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ORIGINAL RESEARCH

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Persistent foramen of Huschke: Presentation, evaluation, and management

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Abstract

Objective: Describe the presentation and management strategy for patients with symptomatic foramen of Huschke (FH).

Patients: Adults with persistent FH confirmed on imaging.

Interventions: Diagnosis and management of symptomatic persistent FH.

Main outcome measure: Resolution of otologic symptoms.

Results: A total of four patients with symptomatic, radiographically-confirmed persistent FH were included. The majority of patients endorsed otalgia ($n = 4$) and otorrhea ($n = 3$), and only one patient was noted to have a conductive hearing loss. All patients were noted to have dynamic movement of an external auditory canal mass with mandible manipulation on examination, and all patients had an identifiable fistula on imaging. Patients underwent surgical intervention, including both preauricular ($n = 2$) and transcanal ($n = 2$) approaches, and all endorsed symptomatic resolution after convalescence.

Conclusions: Persistent FH remains an uncommon and potentially underrecognized cause of otologic symptoms. Diagnosis requires a high index of suspicion, and one must rely on both key examination findings and imaging to confirm this diagnosis. In appropriately selected patients, surgical intervention can provide durable symptomatic resolution.

Level of evidence: IV

KEYWORDS

external auditory canal fistula, foramen of Huschke, foramen tympanicum, otalgia, otorrhea, temporomandibular joint, tympanic dehiscence

1 | INTRODUCTION

The tympanic ring is incompletely developed at birth, with completion of ossification and fusion of the anterior and posterior prominences occurring within the first 5 years of life. A persistent foramen of Huschke (FH), also referred to as a foramen tympanicum or a tympanic dehiscence, is thought to result from incomplete fusion or ossification of the external auditory canal (EAC) during normal development.[1]

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Arrested or incomplete development may result in a persistent gap in the bony EAC, serving as a potential conduit for soft tissue herniation.

Although incidental persistent FH is diagnosed in 11.5%–20% of individuals undergoing temporal bone imaging, few studies have described the clinical nature of this pathology.[2–4] Available literature reports on single cases[5–14] or small case series[15,16] that highlight the presentation and management variability associated with this pathology. Understanding of this pathology from the lone review examining temporomandibular joint herniation into the EAC is limited given the wide variance in literature and the presentation of all EAC fistula patients, including spontaneous and non-spontaneous fistulae, as a single group in this study; therefore, conclusions are restricted when looking specifically at persistent FH.[17] Because persistent FH remains a less common and underreported cause of otologic symptoms such as otorrhea and otalgia, a high index of suspicion and a multidisciplinary care team, including surgeons, audiologists, and radiologists, are beneficial in making a correct diagnosis and effectively treating patients. The present study reviews the presentation, treatment strategy, and outcomes in a series of patients with symptomatic FH in an effort to highlight important principles in the diagnosis and management of this pathology.

2 | METHODS

After Institutional Review Board approval (Mayo Clinic, #21-000255), patients with a diagnosis of persistent FH were retrospectively identified using the electronic medical record. Patients were included in the study if they had radiographically confirmed persistent FH, designated as a bony defect in the anterior EAC with evident soft tissue herniation of any size, as well as otologic symptoms which could be attributed to the dehiscence. Patients were excluded if they developed an EAC fistula as a result of another etiology (e.g., trauma), lack of research consent, and lack of computed tomography (CT) or magnetic resonance (MR) imaging of the temporal bone to confirm the diagnosis. Patient demographic information, clinical details, radiographic findings, surgical treatment, and audiometric testing were reviewed. Findings were reported utilizing descriptive statistics. Non-normally distributed continuous features were summarized with medians and ranges, and categorical features were summarized with frequency counts and percentages.

3 | RESULTS

Four patients were identified to have a diagnosis of symptomatic persistent FH confirmed on imaging (Table 1). Symptoms at presentation varied with the majority experiencing otalgia ($N = 4$) and clear otorrhea that worsened with jaw movement or eating ($N = 3$). No patient experienced aural fullness, audible noise, or facial swelling. A delay in diagnosis prior to presentation at the authors' facility was noted frequently ($N = 3$), with suspected diagnoses including exostoses, otitis externa with cerebrospinal fluid leak, and branchial cleft anomaly. The range of observed delays was 7–8 months. Physical examination and imaging were key in securing a diagnosis (Figures 1 and 2); all four patients exhibited a soft-tissue EAC mass, which was displaced with jaw movement. One patient was noted to have a substantial air-bone gap with persistent FH, but the remaining did not have objective hearing loss.

