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Case Report

Application of Hyperbaric Oxygen Therapy in Chronic Distal Tibial Osteomyelitis in Severe Extremity Trauma

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Abstract

The purpose of this case study is to present the utility of using hyperbaric oxygen therapy (HBOT) as a tool to treat septic arthritis and tibial distal osteomyelitis.

A 28-year-old female patient presented with septic arthritis and tibial distal osteomyelitis following an open complex ankle fracture due to a motor vehicle accident (MVA). The patient had internal fixation surgery, flap surgery and the debridement's for infection.

Osteomyelitis remains a troubling disorder to treat with catastrophic repercussion for the infected limb. The patient underwent 50 total HBOT sessions at 100 kPa using the integrant Hyperbaric mono chamber. This case study proves the viability of HBOT as an important adjunctive treatment for septic arthritis and osteomyelitis. It also shows that osteomyelitis can be reclaimed without necessity to remove it.

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Introduction

Currently Hyperbaric Oxygen Therapy (HBOT) is used in regenerative medicine and for a variety of medical conditions of which 16 are approved by the TGA, including chronic wounds [1]. Studies show that HBOT is a potentiator in regenerative medicine with applications due to its anti-inflammatory effects, stimulation of cell regeneration, and healing properties [2]. The case that will be used in this study is a 28-year-old female patient who sustained a complex open ankle fracture after Motor Vehicle Accident (MVA). Open fractures in trauma sometimes can be complicated by chronic osteomyelitis with devasting effects on the pt. even resulting in amputation. The most common organism which causes osteomyelitis is staphylococcus

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aureus [3]. Staphylococcus aureus is a community-acquired pathogen and can live on the human skin and mucous membranes [4]. Osteomyelitis is historically known to be difficult to cure, with a high morbidity rate [5]. This can be attributed to the rise of Methicillin-resistant staphylococcus aureus (MRSA), which is often found as hospital acquired infection [6]. HBOT has been used as adjunct in a variety of acute infections [7].

The patient on initial presentation was in severe pain and NWB in a cam walker. The Motor vehicle accident had occurred 18 months prior. Three debridement's, a defect reconstruction with a propeller flap, and a right ankle abscess incision and drainage had been performed. Prior to presentation. The patient had been on antibiotics for over a year. Appropriately below knee amputation had been discussed with the patient. Internal fixation of ankle fractures is associated with excellent results [8]. Unfortunately, in this case septic arthritis and distal tibial osteomyelitis complicated the post-operative course. This required eventually for the metal to be removed and numerous debridement procedures. Osteomyelitis complicating the treatment of ankle injuries is well described [9]. The X-Ray report of the X-Ray shown in FIGURE 1 was as follows: Multiple vascular clips in situ. Comminuted fracture distal fibula. There is presumed old, healed injury of the distal tibia with hardware having been removed. There is marked irregularity of the distal tibial articular plateau with narrowing of the joint space. Diffuse osteopenia present.

Figure 1 demonstrates that ankle at presentation also had advanced joint line chondral loss secondary to trauma and infection. Part of the fibula has been removed. Surgical clips used in the flap surgery can also be seen [10-12]. The MRI report was extracted from the MRI's shown in FIGURE 2 mentioned the following:

1. Previous evidence of ankle fixation on distal tibia and fibula.
2. Ongoing evidence of septic arthritis and osteomyelitis at the ankle joint.
3. Chronic non-union of distal fibular shaft fracture. There is associated subcortical marrow oedema.

Figure 1: Right Ankle AP X-Ray of patient with comminuted fracture on distal fibula.

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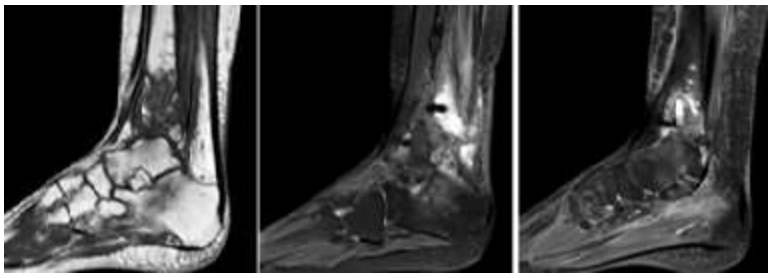

Figure 2: Right Ankle MRI of patient with septic arthritis and tibial distal osteomyelitis.

The tibial distal osteomyelitis/septic arthritis and treatment prior to presentation

After the diagnosis of septic arthritis and distal tibial osteomyelitis the patient was placed under rigorous antibiotics and medication to alleviate the pain and disease. These medications consisted of doxycycline 100 mg BD and Moxifloxacin 400mg BD for her bone infection along with TARGIN and ENDONE for pain tolerance. Procedures which the patient undertook for the osteomyelitis consists of debridement, washouts, ankle aspiration, and cerement along with a defect reconstruction using a propellar flap for the compound fracture as seen in FIGURE 2. Completing a defect reconstruction using a propeller flap in the middle and distal lower limbs is well described limb areas was p [13]. A drawback with debridement is that sequential removal of tissues by nature defunctions the limb ultimately [14]. However, using antibiotics can be problematic due to the increased prevalence of antibiotic- resistant organisms [15]. These effects were evident due to the issue of the septic arthritis constantly returning and requiring multiple debridement's and high levels of medication. Osteomyelitis is also known to be unforgiving where it can cause necrosis and sequestrum (dead bone) formation within the affected area [16].

