



## Full Length Review Article

### EFFECT OF CITRIC ACID DRESSING ON WOUND HEALING OF DIABETIC FOOT ULCER

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#### ABSTRACT

**Aims:** The study aim was to assess the effect of Citric acid dressing on wound healing of diabetic foot ulcer and to identify the association of wound healing with the selected demographic and clinical variables among the patients with diabetic foot ulcer.

**Materials and Methods:** Totally sixty patients admitted in surgical wards with diagnosis of diabetic foot ulcer were included in the study. Diabetic patients who were sensitive to citric acid and non-diabetic foot ulcer were excluded from the study. The tool used for the study was Modified Bates Jensen's Wound assessment tool and data was collected by observation method. The wound dressing was carried by using 3% citric acid solution upto 21 days daily once. The wound was assessed before and after citric acid dressing on 8<sup>th</sup> day, 15<sup>th</sup> day and 22<sup>nd</sup> day.

**Results:** Out of sixty patients, nine (15%) patients had critical wound status and 51 (85%) had moderate level wound healing status on the 15<sup>th</sup> day assessment after citric acid dressing. On the 22<sup>nd</sup> day assessment after citric acid dressing, only two (3.3%) patients had critical wound status, four (6.7%) had moderate level wound, 53 (88.3%) had mild level wound and one (1.7%) patient had minimal level wound. In pre-assessment on 1<sup>st</sup> day all patients had critical wound status. In post assessment, after 21 day of citric acid dressing, majority of the patients had mild wound status.

**Conclusion:** There was good response to citric acid dressing on wound healing of diabetic foot ulcer. Citric acid solution dressing is more effective on wound healing of diabetic foot ulcer. It is simple and the better than other dressing solution used for diabetic wound dressing.

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#### INTRODUCTION

Diabetic foot infection is a common cause for hospital admission among the diabetic patients in India. This could be attributed to several socio-cultural practices such as barefoot walking, inadequate facilities for diabetes care and education and poor socio-economic conditions. The recurrence rates for ulcers in neuropathic subjects were estimated at 52 % in a study carried out among 374 patients. In India, the patients with foot infection spend a significantly higher proportion of their income on treatment than those without foot complications. Further, there is a poor awareness regarding the need for foot care among the diabetic patients. Foot ulceration generally, is preventable and relatively simple interventions can reduce the amputations up to 80 percent. Foot ulceration is

common in both type 1 and type 2 diabetes and occurs in every part of the world (Viswanathan *et al.*, 2007). Every 30 seconds, a diabetic patient, somewhere in the world loses a limb as a direct result of diabetes. Thirty three percent of diabetic people are at the risk of developing foot ulcer. Sixteen percent of diabetic people will definitely develop the foot ulcer. The prevalence of amputation among type 2 diabetic patients is 3%. Of the total lower limb amputations, 85% are due to diabetic foot. One ulcerated diabetic is 58 times more likely to re-ulcerate and five percent of the diabetic patients anticipate foot ulcer in one year (<http://www.idf.org/diabetesatlas/5e/the-global-burden>). Dr Das, a senior health specialist and the president of Diabetic Foot Society of India (DFSI), stated that fifteen per cent of all diabetics develop ulcers in their feet. In 50 per cent of these cases, the infection becomes severe and leads to amputation. In the majority of cases, the amputations are above the knee. In India, 71 per cent of non-accident related limb amputations are due to diabetes (<http://articlestimesofindia.Indiatimes.Com/2011>).

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Infection is a common reason for poor wound healing, especially, in chronic wounds. Significant reduction in the number of bacteria is essential for healing. Citric acid was found effective against almost all bacterial pathogens causing wound infections in vitro. Local application of citric acid to a variety of chronic infected wounds such as diabetic foot infections, chronic traumatic wound/non-healing ulcers, lepromatous ulcers, necrotizing fasciitis, burns infections, etc. resulted in complete healing in more than 95% of chronic infected wounds indicating that the citric acid is most effective in the treatment of various wounds, including wounds for which there are no alternative options available (Nagoba, 2012). Citric acid dressing will improve wound healing, minimize the incidence of amputation and reduce the health care utilization, the stay and the cost of hospitalization, which would improve the quality of life among the patients with diabetic foot ulcer. So, the present study was conducted to assess the effect of Citric Acid Dressing on Wound Healing of Diabetic Foot Ulcer in and to identify the association of wound healing with the selected demographic and clinical variables among the patients with diabetic foot ulcer.

