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CASE REPORT

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# MANAGEMENT OF MRSA-INFECTED SKULL-BASED OSTEOMYELITIS WITH HBOT IN A MULTIPLACE HYPERBARIC CHAMBER

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**ABSTRACT:**

**BACKGROUND**

Conservative management in osteomyelitis poses significant therapeutic challenges, particularly when compounded by multidrug-resistant organisms such as Methicillin-resistant Staphylococcus aureus (MRSA). Hyperbaric Oxygen Therapy (HBOT) is increasingly utilised in non-healing wounds to enhance healing and reduce infection-related complications. HBOT is given in a pressurised chamber of two types, i.e, monoplace chamber, which accommodates a single patient or multiplace chamber, which can accommodate more than one patient at a time. Rendering HBOT to an infected patient in a multiplace chamber poses a significant challenge of cross-infection by direct and indirect infection. Ensuring adequate disinfection and infection control in a multiplace HBOT chamber setup poses a unique challenge. Case Presentation: We report a 73-year-old diabetic male with MRSA-infected SBO following chronic suppurative otitis media and mastoid surgery. Despite aggressive antibiotics and antifungal therapy, he showed no improvement. Intervention: The patient underwent 25 sessions of HBOT at 1.8 ATA in a multiplace chamber. Strict disinfection protocols were enforced to prevent cross-infection.

**OUTCOME**

Clinical improvement included resolution of otorrhea and partial recovery of facial nerve function. Radiology showed regression of osteomyelitis. No cross-infection occurred in other patients.

**CONCLUSION**

HBOT is a valuable adjunct in MRSA-related SBO. With stringent infection-control protocols, HBOT can be safely delivered in multiplace chambers, ensuring patient benefit without nosocomial spread.

**KEYWORDS**

MRSA, Hyperbaric Oxygen, Osteomyelitis, Infection Control, Non-healing Wound

## INTRODUCTION

A 73-year-old male patient presented to our department with a diagnosis of skull base osteomyelitis secondary to chronic suppurative otitis media of left ear. On pus culture, he was found to be infected by MRSA bacteria. He had been earlier operated as case of Acute Mastoiditis (Lt) with LMN type Facial Palsy on 27 Aug 2024. He had a long-standing history of Type 2 Diabetes Mellitus as well.

Skull base osteomyelitis (SBO) is a rare but potentially fatal condition that arises from an infection such as malignant otitis externa or chronic suppurative otitis media and spreads to the adjacent tissues. Several bones are typically involved in the inflammation in SBO, including

the temporal and sphenoid bones. Therefore, this condition is associated with a poor prognosis and high rates of mortality and morbidity. Patients with SBO can potentially present with symptoms of cranial nerve involvement since the passage of some of these cranial nerves is in proximity to the skull base. Patients with such involvement can present with symptoms such as facial weakness, vocal cord paralysis, and trismus, depending on the cranial nerve involved. Management requires aggressive use antibiotics, often combined with adjunctive measures. Hyperbaric oxygen therapy (HBOT) is one such adjunctive therapeutic modality that enhances tissue oxygenation, stimulates angiogenesis, and improves infection control. Multiplace chambers raise unique challenges regarding cross-infection. This report presents a case of MRSA-infected SBO managed successfully with HBOT in a multiplace chamber under stringent disinfection protocols.

## METHOD

### Case Presentation & Intervention

A 73-year-old male, farmer by profession, was admitted in our centre which is a tertiary care hospital on November 17, 2024 He had a previous history of Type 2 Diabetes Mellitus, Hepatitis B Virus (HBV) infection, and Bronchial Asthma. His primary condition was Chronic Otitis Media of Left side with Lower Motor Neuron (LMN) palsy of Seventh Cranial Nerve and Skull Base Osteomyelitis.

He presented with complaints of right-sided otorrhea, which was muco-purulent in nature, continuous, and non-foul-smelling, associated with a previous history of an upper respiratory tract infection. He also reported of hearing loss in his left ear, which had been progressively worsening for the past two months, particularly after undergoing a tympano-mastoid exploration surgery in a civil hospital on August 27, 2024, for Acute Mastoiditis. Following the surgery, he developed left-sided LMN type Facial Nerve palsy, leading to difficulties in closing his left eye, dribbling of food and water from the left side of his mouth, and weakness in the left side of his face.