It appeared the osteomyelitis was due to more than one organism. One of which was anaerobic. Due to the inability to resolve the infection and severe pain below knee amputation was contemplated.

Figure 3: Defect reconstruction with propeller flap on patients' legs.

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Using the HBOT to heal the tibial distal Osteomyelitis and septic arthritis

Once the patient arrived in the care of the senior author, an ankle arthroscopy and subtalar joint arthroscopy was completed to identify the extent of the septic arthritis. This included a washout which is shown to be effective for ankle septic arthritis [17]. A study with Ellis HB, et al. previously described arthroscopy for the management of septic arthritis of the hip in children. The principles of large bore cannula and removal of intra-articular debris were employed as per technique we have previously described in septic arthritis in children [18]. HBOT was recommended for osteomyelitis after bacterial species Dysgomonas, Corynebacterium amycolatum and Staphylococcus epidermidis were identified. These are both facultative anaerobes [19-21], which can be stunted by HBOT [22]. HBOT is considered an effective, non-invasive procedure that is approved by the FDA to heal severe infections of the skin and bone [23]. The machine used for hyperbaric treatments was an Integrant TROJEN model that can be sourced from Regen U, which can be seen in Figure 3 [24]. This specific model can reach up to 2.4 Atmospheres Absolute (ATA), which can increase the O_2 tissue pressure by 1200% [25]. In osteomyelitis, the infected bone is often in a hypoxic state, which can impair the bacterial killing leukocyte, along with fibroblastic collagen production supporting angiogenesis [26,27]. Increase of oxygen within the infected bone leads to a state of hyperoxia which cancels the hypoxic state of the bone.

HBOT has been used in many cases to heal osteomyelitis, due to its non-invasiveness and being used for patients undergoing multiple washouts and debridement [28,29]. A combination of appropriate antibiotics and HBOT can allow the body to reclaim bone affected by infection in much the same was that the body resolves cellulitis. The patient would be approved for HBOT to treat the tibial distal 50 HBOT sessions were started with 90-minute sessions sometimes twice per day.

Initially, the patient was unable to bear any weight onto the leg and they were on a walker. Many studies show the longer a patient does not bear weight on the leg, the slower it is for the patient to start walking again [30]. The study conducted by Brinkman JM, et al., concludes that patients regained proper knee function in a shorter time when weight bearing earlier. The pain associated was compensated with numerous medications as previously mentioned. After 7 sessions, the patient was able to walk without the use of crutches using a cam walker. This was a gratifying start as prior she had not walked for 18 months.

Hydrotherapy has begun to improve gait and balance [31]. Once completing 18 sessions, the patient would reduce the medication they were on reducing the DOXYCYCLINE to one per day, a maximum of 6 TARGIN per week, and a maximum of 2 ENDONE per week these were gradually reduced. Opioids are addictive medicines which there is increasing efforts by the government to restrict the use of by doctors [32]. Hence finding an alternative which can reduce the use of medication, like using the HBOT is beneficial. Following 40 total sessions in the HBOT, the patient can bear weight on the leg and ambulate without a walking aid whilst in supportive shoes.

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Antibiotics have ceased without relapse for the first time in 18 months. The patient gradually became optimistic when seeing the improvements.

Figure 4: HBOT used for patient's treatments.

Discussion

Despite great advances in surgical techniques and medicines, infection after lower limb trauma remains a limb critical condition in some cases. To combat septic arthritis and distal tibial osteomyelitis constant debridement and washouts were used to combat the disease. Debridement is defined as the removal of dead and infected material [33].

The authors would caution against the aggressive removal of tissues in these settings as infection is not cancer and removal of tissues then requires extensive reconstruction techniques which both defunction the affected limb but also damage the donor area [34], these procedures in particular are destructive in deep infections [35]. The authors propose the use of hyperbaric oxygen therapy in these settings as an adjunct therapy that can help reclaim infected tissues including bone [36]. HBOT is non-invasive, hence having little to no chance of side effects [37]. With the approval of the FDA [16], the HBOT has been used to aid in a variety of wounds which includes diabetic foot ulcers [38], crush injuries [39], burn wounds [40], along with various other infections [41].

Hence the HBOT being a useful addition to other surgeries for the septic arthritis and distal tibial osteomyelitis.

Conclusion

The purpose of this case study is to present the utility of using the HBOT as a tool to treat septic arthritis and tibial distal osteomyelitis in combination with minimally invasive surgical washout.

Overall, this case study adequately shows this by the vast improvements which the patient

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has made throughout the journey of the 50 HBOT sessions.

Initially the patient would receive an ankle fixation proceeding to an MVA, which would result in further complications. These complications would include the ankle being affected by septic arthritis and tibial distal osteomyelitis, rendering the patient unable to walk for up to 18 months. To counteract the disease, constant debridement and washouts were completed which did not produce remission of the infection being transferred.

Overall, the patient has dramatically improved while using the HBOT. This can be shown as the patient being in remaining in remission for 4 months. This study proves the viability of the HBOT being an essential adjunctive treatment for septic ankle arthritis and tibial distal osteomyelitis.

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