



Occupational metallic foreign body in the hypotympanum: the critical role of timely treatment. Two case reports and a review of the literature

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ABSTRACT

Background: We present two rare cases where a metal splinter became lodged in the middle ear (hypotympanum) as a result of occupational accidents. **Methods:** Retrospective analysis of two patients underwent surgical procedures for the removal of a metallic foreign body from the middle ear was reported. A systematic literature review was conducted using PubMed. **Results:** The patients reported symptoms of hearing loss, otorrhea, and vertigo following the injury. Temporal bone CT scans confirmed the presence of a foreign body in the hypotympanum in both cases. In the first case, the patient sought medical attention promptly and underwent a single surgical procedure: exploration of the tympanic cavity allowed removal of the foreign body, followed by myringo-plasty. In contrast, the second patient delayed seeking treatment for 11 days, resulting in severe inflammation. This patient required two surgical interventions, the second involving mastoidectomy, to extract the foreign body. This highlights the need for improved occupational health safety measures, particularly in professions at risk for such injuries, and emphasizes the importance of timely medical care for optimal outcomes. **Conclusion:** Delayed treatment can lead to complications, necessitating more complex surgical procedures and prolonged recovery. Early diagnosis and timely surgical management are essential to minimize complications and preserve auditory function.

KEYWORDS

Metallic foreign body, Hearing loss, Middle ear, Occupational health, Otolaryngology.

1 Introduction

The presence of a metallic foreign body in the middle ear of an adult is an exceptionally rare clinical finding. Most foreign bodies encountered in otolaryngology are located in the external auditory canal and are more commonly observed in pediatric patients (Kadish, 2005; Olajide et al., 2011). However, in adults, middle ear foreign bodies are more frequently associated with occupational exposure, particularly in high-risk work environments (Naveethan et al., 2014; Ryan et al., 2006). Among these, welding-related injuries are an uncommon but severe cause of otologic damage.

Welding activities can expose the ear to molten metal particles that can cause tympanic membrane perforation. In rare cases, these particles can penetrate the middle ear, resulting in thermal injury, inflammation, and long-term auditory sequelae (Fisher and Gardiner, 1991; Mertens et al., 1991). Such injuries may be further complicated by delayed presentation, which increases the risk of infection, scarring, and damage to middle and inner ear structures (Stage and Vinding, 1986).

This report describes two cases of middle ear foreign bodies related to occupational accidents to emphasize the critical role of

timely diagnosis and surgical management in occupational health and workplace safety. Written informed consent was obtained from the patients for publication of this case report and any accompanying images.

2 Case presentation

2.1 Case 1

A 66-year-old woman presented at the first aid department on the same day as experiencing an accidental ear injury from a welding splinter, and received specialist attention on the following day. Her symptoms were hypoacusia, serous otorrhea, otalgia and vertigo in the left ear. The specialist detected a left tympanic perforation of the posterior quadrants of the membrane. She underwent an audiometry test which showed mixed left hearing loss (Fig. 1), and a CT scan of the ear which detected the presence of a hyperdense metallic foreign body in the hypotympanum (Fig. 2a, b, c).

The patient underwent a surgical intervention under general balanced anesthesia to remove the metallic foreign body. We performed a left-sided helix inter tragus incision, raised a tympan-

Peer review under responsibility of PLA General Hospital Department of Otolaryngology Head and Neck Surgery.

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<https://doi.org/10.26599/JOTO.2026.9540068>

