tube: a randomized controlled trial with 6 months follow-up. *J Int Adv Otol*. 2022;18(6):501-506. doi:10.5152/iao.2022.21198.

25. Alzahrani M, Saliba I. Tympanic membrane retraction pocket staging: is it worthwhile? *Eur Arch Otorhinolaryngol*. 2014;271(6):1361-1368. doi:10.1007/s00405-013-2644-4.

26. Subashini P, S S. Differential tympanic membrane retraction: a comprehensive study. *Int J Health Sci*. 2022;6:11316-11328.

27. Hang NT. Clinical and paraclinical characteristics and preliminary treatment outcomes of tympanic membrane atelectasis at Vinh City General Hospital, 2024. *J Med Pharm (Vinh Med Univ)*. 2024;1:31-36 [in Vietnamese].

28. Chibou D, Romdhane N. Tympanic membrane retractions in children: clinical

features and surgical outcomes. *Orig Artic*. 2021;46:58-62.

29. Jayadevan PJ, Raj P, Anand V, Singh K. Prevalence of eustachian tube dysfunction in patients with allergic rhinitis: an observational cross-sectional study. 2024;26:253-257. doi:10.4103/jmms.jmms_109_23.

30. Shukla N, Singh DK, Adhaila G, Sengar M. Clinical manifestations of attic retraction pockets. *Orig Res Artic*. 2024;6:1043-1045.

31. Canali I, Rosito LPS, Longo VD, da Costa SS. Critical analysis of moderate and severe retractions in the pars tensa and pars flaccida of the tympanic membrane. *Braz J Otorhinolaryngol*. 2023;89(1):114-121. doi:10.1016/j.bjorl.2021.10.005.

32. McCoul ED, Anand VK, Christos PJ. Validating the clinical assessment of eustachian tube dysfunction: the eustachian tube dysfunction questionnaire (ETDQ-7). *Laryngoscope*. 2012;122(5):1137-1141. doi:10.1002/lary.23223.