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Gallium Scintigraphy-Guided Discontinuation of Antibiotics in Skull Base Osteomyelitis: A Case Report

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ABSTRACT

Skull base osteomyelitis (SBO) is a rare and potentially life-threatening infection often complicated by multiple cranial nerve palsies. A case of SBO, complicated by multiple cranial nerve palsies, in which antimicrobial therapy was guided by gallium scintigraphy uptake, resulting in a favorable clinical course without recurrence, is reported. A 79-year-old man presented with right otalgia, otorrhea, hearing loss, and facial nerve paralysis. He was initially diagnosed with otitis media-related labyrinthitis and treated with antibiotics and corticosteroids. Two months later, the patient developed recurrent otorrhea and multiple cranial neuropathies. Contrast-enhanced computed tomography/magnetic resonance imaging revealed bone destruction and strong enhancement from the petrous apex to the clivus and nasopharynx. The patient was diagnosed with SBO and was administered intravenous antibiotics for 2 months. Oral antibiotics were continued for approximately 3 months post-discharge. Gallium-67 scintigraphy revealed near-complete resolution 5 months after discharge; accordingly, oral antibiotics were discontinued at that time. No recurrences were observed during 18 months of follow-up.This case highlights the importance of considering SBO in patients with cranial neuropathies, even when initial middle ear findings improve. Long-term culture-directed antibiotics guided by functional imaging, such as gallium scintigraphy, can optimize treatment, prevent recurrence, and improve outcomes in severe cases.

KEYWORDS

Skull base osteomyelitis, Multiple cranial nerve palsies, Gallium scintigraphy, Long-term antibiotics.

1 Introduction

Skull-base osteomyelitis (SBO) associated with malignant external otitis was initially described by Chandler (1968). Thereafter, Chandler et al. (1986) reported that SBO is a distinct clinical entity, in which the infection extends from the malignant external otitis to the skull base. Patients with SBO present with severe otalgia, headache, and otorrhea, and may progress to multiple cranial neuropathies. Despite advances in treatment, SBO is associated with a high mortality rate, thus prompting subsequent reports describing SBO without external otitis. SBO arising secondary to typical malignant external otitis is referred to as "typical" SBO, whereas cases without external otitis are termed "atypical" SBO, or "central" SBO, based on anatomical location (Chapman et al., 2021). In addition to external otitis, otitis media, labyrinthitis, nasopharyngitis, and upper respiratory tract infections via the eustachian tube have been proposed as potential routes of infection.

Pseudomonas aeruginosa is the most commonly isolated pathogen. SBO frequently occurs in immunocompromised individuals, including those with diabetes mellitus, long-term steroid or immunosuppressive use, and patients undergoing hemodialysis. Long-term antibacterial therapy has also been shown to be effective (Trent et al., 2025). Diagnosis requires the exclusion of differential diagnoses, such as malignant tumors, external or middle ear cholesteatoma, tuberculosis, and anti-neutrophil cytoplasmic antibody (ANCA)-associated otitis media, making histopathology, laboratory investigations, and microbiological cultures essential.

The recommended treatment regimen consists of ≥ 6 weeks of intravenous antibiotics active against the causative organism, followed by several months to 1 year of oral antibiotic therapy (Trent et al., 2025). Inadequate antimicrobial treatment may result in recurrence and can be fatal (Saxena et al., 2021). However, blood C-reactive protein (CRP) levels are often normal, making it difficult to assess disease activity using routine laboratory investigations. In addition, there are currently no established criteria for determining treatment completion. Contrast-enhanced magnetic resonance imaging (MRI) may reveal persistent enhancement for prolonged periods, whereas gallium (Ga) scintigraphy, which more directly reflects inflammatory activity, has been reported to be useful during follow-up (Auinger et al., 2021; Kulshrestha, 2024).

