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Case report

Saving diabetic foot ulcers from amputation by surgical debridement and maggot therapy: A case report

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ABSTRACT

Introduction and importance: A diabetic foot ulcer (DFU) is one of the major diabetes complications that may lead to limb amputation. Amputation can have profound physical and psychological effects on an individual's life. Nowadays, the prevention of limb amputation and treatment of DFUs are known as the major health challenges.
Case presentation: The present case report is of a 72-year-old woman with a 20-year history of type 2 diabetes who has had asymmetrical and superficial DFUs with sizes of 6 × 5 cm and 3 × 3 cm on the heel and the sole of the right foot, respectively. The ulcers were infected by *S. aureus* and *E. coli*. The patient had been hospitalized several times for receiving treatment, and not only the ulcers had not been healed, but also they had considerably extended so that the risk of foot amputation had been greatly increased. The patient was transferred to our wound care service. After conducting one session of surgical debridement, the patient underwent ten sessions of maggot therapy (one session every two days) using sterile *Lucilia sericata*. After about six months, the patient's DFUs were completely healed.
Clinical discussion: DFU can affect a patient's quality of life and lead to infection, sepsis, amputation, and even patient death. Therefore, using effective treatment approaches is very important for the management of DFUs.
Conclusion: The combined use of surgical debridement and maggot therapy is a safe and effective method for improving diabetic foot ulcers and preventing amputation.

1. Introduction

One of the most serious and costly complications of diabetes is the refractory and non-healing diabetic foot ulcer (DFU) [1]. DFU can lead to infection, gangrene, necrosis, and skin defects in all layers from the distal to proximal areas of the body [2]. DFU can be caused by a defective healing process resulting from intrinsic (neuropathy, vascular disorders, and other systemic effects of diabetes) and extrinsic factors (wound infection, callus formation, and high-pressure injection) [3]. Approximately 20% of patients with diabetes refer to the medical centers with the chief complaint of DFU [2]. It is estimated that about 15–34% of patients with diabetes suffer from DFU, 20% of moderate to severe forms of which may eventually lead to foot amputation [1,4]. Over the last decade, the yearly rate of DFU-related amputation has increased from 1.5 to 3.5 cases per 1000 patients with diabetes [3]. Lower limb amputation can lead to disability, increased length of hospital stay, and premature death [5].

There are many conventional and modern methods for managing DFUs and preventing amputation, including antibiotic therapy, necrotic tissue debridement, wound dressing, Negative Pressure Wound Therapy (NPWT), Hyperbaric Oxygen Therapy (HBOT), stem cell-based therapy, growth factor therapy, and Maggot Debridement Therapy (MDT) [6,7]. The single use of different methods may not be considerably efficient and cause pain and mechanical damage to healthy underlying tissues [3]. In this regard, MDT is an effective method for treating DFUs and preventing foot amputation in patients with diabetes [8].

MDT, also known as larval therapy, refers to the medical use of fly larvae (under sterile conditions) to treat refractory DFUs [9]. The main

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mechanism of MDT is to reduce the bacterial burden of the infection site through the digestion of bacteria, production of antibacterial secretions, and destruction of biofilms [10]. The effectiveness of *Lucilia sericata* larvae has been proven as an influential factor in MDT, disinfection, and improvement of DFU healing processes [3]. Following the successful use of MDT in various countries, especially the United States and Europe, the United States Food and Drug Administration (FDA) has approved the medical use of *Lucilia sericata* larvae [11].

Refractory DFUs do not readily respond to standard pharmacological therapies, and the prevention of DFU-related amputation is of paramount importance since limb amputation can have a significant impact on an individual's life [5,10]. This case report is of a female patient with DFUs who was a candidate for amputation, although she recovered using surgical debridement and MDT.

