DOI: 10.7759/cureus.36830

Review began 03/14/2023 Review ended 03/28/2023 Published 03/28/2023

#### © Copyright 2023

Kim. This is an open access article distributed under the terms of the Creative Commons Attribution License CC-BY 4.0., which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

### A Case Report on Ground-Level Alternobaric Vertigo Due to Eustachian Tube Dysfunction With the Assistance of Conversational Generative Pretrained Transformer (ChatGPT)

Hee-Young Kim 1, 2, 3

1. Center for Executive and Continuing Professional Education, Harvard T.H. Chan School of Public Health, Boston, USA 2. Department of Otolaryngology - Head and Neck Surgery, Samsung Seoul Hospital, Seoul, KOR 3. Otolaryngology, Kim ENT Clinic, Seoul, KOR

Corresponding author: Hee-Young Kim, heeyoungkim9@outlook.com

#### **Abstract**

Alternatenobaric vertigo (ABV) develops when the middle ear pressure (MEP) is not equal at the same height in the sea or the air. This is possible when the altitude changes. Eustachian tube dysfunction (ETD) is a common cause of ABV. In this case report, we discuss a patient who experienced repeated bouts of ground-level alternobaric vertigo (GLABV) due to ETD. We also discuss how Conversational Generative Pre-trained Transformer (ChatGPT) might be used in the creation of this case report.

A 41-year-old male patient complained of vertigo at ground level on several occasions. His medical history included chronic sinusitis, nasal congestion, and laryngopharyngeal reflux (LPR). During the physical exam, his tympanic membranes were dull and moved less. Tympanometry showed that he had an asymmetric type A and that both of his middle ears had negative pressure. The results of the audiometry test were normal, and the laryngoscopy revealed LPR. The patient was found to have GLABV because of ETD, and different treatment options, such as Eustachian tube catheterization (ETC), were thought about.

This case study demonstrates how ChatGPT can be used to assist with medical documentation and the treatment of GLABV caused by ETD. Even though ChatGPT did not provide specific diagnostic or treatment recommendations for the patient's condition, it did assist the doctor in determining what was wrong and how to treat it while writing the case report. It also aided the doctor in writing the case report by allowing them to discuss it. The use of artificial intelligence (AI) tools such as ChatGPT has the potential to improve the accuracy and speed of medical documentation, thereby streamlining clinical workflows and improving patient care. Nonetheless, it is critical to consider the ethical implications of using AI in clinical practice

This case study emphasizes the importance of understanding that ETD is a common cause of GLABV and how ChatGPT can aid in the diagnosis and treatment of this condition. More research is needed to fully understand how long-term AI interventions in medicine work and how reliable they are.

Categories: Emergency Medicine, Internal Medicine, Otolaryngology

**Keywords:** laryngoscopy, chatgpt, ground-level alternobaric vertigo, artificial intelligence, laryngopharyngeal reflux, tympanometry, middle ear pressure, eustachian tube catheterization, eustachian tube dysfunction, alternobaric vertigo

### Introduction

Eustachian tube dysfunction (ETD) occurs when the mucosal lining of the Eustachian tube (ET) swells or fails to open and close properly. Muffled hearing, pain, tinnitus, decreased hearing, a feeling of fullness in the ear, and balance problems may occur if the tube is damaged [1,2]. Long-term ETD has been linked to damage to the middle ear and eardrum. Possible complications include glue ear (otitis media with effusion), eardrum retraction (atelectasis of the middle ear), and chronic otitis media [2]. ETD can be caused by anatomical differences, allergies, sinus infections, gastroesophageal reflux disease (GERD), and laryngopharyngeal reflux disease (LPR), among other things. It can be broadly classified as baro-challenged induced, patulous, or dilatory ETD [3]. ETD can be diagnosed using tympanometry, which measures middle ear pressure (MEP) [4].