We report a case initially diagnosed as labyrinthitis with otitis-related facial nerve palsy and sensorineural hearing loss. Although symptoms improved and antibiotics were discontinued, the disease

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subsequently recurred with multiple cranial neuropathies. Long-term antibiotic therapy was administered, and Ga scintigraphy was performed to monitor treatment response. The disappearance of radiotracer uptake was used as an indicator of disease resolution, and the patient has remained recurrence free since.

2 Case Presentation

The patient was a 79-year-old man who presented with chief complaints of right otalgia, otorrhea, hearing loss, and facial nerve paralysis. His medical history included type 2 diabetes mellitus, hepatic abscess (at 50 years of age), cholelithiasis, arrhythmia, and hypertension.

After performing a forceful Valsalva maneuver, the patient developed right otalgia and otorrhea and attended a local clinic. He was treated for acute otitis media using topical antibiotics and aural irrigation with normal saline; however, symptoms exhibited poor improvement. Subsequently, right facial nerve paralysis developed, and the patient was referred to the authors' department. The right external auditory canal exhibited redness and otorrhea, and the tympanic membrane was pulsatile and bulging. According to the Yanagihara grading system, the patient had moderate facial paralysis with a score of 12 (House—Brackmann grade Ⅳ) (Satoh et al., 2000). The patient was completely deaf on the right (i.e., affected) side. Temporal bone computed tomography (CT) revealed soft-tissue density filling the right tympanic cavity and mastoid air cells without bone destruction, suggesting effusion accumulation. On the same day, a tympanostomy tube was inserted, and purulent discharge was drained daily. The patient was diagnosed with otitis-related facial nerve paralysis and labyrinthitis, and was urgently admitted.

Laboratory investigations yielded the following findings: white blood cell (WBC) count 8,500/μL; neutrophils 5,800/μL; CRP 2.5 mg/dL; and PR3/MPO-ANCA negativity. Ear irrigation was performed daily, and topical ofloxacin along with intravenous meropenem (MEPM) as systemic antibiotic therapy, was administered. Prednisolone (120 mg/day) was initiated and tapered thereafter for facial nerve paralysis and acute sensorineural hearing loss. The following day, the otalgia resolved, and facial paralysis began to improve. Cultures revealed the presence of *P. aeruginosa* without antimicrobial resistance. One week after admission, systemic antibiotics were switched from MEPM to piperacillin (PIPC) based on the susceptibility results. Facial paralysis eventually fully resolved on day 12 of hospitalization. As the external ear became dry and the otalgia disappeared, both antibiotics and oral steroids were discontinued, and the patient was discharged on hospital day 14. Laboratory investigation for CRP decreased to 0.08 mg/dL on the day of discharge, although the right-sided hearing loss did not improve. To rule out a perilymphatic fistula, cochlin tomoprotein testing yielded a value of 23.6 ng/mL, which was considered to be negative.

Approximately 2 months after discharge, the patient experienced recurrence of right otorrhea and otalgia, along with dysphagia and hoarseness. Examination revealed right vocal cord paralysis, soft palate paralysis, and impaired tongue movement, leading to multiple unilateral cranial neuropathies. Contrast-enhanced CT revealed strong enhancement and bone destruction extending from the right petrous apex to the clivus and nasopharynx (Figure 1A,B). Additionally, contrast-enhanced MRI revealed enhancement extending from the right skull base to the nasopharynx and parapharyngeal space (Figure1C,D). Gallium-67(Ga) scintigraphy also revealed a significant increase in the uptake in the same region