## MATERIALS AND METHODS

The study was conducted in Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER), Puducherry, India. Totally, sixty diabetic foot ulcer patients who were admitted in the general surgical wards with or without co-morbidity illness included for the study. The patients who were sensitive to citric acid and critically ill were excluded from the study. Socio-demographic variables of the patients and the clinical data were gathered by using the interview method in regional language. For assessing the ulcer, the Modified Bates Jensen's Wound Assessment tool was used. It is a comprehensive tool which gives adequate information of diabetic foot wound like size, depth, edges, undermining, necrotic tissue types, necrotic tissue amount, exudate type, exudate amount, skin colour surrounding the wound, peripheral tissue edema, peripheral tissue induration, granulation tissue, epithelization and assessment of bio-burden. Modified Bates Jensen's wound assessment tool was used to assess the diabetic foot ulcer healing process by direct observation method. The tool evaluates fourteen wound characteristics on a five point rating scale, with lower scores indicating greater desirability of wound healing process. Each parameter was marked with scores based on the severity of the wound. Total scores ranged from fourteen (skin intact but at risk for further damage) to 70 (profound tissue degeneration).

noted as mild wound, 34-44 were stated as moderate wound and 45-70 were classified as critical wound. Ethical approval was obtained from Institute Ethical Committee (Human Studies). The reliability of the Modified Bates Jensen's wound assessment scale was found 0.88 by inter-rater method, which showed a highly positive correlation of the intervention. Descriptive and inferential statistics were used for analyzing the data. The mean, standard deviation, percentages, paired 't' test and chi-square test were used to express the data.

## Study Intervention

Commercially available citric acid (Monohydrate) is used for pharmaceutical purpose. It easily dissolves in water. Citric acid is added to distilled water in the ratio of 3gm/100ml. Citric acid solution is prepared in pharmacy preparation wing by the pharmacist. Three percent citric acid solution is stored in a sterile container and closed with air tight cap. The wound status was assessed before starting citric acid dressing (pre assessment) on the first day. The wound was cleaned with 3% citric acid soaked gaze pieces, and then the spread the citric acid soaked gazes over wound and applied dressing not used any other solutions. For each dressing, approximately 50 to 100 ml of citric acid solution was needed. Initially wound size was large, so more solution was required and gradually wound size became small after healing which required less solution. So, the cost of each dressing using citric acid solution was 0.25 paisa to 0.50 paisa (costs mentioned in the study is the JIPMER hospital rate at the time of data collection). The citric acid dressing was carried out upto 21 daily once. The wound healing status (post assessment I, II & III) was assessed on 8<sup>th</sup> day, 15<sup>th</sup> day and 22<sup>nd</sup> day.

## RESULTS

The table mentioned data was revealed that after 21 days citric acid dressing, out of 60, four (6.7%) patients had moderate wound status, 53 (88.3%) patients had mid wound status and one (1.7%) had minimal wound status. On the whole, the patients had good response to citric acid dressing which was proved by the reduction in number of patients with critical wound status from 60 (100%), during pre-assessment, to 2 (3.3%) on the 22nd day of citric acid dressing. In the pre-assessment (before citric acid dressing), the mean score of wound status was 66.23 with the standard deviation of 1.995. In the post-assessment I (on the 8th day), the mean score was 55.58 with the standard deviation of 3.903 and the mean score variation, between the pre-assessment and post-assessment I, was 10.650.

**Table 1. Effect of Citric Acid Dressing on Wound Healing of Diabetic Foot Ulcer**

| Wound healing status (scores) | Pre-Assessment (1 <sup>st</sup> day) |     | Post-Assessment I (on 8 <sup>th</sup> day) |     | Post-Assessment II (15 <sup>th</sup> day) |    | Post-Assessment III (22 <sup>nd</sup> day) |      |
|-------------------------------|--------------------------------------|-----|--|-----|---|----|--|------|
|                               | No.                                  | %   | No.  | %   | No.                                       | %  | No.  | %    |
| Critical Wound (70 – 45)      | 60                                   | 100 | 60   | 100 | 9   | 15 | 2  | 3.3  |
| Moderate wound (34 – 44)      | -                                    | -   | -  | -   | 51  | 85 | 4  | 6.7  |
| Mild Wound (23 – 33)          | -                                    | -   | -  | -   | -   | -  | 53   | 88.3 |
| Minimal wound (14 – 22)       | -                                    | -   | -  | -   | -   | -  | 1  | 1.7  |

