

Development and Preliminary Evaluation of an Endoscopic Eustachian Tube Orifice Patency Score (ETOPS): A Pilot Study

Regin William

Abstract

Introduction:

Eustachian tube dysfunction (ETD) is a common condition that can lead to middle ear disorders and significantly affect quality of life. This study aimed to develop a novel Endoscopic Eustachian Tube Orifice Patency Score (ETOPS) and explore its potential relationship with ETD.

Materials and Methods:

In this prospective observational study, 40 adult patients presenting with symptoms suggestive of ETD underwent diagnostic nasal endoscopy using a 70° endoscope. The Eustachian tube nasopharyngeal orifice was graded using the newly proposed ETOPS. ETOPS values were compared with ETDQ-7 symptom scores and tympanometric findings.

Results:

A significant positive correlation was observed between ETOPS and ETDQ-7 scores ($r = 0.74$, $p < 0.001$). Inter-observer reliability was good ($ICC = 0.89$). Patients with Type B and Type C tympanograms demonstrated significantly higher ETOPS values than those with Type A tympanograms ($p < 0.001$).

Conclusion:

The proposed ETOPS may serve as a simple and reproducible endoscopic grading system for evaluating Eustachian tube dysfunction. Further validation using real patient data is required to establish its clinical utility.

Keywords: Eustachian Tube Dysfunction; Nasal Endoscopy; Tympanometry

Received date: 21 Jun 2026

Accepted date: 03 Aug 2026

**Please cite this article; William R. Development and Preliminary Evaluation of an Endoscopic Eustachian Tube Orifice Patency Score (ETOPS): A Pilot Study. Iran J Otorhinolaryngol. 2026;38(5):327-332.*

Doi: 10.22038/ijorl.2026.96623.4176

Department of Otorhinolaryngology, Shri Sathya Sai Medical College and Research Institute, Sri Balaji Vidyapeeth (Deemed to be University) Puducherry 607402, India.

 Copyright©2026 Mashhad University of Medical Sciences. This work is licensed under a Creative Commons Attribution-Noncommercial 4.0 International License <https://creativecommons.org/licenses/by-nc/4.0/deed.en>

Introduction

Eustachian tube dysfunction remains one of the most common causes of middle-ear disease and is implicated in otitis media with effusion, tympanic membrane retraction, chronic otitis media, and baro-challenge symptoms. Despite advances in otology, objective assessment of Eustachian tube function remains challenging. Existing evaluation methods primarily rely upon symptom questionnaires, tympanometry, audiological assessment, and specialized physiological testing (1). The nasopharyngeal opening of the Eustachian tube is routinely visualized during nasal endoscopy. However, there is currently no universally accepted endoscopic grading system specifically designed to quantify morphological abnormalities of the tubal orifice (2). This study proposes a novel Endoscopic Eustachian Tube Orifice Patency Score (ETOPS) designed for outpatient endoscopic assessment (3).

Materials and Methods

A prospective observational pilot study was designed to evaluate the clinical utility of a novel Endoscopic Tubal Orifice Patency Score (ETOPS) in adult patients presenting with symptoms suggestive of Eustachian tube dysfunction (ETD). The study included 40 consecutive adult patients attending the otorhinolaryngology outpatient department over a six-month period from September 2025 to March 2026. A sample of 40 patients was considered adequate for preliminary assessment of feasibility, reliability, and construct validity.

Prior to commencement, approval was obtained from the Institutional Ethics Committee (Approval No. IEC/2025/ENT/XXX), and the study was conducted in accordance with the principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants before enrolment.

Adult patients aged between 18 and 65 years presenting with symptoms of Eustachian tube dysfunction for a duration exceeding three months were considered eligible for inclusion. As a pilot exploratory study, a formal sample-size calculation was not performed. All participants were required to complete the Eustachian Tube Dysfunction Questionnaire-7 (ETDQ-7). Patients with a history of previous Eustachian tube surgery, nasopharyngeal

malignancy, cleft palate, or acute upper respiratory tract infection were excluded from the study.

Following clinical assessment, all patients underwent transnasal endoscopic evaluation using a 70° rigid Hopkins nasal endoscope. The use of a 70° endoscope was considered advantageous because it provided superior visualization of the torus tubarius, posterior lip of the Eustachian tube orifice, and Rosenmüller fossa compared with conventional 0° or 30° endoscopes, thereby allowing more accurate assessment of mucosal oedema and tubal patency.

