Hyperbaric Oxygen Therapy in the Treatment of Diabetic Foot Ulcers — Prudent or Problematic: A Case Report

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Abstract

Hyperbaric oxygen (HBO) therapy is increasingly used in the management of problem wounds, notably diabetic foot ulcers. However, concerns about unnecessary, inappropriate, and prolonged use of this adjunctive treatment exist. A case report of a 52-year-old patient with diabetes mellitus, Charcot foot, and a nonhealing plantar ulcer who had received HBO treatments only illustrates these concerns. He presented with normal pedal pulses, adequate transcutaneous partial oxygen pressure levels, no offloading footwear, and a heavily contaminated ulcer (*Pseudomonas* spp.). Following a course of oral antibiotics, appropriate topical wound care, and offloading instructions, the wound healed within 3 months. Advanced wound therapy modalities are only indicated for use in patients when accepted standards of wound care, including identification and correction of underlying disorders and comorbidities, have failed. To prevent misuse/overuse of HBO therapy, stand-alone HBO centers should include a multidisciplinary wound care team.

Key Words: case study, diabetic foot ulcer, hyperbaric oxygen therapy, quality of healthcare, multidisciplinary care


Potential Conflicts of Interest: none disclosed

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A case report discussing the treatment of a patient with Charcot foot is presented to illustrate the inappropriate use of HBO and the need for a comprehensive approach to wound management.

Case Report

Mr. K, a 52-year-old man with type 2 diabetes mellitus of 10 years duration and relatively good glycemic control (HbA1c 7.4%), presented to the authors’ hospital-based wound care and hyperbaric medicine center with a nonhealing ulcer on the plantar surface of his midfoot. He was being treated with insulin and had no other comorbidities. One year previous, Mr. K had a Charcot attack, a condition that leads to foot deformity. He was misdiagnosed with rheumatoid arthritis and advised to walk as much as possible. Nine months later, the midfoot collapsed due to Charcot foot and Mr. K developed an ulcer over a bony prominence. He was referred to a HBO center where he received a total of 24 sessions of HBO at 2.4 ATA, 2 hours each, in a multipurpose chamber for 1 month. Over the course of the HBO treatment regimen, Mr. K was not evaluated for infection or vascular status. He did not receive guidance regarding footwear and offloading. The only wound care Mr. K claimed to have received was wound cleansing with povidone iodine and saline solution.

Because the wound was not healing, Mr. K presented to the authors’ clinic 45 days after wound onset. On examination, he was found to have a full-thickness ulcer over a bony prominence. Heavy callus formation with green discoloration was present at the margins of the ulcer; the base was relatively clean. Mild cellulitis (<3 cm) was present around the ulcer (see Figure 1). Initially, the patient was assessed using a comprehensive diabetic foot document that facilitated recording ulcer characteristics along with demographic factors. Two days after his admission, Mr. K was assessed by the multidisciplinary wound care team.

The ulcer area, determined by multiplying the longest and widest diameters of the wound, was 5 cm². The callus was removed and the wound bed debridged to achieve a well-bleeding granulating base. The wound was cultured; *Pseudomonas* spp. was isolated and oral levofloxacin 500 mg, once daily, was started and continued for 2 weeks until pathogens ceased to be cultured. Collagen dressings were used for 2 months, followed by a synthetic skin substitute (Epigard®) until complete epithelialization. Because Mr. K had normal pedal pulses, a transcutaneous partial oxygen pressure (TcpO₂) level of 56 mm Hg, and the infection was not clinically limb-threatening, HBO treatment was not administered. Maintenance wound care, which included daily cleansing with a saline solution, wound currettage, and debridement when needed, was provided. Mr. K declined a total contact cast; thus, he was admonished to stay off his feet.

Two weeks later, Mr. K was discharged. The infection resolved, the wound bed exhibited good granulation tissue, and wound size (~2 cm²) had markedly decreased (see Figure 2). The patient was provided crutches for offloading and was prescribed therapeutic footwear with extra depth and a compliant insole with a window under the ulcerated area. He continued regular weekly outpatient visits until the wound healed (within 3 months) (see Figure 3).

