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CASE REPORT

Management of Necrotic Transmetatarsal Amputation with *Argania* Honey Dressing: A Case Report

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Abstract

Chronic wounds represent a significant global health concern, accounting for a considerable proportion of amputations. Recent advances in healthcare have highlighted the importance of effective wound healing and the prevention of bacterial infections, as these factors are crucial contributors to elevated morbidity rates. Selecting an appropriate wound dressing has presented a significant challenge for healthcare professionals, particularly in developing countries. Honey, a traditional remedy with a long history of use, has been employed in wound care for centuries. This report presents a case study of effective management in a 74-year-old patient with a 28-year history of type II diabetes. This individual experienced a complication related to diabetic foot issues, necessitating toe amputation. This procedure subsequently resulted in difficulties involving necrosis. The treatment protocol included the application of a dressing based on pure *Argania* honey (*Argania spinosa*, an endemic tree of southwestern Morocco), without additives, pasteurisation or manipulation. A sharp debridement procedure was previously performed to facilitate the impregnation of honey in the affected area of necrosis. At the end of the treatment all symptoms, including pain, exudates, odour, burning sensation and itching, were fully alleviated. Moreover, a considerable decrease in swelling and wound size was evident, suggesting significant healing in the injured area. The administration of natural remedies for the treatment of this kind of injury may prove an efficacious strategy for the enhancement of quality of life for diabetic patients.

Keywords: Amputation, *Argania*, Diabetic, Honey, Wound Healing, Wound Infection

1. Introduction

The World Health Organization (WHO) has identified wounds in the lower extremities as a significant public health problem, affecting a considerable proportion of the global population[1]. Globally, chronic wounds impact approximately 0.78% of the population, with the majority of affected individuals aged over 60[2]. As our society continues to age, the prevalence of chronic wounds among adults is likely to increase[3]. The surgical practice of limb amputation is a procedure with a long history, tracing its roots back to ancient civilisations[4].

The prevalence of foot infections in individuals with diabetes represents a significant public health concern. The management of this condition must be multidisciplinary[5]. Lower limb amputation is most often performed following arterial insufficiency (92%) or trauma (7%), with an incidence rate of trans metatarsal and proximal amputations of about 10 per

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100,000 people per year[6]. The precise global count of amputees is challenging to ascertain, primarily because numerous countries do not maintain records of limb amputation cases. Annually, over 150,000 individuals are hospitalised for amputations attributed to peripheral vascular disease or diabetes[7].

Amputation is regarded as a definitive surgical intervention when no alternative medical solutions are available. It entails the excision of a limb or a portion of it from the body, typically due to a multitude of reasons including arterial insufficiency in the lower extremities, infection, tumour growth, trauma or congenital malformations[6]. The occurrence of lower limb amputation rises with advancing age, with more than half of all diabetic amputations occurring in individuals aged 70 and above[8]. Furthermore, individuals with diabetes tend to undergo lower limb amputation at a somewhat younger age compared to those with vascular disease alone[9].

Patients at risk of requiring amputation are vascular patients and diabetics[10]. Chronic vascular disease can result in tissue death in the toes, feet and legs. Of patients undergoing amputation for complications of these diseases, nearly half do not survive beyond five years following the amputation procedure[11,12].

As with any surgical procedure, amputation carries an inherent risk of complications. To mitigate this risk, it is imperative to conduct regular postoperative evaluations of the amputation wound to identify and address potential issues, such as the emergence of foul odour, bleeding or excessive exudate, which could indicate the development of a complication[13].

Insufficient tissue perfusion leads to ischemia and subsequent tissue necrosis, manifesting in observable signs like alterations in skin pigmentation, mottled discolouration and scaling. These developments can then increase the risk of wound rupture and dehiscence[14]. In many cases, the extent of nonviable tissue determines the need for wound debridement or revision surgery[15].

In the present era, there is a growing interest in using natural remedies, whether for wound management or to promote general health[16]. With the advent of modern medicine and the concomitant increase in life expectancy, which has resulted in a larger proportion of the population reaching advanced age, the financial implications of treating specific pathologies and the rise in antibiotic resistance provide compelling reasons for professionals and decision-makers to consider alternative options[17].

A novel perspective has emerged regarding the selection of dressings in wound care, prompting healthcare professionals to recognise the substantial impact of suitable dressings on the management and acceleration of the healing process. However, it is crucial to acknowledge the considerable financial and accessibility constraints associated with modern dressings in developing nations[18]. In addressing this issue, it has become evident that the careful selection and utilisation of suitable dressings are essential for achieving successful treatment and facilitating the healing process.