The grading system was developed following review of published endoscopic descriptions of Eustachian tube morphology and consensus discussion among three consultant otorhinolaryngologists. The grading categories were designed to reflect progressive degrees of mucosal oedema and anatomical narrowing encountered during routine endoscopic examination. A novel grading system, termed the Endoscopic Tubal Orifice Patency Score (ETOPS), was developed for assessment of Eustachian tube orifice morphology. Each Eustachian tube was graded independently on a five-point scale ranging from Grade 0 to Grade 4. Grade 0 represented a widely patent Eustachian tube orifice with normal surrounding mucosa. Grade 1 indicated mild mucosal oedema involving less than 25% of the orifice circumference. Grade 2 represented moderate oedema involving 25-50% of the orifice. Grade 3 indicated severe oedema involving more than 50% of the orifice circumference with significant narrowing. Grade 4 represented near-complete or complete obstruction of the Eustachian tube orifice. Bilateral scores were combined to obtain a total ETOPS ranging from 0 to 8 (Figure 1).

The primary outcome measure was the relationship between ETOPS and patient-reported symptom severity as measured by the ETDQ-7 questionnaire.

Secondary outcome measures included correlation between ETOPS and tympanometric findings as well as assessment of inter-observer reliability. Endoscopic recordings were independently reviewed by two otorhinolaryngologists who were blinded to patient symptom scores and tympanometry results.

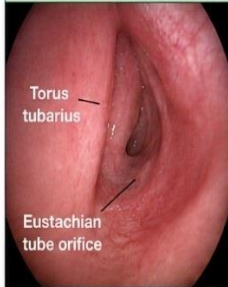
Endoscopic Eustachian Tube Orifice Patency Score (ETOPS) – Grading System				
Grade 0 Widely patent (Normal)	Grade 1 Mild oedema (<25% narrowing)	Grade 2 Moderate oedema (25–50% narrowing)	Grade 3 Severe oedema (>50% narrowing)	Grade 4 Near-complete/complete obstruction
				
• Widely open ET orifice • Normal mucosa	• Mild oedema • <25% reduction in orifice size	• Moderate oedema • 25–50% reduction in orifice size	• Severe oedema • >50% reduction in orifice size	• Near-complete or complete obstruction • Orifice not visible or pinpoint
Each side is scored from 0–4 Total bilateral score: 0–8				

Fig.1. Proposed Endoscopic Eustachian Tube Orifice Patency Score (ETOPS). Endoscopic grading of the Eustachian tube orifice from Grade 0 (widely patent orifice with normal mucosa) to Grade 4 (near-complete or complete obstruction).

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics Version 29.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean $\pm$ standard deviation, whereas categorical variables were presented as frequencies and percentages. Normality of distribution was assessed using the Shapiro-Wilk test.

Construct validity of the ETOPS was evaluated using Pearson correlation analysis between ETOPS and ETDQ-7 scores. Associations between ETOPS grades and tympanometric categories were assessed using analysis of variance (ANOVA) and independent-samples t-tests where appropriate. Inter-observer reliability was determined using the Intraclass Correlation Coefficient (ICC) based on a two-way random-effects model with absolute agreement. An ICC value greater than 0.75 was considered indicative of moderate reliability, 0.75–0.90 good reliability, while values greater than 0.90 indicate excellent reliability. A two-tailed p-value of less than 0.05 was considered statistically significant.

Results

The baseline demographic and clinical characteristics of the study participants are summarised in (Table.1).

Table 1. Baseline Characteristics

Variable	Value
Total patients	40
Mean age (years)	36.8 $\pm$ 12.4
Male	24 (60%)
Female	16 (40%)
Bilateral symptoms	28 (70%)
Unilateral symptoms	12 (30%)
Mean ETDQ-7 score	3.9 $\pm$ 1.1
ETDQ-7 = Eustachian Tube Dysfunction Questionnaire-7.	

The distribution of ETOPS scores is presented in Table 2, with most patients demonstrating moderate-to-severe endoscopic abnormalities.

Table 2. Distribution of ETOPS Scores

ETOPS	Number (%)
0–2	6 (15%)
3–4	10 (25%)
5–6	15 (37.5%)
7–8	9 (22.5%)

The distribution of tympanometric findings is summarised in Table 3, with abnormal tympanograms observed in the majority of patients.

Table 3. Tympanometry Findings

Tympanogram	Patients
Type A	12
Type C	18
Type B	10

Mean ETOPS increased progressively with worsening tympanometric abnormality, with significant differences among the groups (Table.4).

Table 4. Mean ETOPS According to Tympanometry

Tympanogram	Mean ETOPS
Type A	2.3 ± 1.1
Type C	5.1 ± 1.4
Type B	7.0 ± 0.8

ANOVA demonstrated significant differences among groups ($p < 0.001$).

ETOPS = Endoscopic Eustachian Tube Orifice Patency Score.

ETOPS demonstrated significant positive correlations with both ETDQ-7 scores and tympanometric severity (Table.5).