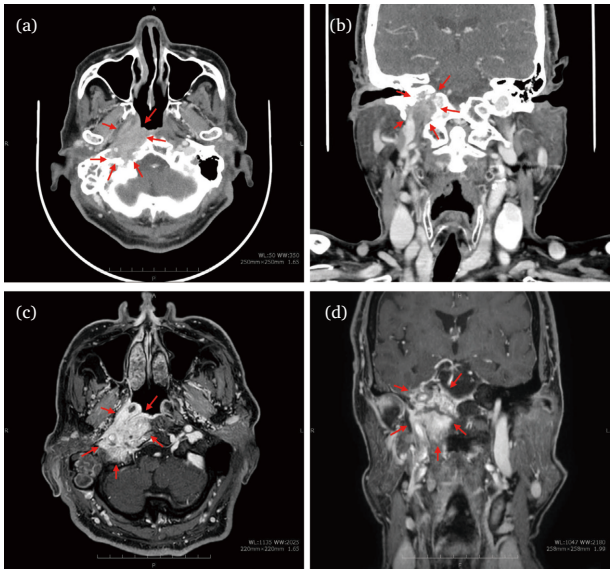


Figure 1 Contrast-enhanced CT and MRI findings at presentation. (A) Axial CT and (B) coronal CT images demonstrate an infiltrative lesion involving the right nasopharynx, clivus, petrous apex, and tissue surrounding the internal carotid artery (red arrows). (C) Axial contrast-enhanced T1-weighted MRI and (D) coronal contrast-enhanced T1-weighted MRI reveal extensive enhancement extending from the right nasopharynx to the clivus, petrous apex, and pericarotid region (red arrows).

(Figure2A). The patient was admitted emergently for a second time, although no facial paralysis was observed at this time. Laboratory investigations revealed a re-elevated CRP level (3.65 mg/dL), PR3/MPO-ANCA was negative again, and immunoglobulin (Ig)G_4 and tumor markers were also negative. Pulsatile otorrhea was noted and cultures revealed non-resistant *P. aeruginosa*. He was diagnosed with SBO with multiple cranial neuropathies. Systemic MEPM therapy, ear irrigation, and topical ofloxacin were administered. A short (two-day) course of prednisolone 120 mg was administered but was discontinued due to concerns of infection exacerbation and diabetes control. Five days after readmission, ciprofloxacin (CPFX) was added to MEPM. Within approximately 2 weeks, tongue movement, soft palate movement, and vocal cord mobility fully recovered. After 1 month, the external ear became dry, dysphagia improved, and oral intake resumed. Although the patient did not report vertigo, the video head impulse test revealed a reduced vestibulo-ocular reflex gain of 0.545 in the right lateral semicircular canal with catch-up saccades. Caloric testing did not induce nystagmus, and cervical vestibular evoked myogenic potential elicited no significant response, suggesting severe right vestibular function loss. Hyperbaric oxygen therapy was initiated 3 weeks after readmission; however, only 3 sessions were performed due to otalgia. During hospitalization, biopsy of the nasopharyngeal mucosa revealed no evidence of malignancy, and dense lymphocytic and intravascular neutrophilic infiltration were observed, consistent with inflammatory extension. Five weeks after readmission, laboratory investigations revealed a WBC count of 2000/μL and neutrophils 300/μL, indicating drug-induced bone marrow suppression. Based on susceptibility testing, the systemic antibiotics were changed to ceftazidime. Ga scintigraphy performed 2 months after readmission revealed gradual improvement, although residual uptake remained (Figure 2B). Although the authors recommended long-term intravenous antibiotics, hospitalization ended after 2 months due to strong patient preference, and was transitioned to outpatient