TABLE 1 Baseline characteristics, clinical details, and objective findings of patients with persistent FH ($N = 4$, unless otherwise noted)

	Median (range) or *N* (%)
Patient demographics	
Age at presentation in years	59 (38–75)
Female	3 (75)
Presenting symptoms	
Otalgia	4 (100)
Otorrhea	3 (75)
Subjective hearing loss	2 (50)
Clicking tinnitus	1 (25)
Physical examination findings	
Evidence of mass with jaw movement	4 (100)
EAC mass	3 (75)
Otorrhea	3 (75)
Audiometric testing	
AC PTA in dB HL	17.3 (12.5–93.8)
BC PTA in dB HL ($N = 3$)	13.8 (6.9–75.0)
PTA air-bone gap in dB HL ($N = 3$)	6.1 (3.8–18.8)
WRS in percent correct ($N = 3$)	90 (0–100)
Imaging findings	
EAC dehiscence	4 (100)
Mass	3 (75)

Abbreviations: AC, air conduction; BC, bone conduction; dB HL, decibels hearing level; EAC, external auditory canal; FH, foramen of Huschke; PTA, pure tone average; WRS, word recognition score.

All patients underwent surgical intervention. One patient underwent a planned transcanal approach given a small polypoid lesion with limited fistula noted on imaging (Figure 2B). The lesion was excised completely after raising a meatal flap, and perichondrium was utilized to reconstruct the persistent FH. A combined pretragal and transcanal approach was planned for another patient, but intraoperative findings allowed for a more conservative transcanal approach. The lesion was debulked after raising a meatal flap. No reconstruction occurred. Two patients underwent a combined approach (Figure 3). These patients were noted to have larger fistulae (≥4–5 mm), with one patient also having notable TMJ arthritis as identified by clinical and radiographic features. In both cases, the joint capsule was entered and explored, removing any pathologic tissue. The EAC defect was identified transcanal, and reconstruction occurred with a tragal cartilage graft placed externally through the pretragal incision. The graft was secured using suture and fibrin glue in both cases. The two patients were subsequently maintained on a soft diet for several weeks. There were no

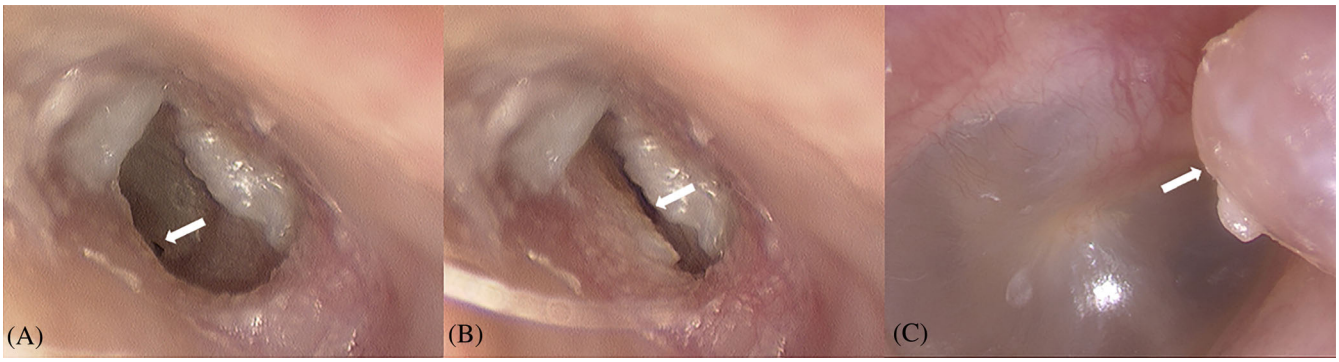

FIGURE 1 Preoperative otoendoscopic images depicting external auditory canal masses associated with a persistent foramen of Huschke. Images A and B were obtained from the same left ear and demonstrate notable posterior prolapse with jaw movement (white arrows). Image C (right ear) demonstrates a well-circumscribed mass corresponding to the typical location of herniating tissue through a persistent foramen of Huschke (white arrow)