2. Case presentation

The patient was a 72-year-old woman from the Armenian minority living in Urmia city who had a 20-year history of type 2 diabetes, which led to the formation of DFUs on the heel and sole of her right foot four years ago. The patient was from a family with low socioeconomic status and only had primary education. She has also been sewing in a workshop for 25 years. She had uncontrolled diabetes and also reported a history of hypertension on physical examinations. To control her blood sugar level, she had undergone a pharmacological treatment with metformin 500 mg tablet three times a day (TDS). In addition, Losartan 40 mg tablet had been prescribed for her hypertension twice a day (BID). The patient had a family history of diabetes and hypertension. She denied any history of drug or alcohol abuse, although she smoked a pack of cigarettes a day. No pathological findings were indicated on neurological examinations. Despite that the patient had been hospitalized several times for receiving DFU treatment, she had not recovered. This case report was reported according to the SCARE 2020 Guidelines to ensure the quality of reporting. [12].

The patient had referred to Imam Reza Hospital in Urmia, Iran on 24 July 2020 with a chief complaint of persistent fever and vomiting. The patient was admitted with a diagnosis of sepsis caused by a DFU infection. Upon arrival to the emergency department, the patient's vital signs were as following: 39.2 °C, Respiration Rate: 18 bpm, Pulse Rate: 112 bpm, Blood Pressure: 150/95 mmHg. The patient had asymmetrical and superficial DFUs with sizes of 6 × 5 cm and 3 × 3 cm on the heel and the sole of the right foot, respectively (Fig. 1). Moreover, some of the patient's laboratory data on admission are presented in Table 1.

The culture antibiogram obtained from DFUs showed drug resistance to *S. aureus* and *E. coli* (Table 2). The patient received intravenous (IV) antibiotics, including Meropenem 1 g TDS, Clindamycin 600 mg BID, and Vancomycin 1 g BID. Furthermore, the patient's blood sugar level was checked using a glucometer every 6 h, and the insulin administration protocol was performed using regular insulin. In addition, the levels of blood glucose were also controlled using Neutral Protamine Hagedorn (NPH) insulin (subcutaneous injection of 16 units in the morning and 8 units in the evening).

Table 1
Patient's laboratory data on admission.

Urine analysis (UA)	Cell blood count (CBC)	Biochemistry
Color: yellow	WBC: 22500 uL	BUN: 14.8 mg/dl
Appearance: semi-clear	RBC: 4240000 uL	Creatinine: 0.9 mg/dl
PH: 5	HGB: 10.2 g/dl	Urea: 40.9 mg/dl
Specific gravity: 1013	HCT: 32.9%	Calcium: 8.70 mg/dl
Protein: negative	MCV: 77.6 fL	Phosphorous: 4.9 mg/dl
Sugar: negative	MCH: 24.1 pg	Sodium: 130 mEq/dl
Blood: negative	MCHC: 31 g/dl	Potassium: 3.9 mEq/dl
Urobilinogen: negative	PLT: 548000 uL	Blood sugar: 644 mg/dl
Ketone: negative	Neutrophils 92.2%	LDL: 288 mg/dl
Cast: not seen	Lymphocytes 6.5%	HDL: 37 mg/dl
Bacteria: few	ESR 1 h 120 mm/h	Cholesterol: 195 mg/dl
WBC: 3–5	***Serology***	Triglycerides: 130 mg/dl
RBC: 0–1	CRP: positive(+3)	HemoglobinA1C: 7.5%

Table 2
The results of the patient's wound culture.

Wound culture	Results
Culture	*Staphylococcus aureus*
Sensitive	Imipenem - Meropenem - Ceftriaxone
Resistant	Trimethoprim-Sulfamethoxazole
Intermediate	Clindamycin - Ciprofloxacin
WBC	3–5
RBC	2–3
Bacteria	Moderate

The osteomyelitis was examined in the patient's right leg by Color Doppler Imaging (CDI) and Magnetic Resonance Imaging (MRI). The findings of CDI showed no signs of Deep Vein Thrombosis (DVT) in the right lower limb. However, imaging examination of the right lower limb showed numerous small and calcified atheroma that had led to multiple arterial stenoses. The findings of the MRI were as follows:

> *"Soft tissue swelling was se en at the dorsal and plantar aspect of the foot. There is an abnormal sign (bone marrow edema) associated with adjacent soft tissue swelling in the cuboid, talus, navicular, calcaneus, and phalanges of 2nd finger."*

