



An Observational study on Silver Nitrate solution in dressing of Diabetic foot Ulcer

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Abstract

Objectives: This study was to evaluate the effect of silver nitrate solution on bacterial load in the wound, rate of granulation tissue formation, time required for healing, skin graft uptake and side effect of topical silver nitrate dressing in diabetic foot ulcer patients.

Methods: Detail history, clinical examinations and relevant investigations were performed to all diabetic foot ulcer patients. Silver nitrate solution was used for dressing of case group patients. whereas in control group dressing was done by 50% w/v povidone-iodine solution.

Results: Data was analysed by using IBM SPSS version 26 software. Mean \pm standard deviations was observed. Chi square test was applied. P value was taken less than or equal to 0.05 ($p \leq 0.05$) for significant differences.

Conclusions: Elderly diabetic age group patients were prone to diabetic foot ulcer. Male was more preponderance than female. A significant beneficial effect was seen in dressing with silver nitrate solution in terms of bacterial load in the wound, rate of granulation tissue formation, time required for healing, skin graft uptake and side effect with respect to 50% w/v povidone-iodine solution dressing in diabetic foot ulcer patients. Hence, Silver nitrate solutions should be used for the management of wound healing in diabetic foot ulcer. It is a cost-effective option with better results.

Keywords: diabetic foot ulcer, liquid silver nitrate, povidone-iodine solution, wound healing, age group

Introduction

Chronic leg ulcers are generally related with reduced quality of life, high morbidity and financial loss to the patient [1,2]. Diabetic foot ulcers precede almost 85% of amputations in India [3]. The dressing of wound is an old art varying from herbal dressing to modern dressing material like creams, ointments and solutions. The classes of wound dressing are occlusive dressing, non-occlusive dressing, absorptive dressing, skin substitutes and negative suction vacuum dressing. Despite many modes of wound dressing, treating diabetic wound is a challenging task and this has led in search of better option for wound healing agent [4,5].

The selection of wound dressings plays a pivotal role in diabetic wound care management. An ideal dressing should be cheap, easy to use, non-adherent, non-allergic, maintain a moist wound environment, absorb excessive exudates, allow gaseous exchange, control wound odour, provide thermal insulation and mechanical protection, prevent wound contamination and lower the risk of infections [6]. Numerous dressings are available like Saline, hydrogels, hydrocolloid, foam, alginate, Paraffin (Tulle), Polyurethane, silver impregnated dressings. Saline dressings are inexpensive and provide an atraumatic moist environment but the maintenance of the moist environment is a problem with these dressings. Hydrogel dressings provide adequate hydration and analgesic effect for dry wounds with necrotic eschar [7, 8]. Hydrocolloid dressings provide more consistent moisture retention, absorb low to moderate level of exudates and retain

growth factors which promote granulation [7, 8]. Liquid Silver nitrate, a newer agent may be tried in treating of diabetic foot ulcer, as it has been claimed for faster granulation tissue formation in the wound. Objectives of our study was to evaluate the effect of silver nitrate solution on bacterial load in the wound, rate of granulation tissue formation, time required for healing, skin graft uptake and side effect of topical silver nitrate dressing in diabetic foot ulcer patients.

Materia & Methods

This present study was conducted in Department of Surgery, Government Doon Medical College and Hospital, Dehradun, Uttarakhand, India during a period from January 2019 to November 2019. Attendants/Entire subjects signed an informed consent approved by institutional ethical committee of Government Doon Medical College, Dehradun. A total of 80 patients of diabetic foot ulcer were enrolled in this study. It was categorized into two group (Control group =40, and case group= 40)

Inclusion Criteria of this study were grade I and II foot ulcers as per Meggitt-Wagner classification and patients on oral hypoglycaemic agent or insulin for Diabetes mellitus.

Exclusion Criteria of this study were

chronic ulcers due to other aetiology., grade III, IV, V foot ulcers as per Meggitt-Wagner classification, immunocompromised state

like HIV, age less than 15 years, patients with varicose vein and decreased vascularity (ischaemia) of lower limb and patients with allergy to silver nitrate.

Procedures

Detailed history was taken. History of IHD (Ischaemic Heart Disease), other chronic systemic ailments, smoking and alcohol drinking was asked and recorded. The site, depth and duration of ulcer were recorded. In all patients haemoglobin, DC (Differential Count), TLC (Total Leucocyte Count), FBS (Fasting Blood Glucose), PPBS (Postprandial blood glucose), blood urea and creatinine were routinely done. Urine routine and microscopic examination was done. After slough removal the surface were measured, tracing the outline on transparent paper. This outline was transferred to graph paper and size was measured in both control and case group patients.

In case group, 2 mL of silver nitrate solution was taken in a syringe after cleaning the wound with distilled water, drying it with sterile gauze and then the silver nitrate solution was sprinkled over the wound surface. After this the wound was covered with gauze soaked with silver nitrate solution, whereas in control group dressing was done by 50% w/v povidone-iodine solution. Dressings were done and followed every alternate day for 14 days. Size of ulcers was measured weekly. Wound culture was done on day 1 and on day 14, observed side effect (local and systemic) were documented.

Statistical Analysis

Data was analysed by using IBM SPSS version 26 software. Mean \pm standard deviations was observed. Chi square test was applied. P value was taken less than or equal to 0.05 ($p \leq 0.05$) for significant differences.

Observations

This present study was included a total of 80 patients and majorities of cases belonged to age group 46 to 60 years. In this study, majorities of cases 60(75%) were male. Male and female ratio was 3:1.