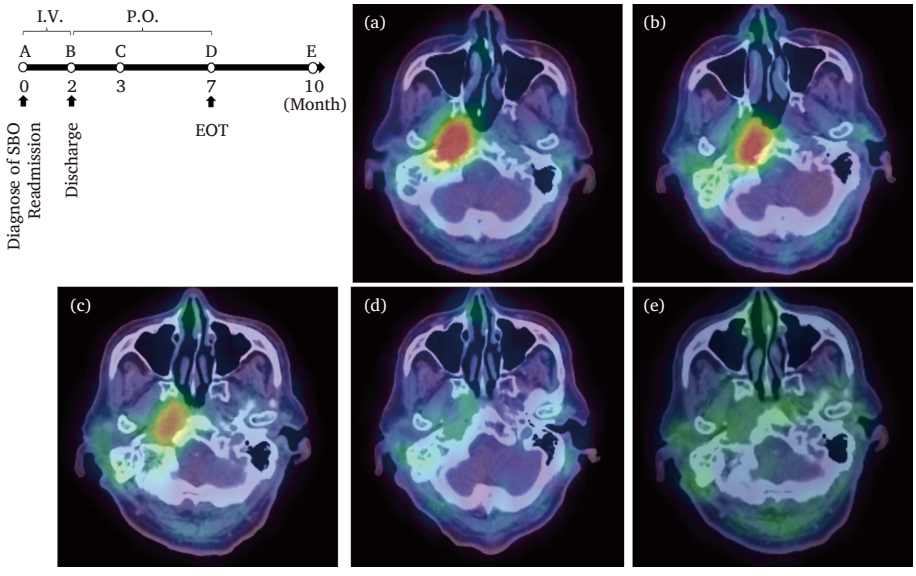


Figure 2 Temporal changes in the fusion images of gadolinium scintigraphy and CT; at diagnose of SBO (A), at discharge of readmission (B), at 1 month after discharge (C), at 5 month after discharge (D), and 8 month after discharge (E). SBO: skull-base osteomyelitis. I.V.: intravenous injection of antibiotics. P.O.: per os (oral administration) of antibiotics. EOT: end of treatment.

care with oral levofloxacin (LVFX). Although clinical symptoms improved substantially and CRP normalized during hospitalization, mild headache persisted. In addition, follow-up gallium scintigraphy remained positive, indicating possible residual disease activity. Based on these findings, antimicrobial therapy was continued despite the favorable clinical and laboratory course. Ga scintigraphy performed 1 month after discharge revealed decreased but persistent uptake (Figure 2C); accordingly, treatment was continued. Ga scintigraphy performed approximately 5 months after the second discharge revealed near-complete resolution (Figure 2D) and LVFX was discontinued. Outpatient follow-up was continued, and no recurrence was observed for approximately 18 months (Figure 2E).

In contrast, osteolytic changes on CT exhibited no apparent improvement at 5 months post-discharge (Figure 3AB), whereas

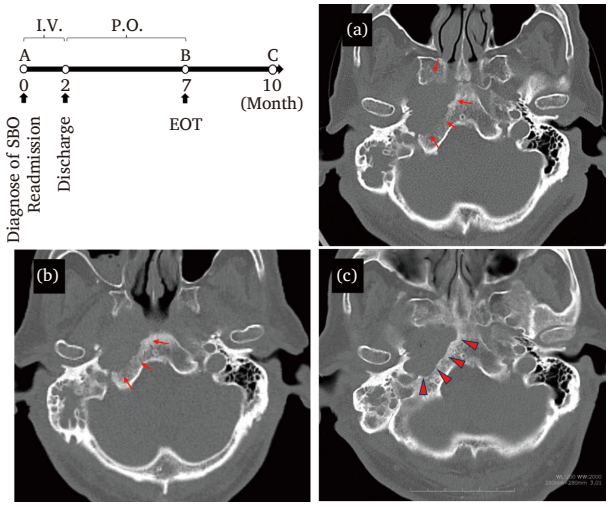


Figure 3 Temporal changes of the lesion in CT bone window setting; at diagnose of SBO (A), at 5 month after discharge (B), and 8 month after discharge (C). Arrows indicate bone destruction, and arrow heads indicate callus formation. SBO: skull-base osteomyelitis. I.V.: intravenous injection of antibiotics. P.O.: per os (oral administration) of antibiotics. EOT: end of treatment.

callus formation was observed at 8 months (3 months after the completion of antimicrobial therapy) (Figure 3C). In addition, contrast-enhanced MRI continued to reveal residual enhancement at 8 months (Figure 4AB), which persisted even at 18 months (1 year after completion of antimicrobial therapy) (Figure 4C).