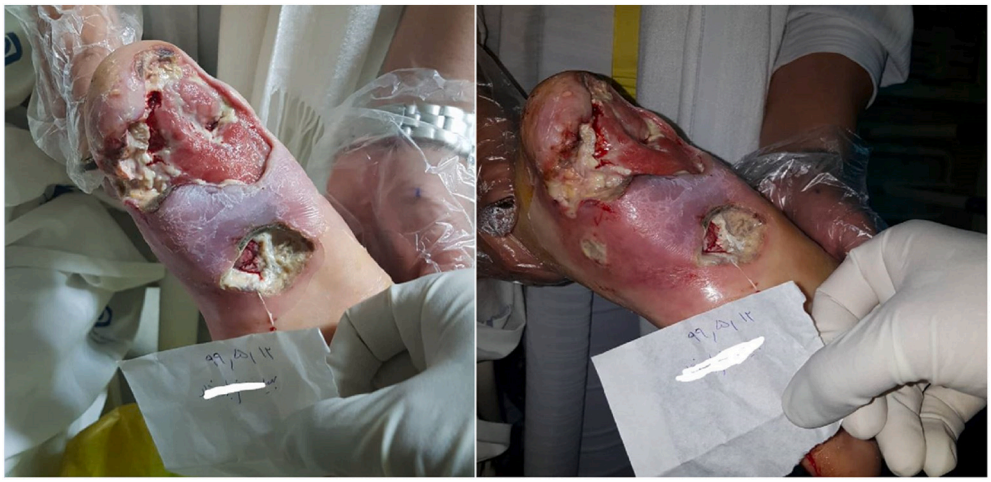

Fig. 1. Patient's DFUs before the beginning of MDT.

Unfortunately, the patient did not recover from DFU using conventional methods, although she received treatments including antibiotic therapy and normal saline dressing (TDS). The patient was asked for orthopedic consultation, based upon which she became a candidate for right foot amputation. The patient withheld consent to the amputation and was then referred to our wound care service. Moreover, the patient was bedridden at this stage.

Concerning the presence of necrotic and infectious tissue, surgical debridement of DFUs was initially performed by a surgeon on 18 August 2020. Infected living and non-living tissues were isolated from the wound bed. This action causes the release of Platelet-Derived Growth Factors (PDGFs), which can improve wound healing and provide a suitable environment for it. PDGF begins inflammatory reaction by stimulating chemotaxis and mitogenicity abilities of macrophages, neutrophils, fibroblasts, and smooth muscle cells to the site of the wound [13]. Then the larvae of L. *sericata* were prepared under sterile condition, and the patient underwent MDT. These larvae consume dead tissue and bacteria at the wound site and secrete antimicrobial enzymes that improve wound healing. MDT was performed in four stages of wound preparation, applying larvae to the wound, hydrocolloid dressing, and removing larvae after 48 h (Fig. 2). Wound preparation was done by placing the surgical drape on the patient's wound and irrigating it with physiological saline. At each phase of the intervention, the patient was inquired a query about tolerating the maggot therapy and continuing the intervention every twenty minutes. If the response was "yes," the intervention was continued, but if the response was "no," the intervention was stopped. Overall, ten sessions of MDT were conducted (one session every 48 h). The procedures were performed by a nurse (first author) who was trained and certified in this field. Furthermore, after the completion of MDT sessions, the patient's DFUs were re-stimulated using mechanical debridement and normal saline, so that all the dead tissues were removed again and the granulation tissues appeared (Fig. 3). The patient's DFUs had partially healed on 16 October 2020 (Fig. 4) and closed three months after the intervention. After treatments were done with MDT in 3 weeks, the silver-containing dressing was applied to the wound by a trained nurse for five months to make granulation tissue grow faster and promote the healing process. The patient was discharged from our wound care service with a good general health condition (Fig. 5). Before discharging the patient, she was instructed to avoid placing excessive pressure on the tissue and be on a crutch or wheelchair until the completion of recovery. Offloading is important for DFU healing. Moreover, the patient was educated about the complications of the procedures after the intervention and their warning signs, and how to manage them. No adverse effects were presented during or after therapeutic intervention. The patient's DFUs healed completely after about six months (Fig. 6) and the patient declared that "I am scared of losing my leg, but I have completely recovered with the proper therapeutic procedure."