Received 20 March 2026; Revised 9 June 2026; Accepted 15 June 2026

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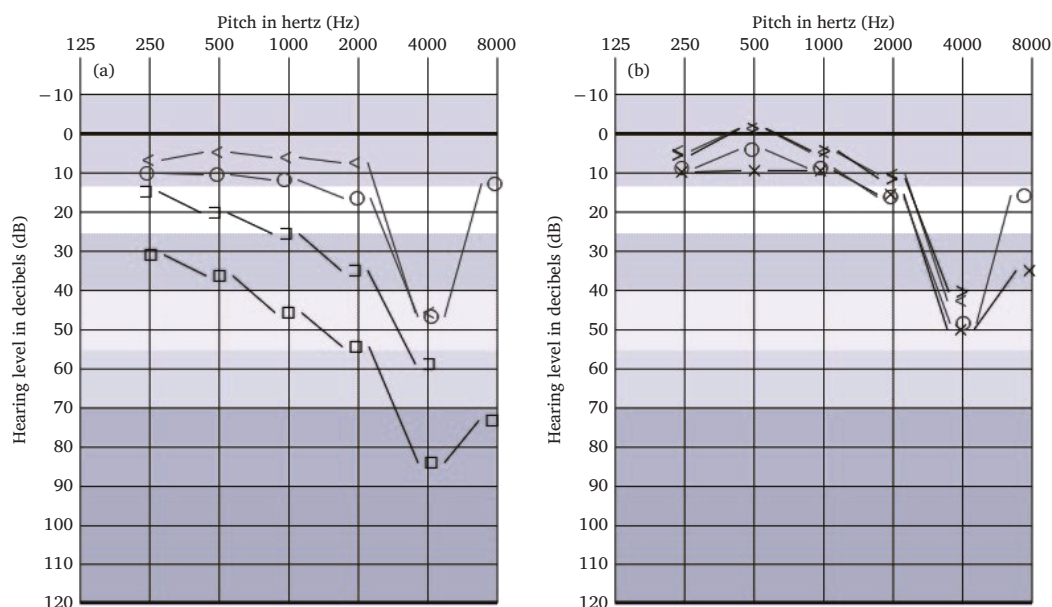


Figure 1 Pure tone audiometry in the first case: (a) preoperative audiogram with mixed hearing loss due to left eardrum injury; (b) full recovery postoperative.

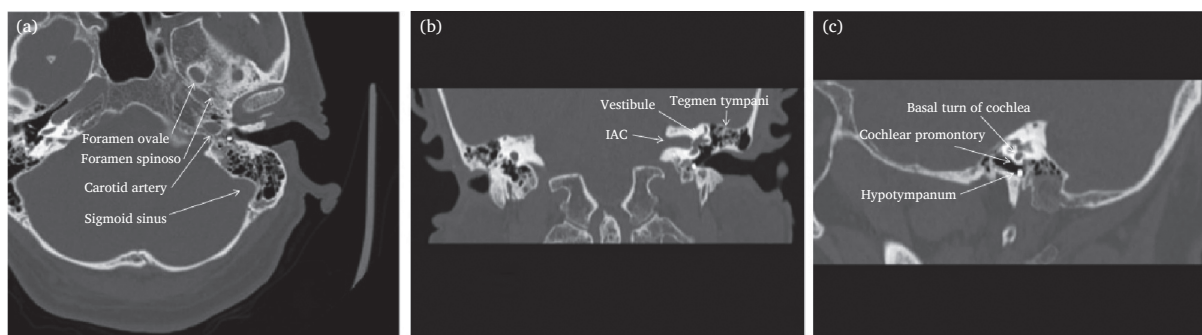


Figure 2 (a, b, c) Preoperative temporal bone CT of first case. (A) Axial CT demonstrating a metallic foreign body in the left hypotympanum. (B) Coronal view showing its relationship with the middle ear and surrounding structures. (C) Sagittal reconstruction highlighting proximity to the cochlear promontory and basal turn of the cochlea.

nomeatal flap and exposed the foreign body, with subsequent excision. Finally, we reconstructed the tympanic membrane using tragal perichondrium. The patient was followed up for 3 months at regular intervals until her ear was dry and with an intact graft. Postoperative recovery was uneventful, with the patient demonstrating full resolution of her symptoms. Follow-up evaluations over three months revealed a dry ear and a fully intact tympanic membrane graft. Audiometric tests confirmed complete recovery of the conductive component of her hearing loss, restoring her auditory function to pre-injury levels.

2.2 Case 2

A 47-year-old man presented at our department with a unilateral left ear discharge over the previous 2 days and reporting occupational trauma over the previous 11 days after using a metal drill. During his first visit, the patient mentioned that, immediately after the trauma, he experienced hypoacusia and dizziness but only decided to go to our hospital during the following week when he experienced a purulent otorrhea. During this first visit, perforation of the anteroinferior quadrant of the tympanic membrane was observed, with copious secretions and a very inflamed tympanic membrane. Subsequently, as in the first case, the patient underwent an audiometry test which detected conductive hearing loss (Fig. 3)

and a CT scan of the left ear (Fig. 4a, b, c), showing a hypotympanic metallic foreign body in a very similar location to that in the first patient.

The patient then underwent a first surgical intervention, under general anesthesia, attempting to remove the metal body. We performed a retroauricular incision, with creation of a vascular strip and fashioning of a tympanomeatal flap, but we did not locate the metallic splinter and noted that the tympanic cavity was very inflamed and with abundant granulation tissue. So finally in the first attempt, we only reconstructed the tympanic membrane with an underlay technique, using temporal muscle fascia.

