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From amputation to healing: A case of advanced diabetic foot ulcers treated with ozone therapy

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Abstract

Diabetic Foot Ulcers (DFUs) are a significant complication of diabetes, presenting a substantial burden on patients and healthcare systems. These ulcers are challenging to treat with standard therapies, often leading to amputation. Ozone therapy offers a promising alternative due to its non-invasive, cost-effective, and low-risk nature. Ozone enhances cellular metabolism, exhibits antibacterial and antioxidant properties, and promotes wound healing through pathogen inactivation, vascular modulation, and immune activation. We report the case of a 32-year-old woman with type 1 diabetes and large progressive DFUs unresponsive to conventional treatments. Despite multiple debridements and antibiotics, her wounds worsened, and below-knee amputation was recommended. She sought ozone therapy as a last resort, undergoing eight weeks of local ozone gas application alongside comprehensive medical care. Remarkably, her ulcers fully healed, avoiding amputation. This case highlights ozone therapy's potential in managing advanced DFUs.

Keywords: Diabetic Foot Ulcers (DFUs); Ozone therapy; Wound healing; Amputation prevention; Antibacterial and antioxidant therapy.

Introduction

Diabetes Mellitus (DM) is a metabolic disease characterized by hyperglycemia, with various types and complications. Hyperglycemia-related complications can be categorized as microvascular or macrovascular, with diabetic ulcers being one of the most debilitating consequences [1].

Diabetic Foot Ulcers (DFUs) are a common complication in patients with poorly controlled DM, affecting 15-20% of this population [2]. DFUs typically develop in three stages: (1) callus formation due to neuropathy that affects sensory, motor, and autonomic functions, (2) subcutaneous hemorrhage leading to

ulcer formation, and (3) delayed healing due to vascular compromise caused by atherosclerosis, ultimately resulting in necrosis and gangrene [3,4]. Motor neuropathy leads to foot deformities, sensory neuropathy reduces sensation, and autonomic neuropathy causes skin dryness, all of which contribute to ulcer formation [4]. DFUs are the leading cause of non-traumatic amputations, with 1% of all diabetic patients requiring amputation [2]. The 5-year mortality risk for patients with DFUs is 2.5 times higher than that of diabetic patients without foot ulcers [4].

Ozone therapy has been utilized in medicine since the 19th century [5]. This therapy enhances antioxidant production, increases tissue oxygenation, and modulates the immune system [6]. By improving vascular, hematological, and immunological systems, ozone therapy promotes wound healing and tissue restoration [7]. Clinical studies have demonstrated its effectiveness in treating peripheral vascular disease, ischemic wounds, and diabetic foot ulcers [8].

In this case report, we highlight the successful use of ozone therapy as an alternative to amputation for managing a severe DFU. This approach not only facilitated wound healing but also prevented limb loss and significantly improved the patient's quality of life.

Case Presentation

We report the case of a 32-year-old woman with an 18-year history of type 1 diabetes mellitus, managed with insulin therapy. She presented with a one-month history of a grade 2 diabetic foot ulcer over the dorsum of the first metatarsophalangeal joint (7×4 cm) (Figure 1). Initial treatment in an orthopedic ward included empirical antibiotics, multiple debridement procedures, and wound dressings. Additionally, Vacuum-Assisted Closure (VAC) therapy was attempted, but no granulation tissue formation was observed after one month of treatment.

The ulcer worsened, and a surgical incision at the heel was performed to aid in debridement. Unfortunately, this led to further deterioration, enlarging the wound to 11×8 cm. A second incision at the anterior leg was made but failed to improve the condition and deteriorated reaching (9×4 cm) (Figure 2). With inflammatory markers (C-reactive protein >370) indicating systemic inflammation, below-knee amputation was recommended to prevent sepsis.

Seeking an alternative to amputation, the patient approached our clinic. She underwent eight weeks of ozone therapy—three sessions per week for the first three weeks, followed by twice-weekly sessions for the next five weeks. This non-invasive treatment involved localized ozone gas application to the ulcers. Alongside this, we optimized glycemic control, corrected vitamin deficiencies, and addressed abnormal inflammatory markers.

At the end of treatment, the ulcers had completely healed (Figure 3), leaving behind normal-appearing scars. The patient was discharged in excellent overall condition, avoiding amputation.