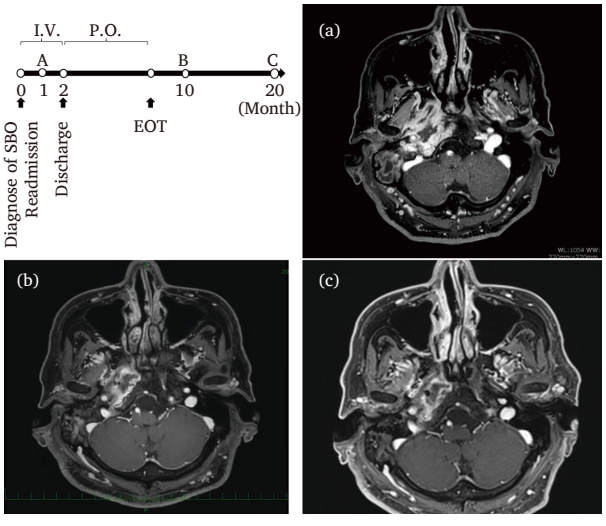


Figure 4 Temporal changes in contrast-enhanced MRI; at 1 month after readmission (A), at 8 months after discharge, and 18 months discharge (C). Enhancement still remains at even 18 months after discharge (20 months after readmission/start of treatment). SBO: skull-base osteomyelitis. I.V.: intravenous injection of antibiotics. P.O.: per os (oral administration) of antibiotics. EOT: end of treatment.

3 Discussion

SBO is a serious and potentially life-threatening condition. Several large reviews and case series have reported mortality rates of approximately 10% to > 30%, depending on factors such as cranial nerve involvement (Auinger et al., 2021). Early detection and prompt initiation of appropriate antimicrobial therapies are widely regarded to be critical for improving patient outcomes

(Spielmann et al., 2013).

In terms of subtype, the case described herein was believed to represent "atypical" SBO triggered by an unplugged ear due to severe middle ear inflammation, despite minimal external auditory canal inflammation. Because there are no universally accepted diagnostic criteria for SBO, the diagnosis depends on a constellation of findings, including the following: clinical symptoms (e.g., persistent otalgia, cranial neuropathies; microbiological or histological confirmation, if possible; imaging evidence of bone involvement or soft-tissue spread; and exclusion of alternate diagnoses (e.g., neoplasm, cholesteatoma, vasculitis) (Khan et al., 2018). High-resolution CT and contrast-enhanced MRI are essential for assessing the anatomical extent; however, conventional imaging alone may be insufficient, especially for follow-up and deciding when to discontinue therapy (Auinger et al., 2021). Nuclear medicine imaging, such as leukocyte scintigraphy (single-photon emission CT) or positron emission tomography (i.e., "PET") is superior for assessing disease activity and monitoring therapy (Rozenblum-Beddok et al., 2018). Although Gallium-67 scintigraphy has traditionally been used to assess disease activity in skull base osteomyelitis, newer modalities such as Gallium-68 PET provide higher spatial resolution and improved image quality (Segard et al., 2019). Compared with Technetium-99 bone scintigraphy, gallium imaging more accurately reflects active inflammation and may therefore be more useful for monitoring treatment response (Benecke, 1989; Chapman et al., 2021). FDG-PET has also emerged as a promising alternative for evaluating residual infection and guiding treatment duration (Chapman et al., 2021; Saxena et al., 2024). In a retrospective series, leukocyte scintigraphy converted from positive at diagnosis to negative after therapy in the majority of patients and helped guide the discontinuation of antibiotics (Rozenblum-Beddok et al., 2018). Relying solely on persistent MRI enhancement or bone marrow signal changes may lead to overtreatment because marrow abnormalities and soft-tissue changes can persist long after clinical resolution (Auinger et al., 2021). Similarly, in the present case, ossification on CT was finally observed 3 months after the disappearance of Ga scintigraphy uptake, and even now, > 1 year after discharge, the enhancement on contrast-enhanced MRI has not disappeared.