After this, the patient was transferred to another center for a second surgical procedure. The surgeons there initially tried to locate the metallic splinter using an endoscopic-assisted technique, but only highlighted inflammatory tissue in the tympanic cavity. Subsequently, they decided to use an infralabyrinthine approach, with extensive removal of the posterior wall of the ear canal and hypotympanum. It was only after this that the surgeon located the metallic foreign body and extracted it. At follow-up evaluations, the tympanic membrane was noted to be intact, dizziness was gone and the inflammatory response in the tympanic cavity had resolved. However, audiometric testing revealed a residual mild conductive hearing loss (5-10 dB).

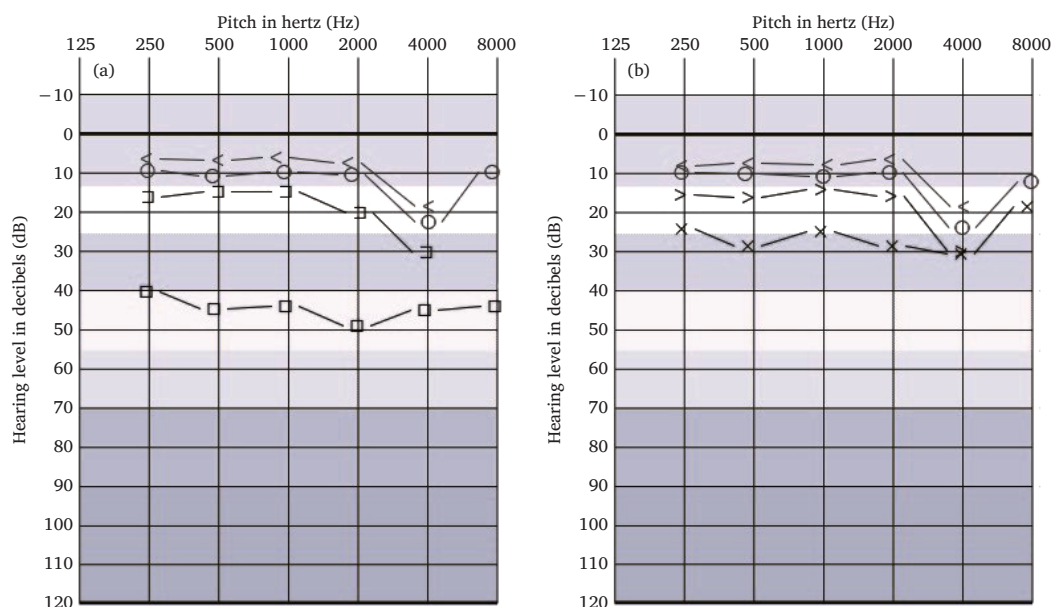


Figure 3 Pure tone audiometry in the second case: (a) preoperative audiogram with a conductive hearing loss; (b) postoperative audiogram with mild conductive hearing loss.

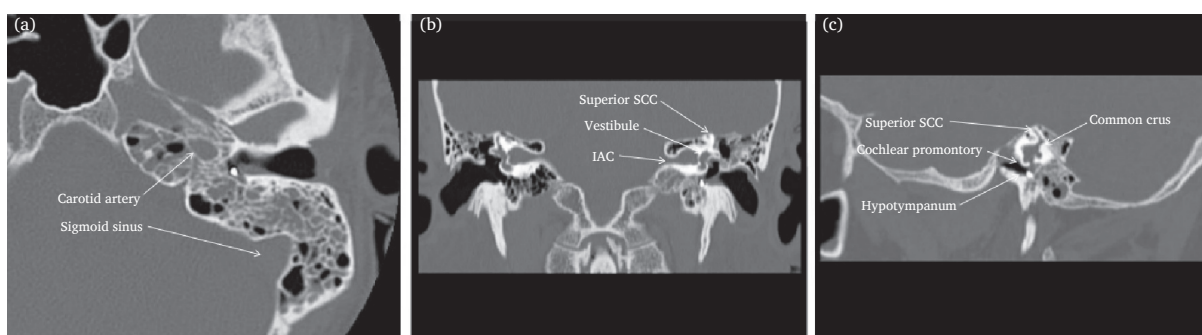


Figure 4 (a, b, c) Preoperative temporal bone CT of second case. (A) Axial CT demonstrating a metallic foreign body in the left hypotympanum. (B) Coronal view showing its relationship with adjacent middle ear structures. (C) Sagittal reconstruction highlighting proximity to the cochlear promontory.

