Use of activated charcoal combined with silver for diabetic foot ulcer

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Summary

Most wounds heal by primary intention, in which the edges of the incision are brought together using sutures, staples, or clips. However, certain wounds may be left open to heal (if there is a risk of infection or there has been considerable tissue loss). These wounds are known as wounds healing by secondary intention. The secondary intention approach is a time-honoured practice with a solid track record. It is sometimes neglected as a good option to urgent repair of wounds, which is unfortunate given the proliferation of many reconstructive procedures that have emerged in recent decades. In certain instances, the aesthetic and functional outcomes of secondary intention healing are on par with those of more difficult reconstructive surgical procedures. This case demonstrates the efficacy of wound closure achieved by secondary intention with the use of activated charcoal combined with silver, which led to extraordinary results.

Keywords: diabetic foot, diabetic foot ulcer, wound healing, actisorb silver, secondary intention

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Introduction

Diabetic foot ulcers are one of the most common consequences of poorly controlled diabetes mellitus. Common causes include inadequate glycaemic management, underlying neuropathy, peripheral vascular disease, and inadequate foot care.[1] They are also a common cause of osteomyelitis of the foot and amputation of the lower extremities. These ulcers frequently develop in areas of the foot that experience repeated tension and strain.[1]

The most common pathogen cultured in diabetic foot ulcers is *Staphylococcus aureus*.[2-4] Interprofessional care teams outperform traditional community care services in terms of diagnostic acumen and wound healing outcomes. Initiatives such as best practice interprofessional diabetic foot care pathways, as well as prompt vascular management of ischaemia, treatment of deep and surrounding infection, and the provision of foot care and footwear, are advocated.[5]

Most wounds heal by primary intention, in which the edges of the incision are brought together using sutures, staples, or clips.[6] However, certain wounds may be left open to heal (if there is a risk of infection or there has been considerable tissue loss).[6] These wounds are known as wounds healing by secondary intention. The secondary intention approach is a time-honoured practice with a solid track record. It is sometimes neglected as a good option to urgent repair of wounds, which is unfortunate given the proliferation of many reconstructive procedures that have emerged in recent decades.[6] In certain instances, the aesthetic and functional outcomes of secondary intention healing are on par with those of more difficult reconstructive surgical procedures.[6] This case demonstrates the efficacy of wound closure achieved by secondary intention with the use of activated charcoal combined with silver, which led to extraordinary results.[6]

Case report

A 50-year-old diabetic male presented to an outpatient clinic in the Gauteng province with a diabetic foot ulcer on the plantar aspect of the 4th metatarsal head of the right foot. He reported the ulcer appeared nine days ago. In addition, he had hyperlipidaemia and sarcoidosis. He took 500 mg of Glucophage twice daily to control his diabetes and reports that the diabetes had been diagnosed 14 years ago. His laboratory results revealed the following: HbA1c – 9% and LDL cholesterol – 179 mg/dL.

The patient reported that he flushed the wound with water and applied an antimicrobial cream (Bactroban®, GlaxoSmithKline, South Africa) and a crepe bandage. Figure 1 (9 days after the ulcer had started) depicts the image of the ulcer at the patient's presentation at first consultation, showing a 1 x 1.5 cm shallow ulceration with an irregular border, hyperaemic wound bed, surrounded by hyperkeratosis and maceration. The ulcer had a foul smell and no apparent signs of epithelialisation or advancement of the margins. To prevent backsplash, the wound was then irrigated with a saline solution using a 50 ml syringe linked to a 19-gauge plastic catheter. The wound was dressed with Actisorb™ Silver 220 (3M™), and the ulcer was then off-loaded using semi-compressed felt with an aperture to allow the ulcer to float. The wound was not swabbed at this point as there were no systemic signs of infection and the ulcer was dressed with Actisorb™ Silver 220 (3M™) since the wound presented with a foul odour. The patient was sent to a primary care physician for a revaluation of blood glucose levels because the HbA1c was concerning and would impede wound healing.