Discussion

Diabetic foot ulceration is a disease of multifactorial etiology that requires a multidisciplinary approach. This comprehensive approach includes the correction of underlying disorders and comorbid diseases, restoration of foot perfusion if needed, and the removal of biologic and mechanical burden has been found to heal most wounds. Mr. K received multidisciplinary assessment; all care team members addressed pertinent issues, including the need for mechanical debridement and subsequent wound care management. When these accepted standards of wound care fail to show a tendency towards healing, advanced wound therapy modalities such as HBO therapy may be implemented.

HBO therapy involves the administration of 100% oxygen at pressures higher than atmospheric pressure to the entire body. The treatment is provided in a monoplace (one person) or multipurpose (several people) hyperbaric chamber. The patient also breathes 100% oxygen through a mask or head tent. HBO therapy is provided to increase the amount of dissolved oxygen in plasma, subsequently increasing tissue perfusion. Oxygen is essential to meet the average requirements of wounds; a wound with adequate perfusion and that heals in an orderly fashion usually will not require additional oxygen.

HBO therapy is the primary treatment modality in decompression sickness, arterial gas embolism, carbon monoxide poisoning, and gas gangrene; it also is used as an adjunctive treatment modality for various problem wounds such as diabetic foot wounds, necrotizing soft tissue infections, refractory osteomyelitis, osteoradionecrosis, crush injury, compromised skin grafts and flaps, and thermal burns. It is used to correct tissue hypoxia, which has been shown to be the primary benefit of the treatment. Additionally, studies have shown that HBO therapy may reduce edema. Results of experimental studies suggest that HBO accelerates microbial oxidative killing, increases collagen synthesis, and stimulates epithelialization. A recent systematic review concluded that HBO...
therapy reduced the risk of major amputations and improved
the chance of healing in patients with diabetic foot ulcers
compared to patients who did not receive HBO treatment.15
In the case presented here, basic principles of wound
management had been neglected and the ulcer was treated
with HBO therapy only, which (although caused no direct
harm to the patient) failed to heal Mr. K’s ulcer. Also, be-
cause he had normal pedal pulses and adequate tissue oxy-
genation confirmed by TcpO₂ measurement (40 mm Hg or
greater values adjacent to the wound have been reported to
be a sign of good oxygenation and discontinuing HBO treat-
ment is recommended in this condition16,17), HBO therapy
was not indicated; thus, it was not successful in assisting
wound healing when administered. Once the issues that hin-
dered healing were addressed, the wound proceeded to heal-
ning and completely epithelialized in 3 months. Mr. K’s
relatively longer healing time was due to his unwillingness
to use total contact casting and his nonadherence with other
offloading recommendations.
This case report highlights two important aspects of HBO
treatment. First, this is an adjunctive therapy in the manage-
ment of diabetic foot ulcers that should be used when indi-
cated and in conjunction with supportive care. Second, to
prevent unnecessary, inappropriate, or prolonged HBO ther-
apy, stand-alone HBO centers should include a multidiscipli-
nary wound care team. The International Working Group on
the Diabetic Foot announced in 2007 that a multidisciplinary
foot care team ideally should consist of a diabetologist, sur-
geon (general and/or vascular and/or orthopedic), podiatrist,
orthotist, educator, and plaster technician.18 Nonhealing
wounds should be assessed by the hyperbaric physician and a
wound care specialist before and throughout the entire HBO
treatment regimen. Some developed, many developing, and
almost all under-developed countries still lack multidiscipli-
nary wound care centers; in many countries, HBO centers
serve as wound care centers. In Turkey, most of the HBO cen-
ters are stand-alone outpatient centers that do not include any
multidisciplinary diabetic wound management team. No
changes have been implemented since this patient’s treatment.

Conclusion
A case report underscores that HBO treatment can be an ef-
effective adjunct to wound healing in selected patients but does
not replace any components of the accepted standards of
wound care. HBO treatment facilities should provide multidis-
ciplinary care that addresses all factors relevant to wound heal-
ning and that may (or may not) include adjunctive therapy.

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MISUSE OF HYPERBARIC OXYGEN THERAPY