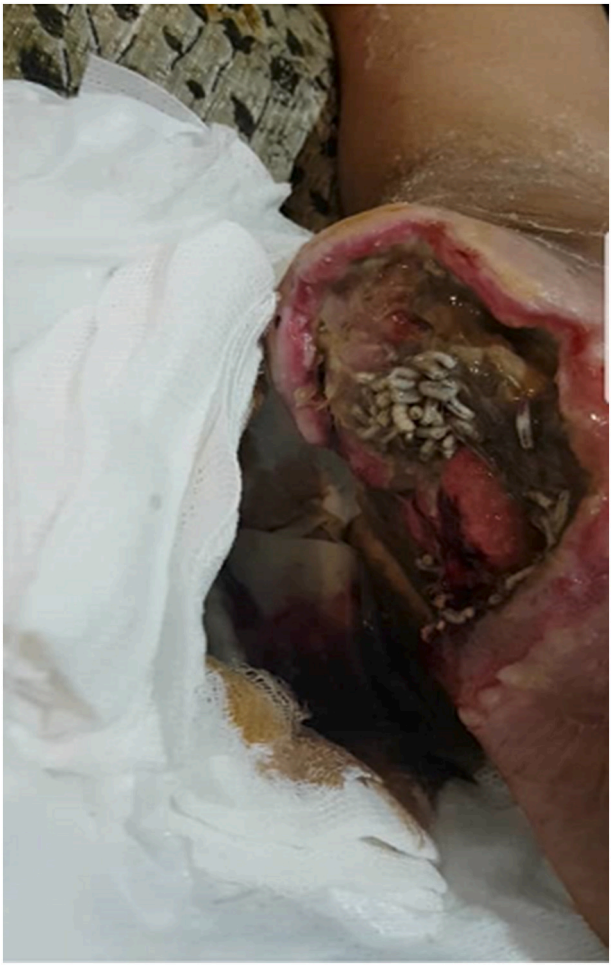

Fig. 2. The application of MDT for repairing the patient's DFUs.

3. Discussion

Severe DFU can affect a patient's quality of life and lead to infection, sepsis, amputation, and even patient death. Therefore, using effective treatment approaches is very important for the management of DFUs [2]. Nowadays, regarding the emergence of antibiotic-resistant bacteria, many physicians have turned their attention to the use of maggot therapy [14]. The FDA approved the use of this method for medical purposes in 2004 [11]. MDT is also applied to treat health conditions, including other types of diabetic ulcers, bedsores, burns, carbuncles, abscesses, and boils where other treatment methods are not advantageous [9]. MDT is a very simple and relatively cost-effective treatment approach so that, unlike antibiotic therapy, it causes no dangerous side effects. However, some patients may encounter itchy skin, such that something crawls on the skin. Regarding the stimulation of the nervous system resulting from larvae distension, some patients may experience different levels of pain, which can be relieved by removing the larvae at the right time or using medication. Anxiety is another complication caused by MDT. Therefore, it is very important to psychologically prepare the patient before the procedure begins [15]. MDT can be easily performed by trained healthcare professionals, even without the need for hospitalization.

The present case report was of a female patient who had a 20-year history of uncontrolled type 2 diabetes, which had led to the formation of DFUs. The patient had a poor general health condition, and her DFUs were not treated using routine hospital treatment methods (IV antibiotic therapy and normal saline dressing) so that she was at a considerable risk of foot amputation.

Given that the patient was from strata with low socioeconomic status and had no underlying disease other than hypertension and that there was no evidence of osteomyelitis, she was found to be very susceptible to the implementation of MDT. In this study, necrotic tissues were first removed surgically using a new approach, and a suitable environment was then provided for wound healing. After conducting surgical debridement, ten sessions of MDT were performed (one session every 48 h) using sterile L. *sericata*. The patient's DFUs miraculously healed after about six months, and the patient was also discharged from our wound care service with a good general health condition.