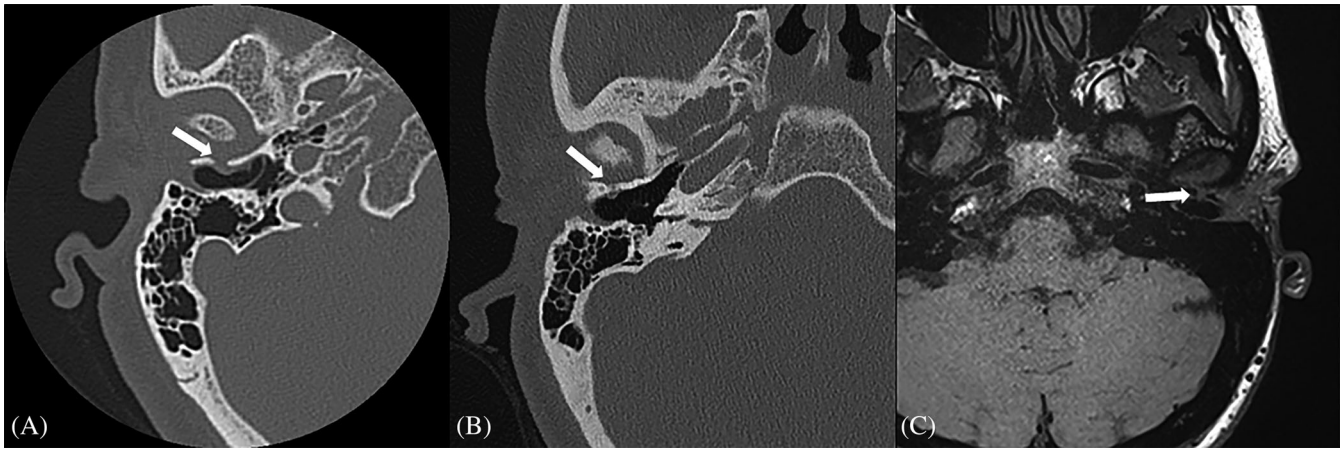

FIGURE 2 Examples of imaging findings associated with a persistent foramen of Huschke. A and B showcase right-sided fistulae between the temporomandibular joint space and the external auditory canal on axial, non-contrasted, high resolution CT for two patients (white arrows). Image C highlights soft tissue herniation (white arrow) through a defect on T1-weighted non-contrasted MRI

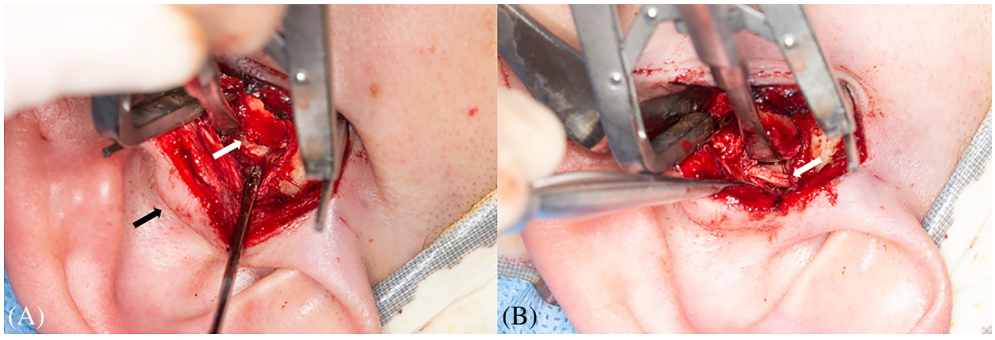

FIGURE 3 Intraoperative photographs depicting a preauricular approach for persistent foramen of Huschke repair on the left side. A. Exposure after temporomandibular joint arthrotomy (white arrow). Note the tragus posterior to the incision (black arrow). B. Reconstruction of the external auditory canal wall with cartilage (white arrow) placed externally

postoperative complications for these patients. The median postoperative follow-up was 6.5 months (range 2–12) with most patients being followed on an as-needed basis after initial standard postoperative appointments, only being seen if concerns arose. During follow-up, the patient that did not undergo canal reconstruction had recurrent signs of an EAC mass when being evaluated for cerumen impaction; however, this patient was noted to be asymptomatic at this time. The remaining patients showed no signs of recurrence, and all endorsed resolution of their symptoms. All patient-level data is provided in Table S1.