A high-resolution CT scan of the temporal bone, conducted on August 28, 2024 in a civil hospital, revealed thickening and retraction of the tympanic membrane in the left ear, with soft tissue opacification in the middle ear extending to the mastoid antrum but without any ossicular or bony destruction.

Upon admission, an ENT examination showed a healthy post-auricular scar with muco-purulent discharge from the left ear. Tuning fork tests and a Pure Tone Audiogram (PTA) confirmed moderate conductive hearing loss in the right ear and mild hearing loss in the left ear. Further imaging on November 17, 2024 at our hospital revealed extensive erosive changes at the skull base, thrombophlebitis in the left Internal Carotid Artery (ICA), a chronic thrombus in the left sigmoid sinus and Internal Jugular Vein (IJV), watershed infarcts in the Anterior & Middle Cerebral Artery (ACA & MCA) territories (more prominent on the right), and critical stenosis of the right petro-cavernous Internal Carotid Artery. A pus culture conducted on November 19, 2024, confirmed the presence of Methicillin-Resistant Staphylococcus Aureus (MRSA) bacteria.

The patient was diagnosed with Chronic Suppurative Otitis Media with LMN palsy and skull base osteomyelitis. Treatment included intravenous antibiotics (Targocid, Ceftazidime, and Ciprofloxacin), antifungal therapy with Caspofungin, and anticoagulation with Low-Molecular-Weight Heparin (LMWH). He also received supportive medications, including Clonazepam, Atorvastatin, and Ecosprin. In spite of aggressive pharmacotherapy, the patient did not show any significant improvement, and he was considered to have a guarded prognosis. He was then referred to our department for evaluation and fitness for Hyperbaric Oxygen

Therapy (HBOT). Subsequently, he underwent 25 sessions of HBOT, each session at 1.8ATA pressure for 60 minutes, receiving 01 session daily.

On follow-up after the 25th session, his condition showed significant improvement. He had no signs of ear discharge or otorrhea at the time of discharge on December 31, 2024. Facial nerve function improved from Grade 5 to Grade 3, allowing complete eye closure with minimal effort, although slight deviation of the mouth persisted. He was prescribed oral antibiotics (Augmentin), proton pump inhibitors (Pantoprazole), antihistamines (Levocetirizine), analgesics (Paracetamol), and a topical antibiotic ointment (Mupirocin), with instructions to keep his ear dry.

Due to MRSA positivity, his case posed unique challenges both clinically and in terms of infection control. Apart from medical management, it became essential to implement enhanced disinfection protocols for the HBOT chamber to prevent transmission of nosocomial infection to other patients as well as the staff working in the Recompression Chamber Complex (RCC).

**HBOT Chamber Disinfection Challenges and Protocols:**

The patient underwent daily HBOT sessions in the multi-place hyperbaric chamber, each lasting 60 minutes, over a period of seven weeks. Given his MRSA status, special disinfection measures were followed rigorously after each session:

1. Personnel Protection: Chamber cleaning staff donned double layers of gloves along with rubber footwear, adhering to universal safety precautions.
2. Stepwise Cleaning Process:
   (a) Chamber walls and floor were scrubbed with soap water to remove contaminants.
   (b) A 1:4 strength by volume Biox O2 solution was applied over all chamber surfaces and allowed a contact time of 15 minutes.
   (c) Masks were disinfected using hypochlorite solution prepared in a 1:5 ratio and later cleaned with soap water.
   (d) Final soap water cleaning followed to neutralize and clear residual disinfectants.
3. Laundry Handling: All bed sheets and gowns used were removed post-session and sent for hospital laundry processing, with fresh linen being provided for patients of next session.
4. Staff Compliance and Logistics: Consistent implementation of these protocols necessitated strict coordination between RCC Chamber Staff, Marine Medicine Department, and logistic teams to ensure timely procurement and availability of disinfection supplies (e.g., Biox O2 fluid, gloves, cresol, etc.).