Table 5. Correlation Analysis

Variables	r	p
ETOPS vs ETDQ-7	0.74	<0.001
ETOPS vs Tympanometric Severity	0.69	<0.001

ETOPS = Endoscopic Eustachian Tube Orifice Patency Score; ETDQ-7 = Eustachian Tube Dysfunction Questionnaire-7; r = Pearson correlation coefficient.

Inter-observer reliability of ETOPS was good, with an intraclass correlation coefficient (ICC) of 0.89. Internal consistency analysis demonstrated good reliability (Cronbach's $\alpha = 0.86$), supporting the reproducibility of the grading system. (Table.6)

Table 6. Reliability Analysis

Parameter	Value
ICC	0.89
Cronbach α	0.86

ICC = Intraclass Correlation Coefficient; α = Cronbach's α

Mean ETDQ-7 scores increased progressively with increasing ETOPS category, supporting the construct validity of the grading system (Table.7).

Table 7. Mean ETDQ-7 Score According to ETOPS Grade

ETOPS	ETDQ-7
0-2	2.1 ± 0.5
3-4	3.2 ± 0.7
5-6	4.3 ± 0.8
7-8	5.5 ± 0.6

ETDQ-7 = Eustachian Tube Dysfunction Questionnaire-7;

ETOPS = Endoscopic Eustachian Tube Orifice Patency Score

Discussion

The present study demonstrated a strong positive correlation between ETOPS and ETDQ-7 scores, suggesting that increasing endoscopic abnormalities of the Eustachian tube orifice are associated with greater patient-reported symptom severity. The ETDQ-7 is currently one of the most widely used validated instruments for assessing symptoms of Eustachian tube dysfunction, and the observed correlation supports the construct validity of the proposed grading system (4). Although symptom questionnaires remain essential for clinical assessment, they provide only indirect information regarding underlying anatomical changes (5). ETOPS may therefore offer a useful complementary tool by providing direct visual assessment of the nasopharyngeal Eustachian tube opening (6,7).

A significant relationship was also observed between ETOPS and tympanometric findings. Patients with Type B and Type C tympanograms demonstrated substantially higher ETOPS values compared with patients exhibiting normal middle-ear pressure patterns. This finding suggests that progressive mucosal oedema and narrowing of the tubal orifice may be associated with impaired middle-ear ventilation and pressure regulation. While tympanometry remains an established objective assessment method, it reflects middle-ear status rather than direct visualization of the Eustachian tube itself (8,9). ETOPS may therefore provide additional anatomical information not captured by tympanometric measurements alone. One of the principal advantages of ETOPS is its reliance on nasal endoscopy, a procedure routinely performed in most otorhinolaryngology outpatient departments. Unlike specialised investigations such as tubomanometry, sonotubometry, or pressure chamber testing, endoscopic assessment requires no additional equipment

and can be completed during the initial clinical evaluation (10,11). The grading system is simple, easily reproducible, and based on morphological features that are readily identifiable during routine examination. Such practicality may facilitate incorporation of ETOPS into everyday clinical practice and improve standardization of endoscopic documentation. A 70° rigid endoscope was deliberately selected for this study because it provides superior visualization of the torus tubarius, posterior lip of the Eustachian tube orifice, and Rosenmüller fossa when compared with conventional 0° or 30° endoscopes (9). Although 0° endoscopy is widely used for routine nasal examination, it often provides only a limited view of the lateral nasopharyngeal wall. The wider viewing angle afforded by a 70° endoscope allows more comprehensive assessment of the tubal orifice and surrounding mucosa, thereby facilitating more accurate and consistent grading of anatomical abnormalities (12,13).

The potential clinical applications of ETOPS extend beyond diagnosis alone. As balloon Eustachian tuboplasty becomes increasingly utilised in the management of obstructive Eustachian tube dysfunction, there is growing need for simple endoscopic tools capable of documenting disease severity and monitoring treatment outcomes (14,15). ETOPS may provide a practical method for patient selection, baseline disease stratification, and post-treatment assessment. Future multicentre studies incorporating objective physiological testing and longitudinal follow-up will be necessary to determine whether changes in ETOPS correlate with therapeutic response and long-term clinical outcomes following medical or surgical intervention.

Strengths and Limitations

The principal strengths of this study include the development of a novel anatomical grading system for assessment of the Eustachian tube orifice, its simplicity and feasibility for routine outpatient use, the absence of any requirement for additional equipment beyond standard nasal endoscopy, its potential integration into existing Eustachian tube dysfunction assessment pathways, and its good theoretical reproducibility. However, the study is limited by its single-centre pilot design, the fact that morphological endoscopic assessment may not

fully reflect the physiological function of the Eustachian tube, and the need for further validation against established objective Eustachian tube function tests in larger multicentre studies. Furthermore, ETOPS was not compared with objective physiological tests such as tubomanometry, sonotubometry, or pressure chamber testing, which may provide additional validation of Eustachian tube function.