In line with our study results, Parizad et al. showed that the combined use of MDT, surgical debridement, silver dressing, and NPWT is very effective in treating refractory DFUs [16]. In a clinical trial, Malekian et al. concluded that MDT using sterile maggots of L. *sericata* is a safe and effective method for treating the DFUs infected with *Staphylococcus aureus* and *Pseudomonas aeruginosa* [10], which is consistent with our results. Siavash et al. and Dehghan et al. also revealed that MDT, as a

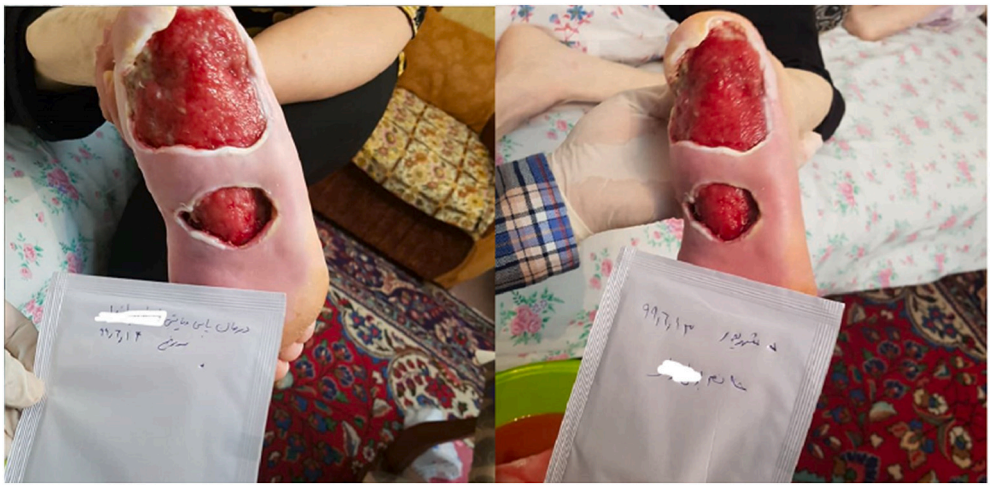

Fig. 3. The patient's DFUs after the completion of MDT sessions.

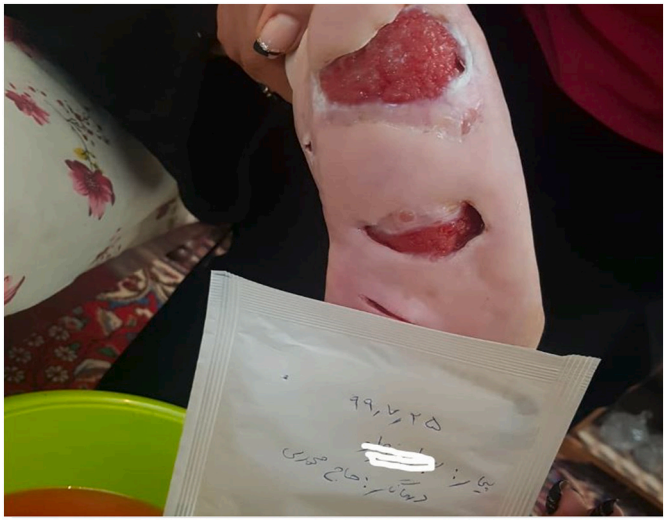

Fig. 4. The patient's DFUs one month after the intervention.

new treatment approach, is effective in treating atypical DFUs that are refractory to conventional therapies [17,3]. In line with the results of our study, Mirabzadeh et al. showed the MDT as an acceptable and easy-to-use method for the treatment of complicated and extensive DFUs [18]. Most studies in this area have demonstrated the effectiveness of MDT in improving DFUs. However, the findings of this case report boldly indicated that MDT could be also utilized in patients who have complicated and non-healing DFU and are candidates for foot amputation.

4. Conclusion

Foot amputation causes irreparable damage to the patient's performance and quality of life. Therefore, new and effective treatment methods are required to prevent foot amputation. This case report study was shown that the combined use of surgical debridement and MDT is a safe and effective approach to improve the healing of DFUs and prevent foot amputation. Consequently, wound care teams are recommended to use this method to accelerate the healing process and prevent foot amputation.