Honey can be an asset due to its therapeutic properties as it is a natural substance of considerable nutritional and prophylactic-medicinal value, produced by bees (*Apis mellifera*) from flower nectar or honeydew[19]. Due to its acidic properties, high sugar content and nutrient composition, honey plays a role in stimulating tissue regeneration by enhancing the presence of free oxygen compounds at wound sites[20].

The results of this case study substantiate the efficacy of the *Argania* honey dressing (*Argania spinosa*), a product derived from a Moroccan tree that is renowned for its medicinal properties and is endemic to the region. It is important to note that the removal of necrotic tissue is necessary and is achieved through a combination of sharp and autolytic debridement facilitated by the action of honey. Furthermore, the application and preparation of the honey dressing on the wound is straightforward, resulting in the rapid regeneration of tissue and the formation of fully developed scar tissue.

2. Materials and Methods

2.1 Case Presentation

A 74-year-old Moroccan patient who had undergone a Transmetatarsal Amputation (TMA) as a result of a diabetic foot complication was contacted at his place of residence following his refusal to return to the hospital for further consultation and treatment. The wound became infected and failed to heal despite the application of routine dressings. He reported

persistent, non-healing post-operative pain with a necrotic appearance around the site of the amputation. The patient experienced pain, a foul odour, purulent discharge and itching. Upon examination, a large wound measuring 13.5cm was observed on the patient's right foot. The patient had been diagnosed with type II diabetes for 11 years and has an unruly lifestyle as evidenced by an HbA1C level exceeding 10% (HbA1C > 10 %). These factors were considered pertinent to this case study. Before the application of a honey dressing to the wound, the patient was undergoing antidiabetic treatment comprising metformin (Glucophage®) and hypoglycemic sulfonamides (A MAREL®). It should be noted that the patient's blood sugar level had never fallen below 200mg/dL. Subsequently, following a consultation with the endocrinologist, the patient was treated with insulin (Mixtard®) at doses of 26IU and 14IU under supervision to maintain the glycemic levels within the standard range, with regular monitoring of blood glucose levels.

2.2 Honey and Dressings

The processing of honey may result in alterations to its efficacy, leading to changes in the ratio of its components. The *Argania* honey is obtained from local beekeepers in the Tiznit region and is processed in its raw, pure form, free from additives, pasteurization and minimal manipulation. The honey was then handed over to the official laboratory of the Moroccan Ministry of Agriculture department for chemical research analysis to ensure its highest quality and purity.

Regarding the requisite materials for the dressing, sterile compresses measuring 5cm × 5cm and 6cm in width were used. The gauze was impregnated by honey during the dressing care.

1.3 Care Procedure

At the outset of the treatment plan, which coincided with the initial dressing session, the patient and their family were provided with a comprehensive explanation of the proper preparation and application of honey dressing for the management of diabetic foot amputation.

The initial dressing procedure entailed a series of steps. The wound was initially cleaned with a solution of 0.9% saline, followed by the application of sterile compresses to facilitate drying. Subsequently, compresses impregnated with *Argania* honey were applied to the wound, followed by the application of a protective bandage. Six days later, a sharp debridement procedure was conducted to remove a black scab that was delaying the healing process. Debridement was performed as previously described by Khattabi *et al.*[21] (Figure 1C). Subsequently, a cleansing procedure was conducted using saline and the surrounding area was gently patted dry. The wound was dressed in four compresses that had been thoroughly saturated with honey along with four other sterile compresses. The dressing materials were applied in a manner that covered the entire wound and extended over its edges. The number of compresses was not fixed, rather, it depended on the depth of the wound. This ensured that the gauze filled the entire depth of the wound, extending above the level of the surrounding skin. To maintain the position of the dressing, a 5cm wide strip of hydrophilic gauze was applied and a 5 cm hypoallergenic tape (Hypafix®) was used to secure the dressing in place. Initially, the dressing was changed daily and after 70 days, the interval was reduced to every three days (reduction in exudates).