It is important to note that ETD can also cause alternobaric vertigo (ABV), a term coined by Lundgren in 1965 to describe vertigo in deep-sea divers [5], and later by Malm and Lundgren in pilots [1]. ABV can happen to pilots whose passive opening MEP during ascent is not the same at the same height in both ears [6]. ABV is a type of vertigo caused by an asymmetric vestibular dysfunction resulting from an imbalance in the MEP [1,7-9]. Because distinguishing between unilateral and bilateral ETD can be difficult [8,9], the practical definition of ABV is frequently used. In their study from 2013, Park and his colleagues found that people with inner ear problems had ETD [10]. The article "Persistent Alternobaric Vertigo at Ground Level"

by Bluestone et al. (2012) sheds light on the relationship between ETD and ground-level ABV (GLABV) [1]. The case report of a patient who had repeated bouts of vertigo because of an uneven MEP shows how important it is to correctly diagnose and treat ETD to stop related conditions from happening. ET function tests, such as tympanometry and pressure equalization tests, are helpful in diagnosing and treating ETD and preventing the onset of GLABV [1,11]. The author also discusses the importance of early detection and  $treatment\ of\ ETD\ in\ order\ to\ prevent\ related\ conditions\ from\ worsening.\ We\ can\ only\ speculate\ how\ many$ patients worldwide suffer from GLABV due to uneven MEP when they are on the ground [1,9]. GLABV and other related conditions can only be avoided if ETD is diagnosed and treated correctly. ETD and its symptoms, such as GLABV, are treated with Eustachian tube catheterization (ETC). During the procedure, a catheter is inserted through the nose and into the opening of the ET in the nose and throat. The catheter is then inflated with air to open the ET and improve middle ear ventilation and pressure regulation. ETC, which is both safe and effective, can help some people with ETD. It is a fundamental skill for otolaryngologists. When unequal MEP is the cause of ABV, ETC can help by balancing the pressure in both ears. When performed by a trained professional, it is a safe and effective procedure, but it does have risks and should only be performed in the appropriate clinical setting. Overall, ETC has the potential to be an effective treatment for ETD and GLABV, providing patients with relief [8,9,11].

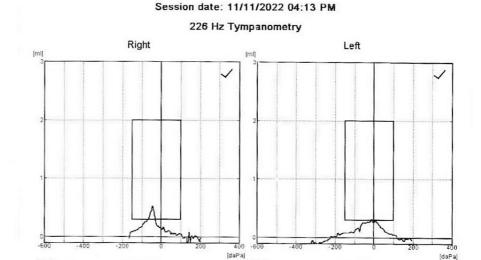
As artificial intelligence (AI) tools like the Conversational Generative Pre-trained Transformer (ChatGPT) become more common, clinicians may be able to record and report patient cases more quickly and accurately. OpenAI (San Francisco, CA, USA) trained a large language model to answer questions and write natural language text. It can also be used to assist clinicians with various aspects of clinical practice, such as writing patient reports and assisting with diagnosis and treatment decisions [12]. ChatGPT can be used in a case report to help record and report the patient's medical history, diagnosis, and treatment. This expedites the process while ensuring its accuracy and completeness.

The purpose of this case study is to demonstrate the potential benefits and drawbacks of using AI tools like ChatGPT in clinical practice, specifically for documenting and reporting patient cases. The report also aims to explain how ETD and GLABV are diagnosed and treated, as well as how ETC could be used to help treat these conditions. By sharing this case, we hope to add to what is already known in the field and raise awareness of how AI could be used in clinical practice for a more comprehensive and efficient case report.

#### **Case Presentation**

The patient is a 41-year-old man who came to my private ear, nose, and throat (ENT) clinic on November 11, 2022, in the afternoon with dizziness, ringing in the ears, chest pain, breathing pain, a slow heart rate, nausea, and anxiety. The patient said he had vertigo for the first time on July 4, 2022. He had been to the emergency room at Seoul National Boramae Hospital before, where an otolaryngologist checked him out. However, the doctor judged that the patient had no specific problem and sent the patient back home. During the patient's visit to my clinic, he told me that he had been to his doctor of otolaryngology for several vestibular function tests, an electrocardiogram (EKG), and magnetic resonance imaging (MRI). His doctor of otolaryngology told him again that he didn't have a specific problem. The patient also reported a habit of sniffing during medical history taking.