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None.

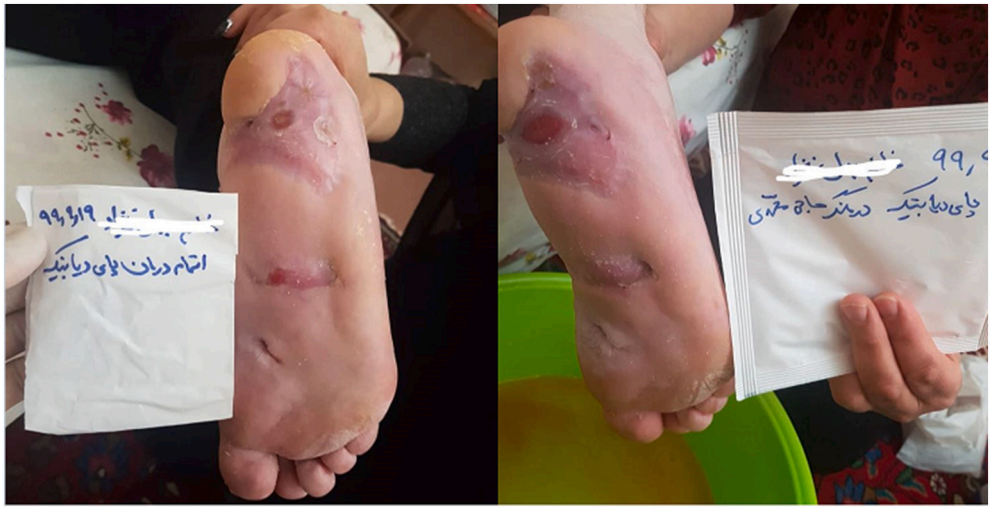

Fig. 5. The patient's DFUs three months after the intervention.

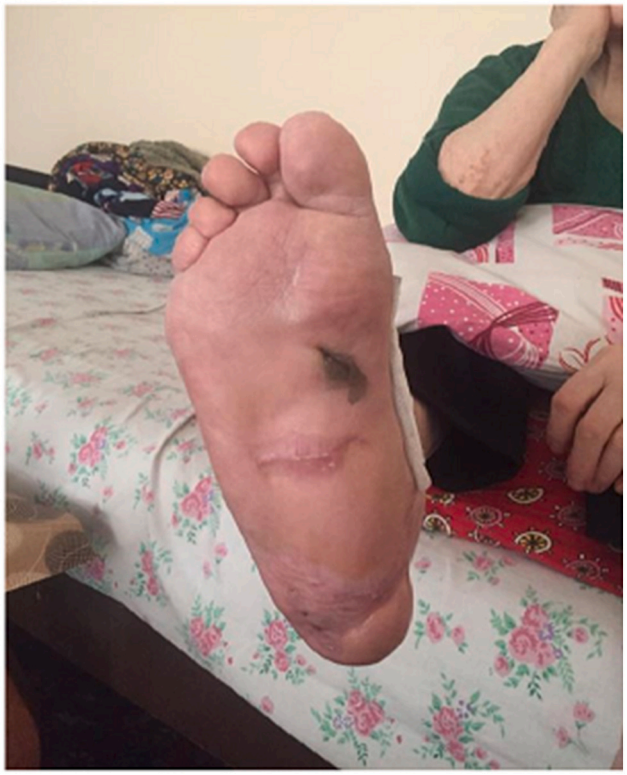

Fig. 6. The patient's DFUs six months after the intervention.

Ethical approval

It was waived because it's a case report according to the policies of the affiliated University institutional review committee.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Authors' contributions

Rasoul Goli: Study concept, data collection, writing the paper and making the revision of the manuscript following the reviewer's instructions. Naser Parizad: Study concept, reviewing and validating the manuscript's credibility. Kazem Hajimohammadi and Amireh Hassanpour: reviewing and validating the manuscript's credibility.

Research registration

Not applicable.

Guarantor

Rasoul Goli.

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Declaration of competing interest

None.

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