Figure 1: Day 9 after the first ulcer had started; shallow ulceration with an irregular border, hyperaemic wound bed, surrounded by hyperkeratosis and maceration

Figure 2: 13 days after the second ulcer had started; second ulcer extending from the medial longitudinal arch up to the medial aspect of the right ankle

Figure 3A: Plantar view; 23 days after the second ulcer had started; secondary intention wound healing is visible as the dimension of the wound borders had decreased

Figure 3B: Medial view; 23 days after the second ulcer had started; secondary intention wound healing is visible as the dimension of the wound borders had decreased

Figure 4A: 35 days after the first ulcer had started; diabetic foot ulcer closure with new tissue and minimal scarring

Figure 4B: 39 days after the second ulcer had started; diabetic foot ulcer closure with new tissue and minimal scarring

Wound progress

The patient returned four days after the initial consultation and a new wound had developed, extending from the medial longitudinal arch of the foot up to the medial aspect of the right ankle (Figure 2, 13 days after the ulcer had started). The patient reported that he had not dressed the wound as advised by the clinician. He informed the clinician that the wound was oozing excessively, and he had decided to dry the entire foot with a hair dryer which caused the second ulcer formation.

After each ulcer was swabbed three times and a full blood count blood test was requested, the diabetic foot ulcers were flushed with saline, dressed with an activated charcoal dressing (Actisorb™ Silver 220, 3M, South Africa) and a secondary layer of foam (Allevyn non-adhesive™, Smith & Nephew, United Kingdom) and then retained with a crepe bandage. The patient was placed in a moonboot to alleviate pressure on the foot.

Microbiology results showed that the most prevalent pathological microorganism was *Staphylococcus aureus*, followed by *E. coli*, as four out of the six swabs taken were positive for *Staphylococcus aureus* and two were positive for *E. coli*. Blood work showed a white blood cell count of 12 367/mm3 and a C-reactive protein of 7 mg/L. The stated findings along with a clinical finding of cellulitis surrounding the ulcers confirmed the presence of a bacterial infection. Cloxacillin (Cloxin®, Aspen Pharmacare, South Africa) capsules were prescribed at 500 mg three times a day.

The patient was advised to change the dressing every four days and to consult once a week for wound assessment and management. Figures 3A and 3B (23 days after the ulcer had started) depict secondary intention wound healing visible as there is advancement of the edges and re-epithelisation of the ulcers. After 35 days of the first ulcer starting and after 39 days of the second ulcer starting, the diabetic foot ulcers had fully healed with minimal scarring (Figures 4A and 4B).

Discussion

Foot ulcers have a significant and detrimental impact on the patient's quality of life. Patients who suffer from foot ulcers often experience mobility loss, making it difficult for them to carry out routine, day-to-day responsibilities and participate in recreational activities. Foot ulcers and their associated complications often result in low quality of life and melancholy.[7] Several studies have shown that people with diabetes mellitus and foot ulcers have a worse quality of life and a higher incidence of depression compared to those who do not have diabetic complications.[8-10]

The aetiology for diabetic foot ulcers is multifactorial. Poor glycaemic management, calluses, improper foot care, ill-fitting footwear, underlying peripheral neuropathy, and poor circulation led to the development of these ulcers on the patient's feet. Diabetic foot ulcers have been successfully treated using silver dressings.[11] In addition to being useful on burn wounds, they may also be utilised on infected or colonised wounds and the current case further reinforces this.[11]

Actisorb™ Silver 220 (3M, South Africa) is a dressing made of activated charcoal and silver,[10] impregnated with elemental silver (33 ug/cm2) on pure activated carbon closed in a porous nylon protective envelope.[12] By binding and protecting the wound, the dressing promotes a favourable environment for successful healing. The dressing destroys microorganisms that pollute and infect wounds, subsequently decreasing wound healing time.[13] The dressing is effective against 150 wound-infecting bacteria, and in this case, it proved effective against *Staphylococcus aureus* and *E. coli*.[12] It may be used as the initial therapeutic step in the treatment of all chronic wounds with varying amounts of exudate. Hence, in this case, we were able to use it as the wound progressed and had varying amounts of exudate with a favourable outcome.

The patient had a favourable response to the treatment as a result of the multidisciplinary approach that was used to treat the ulcers. Additionally, the case was approached from the perspective of a multifaceted treatment plan that considered all the elements that may inhibit wound healing.

Conclusion

This case reports on the use of activated charcoal combined with silver in treating diabetic foot ulcers as a good treatment option to obtain wound healing by secondary intention. This case also highlights the importance of a multidisciplinary approach for favourable outcomes in diabetic patients suffering from this debilitating complication.

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Conflict of interest

None.

Ethical approval

Ethics approval was obtained from the University of Johannesburg Research Ethics Committee (REC 241112-035).

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