Given the high risk for relapse if therapy is insufficient, prolonged culture-guided antibiotic therapy, often starting with several weeks of broad-spectrum intravenous antibiotics, followed by an extended course of oral antibiotics, remains the mainstay of treatment (Khan et al., 2018). Furthermore, persistence or recurrence appears to be more likely in cases in which clinicians judged the disease to be "mild" based only on initial improvement—especially if oral therapy was short or discontinued without functional imaging confirmation of healing. This echoes concerns raised in recent clinical reviews that discontinuing therapy based only on improvement in symptoms may be misleading (Auinger et al., 2021). Therefore, in cases, such as ours, in which cranial neuropathies (e.g., facial paralysis and sensorineural hearing loss) occur even if middle ear findings improve, clinicians should maintain high suspicion and consider deep extension toward the skull base. An initial negative CT does not exclude SBO; contrast-enhanced MRI and early microbiological sampling (including biopsy, if feasible) may facilitate earlier detection. Once diagnosed, long-term culture-directed antimicrobial therapy should be considered, and treatment discontinuation should, ideally, be guided by functional (nuclear medicine) imaging rather than anatomical imaging alone (van Kroonenburgh et al., 2018). Similar to the present investigation, many studies have used the disappearance of uptake on Ga scintigraphy as a criterion to determine the timing for treatment discontinuation (Chapman et al., 2021; Yano et al., 2024). Several previous reports, including those by Paramsothy et al. (1997) and Yano et al. (2024), have demonstrated the usefulness of gallium scintigraphy in the diagnosis and follow-up of skull base osteomyelitis (Paramosothy et al., 1997; Yano et al., 2024). However, the present case differs from these reports in several important respects. First, our patient had atypical skull base osteomyelitis rather than the more common form secondary to malignant otitis externa. Second, gallium scintigraphy was used not only to monitor disease activity but also to guide the discontinuation of antimicrobial therapy. Third, we documented a recurrence-free clinical course for 18 months after treatment cessation. Finally, serial imaging demonstrated persistent contrast enhancement on MRI despite normalization of gallium scintigraphy and sustained clinical remission, providing direct evidence that residual MRI abnormalities may not necessarily indicate active disease. These features differentiate the present case from previously reported cases and highlight the novel contribution of our report.

Another notable feature of the present case was the severe vestibular dysfunction demonstrated by objective vestibular testing. Although the patient did not complain of vertigo, vestibular assessment revealed a reduced vestibulo-ocular reflex gain with catch-up saccades on vHIT, absent caloric responses, and absent cervical VEMP responses, suggesting extensive impairment involving both the superior and inferior vestibular pathways. Vestibular dysfunction in SBO may result from inflammatory extension to the inner ear or vestibular nerve, as well as ischemic injury secondary to involvement of the labyrinthine circulation. In the present case, the absence of subjective vertigo despite severe vestibular dysfunction may reflect gradual vestibular decompensation and central compensation during the prolonged disease course. These findings suggest that vestibular involvement can occur even in the absence of overt vestibular symptoms and may be underestimated when assessment relies solely on patient-reported complaints.

Considering reports of relapse even months after apparent resolution, cases with recurrence after 1 year have also been reported (Emanuel et al., 2023); as such, a follow-up period ≥ 1 year may be reasonable to monitor for recurrence, especially if functional imaging was not used to confirm remission (Khan et al., 2018; Chapman et al., 2021).

4 Conclusion

Gallium scintigraphy may be a valuable tool for assessing disease activity and determining treatment duration in skull base osteomyelitis. This case demonstrates that persistent abnormalities on anatomical imaging do not necessarily indicate active disease.

Data availability statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical approval

This study was approved by the Ethics Committee of Kumamoto University Hospital (Approval No. 2647) and was conducted in accordance with the Declaration of Helsinki.

Informed consent

The requirement for written informed consent was waived by the Ethics Committee of Kumamoto University Hospital because of the retrospective nature of the study. Information regarding the study was disclosed on the institutional website, and participants were provided with the opportunity to opt out.

Conflicts of interest

The authors have declared that no conflicts of interest exist.

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Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work the author partially used ChatGPT in order to improve English. After using this tool, the author reviewed and edited the content as needed and takes full responsibility for the content of the published article.

