The clinical and cost effectiveness of bee honey dressing in the treatment of diabetic foot ulcers

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1. Introduction

Diabetic foot ulcers are major cause of morbidity and disability in diabetic patients. They frequently lead to lower extremity amputations especially when associated with neuropathy and/or ischemia [1,2].

On the national level, foot ulceration is common; it affects 6.9% of diabetics during their lifetime [3]. Moreover, ulceration is the most common cause of hospitalization and precedes 80% of lower limb amputations [4].

Despite recent advances in antimicrobial therapy, diabetic foot infections are still a serious problem. Although topical, as well as systemic, antibiotics and agents have been used, solely and in combination, to eradicate this resistant infection, it persisted. Moreover, these agents had lead to the emergence, and subsequent rapid overgrowth, of resistant bacterial strains, drug side-effects and organ specific toxicity [5–7].

Medicinal properties of honey have been recognized since antiquity [8]. It was used as a wound dressing to treat infected wounds and promote healing. Modern studies revealed its
effectiveness against antibiotic-resistant strains of bacteria; it prevents bacterial growth even when wounds are heavily infected [9–11]. Even when it was ineffective, it never resulted in the emergence of resistant strains [12]. The antimicrobial activity of bee honey has been attributed to several properties, including its osmotic effect, naturally low pH, and the production of hydrogen peroxide [13–15]. It therefore seems time to revive honey as dressing for these resistant wounds.

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2. **Aim of the work**

This study was conducted to investigate the value of honey as topical treatment for diabetic foot ulcers. In addition, analysis of wound factors and criteria of patient that affect the outcome of honey dressing was done to optimize its use.

3. **Patients**

Thirty patients complaining of diabetic foot ulcers presenting to the Surgery Department, Suez Canal University Hospital, Ismailia, Egypt in the period between March and September 2007 were submitted to this study.

Patients of all ages and both sexes were included in this study. All patients with diabetic foot ulcers, regardless of their depths, areas or presence of infection were included in the present work. Patient selection was done by randomly allocating patients presenting to Surgery Department, either through outpatient or consultation from inpatient till reaching the sample size (30 patients). This was achieved after 6 months.

The exclusion criteria were pending amputation (due to severe vascular compromise and/or toxemia) and immuno-compromised patients (e.g. chemotherapy or steroid therapy).

As all the patients who attend the Surgery Clinic are mostly of resistant wound type, i.e. with at least 3 months history of cessation of progression or worsening of the wound, there was no need to have control group as the patients themselves were considered control before starting honey dressing. In addition, the same regimen that was followed in the previous period was the same applied to the study except for using honey as topical dressing to standardize all the factors implemented in wound management in both periods.

4. **Methods**

The surface area of all wounds was used to assess the initial size and evaluate the progress. For irregular wounds, surface area was calculated by multiplying the two largest dimensions. If the wound was roughly circular, quadrangular or triangular, the surface area was calculated according to the geometrical rules. In addition, for deep wounds (reaching the subcutaneous tissue), University of Texas Diabetic Wound Classification [16] was used to assess the grade and stage of the ulcers.

At the initial visit, the patient was assessed through detailed history and thorough clinical examination. Peripheral neuropathy and vascular sufficiency were judged clinically through sensory, motor and trophic changes. Following the diabetic foot regimen management, bacterial swab was taken from the wound for culture and sensitivity. If the wound was initially showing signs of invading infection, a combination of ciprofloxacin and metronidazole was started for 5 days. If infection was to appear during the study, antibiotic therapy was to be given according to the result of the last culture.

As we are convinced that processing of honey might alter its effectiveness (altering the ration of its components), pure raw untreated commercial honey was used in this work (no additives, pasteurization or manipulations). To assure highest quality and purity of honey, it was supplied by the Firm of Faculty of Agriculture, Alexandria University. Honey was applied the form of impregnated gauze.

4.1. **Preparation of honey impregnated gauze**

Medium-pored non-sterile gauze was used in this study. According to the surface area of the wound, the length of the gauze piece was determined (it should cover the whole wound and hang over the edges in two layers for a single piece). The number of the pieces depended upon the depth of the wound (the gauze should fill the whole depth of the wound to above the surrounding skin level).

Prior to the dressing session, the gauze length was cut (with about 10 cm more than the desired size), and submerged in a deep container to be folded over itself smoothly in multiple layers. The other edge was left to hang over the edge of the container. The gauze was left to be saturated with honey during the wound bed preparation. Excess honey was removed, particularly in highly oozing wounds, by passing the gauze between the firmly opposed middle and ring fingers.