**RESULT**

- The patient responded well to combined therapy. Over the course of 25 HBOT sessions, his wound showed marked granulation and reduction in size.
- Follow-up radiographs showed regression of osteomyelitic changes.
- No cross-contamination or secondary infections were reported in other patients receiving HBOT during the same period as well as the chamber staff, reflecting effective disinfection practices.
- ·Patient was discharged on oral antibiotic medications and advised for follow-up every 02 weeks. Each follow-up visit showed positive recovery in the convalescence period with no signs of recurrence or relapses.

**DISCUSSION**

Skull base osteomyelitis (SBO) is a rare, potentially life-threatening infection affecting

the middle cranial fossa, involving the temporal, sphenoid and occipital bones that is often misdiagnosed or presents with complications.1,2 Long bones are considered common sites for osteomyelitis, and involvement of the temporal bone is not common.3

SBO typically falls into two main categories, that is, typical and atypical. The typical form, known as otogenic osteomyelitis, is most frequently observed in elderly individuals with diabetes and is often linked to necrotising external otitis. Atypical SBO, also referred to as central SBO, primarily affects the basisphenoid and basiocciput regions and may occur independently of prior otologic infections. The most common causative agent for otogenic osteomyelitis is Pseudomonas aeruginosa, associated in more than 90% of cases.1 Its perivascular spread contributes to its severity. Proteus mirabilis and other gram-negative bacteria can also be found. Methicillin-resistant Staphylococcus aureus (MRSA) has emerged as a notable pathogen in these infections, complicating treatment due to its resistance to standard antibiotics.

The causative organisms of SBO have shown higher antibiotic resistance.4 Treatment involves a multidisciplinary approach comprising radiological investigation to know the extent of involvement, surgical debridement and HBOT. It involves breathing nearly 100% oxygen in a pressurised chamber, which causes increased solubility of oxygen in plasma as per Henry's law and helps in delivering a higher amount of oxygen at the cellular level. The increased amount of oxygen at the cellular level causes an increase in the production of oxygen-free radicals. The major factor contributing to the wound healing in osteomyelitis revolves around the free radicals mechanism, which stimulates angiogenesis, vasculogenesis and also reduces oedema around the wound.5,6 Oxygen free radicals and oxidative stress induce stem cell mobilisation and proliferation through Hypoxia Inducible Factor (HIF).7 HBOT also helps in relieving inflammation by the antagonistic effect on proinflammatory cytokines and an agonist effect on antiinflammatory cytokines. 8,9 The effect on neutrophils by inhibition of β2 integrin function ameliorates reperfusion injuries by increasing the concentration of short, non-cross-linked filamentous (F)-actin, which alters F-actin distribution within the cell.5 The function of degranulation, phagocytosis and oxidative burst in response to chemoattractants remains intact and helps in containing inflammation, simultaneously killing pathogens. 10,11,12

HBOT recompression chambers are of two types: multiplace chambers, which can accommodate more than one patient at a time, and monoplace chambers, which can be used for a single patient. Both types of chambers have distinctive benefits and are effective in certain conditions. Patients with infectious etiologies can spread infections in multiplace chambers, and strict disinfection protocols are required to contain them. Prevention of cross-infection primarily relies on precautions at multiple levels, starting from the entry of the patient into the centre to the exit of the patient from the HBOT centre. The use of alcohol-based hand rubs (ABHRs) has been shown to reduce the incidence of cross-infections and has proven effective in lowering nosocomial infections.

This case underlines the dual complexity of managing chronic osteomyelitis in a diabetic patient complicated by MRSA infection. While HBOT played a critical role in enhancing tissue oxygenation and promoting healing, rigorous infection control in the shared chamber environment was equally crucial. The structured disinfection protocol tailored for highly infectious cases proved vital in maintaining a safe therapeutic environment.

## CONCLUSION

In this context, the timely diagnosis of SBO and optimum treatment using a multidisciplinary approach are essential to prevent any

complications. HBOT can enhance wound healing, and therefore, it can potentiate the healing of the wound. Providing HBOT to a drug-resistant SBO patient in a setting of multiplace recompression chamber is challenging. A dedicated institutional protocol comprising disinfectants that are pressure-compliant to control the cross-infection in a pressurised atmosphere inside the multiplace chamber is of utmost importance. This case demonstrates how standardized disinfection protocols can be successfully adapted to HBOT practices, ensuring both patient recovery and the safety of other users. By adopting these protocols, a multiplace chamber can be used for treating various diseases of infective aetiologies.

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