3 Discussion

A structured literature review was conducted to identify cases of middle ear foreign bodies related to occupational or metallic injuries that had been reported previously. The PubMed database was systematically searched up to December 2025. The search strategy combined the following Medical Subject Headings (MeSH) terms and keywords: 'middle ear foreign bodies', 'hypotympanum', 'metallic foreign body', 'welding injury' and 'occupational ear injury', using Boolean operators (AND/OR) as appropriate. The inclusion criteria were: (1) case reports or case series describing foreign bodies located within the middle ear; (2) a metallic or occupational aetiology; and (3) the availability of sufficient clinical, radiological and/or surgical data. Articles focusing exclusively on foreign bodies in the external auditory canal, non-metallic materials, cases without middle ear involvement, paediatric non-occupational cases, experimental studies and review articles without original clinical data were excluded. Only studies published in English were considered. Two authors independently screened titles and abstracts for relevance. Full-text articles were retrieved when eligibility was uncertain. Discrepancies were resolved through discussion among the authors. Additionally, the reference lists of selected papers were manually reviewed to identify further

relevant publications.

The clinical data, including the presenting symptoms, imaging findings, surgical details, and postoperative outcomes, were collected from the patient records. The outcomes were assessed in terms of symptom resolution, hearing improvement, and complications. The timeline between the injury and the intervention was analysed to evaluate its impact on surgical complexity and patient recovery.

A total of 11 reports (Frenkiel and Alberti, 1977, Jarzebski, 1979, Simons and Eibling, 2005, Eleftheriadou et al., 2007, Keogh and Portmann, 2009, Leedman and Kuthubutheen, 2021, Hervochon et al., 2023) detailing middle ear injuries caused by welding debris, many earlier case reports did not systematically report detailed audiological or timing variables, Table 1 summarises the consistently reported clinical features, such as injury mechanism, anatomical location, surgical management and documented timing of intervention.

Although uncommon, these cases demonstrate that metallic foreign bodies may penetrate beyond the tympanic membrane and involve the middle ear, potentially leading to persistent perforation, chronic inflammation, ossicular damage, and, in severe cases, facial nerve or inner ear involvement.

These injuries frequently occur due to the penetration of hot

Table 1 Literature Review.

Author (Year)	No. of Cases	Mechanism of Injury	Anatomical Site	Reported Surgical Approach	Timing of Intervention*	Reported Outcome
Frenkiel and Alberti (1977)	11	Thermal injury from welding sparks	Middle ear	Tympanoplasty in selected cases	Not specified	TM repair in most cases
Jarzebski (1979)	19	Welding spark injury	Middle ear	Conservative treatment and tympanoplasty	Not specified	Variable hearing outcomes
Stage and Vinding (1986)	1	Metal spark penetration	Middle ear	Exploratory surgery	Not specified	Persistent facial nerve palsy
Fisher and Gardiner (1991)	5	Welding splinters	Middle ear	Myringoplasty	Not specified	Successful TM closure
Mertens et al. (1991)	25	Welding spark injury	External canal and middle ear	Conservative treatment or tympanoplasty	Variable	Hearing impairment reported in a minority
Panosian et al. (1993)	2	Slag injury	Eustachian tube region	Middle ear exploration	Within days after trauma	Persistent hearing deficit
Simons and Eibling (2005)	1	Retained metallic slag	Promontory	Surgical exploration	Not specified	Successful removal
Eleftheriadou et al. (2007)	1	Metallic foreign body	Ossicular region	Middle ear exploration	Delayed presentation	Hearing recovery after removal
Keogh and Portmann (2009)	1	Thermal welding injury	Middle ear	Myringoplasty	Not specified	TM repair
Leedman and Kuthubutheen (2021)	1	Metallic foreign body	Sinus tympani	Endoaural approach	Delayed presentation	TM repair and hearing improvement
Hervochon et al. (2023)	1	Severe thermal injury	Middle and inner ear	Cochlear implantation and facial nerve repair	Immediate intervention	Functional rehabilitation

*Timing refers to the interval between injury and surgical management when reported in the original study.

molten metal, or slag, into the ear. This slag can reach temperatures exceeding 1000°C, causing devascularization and tissue destruction, particularly of the tympanic membrane (Fisher and Gardiner, 1991; Simons and Eibling, 2005).