In control group, 6(15%) patients had ulcer size < 5 cm; 12(30%) patients had ulcer between 5 - 10 cm and 4(10%) patients had ulcer size > 10 cm. In case group, 8(20%) patients (20%) had ulcer size < 5 cm; 5(12.5%) patients had ulcer size 5 - 10 cm and 6(15%) patients had ulcer size > 10 cm.

The rate of granulation tissue formation was assessed on 14th day.

Most of the control cases 20(50%) had granulation tissue 81%-90%. Most of the case group patients 24(60%) had granulation tissue 91%-100%. Both groups were significantly differenced ($p=0.001$).

Table 1: Showing granulation tissue formation on 14th Day

Granulation Tissue	Control N=40	Study N=40	P-value
71% - 80%	15	4	0.001
81% - 90%	20	12	
91% - 100%	5	24	

After granulation tissue formulation, the patients in both groups were subjected to spilt thickness skin grafting and graft uptake

was again measured on the 7th post-operative day as the % of ulcer surface area was mentioned.

In case group, most of the patients 24(60%) had successful graft (91-100%), and in control group, most of the patients 21(52.5%) had successful graft (81-90%) it was found to be highly significant ($p= 0.0001$)

Table 2: showing graft uptake

Graft Uptake	Control n=40	Study n=40	p- value
$< 70\%$	12	3	0.0001
71% - 80%	5	5	
81% - 90%	21	8	
91% - 100%	2	24	

Table 3: Showing duration of hospital stay

Duration of Hospital Stay	Control N=40	Study N=40	p-value
Mean \pm SD	36.00 \pm 3.524	24.41 \pm 2.45	0.0001

Hospital stay for case group patients was 24.41 \pm 2.45 days and in control group was 36.00 \pm 3.524 days. It was found to be extremely significant ($p= 0.0001$)

Difference in mean duration of hospital stay between the control and study group is 11.59 days

Patients of both groups were subjected to culture and sensitivity test and antibiotics were adjusted accordingly. At 1st day, 18(45%) were positive in control group and 9(22.5%) case group patients were positive for bacterial culture. And it significant differences $p=0.001$)

Table 4: Showing bacterial culture report on day 1

Result	Control N=40	Study N=40	P-value
Positive	18	9	0.001
negative	22	31	

After 14 days again, culture and sensitivity test was performed. And extremely significant differences was found ($p=0.0001$). And 26(65%) patients were negative in control group. And 37(92.5%) patients were negative in case group.

Table 5: Showing bacterial culture report on day 14

Result	Control N=40	Study N=40	P-value
Positive	14	3	0.0001
negative	26	37	

Discussions

Diabetes Mellitus (DM) is one of the most common chronic and metabolic diseases. Diabetic foot ulcer (DFU) are characterized by infection, ulceration and destruction of the deepest tissues of lower limbs, associated with neurologic alterations and diverse degrees of peripheral vascular disease [9]. Infection of DFU with Multi-Drug Resistance (MDR) microorganisms may increase the time of wound healing, hospitalization, treatment costs and patient mortality [10].

In our present study, we were used as a dressing material silver nitrate in liquid form for diabetic foot ulcer. This study was similar to Muthu Kumar Swamy MG *et al*, [11], who tried with phenytoin.

Silver and its compounds were readily used by medical professionals to counter bacterial infections in acute and chronic

wounds, including burns^[12]. Silver dressings contain silver atoms that are slowly released as positively-charged silver cations (Ag⁺), which have a strong antimicrobial effect: they bind to bacterial cell wall, causing disruption of the wall and the death of the bacteria^[13, 14]. Ag⁺ ions also bind to bacterial enzymes thereby preventing them from performing their function as well as to bacterial cell DNA, thus interfering with cell division and replication^[13].

In this present study, mean age of patients were 49 years. Majorities of cases were belonged to age group 46 to 60 years. Male and female ratio was 3:1.

A highly significant (p=0.001) granulation was seen in case group patients with respect to control group diabetic foot ulcer patients on 14th day.

Nanocrystalline silver ion dressing is an effective antimicrobial barrier composed of an absorbent inner core that maintains a moist environment optimal for wound healing and outer layers of silver coated polyethylene nets which prevent wound contamination and exhibit bactericidal effect^[15]. Waterproof top film with visible strike through indicates when dressing change is required. To achieve a broad spectrum bactericidal effect, silver ions concentration must be atleast 30-40 mg/l. Nanocrystalline silver ion dressings provides concentration of silver at 70-100 mg/l which is bactericidal and kills over 150 types of pathogens. It releases as much as 30 times silver ions which allows dressing changes to be reduced from once or twice daily to every second or third day^[16]. A continuous equilibrium of aqueous silver is maintained for over 48 hours and silver is released at good concentration levels even when water volume is doubled at 24 hours.

This present study was also similar with other studies like Pendse *et al*^[17], and Bansal *et al*^[18].

In this present study, extremely significant successful graft was seen in case group patients with respect to control (p=0.0001). Extremely significant (p=0.0001) short hospital stay was seen in case group patients than control. Difference in mean duration of hospital stay between the control and study group is 11.59 days. On 14th day culture sensitivity test, extremely negative significant differences (p=0.0001) was seen in case group patients with respect to control group patients.

Conclusions

This present study concluded that the elderly diabetic age group patients were prone to diabetic foot ulcer. Male was more preponderance than female. A significant beneficial effect was seen in dressing with silver nitrate solution in terms of bacterial load in the wound, rate of granulation tissue formation, time required for healing, skin graft uptake and side effect with respect to 50% w/v povidone-iodine solution dressing in diabetic foot ulcer patients. Hence, Liquid silver nitrate solution should be used for the management of wound healing in diabetic foot ulcer. It is a cost-effective option with better results.

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