Figure 1: Initial presentation of the diabetic foot ulcer over the dorsum of the first metatarsophalangeal joint, measuring 7×4 cm. The ulcer demonstrates significant tissue loss with surrounding erythema, indicative of infection.

Figure 2: Progression of the ulcer following multiple debridement procedures and surgical incisions. The wound has enlarged to 11×8 cm, with extensive necrotic tissue and signs of inflammation.

Figure 3: Post-treatment images after eight weeks of ozone therapy. The ulcers have completely healed, leaving behind normal-appearing scars, indicating successful wound management and resolution of the prior infection.

Discussion

Diabetic Foot Ulcers (DFUs) represent one of the most prevalent and debilitating complications of Diabetes Mellitus (DM), affecting 15-25% of individuals with poorly controlled DM [2]. These ulcers result from a combination of peripheral neuropathy, vascular insufficiency, and infection, often leading to delayed healing, disability, and amputations.

Ozone therapy has emerged as a promising treatment modality, leveraging its antimicrobial, anti-inflammatory, and tissue-regenerative properties. Ozone, a triatomic oxygen molecule discovered in the mid-19th century, enhances antioxidant production, increases tissue oxygenation, and modulates immune responses [9]. It has been shown to reduce amputation rates by promoting granulation tissue formation, preventing infection progression, and lowering inflammatory markers such as CRP and ESR [10]. By improving blood circulation, decreasing prostaglandin production, and activating Nrf2 and NF-κB pathways, ozone stimulates healing, angiogenesis, and the release of growth factors [11,12]. Additionally, its direct antimicrobial activity disrupts microbial membranes, while its indirect effects generate oxygen-free radicals and enhance leukocyte function, phagocytic activity, and cytokine release [13]. Clinical studies demonstrate accelerated wound healing, reduced infection rates, and decreased need for revision procedures in patients receiving ozone therapy [14,15]. Although generally well-tolerated, contraindications include severe glucose-6-phosphate dehydrogenase deficiency, thrombocytopenia, severe cardiovascular instability, hyperthyroidism, myasthenia gravis, and ozone allergy [16]. Reported side effects, such as mild skin or respiratory irritation, are rare, and no teratogenic effects have been observed [17]. Ozone therapy offers a safe, effective, and cost-efficient alternative to amputation in DFU management, improving patient outcomes and quality of life. However, further high-quality studies are required to establish standardized protocols for its optimal use.

Our case highlights the successful use of ozone therapy in a patient with a large, infected diabetic foot ulcer that had failed to respond to conventional treatments and was slated for below-knee amputation. Ozone therapy, combined with strict glycemic control and management of underlying deficiencies, resulted in complete wound healing, prevention of limb loss, and significant improvement in the patient's quality of life.

Conclusion

Ozone therapy has demonstrated a significant improvement in the healing process of DFUs as well as a decrease in the risk of infection and amputation. In addition to being less expensive than other traditional therapies, it is also less invasive than other procedures, which makes it simpler for patients to accept. In the healing phase of refractory DFUs, ozone therapy is sufficiently safe, effective, and has few side effects, as demonstrated by this case report study. This saved the woman's foot from amputation.

Future researches are expected to look at different ozone therapy concentrations, formulation styles, and exposure durations in order to ascertain its exact role and therapeutic window so that the proper doses can be given for DFUs healing with a lower chance of toxicity.

Declarations

Authors contributions: Study concept or design: Mutasem Iqnaibi; Writing the manuscript: Jamal Ahmad, Yaman N. Qunaibi, Rawand B. Amro, Rama AL-riji and Aseel S. Tamimi; Review & editing the manuscript: Alaa R. AL-Ihribat, Mutasem Iqnaibi.

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Ethics statement: Our patient and her family provided the consent for this study with a written informed consent, approved by our institution.

Consent to participate: Ethical approval was not required for this case report as it involved a single patient's clinical data with informed consent obtained. The study adhered to ethical guidelines for case reporting and patient confidentiality.

Consent for publication: This case report does not include any personal data, images, or videos of individual patients.

Data availability and guarantor: The data that support the findings of this study are available from corresponding author upon reasonable request.

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