3. Results

The care provided to a 74-year-old diabetic patient who had undergone amputation due to necrosis involved the use of an *Argania* honey-based dressing. The patient's condition exhibited a highly favourable evolution, with notable budding occurring after 53 days (Figure 1D). The overall response of the wound was conducive to the desired outcome, progressing through several healing stages (Table 1). Initially, the wound proceeded through the fibrinous stage characterised by the formation of moist fibrin layers that settled on the wound bed (Figure 1B). The development of the wet budding stage was characterised by the filling of the cavities, thereby contributing to a reduction in the extent of the wound in depth (Figure 1D). The prognosis of the wound was evident due to the natural course of healing which was observed to progress from the onset of epithelialisation (Figure 1E) to complete healing (Figure 1F). The presence of fibrin (Figure 1B) was observed in the early stages of the healing

process, specifically during the fibrinous stage and following various techniques of autolytic and sharp debridement. The preparation of the wound bed (as shown in Figure 1A-1B) and the application of honey during the treatment contributed to the elimination of the initial unpleasant odours. A gradual enhancement was noted in several parameters, including colour and depth, which exhibited a reduction until the complete

Table 1. Chronological progression of *Argania* honey dressing treatment and explanation of evolving care phases

Case Figure	Stages	Treatment Period (Days)	Description	Fibrin	Exudate	Smell
A	Necrosis Stage	1st day	Wound bed with adherent black tissue at a recent amputation.	+++	+++	+++
B		4 days	Formation of soft yellowish moist black tissue at the wound.	+++	+++	+++
C	Debridement	2 days	Sharp debridement of the entire necrosis.	++	+++	++
D	Budding Stage	46 days	Budding and filling of the wound cavity.	+	++	+
E	Epithelialisation Stage	42 days	The development of epithelium along the wound's margins and the growth of new tissue.	-	-	-
F	Remodeling Stage	36 days	Complete healing.	-	-	-
Total		**131 days**				

Level of presence (- None, + Low, ++ Medium, +++ High).

A-B. Necrosis stage; **C**. Debridement; **D**. Budding stage; **E.** Epithelialisation stage; **F**. Remodeling stage

Figure 1. Healing stages of a necrotic transmetatarsal amputation treated with *Argania* honey dressing.

resolution of the exudates. Concerning the granulation tissues, the discharges were eliminated thereby contributing to the contraction of the epithelial tissue and the reduction in the dimensions of the scar. The complete healing was recorded at 131 days (Table 1, Figure 1F). No treatment-related complications were detected. The honey dressing was observed to be free of any indications of infection or allergic reactions. Throughout the treatment, the family expressed high satisfaction with the results of the dressing and the condition of the scar, given the patient's advanced age.

4. Discussion

The objective of this research was to investigate the potential therapeutic properties of *Argania* honey dressing in the treatment of a necrotic TMA in an elderly diabetic patient. The dressing resulted in remarkable wound healing, effective control of exudates and improvement of perilesional skin quality.

In light of the rising prevalence of chronic wounds and the alarming increase in microbial resistance to antibiotics, there has been a surge in research exploring novel agents for wound healing[22]. A plethora of dressing types have been developed to facilitate the wound-healing process. Furthermore, several approaches are available for addressing necrosis that occurs after an amputation, including the use of hydrocolloid gels, growth factors, enzymatic debridement agents, hyperbaric oxygen therapy and skin substitutes[23]. Negative pressure therapy is considered to be more effective than conventional treatment modalities[24]. However, all of these treatments are expensive, especially for low-income countries[25].

In traditional medicine, the combination of natural products is a common practice that has demonstrated synergistic effects, leading to enhanced effectiveness in the treatment of various medical conditions[26]. Selecting the most suitable dressing is crucial for promoting rapid recovery and wound healing[27].

Honey used as a dressing is among the natural products that encompass physical characteristics contributing to providing antimicrobial protective properties. It has been shown to absorb wound exudates and provide essential moisture and oxygenation to optimise epithelialisation[28]. Additionally, honey has been recognised for its ability to stimulate the production of growth factors and promote autolytic debridement, facilitating the formation of granulation tissue[25].

Special consideration is required for the management of chronic wounds, as debridement stands as the primary treatment approach for this category of wounds[29].The elimination of necrotic tissue is a vital step in the wound healing process as it fosters the activation of angiogenesis, the development of granulation tissue, epidermal regeneration and the proper formation of the Extracellular Matrix (ECM)[30], thus, contributing to wound healing[3]. Extensive debridement was performed only once at the beginning of the treatment, around the 7th day, due to the tendency of necrotic tissue to resurface[15].

