

## CASE REPORT

# Successful treatment of a high-risk diabetic foot ulcer by ozone therapy and collagen powder: A case report

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**Key Clinical Message**

A high risk diabetic foot ulcer is treated by ozone therapy and collagen powder. The goal of this study was to report a high risk case, treated by ozone therapy, and collagen powder. Ozone therapy and collagen powder can improve healing process of diabetic foot ulcers.

**Abstract**

This case report presents a successful nonsurgical outpatient approach for managing a high-risk diabetic foot ulcer with tendon exposure in an older adult with uncontrolled diabetes mellitus and severe heart failure. Due to the patient's comorbidities, surgical intervention was not an option, leading to the utilization of ozone therapy, collagen powder, and Phenytoin ointment. The significance of this case lies in the treatment of a high-risk foot ulcer through a nonsurgical approach, considering the patient's uncontrolled diabetes and severe heart failure. Diabetic foot ulcers (DFUs) are debilitating and life-threatening complications, often resulting in amputations, socio-psychological burdens, and lifestyle changes. Conventional treatment methods have shown limited success, necessitating the exploration of new and innovative approaches. The use of ozone therapy has emerged as a potential treatment, but its safety and efficacy in DFUs require further investigation. The positive outcomes observed in this case report suggest that ozone therapy may be a viable option for treating DFUs, and further studies are recommended to evaluate its effectiveness.

**KEYWORDS**

diabetes, diabetic foot ulcers, ozone therapy, wound management

## 1 | INTRODUCTION

Diabetic foot ulcers (DFUs) cause a significant challenge for diabetic patients, with a heavy economic and health burden on both the patients and their family.<sup>1</sup> Patients condition become more vulnerable when there is a risk

of amputation and tissue loss. Despite microcirculatory dysfunctions and neuropathic complications in diabetic patients, older adult patients are more susceptible to DFU and its consequences due to degenerative effects of aging.<sup>2</sup> surgical interventions such as secondary flap prostheses or other plastic surgery methods is needed to treat high-risk

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DFUs. Indeed, older adults with cardiovascular diseases or ages above 70 years have limitations to perform surgical methods, which forces wound therapist and the medical team to choose nonsurgical methods.<sup>3</sup>

In this case, we report a high risk tendon exposed DFU healed by ozone therapy and collagen powder and phenytoin ointment.

## 2 | CASE HISTORY/ EXAMINATION

In January 23, 2022, a 73-year-old Iranian male with uncontrolled diabetes mellitus since 24 years ago, presented with a large diabetic ulcer on his right foot's Achilles tendon that had been present for 3 months (Figure 1). The patient had a history of heart failure with an ejection fraction of 30% and previously undergone angiography and pacemaker insertion. He had been self-administering metformin (500 mg, BD) for the past 7 years, and scars on other parts of his foot indicated a history of multiple healed ulcers.

Upon examination, the patient presented with a Wagner II, tendon-exposed, non-infected ulcer measuring

10 cm in length and 4.2 cm in width, with 9.5 cm of Achilles tendon exposed out of the tendon sheath. The condition had deteriorated due to previous unnecessary surgical debridement, and poor blood perfusion in the engaged limb with an ankle-brachial index of 0.7. The ulcer had only a few granulated tissues in the wound edges, with most of the ulcer occupied by the tendon (Figure 1). The patient was using regular-dry sterile gauzes to dress the ulcer, but the tendon was at risk of dehydration tensions and necrosis. The patient was referred to a surgeon for surgical treatment, but due to his cardiovascular conditions, the medical team decided to perform nonsurgical methods.

### 2.1 | Differential diagnosis

Due to the patient's medical history and the characteristics of the ulcer, the existence of other diagnoses did not seem very likely. Meanwhile, vasculitis and pyoderma gangrenous or osteomyelitis were considered in differential diagnosis. In further assessments, the ulcer did not have any infectious exudates or abnormal odor.

### 2.2 | Investigations and treatment

In order to manage diabetes; Initial laboratory results indicated a HbA1C of 9.2% and mean blood glucose of 226 mg/dL. Synoripa 5/500 BD and daily dose of Gliclazide 30 mg were prescribed. The wound care nurse provided education on off-loading and diabetic diet tips. In 26, January 2023, the fasting blood sugar returned to the normal range. The wound care nurse (first author) commenced dressing of the ulcer using betaine-polyhexanide solution as a proper disinfectant, directly on the ulcer, silver dressings and hydrogels as the first dressing and a poly urethane foam as secondary dressing in every dressing session. After 20 days of every 2 days dressing, in February 16, 2023, the healing process seemed to be very slow. Considering the tendon-exposed, time was extremely vital for the medical team to save the tendon by granulating the ulcer. Therefore, as the ulcer had a margin of granulated tissue, 0/5 g of collagen powder along with Phenytoin ointment was used each session to boost the granulation process. Furthermore, as complementary treatment, the patient underwent local ozone therapy by 70 mcg/dL.<sup>1</sup> The ozone was generated by an ozone therapy device using an oxygen cylinder to produce ozone gas and a monitor to adjust the proper dosage. The ozone gas was conducted to the ulcer using a silicon tube which was connected to the plastic tent on the patient's foot over 24-days period in 12 sessions (Figure 2).



FIGURE 1 Day 1; tendon exposed diabetic foot ulcer.



**FIGURE 2** The ozone generator device. By the Day 44, in March 10, 2023, the ulcer was totally granulated, and the Achilles tendon seemed to be safe (Figure.3).