Patients and their relatives were taught the method of preparing and applying the honey impregnated gauze in the initial visit or during hospitalization.

4.2. **Dressing technique**

Patients were treated on outpatient clinic except when there was an indication for admission (bad glucose control, need for surgical debridement, vascular insufficiency, ... etc.). As soon as the indication of hospitalization was overcome, patients were referred to outpatient clinic for follow-up.

The wound was meticulously debrided (sometimes under anesthesia) and thoroughly washed using normal saline (no antiseptic). Heavily infected wounds were rinsed with warm tap water after debridement. After drying the wound, honey impregnated gauze was applied. The gauze was held from the non-impregnated part (removed after application by scissors). Fluffy dressing was applied over the gauze and kept in place by bandage.

Frequency of dressing depended upon the amount of exudates; whenever the dressing is soaked, it should be changed by the same technique. Once single daily dressing was reached, provided all the other parameters were accepted, the patient was discharged and followed up in the outpatient clinic on weekly basis.

All patients received vitamin B complex for life. Health education was provided to all patients. The education program emphasized on the importance of: follow-up in the clinic, foot hygiene, nail care, proper footwear, nutritional regimen and management of newly healed foot ulcer.
For follow-up, monthly wound measurements, photos and culture were obtained (in addition to the routine follow-up of the laboratory and other medical investigations of the diabetic patient).

5. Results

Table 1 demonstrates demographic data of patients participating in this study. The majority of our patients (46.7%) were in their sixth decade of their life with mean age of 52.3 years. Two thirds of our patients were males. All the smokers in this study (56.7%) were males.

Table 2 shows the diabetic profile of patients participating in the study. Twenty-eight patients (93.3%) were type II. Twenty patients (66.7%) were diabetics for more than 10 years. Percentage of control in patients on insulin therapy (64.7%) was less than those on oral hypoglycemic drugs (92.3%).

Regarding the peripheral neuropathy (PN), only 9 patients (30%) had no PN.

In this study, only 6 patients (20%) had no vascular disease.

Table 3 shows the change of the ulcer size throughout the whole period of follow-up. The ulcer size decreased, with highly significant statistic rates, in 28 patients (93.3%); the remaining 2 patients (6.7%) were candidates for amputation.

Table 4 demonstrates the progression in grade and stage of the wounds throughout the whole period of the study. Improvement, in grade and stage (G&S), of ulcers was significant along the whole period of study.

At the initial visit, the highest frequency of G&S was 1-b in 20 patients (66.7%). The lowest frequency was 2-d in 1 patient (3.3%). After the first month, the highest frequency was 2-a in 18 patients (60%). By the end of second month, the highest frequency was 1-a in 13 patients (46.7%). The lowest frequency was in 6 patients (20%) in G&S of 2-a.

At the end of the study, the highest frequency was found in 12 patients (40%) in G&S of 1-a. The lowest was in 1 patient (3.3%) in G&S of 2-a.

Table 5 shows the presence of inflammation signs in the wound during the period of study. All ulcers showed signs of inflammation in initial assessment. After 1 month, 27 patients (90%) showed significant improvement with only 1 patient (3.3%) showing persistence of inflammatory signs (2 patients were subjected to amputation).

Starting from the second month, no patient showed signs of inflammation in the ulcer.

Table 6 demonstrates the presence and nature of exudates in the wound. There was significant improve in the amount and nature of discharge throughout the whole study period.

The highest frequency of ulcer exudates was foul and profuse in 23 ulcers (76.7% of the studied group) by the initial assessment.

After 1 month, the highest frequency was serosanguinous moderate exudate in 22 ulcers (73.3%).

In the second month, there were 11 ulcers (36.7%) had scanty serous exudates.
By the end of the study, all ulcers had serous very scanty exudate. The type and amount of exudate varied significantly every month throughout the whole period of the study.

Table 7 shows the percentage differentiation of microorganisms in ulcers before and after honey dressing. No ulcer was completely sterile either at the initial assessment or at the end of the study.

Staphylococcus aureus was isolated in 12 patients at the initial assessment (40% of the cases). At the end of the study, 28 ulcers (93.3%) were colonized by Staphylococcus epidermidis, while 2 ulcers only (6.7%) were colonized by Pseudomonas aeruginosa.

Table 8 shows the overall outcome of honey dressing. There was significant number of wound completely closed (13 wounds) or showing healthy granulation and surface area reduction (13 patients) by the end of the study.

Amputation was the outcome in two cases (6.7%). Graft was done in one case (3.35%) during the third month in the presence of healthy granulation tissue as the size of the ulcer was not expected to heal spontaneously. Another case (3.35%) was grafted, upon the patient request, during the second month.