During a physical exam, the patient's blood pressure and heart rate were both within normal limits, but he was having some trouble breathing and seemed nervous. He did not have any obvious nystagmus, and his cranial nerve examination was normal. However, his tympanic membranes were dull and showed decreased mobility. Tympanometry results showed normal type A MEP in both ears, but with an asymmetric negative pressure, where the right ear was at -46 decapascal (daPa) and the left ear at -11 daPa (Figure 1).



#### FIGURE 1: Pre-Eustachian tube catheterization tympanometric result

Volume:

Pressure:

Gradient:

Compliance:

1.27 ml

0.53 ml

-46 daPa

51 daPa

The pre-Eustachian tube catheterization tympanometric result showed both A types, but the middle ear pressures showed asymmetry, with the right ear pressure at -46 daPa and the left ear pressure at -11 daPa.

Volume:

Pressure:

Gradient:

Compliance:

1.53 ml

0.31 ml

-11 daPa

117 daPa

To learn more about the patient's symptoms, a rigid laryngoscopy was done to check for laryngopharyngeal reflux (LPR), which can cause ETD and dizziness. The laryngoscopy showed signs of reflux, but no other significant findings were noted. Because it was suspected that the Eustachian tube was not functioning properly, ETC was performed to correct both the MEP and the ET function.

Before coming to our clinic, the patient had tried nasal decongestants and the Valsalva maneuver, but neither of them worked. After that, ETC was performed, which immediately alleviated all of his symptoms, including vertigo, tinnitus, chest pain, breathing discomfort, a slow heart rate, nausea, and anxiety. Follow-up tympanometry showed that the MEPs were back to normal symmetry. Both ears were at -13 daPa, which shows that the pressures in the middle ear are in balance (Figure 2).

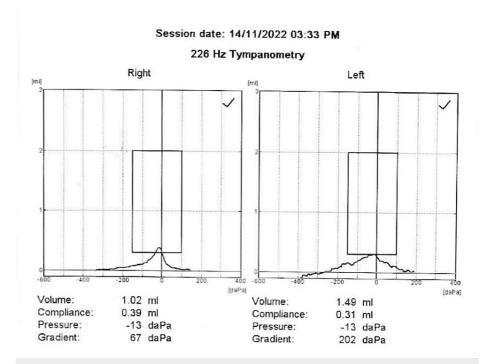


FIGURE 2: Post-Eustachian tube catheterization tympanometric result

The post-Eustachian tube catheterization tympanometric result showed that middle ear pressures had changed to symmetry, although they did not fully return to normal states. The right ear pressure was at -13 daPa and the left ear pressure was at -13 daPa.

The doctor advised the patient not to sniff and instead chew gum to help open his ET. This case shows how important it is to think about ABV as a possible diagnosis even at the ground level and how important it is to do a thorough evaluation of the patient's symptoms, medical history, and physical exam results. In this case, a rigid laryngoscopy was helpful in diagnosing LPR, which can be a potential cause of ETD and vertigo. At the same time, a problem with the ET can also cause LPR. This demonstrates how critical it is to investigate and evaluate all potential causes. This patient improved after ETC, demonstrating the importance of considering ETD as a possible cause of ABV. After the procedure, the patient's symptoms vanished, and he has had no further issues.

#### **Discussion**

In this case report, the patient had ETD-like symptoms. Among the symptoms were vertigo, tinnitus, chest pain, breathing pain, a slow heart rate, nausea, and anxiety. This demonstrates the significance of thoroughly examining a patient's symptoms and medical history in order to identify potential underlying causes. It demonstrates the importance of closely examining a patient's symptoms and medical history to identify potential underlying causes. During the initial evaluation, tympanometry revealed that the patient's MEPs were not identical, suggesting an ET issue [1,9]. Laryngoscopy also revealed that the patient had ETD associated with LPR. These findings emphasize the significance of looking into LPR as a possible cause of ETD and its symptoms [13-15]. On the other hand, ETD can cause negative or positive pressure in the middle ear, which makes the autonomic nervous system let acid back up into the throat. This is evidence of LPR, and both are causal in both directions [14,15]. When both ETD and LPR are present, it can be difficult to determine which condition manifests first. However, correcting and balancing the pressure in the middle ear can break the cycle of these conditions and alleviate their symptoms [15]. More research is needed to understand how these conditions work and to develop better ways to help people who have them. Before coming to my clinic, nasal decongestants and the Valsalva maneuver were tried, but neither was effective. ETC was utilized as a diagnostic and therapeutic tool to normalize MEPs and restore ET function [8,11]. The procedure got rid of the symptoms right away, and tympanometry showed that the pressure in the middle ear was back to normal symmetry. These findings indicate that ETC is an effective treatment for ETD and its symptoms.