### 3 | OUTCOMES

This case report demonstrates successful management of a high-risk diabetic foot ulcer with tendon exposure in an older adult with uncontrolled diabetes and severe heart failure using ozone therapy, collagen powder, and Phenytoin ointment. The positive outcomes highlight the potential of innovative treatments in complex cases. Individualized, multidisciplinary care is crucial for improving patient outcomes in DFUs. Ozone therapy as an adjunctive treatment shows promise in enhancing wound healing and potentially reducing amputations. In conclusion, Critical tendon exposed DFUs can be healed rapidly by ozone therapy and collagen powder. Consequently, preventing tendon loss and further complications is more convenient when the healing process is faster. The authors recommend additional research in this area to better understand the wound healing process in DFUs and to determine the optimal use of ozone therapy as a nonsurgical treatment option.

### 4 | DISCUSSION

In this case report, we present the successful treatment of a high-risk diabetic foot ulcer in an older adult using ozone therapy and collagen powder. The patient's



**FIGURE 3** Granulation phase. In order to manage the exudate and prevent maceration on the pre-wound skin and wound edge, a single layer foam dressing was applied to the ulcer for another 20 days (Figure.4).

comorbidities, including uncontrolled diabetes mellitus and severe heart failure, precluded surgical management, necessitating a nonsurgical approach in an outpatient setting.

DFUs are a life-threatening and debilitating complication of advanced diabetes, often resulting in amputations and substantial socio-psychological burden for patients. Prevention is a key component of diabetic foot ulcer management.<sup>4</sup> Additionally, managing underlying diabetes is crucial to prevent further microvascular changes and decrease the recurrence rate. Conventional treatment methods for DFUs have had limited success, highlighting the need for new and innovative approaches.<sup>5</sup>

While local skin flaps are the preferred option for small foot and ankle ulcers with exposed bone or tendon, nonsurgical approaches can serve as an alternative, especially when patients have comorbidities. Soft tissue defects involving tendons in the foot and ankle present challenges



**FIGURE 4** Epithelialization phase. Meanwhile, a new HbA1C and FBS test were performed, and the results (6.9%–104 mg/dI) indicated that the diabetes is under control. By the Day 65, in April 1, 2023, almost all the ulcer was covered by the new immature skin (Figure.5) and the patient returned to his daily activities.



**FIGURE 5** Day 65; the healing ulcer. In order to complete the treatment, the patient and family were educated by the wound care nurse and physician to dress the ulcer by a single layer polyurethane foam until the new skin matured. Ten days later, in April 11, 2023, the ulcer was almost completely healed (Figure.6).

in healing due to limited availability of epithelial cells and lack of soft tissue coverage, further compounded by additional comorbidities such as severe heart failure.<sup>6</sup>

Ozone therapy has emerged as a potential treatment modality in recent years. Possible mechanisms associated with wound healing in ozone therapy include antibacterial effects, growth factor release, and tissue oxygenation.<sup>7</sup> However, improper application of ozone therapy can lead to respiratory tract damage, gastrointestinal symptoms, and headaches.<sup>8</sup> A systematic review by Fitzpatrick et al. demonstrates the potential effect of ozone therapy on the wound healing process by investigating nine studies (453 patients).<sup>9</sup>

The use of ozone therapy in DFUs remains controversial, and its safety and efficacy have not been extensively investigated. Previous case reports utilizing ozone therapy for diabetic foot ulcer management have shown positive results, but these studies used different methods such as ozone bagging.<sup>10,11</sup> In our case, we utilized ozone therapy by tent.

A study by Kadir et al. showed that ozone therapy as an adjunct to standard treatment did not significantly impact the healing process but did reduce bacterial infections.<sup>12</sup> Additionally, Uzun et al. reported a case in which intraleisional ozone injection resulted in severe foot infection and necrosis, suggesting the potential risks of ozone therapy.<sup>13</sup>



**FIGURE 6** Healed ulcer.

However, it is important to note that the patient in the Uzun et al. study had poor adherence to diabetes treatment, which may have contributed to the negative outcome. Moreover, a single blind randomized clinical trial by Izadi et al 2018, showed that all patients ( $n = 100$ ) experienced wound closure after ozone therapy while 25% of the control group ( $n = 100$ ) did not heal completely in the same treatment duration.<sup>14</sup> This information aligns well with our case which reveals the importance and efficacy of ozone therapy in treating patients with diabetic foot ulcer.

### AUTHOR CONTRIBUTIONS

**Hooman Mohammad talebi:** Conceptualization; data curation; writing – original draft; writing – review and editing. **Javad Javaheri:** Conceptualization; data curation; supervision; writing – review and editing. **Mohammad Sadegh Fakhari:** Conceptualization; writing – original draft; writing – review and editing.

### ACKNOWLEDGMENTS

We would like to extend our sincere thanks to Dr. Maryam Jenabi, Dr. Sahba Sheikholeslami and Dr. Sophia Emamdoost for helping us with material supports.

### FUNDING INFORMATION

This article was no funded by any individual or organization.

### CONFLICT OF INTEREST STATEMENT

All the authors declared no conflict of interest.

### DATA AVAILABILITY STATEMENT

All data are available from the corresponding author on reasonable request.

### ETHICS STATEMENT

A written informed consent was obtained from the next of kin. Authors confirm that all methods were performed in accordance with institutional ethical standards and Declarations of Helsinki.

### CONSENT

Written informed consent was obtained from the patients to publish this report in accordance with the journal's patient consent policy.

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**How to cite this article:** Talebi HM, Javaheri J, Fakhari MS. Successful treatment of a high-risk diabetic foot ulcer by ozone therapy and collagen powder: A case report. *Clin Case Rep.* 2024;12:e8728. doi:[10.1002/ccr3.8728](https://doi.org/10.1002/ccr3.8728)