Manna *et al*,[31] have reported that it is possible to combine other methods of debridement. In this case, the application of an *Argania* honey-based dressing favoured autolytic debridement and also demonstrated a hydrating effect allowing for the softening of the necrotic tissue and liquefaction of fibrin through phagocytic degradation[32].

Regarding the management of the *Argania* honey-based dressing, it was found that the honey-impregnated gauze was a relatively simple preparation and application process, a task that could be easily performed by the patient's family members. The characteristic viscosity and moisture of the honey enabled straightforward removal without adhesion[33]. Consequently, damage to recently formed tissues was avoided, and dressing changes were conducted comfortably and painlessly, as reported by the patient[34]. In comparison to alternative dressing types such as the Betadine® dressing, which was reported to be painful due to its drying effects on the wound, leading to adherence of the dressing to the skin, the honey-based dressing demonstrated superior performance[35].

Moreover, the hyperosmolarity of honey in wounds absorbs exudates and promotes a decrease in lesion oedema, which indirectly enhances local microcirculation[36]. The variation in exudate quantity, a hallmark of amputations, was significantly evident throughout the study period. There was a notable improvement over time. During the initial seven-day period, the highest levels of exudate secretion were observed, accompanied by a foul odour. However, an improvement was evident in subsequent weeks, with a

decrease in the quantity and the nature of the exudate. Excessive exudate production represents a significant concern in the management of this type of wound, as it can lead to a range of complications, including an increased risk of infection, maceration and erosions, which often manifest with a foul odour[37].

Overall, the delay in the healing process is always related to the complex and inflammatory nature of chronic wounds[38]. In the healing process of this TMA, the inflammatory phase was prolonged compared to the epithelialisation phase, but the *Argania* honey dressing demonstrated tissue regeneration at the edges of the wound with the appearance of tissue budding (Figure 1D). Furthermore, the rapid absorption of oedema around the ulcerative margins allowed for the acceleration of the process of desquamation of devitalised tissue by macrophages, which, by cleaning the wound, provides local protection and a source of cellular energy[39].

Following 131 days, the wound was completely healed, enabling the patient to resume daily activities after completion of the treatment. This outcome is noteworthy, especially considering that healing following a TMA can be challenging and frequently results in the need for a more extensive, higher-level amputation[40]. The healing time is an important parameter to be considered, as prolonged healing periods entail significant costs associated with wound care. A meta-analysis has also been conducted to support this observation, which reported that the healing duration with honey is shorter than with povidone-iodine in the healing of chronic wounds[41]. To date, Medical-Grade Honey (MGH) has demonstrated a beneficial impact on the healing process of heel pressure wounds among elderly patients, particularly those over the age of 65, with healing durations varying from two to seven months (mean of 128 days, a median of 118 days)[42].

Previous studies conducted by Kateel *et al.* and Moghazy *et al.*[43,44] have demonstrated the effectiveness of honey-based dressings in promoting the healing of foot ulcers. Manuka honey is most commonly employed for medical applications[45] and it has effectively supplanted the necessity for antibiotics and hospitalisation in patients with diabetic foot neuropathic ulcers[46].

The use of honey dressing may represent an effective option for enhancing the healing of toe amputation wounds in diabetic patients when compared to the use of conventional dressings[47]. Honey-based dressings are low-cost dressings with significant beneficial properties for wound healing[48], particularly in low-income countries.

Nevertheless, further research is required to gain a deeper understanding of the mechanisms through which honey exerts its effects on the process of wound healing. The distinctive characteristics of each wound and patient, shaped by a range of biological, environmental and epidemiological factors, can impede the healing process of chronic wounds. It is, therefore, imperative that further clinical trials be conducted to enhance the management and cost-effectiveness of treating such wounds.

5. Conclusion

The use of *Argania* honey as a dressing has been shown to have the potential to promote wound healing in elderly diabetic patients with chronic wounds, without causing allergic reactions or secondary bacterial infections. The patient's family expressed high levels of satisfaction with the outcome. It is noteworthy that the wound took several months to achieve full closure, specifically 150 days. *Argania* honey may serve as an alternative therapeutic option for wound healing, particularly in resource-limited developing countries.

6. Acknowledgment

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7. Ethical Approval

Informed consent was provided by the patient's family before starting the care according to the World Medical Association Declaration of Helsinki.

8. Consent for Publication

The patient participated voluntarily. Approved informed consent was obtained by designated patient

representatives and the institutional ethics committee. All care and procedures comply with the ethical rules of human experimentation set out in the Declaration of Helsinki.

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