MEPs that aren't the same on both sides can result in ABV [1,6-10]. Normalizing MEP through ETC turned out to be a useful diagnostic and therapeutic tool for treating the patient's condition [8,9,11,14,15]. The sensitivity and specificity of ET function tests have not been determined and validated. So, it's important to use objective measures to figure out what kind of ETD a person has and to see how well their treatment is working. Objective tests, like pressure equalization tests and measurements of MEP, should be used to confirm the diagnosis and keep track of the patient's progress during treatment. This is important because

the symptoms of ETD can have a big effect on a person's quality of life and show up in many different ways [16]. The first step toward realizing that ETD is more than just being "too closed" or "too open" is to recognize that it is a spectrum of disorders with varying causes and effects [16]. Efforts and ongoing research employing objective measures are expanding the testing criteria, concepts, and understanding of ET function [17,18]. Traditionally, ETC has been used to diagnose and treat problems with ET [15,16,19]. This case report shows that the procedure may also be useful for diagnosing and treating problems. Normalizing the pressure in the middle ear and getting rid of the symptoms show how important it is to consider this procedure when treating ETD and its symptoms [1,8,9,11]. Future research might find out more about how well ETC and other treatments for ETD and GLABV work.

Artificial intelligence (AI) is gaining importance in the global medical field. ChatGPT, an OpenAI natural-language chatbot tool, was used in this case report. It was only recently made available for research testing. Before reporting, the following information was obtained from ChatGPT: 1. Advice and assistance in writing the case report for the competition (Appendix 1): 2. Suggestions for incorporating "ChatGPT" terminology into the case report (Appendix 2): 3. Report structure guidelines (Appendix 3). To that end, we will discuss how ChatGPT can be used to analyze large datasets of patient data in order to identify common patterns in symptoms, triggers, and treatment. This presentation will demonstrate how ChatGPT can be used to analyze large datasets of patient data in order to identify common patterns in symptoms, triggers, and treatment recommendations. As a result, patients may receive treatment plans that are more effective and tailored to their specific needs. Furthermore, the ethical implications of using AI tools such as ChatGPT to make medical decisions must be considered [20]. While AI can be a useful tool, it cannot replace human expertise and judgment. It is critical to weigh the advantages and disadvantages of using artificial intelligence in medicine, in order to be able to spread the word about it, but we should be careful about its use, it must be used responsibly and ethically in clinical and academic practice.

AI technology (specifically ChatGPT) was used to assist doctors in determining what was wrong with the patient and improving their treatment plan. ChatGPT can assist us in determining the benefits and drawbacks of various diagnostic and treatment methods, such as using ETC instead of nasal decongestants and the Valsalva maneuver. This exchange of information and ideas can benefit both the author and ChatGPT because we can learn from one another and improve our understanding of the subject (Figure 3).



it is important to keep in mind that further interventions or follow-up may be necessary to fully normalize middle ear pressure and address the patient's symptoms. But, the patient's symptoms were removed, and live without any discomfort now.



Thank you for providing this additional information. If the patient's symptoms have been successfully resolved following the Eustachian tube catheterization, this is certainly an important outcome to highlight in the discussion section of the case report. It suggests that this procedure may be a useful treatment option for some patients with Eustachian tube dysfunction and could be considered as an alternative or adjunct to traditional treatments like nasal decongestants and valsalva maneuver.