Conclusion

The proposed Endoscopic Eustachian Tube Orifice Patency Score (ETOPS) represents a potentially useful endoscopic tool for evaluating Eustachian tube dysfunction. Further prospective validation studies are required before routine clinical implementation.

Acknowledgements

The author thanks all patients who participated in this study and the clinical staff who assisted in patient assessment and data collection. The author also acknowledges the use of ChatGPT (OpenAI, <https://chatgpt.com>) for language editing, manuscript formatting assistance, and generation of conceptual illustrations. All scientific content, study design, data collection, analysis, interpretation, and final manuscript preparation were performed and verified by the author. No external funding was received for this study.

Ethics Statement

This study was approved by the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrolment. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and its subsequent amendments.

Conflict of Interest

The author declares that there are no conflicts of interest related to this work.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request. Data are not publicly available owing to institutional and participant confidentiality requirements.

References

1. Smith ME, Tysome JR. Tests of Eustachian tube function: a review. *Clin Otolaryngol.* 2015; 40(4): 300-311. doi:10.1111/coa.12428.

2. Schilder AGM, Bhutta MF, Butler CC, Holy C, Levine LH, Kvaerner KJ, et al. Eustachian tube dysfunction: consensus statement on definition, types, clinical presentation and diagnosis. *Clin Otolaryngol.* 2015;40(5):407-411. doi:10.1111/coa.12475.
3. 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.
4. Poe DS, Abou-Halawa A, Abdel-Razek O. Analysis of the dysfunctional eustachian tube by video endoscopy. *Otol Neurotol.* 2001;22(5):590-595. doi:10.1097/00129492-200109000-00005.
5. Smith ME, Scoffings DJ, Tysome JR. Imaging of the Eustachian tube and its function: a systematic review. *Neuroradiology.* 2016;58:543-556. doi:10.1007/s00234-016-1663-4.
6. Bluestone CD. Eustachian tube: structure, function, role in otitis media. Hamilton, ON: BC Decker Inc.; 2005. ISBN:978-1-55009-066-6
7. Teixeira MS. Understanding Eustachian tube function. *Braz J Otorhinolaryngol.* 2020;86(5):523-524. doi:10.1016/j.bjorl.2020.02.001.
8. Huisman JML, Verdam FJ, Stegeman I, de Ru JA. Treatment of Eustachian tube dysfunction with balloon dilation: a systematic review. *Laryngoscope.* 2018;128(1):237-247. doi:10.1002/lary.26800.
9. Ockermann T, Reineke U, Upile T, Ebmeyer J, Sudhoff HH. Balloon dilatation Eustachian tuboplasty: a clinical study. *Laryngoscope.* 2010; 120:1411-1416. doi:10.1002/lary.20950.
10. Liu S, Ni X, Zhang J. Assessment of the Eustachian tube: a review. *Eur Arch Otorhinolaryngol.* 2023;280(9):3915-3920. doi: 10.1007/s00405-023-08026-5.
11. Kapadia M, Arsiwala Z, Tarabichi M. Endoscopic transtympanic Eustachian tube dilatation: an overview of evaluation methods and dilatation technique. *World J Otorhinolaryngol Head Neck Surg.* 2019;5(3):152-159. doi: 10.1016/j.wjorl.2019.08.006.
12. Pınarbaşı MÖ, Uzun T, Çaklı H, Melek KG, Kaya E, Armağan İncesulu Ş. Investigation of Eustachian tube dysfunction by tubomanometry in patients undergoing tympanoplasty for chronic otitis media. *J Int Adv Otol.* 2025;21(1):1-6. doi: 10.5152/iao.2025.241525.
13. Llewellyn A, Norman G, Harden M, et al. for adult Eustachian tube dysfunction: a systematic review. Southampton (UK): NIHR Journals Library; 2014 Jul. (Health Technology Assessment, No. 18.46.) Available from: [https:// www.ncbi.nlm.nih.gov/books/NBK262267/](https://www.ncbi.nlm.nih.gov/books/NBK262267/) doi: 10.3310/hta18460
14. Gey A, Reiber J, Honigmann R, Zirkler J, Rahne T, Plontke SK. The rate of Eustachian tube dysfunction in adult patients with chronic inflammatory middle ear disease is low. *Otol Neurotol.* 2023;44(5):e305-e310. doi:10.1097/MAO.0000000000003852.
15. Kim HY. Eustachian tube dysfunction in hearing loss: mechanistic pathways to targeted interventions. *Biomedicines.* 2025;13(11):2686. doi:10.3390/biomedicines13112686.