References

Auinger, A.B., Dahm, V., Stanisz, I., et al., 2021. The challenging diagnosis and follow-up of skull base osteomyelitis in clinical practice. *Eur. Arch. Oto-Rhino-Laryngol.* 278(12), 4681–4688.

Benecke, J.E.Jr., 1989. Management of osteomyelitis of the skull base. *Laryngoscope* 99(12), 1220–1223.

Chandler, J.R., 1968. Malignant external otitis. *Laryngoscope* 78(8), 1257–1294.

Chandler, J.R., Grobman, L., Quencer, R., et al., 1986. Osteomyelitis of the base of the skull. *Laryngoscope* 96(3), 245–251.

Chapman, P.R., Choudhary, G., Singhal, A., 2021. Skull base osteomyelitis: A comprehensive imaging review. *Am. J. Neuroradiol.* 42(3), 404–413.

Emanuel, H., Neeff, M., Thomas, M., et al., 2023. Skull base osteomyelitis in the Auckland region. *Aust. J. Otolaryngol.* 6, 2.

Khan, M.A., Quadri, S.A.Q., Kazmi, A.S., et al., 2018. A comprehensive review of skull base osteomyelitis: Diagnostic and therapeutic challenges among various presentations. *Asian J. Neurosurg.* 13(4), 959–970.

Kulshrestha, R., 2024. Usefulness of Gallium-67 SPECT/CT to prior high resolution petrous temporal CT and MR IAMs in confirming or excluding skull base osteomyelitis. J. Nucl. Med. 65(Suppl. 2), 242568.

Paramsothy, M., Khanijow, V., Ong, T.O., 1997. Use of gallium-67 in the assessment of response to antibiotic therapy in malignant otitis externa: A case report. *Singapore Med. J.* 38(8), 347–349.

Rozenblum-Beddok, L., Verillaud, B., Paycha, F., et al., 2018. ^{99m}Tc-HMPAO-leukocyte scintigraphy for diagnosis and therapy monitoring of skull base osteomyelitis. *Laryngoscope Investig. Otolaryngol.* 3(3), 218–224.

Satoh, Y., Kanzaki, J., Yoshihara, S., 2000. A comparison and conversion table of 'the House-Brackmann facial nerve grading system' and 'the Yanagihara grading system'. *Auris Nasus Larynx* 27(3), 207–212.

Saxena, A., Paul, B.S., Singh, G., et al., 2021. Predicting outcome in skull base osteomyelitis: An assessment of demographic, clinical, and pathological attributes. *J. Neurosci. Rural Pract.* 12(4), 751–757.

Saxena, A., Subramanyam, P., Sarma, M., et al., 2024. 18F-FDG PET imaging for treatment response assessment and management guidance in patients with skull base osteomyelitis. *Nucl. Med. Commun.* 45(7), 589–600.

Segard, T., Morandeau, L.M.J.A., Dunne, M.L., et al., 2019. Comparison between gallium-68 citrate positron emission tomography-computed tomography and gallium-67 citrate scintigraphy for infection imaging. *Intern. Med. J.* 49(8), 1016–1022.

Spielmann, P.M., Yu, R., Neeff, M., 2013. Skull base osteomyelitis: Current microbiology and management. J. Laryngol. Otol. 127(Suppl. 1), S8–S12.

Trent, M., Kelly, K.M., Tan, D., et al., 2025. Defining the appropriate length of antimicrobial therapy for skull base osteomyelitis. *Laryngoscope* 135(8), 2889–2900.

van Kroonenburgh, A.M.J.L., van der Meer, W.L., Bothof, R.J.P., et al., 2018. Advanced imaging techniques in skull base osteomyelitis due to malignant otitis externa. *Curr. Radiol. Rep.* 6(1), 3.

Yano, T., Tomioka, R., Inagaki, T., Akai, R., Miyake, K., Arai, S., Tsukahara, K. (2024). Role of follow-up gallium scintigraphy in the evaluation of malignant external otitis (skull base osteomyelitis): A case report. SAGE Open Medical Case Reports, 12, 2050313X241253462. https://doi.org/10.1177/2050313X241253462