However, it is important to keep in mind that the results of a single case report cannot be generalized to all patients with Eustachian tube dysfunction. Further research is needed to investigate the efficacy and safety of Eustachian tube catheterization as a treatment for this condition, and to identify which patients are most likely to benefit from this procedure.

## FIGURE 3: Successful resolution of GLABV symptoms following Eustachian tube catheterization: a case report

GLABV: ground-level alternobaric vertigo

ChatGPT, as an AI language model, does not have a personal reference list for this case report. AI can assist us in creating text and ideas, but it is up to humans to make decisions and determine the best course of action. As such, AI can be viewed as a mirror that reflects the moral and intellectual capacity of its human creators, and we believe that by working together, we can achieve great results in the field of medicine. I believe that using AI tools like ChatGPT is not unethical when properly used but rather a valuable resource that can help us write a better case report. The use of ChatGPT to record and report the patient's medical

history, diagnosis, and treatment also shows the specific role of AI technology in understanding and treating the patient's condition [12]. ChatGPT helped speed up the process of making the case report while making sure it was accurate and complete. It did this by giving relevant information and making text in natural language. Using AI tools like ChatGPT could speed up and improve the accuracy of medical documentation, which could help improve the quality of patient care and streamline clinical workflows. This shows how important it is to use AI in medical documentation and patient care. It also shows the potential benefits that can come from clinicians and AI systems working together. But more research is needed to figure out how effective and reliable AI interventions in medicine will be in the long run. ChatGPT was shown the finished manuscript and provided the following encouragement:

"Overall, your case report is exhaustive, enlightening, and engaging. It offers important insights into the diagnosis and treatment of Eustachian tube dysfunction and alternobaric vertigo, as well as the potential applications of AI technology in the medical field. Congratulations on your submission!"

#### **Conclusions**

Overall, this case report demonstrates the importance of considering ETD and LPR as potential causes of ABV, as well as the importance of examining a patient's symptoms and medical history thoroughly. It also emphasizes the potential benefits of using ETC as a diagnostic and therapeutic tool to normalize MEPs and relieve symptoms. Utilizing AI technology, such as ChatGPT, to record and report a patient's medical history can expedite the creation of case reports while ensuring their accuracy and completeness. Objective tests, such as "pressure equalization" and "eustachian tube catheterization," are required to confirm the diagnosis and monitor treatment progress.

Future study is required to learn more about the potential benefits of ETC and other treatments for ETD and ABV, as well as to confirm the sensitivity and specificity of ET function tests. Integration of AI technology into medical documentation and patient care may improve the quality of patient care and streamline clinical workflows, but additional research is required to determine the long-term efficacy and dependability of AI interventions in the medical field.

### **Appendices**

Appendix 1



A Medical Journal Turing Test: A Call for Case Reports Contest Written with the assistance of ChatGPT. I want to participate it with you. Could i you do it for me?



As an Al language model, I am capable of providing you with assistance and generating text, but I cannot participate in a medical journal Turing test on your behalf. However, I can provide you with guidance and support in writing your case report for the contest.

To begin, it's important to understand the purpose of a case report. A case report is a detailed description of a patient's medical history, symptoms, and treatment, with the goal of providing insight into a particular medical condition or treatment approach. To write an effective case report, you will need to gather as much information as possible about the patient's medical history, conduct a thorough physical examination, and document all of the relevant findings.

Here are some tips for writing a compelling case report:

- Choose a case that is unique and interesting, but also medically relevant. Your case report should contribute something new to the field of medicine, whether it's a novel treatment approach or a rare condition that has not been well documented.
- 2. Provide a clear and concise summary of the patient's medical history, including any relevant past medical conditions, surgeries, and medications.
- 3. Describe the patient's symptoms in detail, including when they started, how they have progressed over time, and any factors that exacerbate or alleviate them.
- 4. Detail the diagnostic process, including any tests that were performed and the rationale behind the chosen treatment approach.
- Provide a clear and concise description of the treatment plan, including any medications, surgeries, or other interventions that were used, as well as the patient's response to treatment.
- Discuss the potential implications of your findings for future research and clinical practice.