4 | DISCUSSION

The present study examines the diagnosis and management of one of the largest series of surgically managed persistent FH in the literature.[15–17] Notably, the majority of the currently presented patients experienced a delay in diagnosis prior to referral to a tertiary facility. In part, this may be due to nonspecific presenting symptoms, such as otorrhea and otalgia, and somewhat subtle examination findings. Importantly, a diagnosis of symptomatic FH hinges on the clinical examination and radiographic confirmation of a dehiscence. All patients in this series had soft tissue herniation within the EAC associated with movement of the temporomandibular joint and most had clear otorrhea correlating with saliva or synovial fluid. Careful examination focused on identifying EAC pathology or mass displacement with temporomandibular joint movement is helpful in diagnosis. Fortunately, hearing loss is not frequently associated with this pathology; however, in larger dehiscences, a soft tissue herniation abutting the tympanic membrane may cause a conductive hearing loss. Notably, either CT or MR can be utilized to confirm a diagnosis of persistent FH (Figure 2). CT temporal bone imaging is particularly advantageous in identifying small bony defects along the anterior bony EAC wall, which separates the ear canal and the temporomandibular joint. While soft-tissue herniation can be appreciated on CT, MR may better delineate the contents of the herniated tissue, such as joint synovium or salivary tissue.

For patients with symptomatic persistent FH, management is generally surgical with a goal to reduce the herniation and close the dehiscence between the EAC and the herniated tissue.[6,11,12,14–17] Decision-making regarding surgical approach considers both the size of the dehiscence as well as the status of the temporomandibular joint and capsule. A fistula that is ≥4–5 mm may require a combined approach, while a smaller fistula may allow for a less invasive transcanal approach. Comorbid TMJ arthritis—as diagnosed by clinical signs including change in occlusion, limited range of motion, and immediate preauricular pain with mastication as well as imaging findings such as loss of joint space, sclerosis of the condyle, subcortical cyst formation, and osseous contour irregularity—dictates a more extensive intervention, including arthrotomy and joint exploration. Additionally, herniation of the capsule through the dehiscence may warrant opening the posterior aspect of the temporomandibular joint to completely access the defect. While debulking of the herniated mass may resolve a patient's symptoms, the authors believe that reconstruction of the defect is likely to result in more durable resolution of symptoms. For smaller defects, perichondrium may be sufficient for reconstruction; however, more robust grafting material, such as tragal cartilage, temporalis muscle, bone pâté, iliac bone crest, collagen mesh, polypropylene, or titanium mesh, may be beneficial in reconstructing larger defects.[6,12,14,16,17] It is the authors' practice to utilize perichondrium and/or tragal cartilage given its adaptability, availability, and limited associated morbidity contrasted with the potential risk of extrusion of non-native substances through thin canal skin. Grafts may be secured with fibrin glue or tacking sutures to minimize graft displacement with temporomandibular joint movement during the postoperative healing period. While the authors did not use non-absorbable packing in this series, this may also be an alternative method to secure grafts within the EAC. Notably, grafting can lead to condylar displacement with corresponding joint fullness or even malocclusion, but this symptomatology has been found to resolve without intervention. Dietary modifications additionally aid in the reduction of joint stress and subsequent graft disturbance.

Interestingly, there is an incongruity in the reported prevalence of radiologically confirmed persistent FH (11.5%–20%) compared to the relatively low number of reported cases of symptomatic persistent FH, suggesting that many patients may be asymptomatic.[2–4] In patients with asymptomatic FH, observation remains the mainstay of management. Although there is a paucity of data in the natural history of asymptomatic persistent FH, the authors do not feel that observation in asymptomatic patients would increase the risk of complications in the future.[5,6,8–10,13,15,17] Further work is warranted to better understand both the natural history of this pathology as well as the prevalence of symptomatic disease among patients with radiographically confirmed dehiscences.