The continuum had two extreme ends of wound condition spectrum. They were wound regeneration and wound degeneration. Each parameter was marked with scores based on the severity of the wound. Total scores ranged from fourteen (skin intact but at risk for further damage) to 70 (profound tissue degeneration). The wound severity was classified as 14 -22 was mentioned as minimal wound, 23-33

In the post-assessment II (on the 15th day) the mean score was 66.23 with the standard deviation of 4.595 and the mean score variation between pre-assessment and post-assessment II was 24.383. In the post-assessment III (on the 22nd day), the mean score was 28.03 with the standard deviation of 5.734 and the mean score variation between the pre-assessment and the post-assessment III was 38.200. According to the data given above,

the wound healing status the mean score was found improved from 66.23 to 28.03 on the 22nd day of citric acid dressing. The paired 't' test was carried out to find whether there was any difference in wound healing status between the pre and post assessments. The significant 'p' value ( $p < 0.0001$ ) gave the inference that the difference in wound healing status existed (after citric acid dressing) among the pre and post assessments I, II, and III which were statistically significant. There was a significant association between the wound status and marital status, history of digital amputation, type of diabetes mellitus and HbA1c level ( $p < 0.05$ ) of the patients with diabetic foot ulcer.

## DISCUSSION

The paired "t" test was carried out to find whether the difference in wound healing status existed between the pre and post assessments. The significant "p" value ( $p < 0.0001$ ) gave the inference that the difference in wound healing status existed (after citric acid dressing) between the pre and post assessments I, II, and III was statistically significant. In pre-assessment, on 1<sup>st</sup> day, all patients had critical wound status. After 21 day of citric acid dressing, majority of the patients had mild wound status in post assessment. There was good response to citric acid dressing on wound healing of diabetic foot ulcer. Citric acid solution dressing is the more effective on wound healing of diabetic foot ulcer. It is simple and better than other dressing solution used for diabetic wound dressing. After 21 days citric acid dressing, the wound status was mild, then the remaining wound was closed by skin graft. Citric acid is highly cost-effective dressing solution than the normal saline, Hydrogen peroxide, Betadine and any other antiseptic solutions. For each dressing, approximately 50 to 100 ml of citric acid solution was needed.

Initially wound size was large so more solution was needed and gradually wound size became small after healing which required less solution. The cost of citric acid solution was 0.25 paisa to 0.50 paisa for each dressing (costs at the time of study period). The study finding was supported by Nagoba, *et al.* (2010) conducted a study on a simple and effective approach for the treatment of diabetic foot ulcers with different Wagner grades at Nagpur, India. An attempt has been made to develop simple and effective treatment modality by using citric acid as a sole antimicrobial agent to control diabetic foot infections not responding to conventional treatment. Hundred and fifteen cases of diabetic foot ulcers of different Wagner grades infected with a variety of bacteria were investigated for culture and susceptibility to citric acid. Citric acid gel was applied to ulcer to determine its efficacy in the management of diabetic foot ulcers with different Wagner grades. Citric acid gel was found effective in the control of foot infections; especially in Wagner grades I and II, the success rate was found to be more than 94%. In Wagner grade III also, it was found effective in complete healing of ulcers without deep osteomyelitis. Amol, Basavraj and Bharat (2012) did a case study of citric acid treatment on large non-healing ulcer in India. A case of 45 years old male patient with a large non-healing ulcer over right leg was a known case of chronic liver disease and was having multiple underlying problems. The ulcer was not responding to conventional treatment for more than one month. This non-healing ulcer was treated simply by local application of three percentage citric acid ointment every day for a month, which led to complete healing of the ulcer without any complications. It revealed that the citric acid dressing was an effective

treatment on chronic diabetic foot wound infections which was not responding to conventional local wound care management. Citric acid dressing showed effective wound healing on diabetic foot ulcer. This type of dressing on diabetic foot ulcer results in rapid desloughing of the wound, reduction of the load of infection, odour, better granulation tissues formation, shrinkage of the wound diameters and adequate progress of epithelialization. There were no noted untoward reactions during the citric acid dressing. It is highly cost effective than the conventional method of dressing.

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## Conflict of Interest

None.

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