6. Discussion

Results proved that honey was an easy-to-use debriding agent. Honey impregnated gauze had rapidly cleaned the wounds.
from debris without the need for enzymatic, chemical or massive mechanical debridement. Wounds were fully debrided as early as the tenth day in 8 patients. By the third week, all wounds were grossly debrided. In addition, honey impregnated gauze was easy to prepare (even by the patients or their relatives) and to apply. It peeled off easily without pain or damage to the newly forming granulation tissue. Furthermore, it was perfect in filling cavities and sinuses within the deep diabetic foot wounds.

This study revealed rapid diminution of the inflammatory signs (e.g. edema, hotness and redness) within 10 days in all patients. This was partially due to its anti-edema effect [15] and partially to its antimicrobial effect. In our study, most of the wounds became sterile by the end of the first month of honey application. These results were found by Lusby et al. [17] who found that honey was effective against twelve of the most common thirteen organisms causing wound infection. Furthermore, Maeda et al. found that honey was effective against MRSA (methicillin-resistant Staphylococcus aureus) [12]. Although P. aeruginosa was still present in 6.7% of wounds, it did not cause any clinical inflammatory manifestations. This finding was explained by Lerrer et al. [18] through abrogating microbial (particularly P. aeruginosa) adhesion to host cells, prior to infection establishment. It therefore prevented their activity in the wound even when heavily contaminated.

No hospital acquired infection was detected in all our series. This might be referred to the viscosity of honey, which provided a protective barrier thus preventing cross-infection [9].

All these factors, in addition to the stimulating effect of honey on granulation tissue and epithelialization [19], resulted in rapid absorption of edema (from the wound and surrounding area), diminution of discharge, deodorization of the wound as early as the end of the first week. This rapid dramatic response might explain the perfect patient compliance throughout the whole period of the study; proven clinically through the absence of dropouts.

The psychological factor is an important aspect in improving and impeding immunity and healing power of patients [20–23]. As honey is well known in the Egyptian, as well as all oriental cultures, as Holy remedy; rendering it a perfect environmentally based dressing (in concordance with patients’ cultural and religious beliefs) that enhanced healing. Therefore, the duration of healing in this study was significantly low (mean of 2.3 ± 0.94 weeks) when compared with other modalities (17.7 weeks with conventional dressings [24], 15 ± 7 with hyperbaric oxygen [25] and 6–8 weeks with low laser therapy [26]). The positive psychological factor as well as cultural and social beliefs explains the variation of clinical effectiveness of honey mentioned by Molan [9].

The omnipresence and low price of honey are two important advantages. This was evident in direct cost savings when compared with conventional and modern dressings; 3 kg of honey (enough for 3 months of dressing) was as expensive as 11 l of Povidone Iodine used only for wound cleansing for less than 1 month. The other important level of cost reduction was in the rapid healing rates and simplicity of the technique (dressing was done by patient relatives and at home with no need to go to clinics or import a health professional). More cost saving was through cessation of antibiotics use after 1 week in all cases as well as reduction of hospitalization period. Further saving of cost was in the reduction of debridement sessions, particularly under general anesthesia, skin grafts and amputations.

This study demonstrated that honey dressing had no major effect on ulcer with exposed bone. Both amputated cases were classified 3-d. The signs of inflammation continued to increase and osteomyelitis ultimately developed. Similarly, when there was severe vascular insufficiency, honey had no effect. Nevertheless, this type of wound showed excellent response to honey dressing after revascularization operation. Although there was a good response, bad control of blood glucose level, poor compliance and bad psychological condition markedly affected the efficiency of honey dressing.

7. Conclusion and recommendations

Honey is ideal as dressing in cases of diabetic foot wounds particularly in the developing countries. It is an environmentally based cost and clinically effective dressing. More importantly, it is very safe as it did not result in any complication (local or systemic), or emergence of resistant bacterial strains. Nevertheless, it is not effective in cases of severe vascular insufficiency, exposed bone (without perios- tum) or established osteomyelitis.

It is indispensable to correct the general condition of the patient to achieve optimum results. Furthermore, patient beliefs and culture should be bared in mind when prescribing treatment modalities.

We recommend a comparative study for comparing the results of believers and non-believers of honey as dressing in cases of diabetic foot wound infection.
Conflict of interest

No financial support or benefits have been received by me or any co-author, by any member of our immediate family or any individual or entity with whom or with which we have a significant relationship from any commercial source which is related directly or indirectly to the scientific work.

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