From an occupational health perspective, preventive strategies must be clearly defined and systematically implemented. In addition to standard eye protection, workers involved in welding or metal drilling activities should routinely use specialized ear protection equipment, such as properly fitted earplugs or over-the-ear earmuffs. This equipment provides a mechanical barrier to protect the external auditory canal and the eardrum against molten metal particles and lateral splinters. Furthermore, any occupational ear trauma should be formally reported to the occupational health physician. An otolaryngologist should be consulted promptly in all suspected cases of tympanic membrane perforation or middle ear involvement. If clinical findings suggest possible penetration beyond the eardrum, a high-resolution temporal bone CT scan should be performed promptly to assess the location of the metallic foreign body and guide surgical planning. Delayed presentation appears to favor an intense inflammatory response, which increases surgical complexity and the risk of complications. This finding is consistent with previous reports (Olajide et al., 2011; Iseh and Yahaya, 2008). The literature suggests that postponing treatment allows for a progressive tissue reaction, which may necessitate more invasive surgical approaches and adversely affect outcomes.

Delayed medical attention was not the only factor that contributed to the surgical difficulties observed in the second case. Although the CT scan revealed a metallic foreign body in a location similar to that of the first patient, the prolonged interval between the trauma and the surgery allowed marked mucosal oedema and granulation tissue to develop, obscuring anatomical landmarks and limiting intraoperative visualization. In the hypotympanum, where access is already anatomically restricted, even moderate inflammatory changes can significantly hinder the identification and safe dissection of foreign material. Pre-operative CT imaging

revealed a localized metallic fragment without clear ossicular or labyrinthine involvement, justifying an initial transcanal/retroauricular exploratory approach aimed at conservative removal. However, the extensive inflammatory reaction encountered during the procedure altered the surgical strategy. During the second intervention, the decision was made to proceed with a more aggressive infralabyrinthine approach to allow for wider exposure of the hypotympanum and posterior mesotympanum, which were not adequately visualized during the first procedure. The clinical relevance of these cases does not lie solely in the fact that delayed treatment increases surgical difficulty, a concept that is already recognized in the literature. Rather, our observations emphasize how the combination of anatomical location and inflammatory response can have a significant impact on surgical decision-making. In particular, foreign bodies located in the hypotympanum can be difficult to identify and remove, even when preoperative CT imaging suggests a localized fragment. In cases of delayed presentation, mucosal oedema and granulation tissue can obscure key anatomical landmarks and reduce surgical visibility. This may require the operative approach to be modified in order to achieve adequate exposure. These findings emphasize the importance of integrating radiological information with intraoperative anatomical assessment when planning the surgical management of foreign bodies in the middle ear. We also recognize the growing role of endoscopic techniques in otologic surgery (Sun et al., 2020), application of endoscopic approaches to the middle ear allow enhanced visualization of hidden recesses and may facilitate more precise removal of lesions in anatomically challenging areas such as the hypotympanum. Although an endoscopic-assisted approach was not employed during the initial procedure in Case 2, its use may have provided enhanced visualization of the hypotympanum and other hidden recesses of the middle ear. Nevertheless, considering the marked inflammatory changes encountered intraoperatively, it is difficult to determine whether earlier endoscopic assistance would have altered the overall surgical outcome or eliminated the need for subsequent revision surgery.

Metallic debris, in particular, poses a dual risk of thermal and mechanical injury, which can lead to deeper tissue involvement and persistent inflammation (Piromchai et al., 2012; Lee et al., 2017).

Beyond surgical considerations, educating patients is key to improving outcomes. Those exposed to welding or similar high-risk activities should be adequately informed about the potential otological consequences of molten metal injuries, as well as the limitations of standard protective equipment. Education should emphasize the consistent use of appropriate ear protection and the importance of seeking immediate medical evaluation after ear trauma, even when symptoms appear mild. Increased awareness at workplace level could reduce delays in seeking treatment, limit inflammatory progression and ultimately decrease the need for more invasive surgical procedures. Standardized training for healthcare professionals in recognizing and promptly treating such injuries should also be emphasized to optimize outcomes.

4 Conclusions

In conclusion, although rare, occupational middle ear injuries caused by metallic foreign bodies may result in significant audiological and vestibular damage. In addition to preventive protective measures, targeted worker education on ear protection and the importance of timely medical evaluation is essential to optimize clinical outcomes and reduce avoidable complications. When indicated, early surgical intervention facilitates metallic foreign body removal by limiting inflammatory reactions and reducing the risk of complications.

Funding

None.

Data Availability Statement

Not applicable.

Ethical Approval

Not applicable.

Informed Consent Statement

Not applicable.

Conflicts of Interest

There are no relevant financial or non-financial competing interests to report.

Acknowledgements

None.

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