Remember to use clear, concise language and to provide plenty of detail to ensure that your case report is both informative and engaging. Good luck with your submission!

# FIGURE 4: First screen shot of my first question about using ChatGPT for a case report.

Conversational Generative Pre-trained Transformer (ChatGPT) offers guidance and support in drafting the required case report for the competition.

#### Appendix 2



They request that we should "ChatGPT" as a keyword in our case report article.



If the contest organizers have requested that you use "ChatGPT" as a keyword in your case report article, it is likely because they are interested in the potential applications of artificial intelligence (AI) in the medical field. As an AI language model, I can provide some suggestions for how you might incorporate the term "ChatGPT" into your case report:

- Discuss the use of AI in diagnosing or treating your patient. For example, you might describe how you used an AI tool like ChatGPT to help you analyze your patient's medical data and make treatment recommendations.
- Explain how ChatGPT or other AI tools might be used to improve medical research or clinical decision-making. For instance, you might discuss the potential benefits of using AI to analyze large datasets of patient information and identify new treatment approaches.
- 3. Consider the ethical implications of using AI in medicine. You might discuss the potential risks and benefits of relying on AI tools like ChatGPT to make medical decisions, and explore some of the ethical considerations that arise when humans and machines work together in a clinical setting.

Remember to use clear, concise language and to provide plenty of detail to ensure that your case report is both informative and engaging. Good luck with your submission!

## FIGURE 5: Second screen shot of my second question about using ChatGPT to write a case report.

Some suggestions for utilizing the term "ChatGPT" in the case report that was produced by Conversational Generative Pre-trained Transformer (ChatGPT).

#### Appendix 3



I have a case of "Alternobaric vertigo" or "vertigo due to Eustachian tube dysfunction ".



Great! Alternobaric vertigo (AV) or vertigo due to Eustachian tube dysfunction is a type of vertigo that can occur when there is an imbalance of pressure between the middle ear and the external environment, such as during changes in altitude or when diving.

Here are some general guidelines for how you might structure your case report:

- Introduction: In the introduction section, you should provide some background information on AV or vertigo due to Eustachian tube dysfunction. This might include a brief description of the condition, its prevalence, and its potential causes.
- Case Presentation: In the case presentation section, you should describe your patient's medical history, including any relevant past medical conditions or surgeries, as well as the onset and duration of their symptoms. You should also provide a detailed description of the patient's symptoms, including any triggers or exacerbating factors.
- Diagnostic Assessment: In the diagnostic assessment section, you should describe the
  tests and procedures used to diagnose your patient's condition. This might include
  audiometric testing, imaging studies, or other diagnostic tools.
- 4. Treatment and Management: In the treatment and management section, you should describe the treatment approach used for your patient, including any medications or surgical interventions. You should also describe any strategies used to manage the patient's symptoms and prevent future episodes of vertigo.
- 5. Discussion: In the discussion section, you should provide an analysis of your findings and discuss the implications of your case report for clinical practice. This might include a discussion of the potential benefits and drawbacks of different treatment approaches, as well as any unresolved questions or areas for further research.

To incorporate the term "ChatGPT" into your case report, you might consider discussing the potential role of AI in diagnosing or managing AV. For example, you might describe how ChatGPT could be used to analyze large datasets of patient information and identify common patterns in symptoms, triggers, and treatment approaches. You might also discuss the potential benefits and drawbacks of relying on AI tools like ChatGPT to make medical decisions in the context of a condition like AV.

Remember to use clear, concise language and to provide plenty of detail to ensure that your case report is both informative and engaging. Good luck with your submission!

## FIGURE 6: Third screen shot of my third question for case report-related experience using ChatGPT

Some recommendations from Conversational Generative Pre-trained Transformer (ChatGPT) regarding the format of the case report.