Limitations of the current work do need to be addressed. Due to the retrospective nature of this study, long-term clinical and audiologic outcomes are not available for each study patient. Consequently, confirmation of the durability of the surgical results are limited to the shorter postoperative follow-up period in this series. Lastly, the heterogeneity of this disease process requires a customizable treatment algorithm ranging from observation in asymptomatic patients to a combined approach to the EAC and temporomandibular joint for larger symptomatic dehiscences. Combined with the relative rarity of symptomatic persistent FH, a study comparing management strategies is thus unachievable.

5 | CONCLUSION

Although a less common cause of otalgia and clear otorrhea, symptomatic persistent FH can be effectively surgically treated with removal of the herniated soft tissue and reconstruction of the bony dehiscence. Early diagnosis via otoscopic examination and radiographic confirmation is key to appropriately treating this patient population.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

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REFERENCES

1. Pirsig W, Mudry A. Huschke's anterior external auditory canal foramen: art before medicine? *Otol Neurotol*. 2015;36:555-560.
2. Koc A, Kaya S. Prevalence of foramen Huschke: evaluation of the association between mastoid pneumatization volume and the existence of foramen Huschke using cone beam computed tomography. *Eur Arch Otorhinolaryngol*. 2021;278:791-796.
3. Deniz Y, Geduk G, Zengin AZ. Examination of foramen tympanicum: an anatomical study using cone-beam computed tomography. *Folia Morphol*. 2018;77:335-339.

4. Tozoglu U, Caglayan F, Harorli A. Foramen tympanicum or foramen of Huschke: anatomical cone beam CT study. *Dentomaxillofac Radiol*. 2012;41:294-297.
5. Kinar A, Bucak A, Ulu S. An Otalgia cause: temporomandibular joint herniation from foramen of Huschke to external auditory canal. *J Craniofac Surg*. 2020;31:e532-e533.
6. Lim KH, Jung JY, Rhee J, Choi J. Temporomandibular joint herniation through the foramen of Huschke with clicking tinnitus. *Eur Ann Otorhinolaryngol Head Neck Dis*. 2019;136:497-499.
7. van der Meer WL, van Tilburg M, Mitea C, Postma AA. A persistent foramen of Huschke: a small road to misery in necrotizing external otitis. *AJNR Am J Neuroradiol*. 2019;40:1552-1556.
8. Choi JW, Nahm H, Shin JE, Kim CH. Temporomandibular joint herniation into the middle ear: a rare cause of mastication-induced tinnitus. *Radiol Case Rep*. 2020;15:125-127.
9. Lee YW, Park YH. Bilateral spontaneous symptomatic temporomandibular joint herniation into the external auditory canal: a case report and literature review. *Auris Nasus Larynx*. 2018;45:346-350.
10. O'Brien DC, Purpura KR, Cassis AM. Bilateral spontaneous temporomandibular joint herniation: a case report and literature review. *Ear Nose Throat J*. 2018;97:E23-E27.
11. Moriyama M, Kodama S, Suzuki M. Spontaneous temporomandibular joint herniation into the external auditory canal: a case report and review of the literature. *Laryngoscope*. 2005;115:2174-2177.
12. Ryu KH, Baek HJ, Hur DG. Spontaneous temporomandibular joint herniation into the external auditory canal through a patent foramen of Huschke: a case report. *Ann Med Surg (Lond)*. 2017;18:33-35.
13. Ertugrul S. Rare cause of tinnitus: spontaneous temporomandibular joint herniation into the external auditory canal. *J Craniofac Surg*. 2018;29:e521-e522.
14. Pons M, Lutz JC, Sigaux N, Tavernier L, Graillon N, Louvrier A. Surgical reconstruction of the foramen tympanicum: what is known and how we do it. *J Stomatol Oral Maxillofac Surg*. 2020;121:545-549.
15. Liu JH, Huang WH, Xu JH, Liu Y, Sha Y. Otoscopy and imaging features of spontaneous temporomandibular joint herniation into the external auditory canal. *BJR Open*. 2020;2:20200005.
16. Park YH, Kim HJ, Park MH. Temporomandibular joint herniation into the external auditory canal. *Laryngoscope*. 2010;120:2284-2288.
17. Jo YS, Cheong TY, Han BH, Lee JM, Kim SH, Moon IS. Temporomandibular joint herniation: review of the literature. *Otol Neurotol*. 2020;41:e1-e6.

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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