### **Additional Information**

#### **Disclosures**

**Human subjects:** Consent was obtained or waived by all participants in this study. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

#### References

- Bluestone CD, Swarts JD, Furman JM, Yellon RF: Persistent alternobaric vertigo at ground level. Laryngoscope. 2012, 122:868-72. 10.1002/lary.22182
- Llewellyn A, Norman G, Harden M, Coatesworth A, Kimberling D, Schilder A, McDaid C: Interventions for adult Eustachian tube dysfunction: a systematic review. Health Technol Assess. 2014, 18: 10.3310/hta18460
- Schilder A, Bhutta M, Butler C, et al.: Eustachian tube dysfunction: consensus statement on definition, types, clinical presentation and diagnosis. Clin Otolaryngol. 2015, 40:407-11. 10.1111/coa.12475
- McCoul ED, Anand VK, Christos PJ: Validating the clinical assessment of Eustachian tube dysfunction: the Eustachian tube dysfunction questionnaire (ETDQ-7). Laryngoscope. 2012, 122:1137-41. 10.1002/lary.23223
- 5. Lundgren CE: Alternobaric vertigo--a diving hazard. Br Med J. 1965, 2:511-3. 10.1136/bmj.2.5460.511
- Tjernström Ö: Middle ear mechanics and alternobaric vertigo. Acta Oto-Laryngologica. 1974, 78:376-84. 10.3109/00016487409126369
- Doslak MJ, Dell'Osso LF, Daroff RB: A model of Alexander's law of vestibular nystagmus. Biol Cybern. 1979, 34:181-6. 10.1007/BF00336969
- Merica FW: Vertigo due to obstruction of the Eustachian tubes . JAMA. 1942, 11:1282. 10.1001/jama.1942.02830150018006
- Kim H-Y: Vertigo due to Eustachian tube dysfunction. Arch Otorhinolaryngol Head Neck Surg. 2017, 1:5. 10.24983/scitemed.aohns.2017.00017
- Park JJ, Luedeke I, Luecke K, Emmerling O, Westhofen M: Eustachian tube function in patients with inner ear disorders. Eur Arch Otorhinolaryngol. 2013, 270:1615-21. 10.1007/s00405-012-2143-z
- Kim H-Y: Eustachian tube catheterization: fundamental skill for competent otolaryngologists. J Otolaryngol-ENT Res. 2019, 4:11. 10.15406/joentr.2019.11.00401
- King MR: The future of AI in medicine: a perspective from a chatbot . Ann Biomed Eng. 2023, 51:291-5.
   10.1007/s10439-022-03121-w
- Zhen Z, Zhao T, Wang Q, Zhang J, Zhong Z: Laryngopharyngeal reflux as a potential cause of Eustachian tube dysfunction in patients with otitis media with effusion. Front Neurol. 2022, 13:1024743. 10.3389/fneur.2022.1024743
- Kim H-Y: Reciprocal causal relationship between laryngopharyngeal reflux and Eustachian tube obstruction. J Otolaryngol-ENT Res. 2015, 15:2. 10.15406/joentr.2015.02.00046
- Kim H-Y: From pioneers to modern medicine: tracing the evolution of our understanding of the relationship between Eustachian tube dysfunction, alternobaric vertigo, and laryngopharyngeal reflux. J Otolaryngol-ENT Res. 2023, 12:23-4. 10.15406/joentr.2023.15.00521
- Teixeira MS: Understanding Eustachian tube function. Braz J Otorhinolaryngol. 2020, 86:523-4. 10.1016/j.bjorl.2020.02.001
- Alper CM, Teixeira MS, Richert BC, Douglas Swarts J: Presentation and eustachian tube function test results in children evaluated at a specialty clinic. Laryngoscope. 2019, 129:1218-28. 10.1002/lary.27545
- Smith ME, Takwoingi Y, Deeks J, et al.: Eustachian tube dysfunction: a diagnostic accuracy study and proposed diagnostic pathway. PLoS One. 2018, 13:e0206946. 10.1371/journal.pone.0206946
- 19. Kim H-Y: The history of Eustachian tube catheterization . J Otolaryngol-ENT Res. 2016, 4:10.15406/joentr. 2016.04.00084
- Kumar P, Chauhan S, Awasthi LK: Artificial intelligence in healthcare: review, ethics, trust challenges & future research directions. Eng Appl Artif Intell. 2023, 120:105894. 10.1016/j.engappai.2023.105894