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COMPARISON OF EFFICACY OF ALGINATE FILLER DRESSINGS WITH CONVENTIONAL SALINE DRESSINGS FOR CAVITY WOUNDS IN DIABETIC FOOT ULCER

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ABSTRACT

Background: Diabetic foot ulcers are a common and serious complication of diabetes mellitus and may be associated with delayed healing, infection, prolonged treatment, and risk of amputation.

Objective: To compare the efficacy of alginate filler dressings with conventional saline dressings for cavity wounds in patients with diabetic foot ulcers.

Methods: This randomized controlled trial was conducted at General Surgery, Sir Ganga Ram Hospital, Lahore, Pakistan from May 06, 2026 to August 10, 2026, included 88 patients with Wagner grade 2 or 3 diabetic foot cavity wounds, with 44 patients allocated to each group. Patients aged 15–70 years were enrolled through non-probability consecutive sampling and randomly assigned using the lottery method. Group A received conventional saline dressings, while Group B received alginate filler dressings.

Results: The two groups were comparable at baseline. At week 6, the mean PUSH score was significantly lower in the alginate group than in the saline group (3.4 ± 1.5 vs. 5.6 ± 1.8, $p<0.001$). Mean wound area was also lower in the alginate group (3.9 ± 2.1 cm² vs. 6.1 ± 2.8 cm², $p<0.001$). Mean wound area reduction was greater with alginate dressings (69.0 ± 16.4% vs. 49.8 ± 18.7%, $p<0.001$), while the mean exudate score was lower (0.7 ± 0.6 vs. 1.2 ± 0.7, $p<0.001$). A ≥50% reduction in wound area was achieved in 36 (81.8%) patients in the alginate group compared with 25 (56.8%) in the saline group ($p=0.020$). Complete wound closure occurred in 15 (34.1%) versus 6 (13.6%) patients, respectively ($p=0.044$), while wound infection was observed in 3 (6.8%) versus 11 (25.0%) patients ($p=0.039$).

Conclusion: Alginate filler dressings were more effective than conventional saline dressings in improving wound healing, reducing wound area and exudate, increasing complete wound closure, and reducing wound infection in patients with diabetic foot cavity wounds.

KEYWORDS: Diabetic foot ulcer, alginate dressing, saline dressing, cavity wound, PUSH score, wound healing.

INTRODUCTION

DM is a complex metabolic disease, where the characteristic is hyperglycaemia, as a result of a defect in insulin action, or a defect in insulin production or both (1). DM is considered a major health problem with a worldwide increase in its prevalence and is the 7th major cause for mortality (2). Typically, 25% of patients with DM develop DFUs, which often result in amputations and a decreased quality of life. Foot ulcers occur in diabetes mellitus and are a significant diabetes complication that is costly, causes a high resource utilization, and has high morbidity and mortality rate (1-3). It has been estimated to occur around 2% of the time annually with lifetime incidence ranging from 19% to 34% (3). In the world, for every 20th second a person loses a limb to diabetics - it is estimated this is the single most common reason for non-traumatic LL amputations (4). Chronic wounds can be treated using 2 surgical interventions: debridement and skin grafting, both of which are costly in terms of care. Various non operative measures have been undertaken in the past for healing of diabetic ulcers starting from normal saline dressings, growth factors like Platelet-Derived Growth Factor β (PDGF beta), and bioengineered skin substitutes to the use of negative pressure wound therapy. But, taking into account the cost of the patients, most of them would not be able to afford the patients. One such cost effective yet efficacious material which can be used for managing cavity wounds are Alginate filler wound dressings (5).

Alginates are found in marine brown algae (pheophycea) with its cell wall constituent in the form of alginic acid, which was first extracted by a British chemist Stanford in 1881. Alginates have been used in the food and textile industries in the past. These were said to have been used by sailors to cure wounds and so were called the ‘mariner's cure'. Blaine employed alginates to treat burns in 1947 when burns were produced in a laboratory. Alginic acid is made up of mannuronic acid (M) and guluronic acid (6). They are manufactured based on an ion-exchange reaction; the soluble sodium alginates produced from the purification and extraction of the seaweed is dissolved in water to produce a colloidal solution which is then passed through a bath of calcium ions thereby converting to insoluble

calcium or calcium sodium alginates (7). Based on their ratio of guluronic acid and mannuronic acid, they can absorb 15-20 times its own weight (8). The important properties of alginates are the ability to absorb exudates which can prevent maceration of wounds, biodegradability which has a significant inhibitory effect on Staphylococcus aureus, Streptococcus pyogenes or Bacteroides fragilis, and haemostasis (9).
A study conducted by Chitrambalam Tg et al. (10) shows results of wound assessment before dressings, at two weeks and at the end of four weeks are as follows: The mean (SD) reduction in wound surface area was 9.07cm2 (1.634) to 6.89cm2 (1.434) to 4.68cm2 (1.272) for alginate group and 9.25cm2 (2.059) to 8.00cm2 (1.905) to 6.50cm2 (1.650) for saline group. The mean (SD) reduction of the exudate amount was 2.02ml (0.505) to 1.09ml (0.473) to 0.14ml (0.347) for the alginate group and 1.98ml (0.590) to 1.43ml (0.625) to 0.75ml (0.615) for the saline group. The mean (SD) cavity wound scores for tissue type decreased from 2.30 (0.701) to 0.16 (0.370) in the alginate group and 2.32 (0.740) to 0.77 (0.743) in saline group after 4 weeks' evaluation period on the basis of Pressure Ulcer Scale for Healing (PUSH) scoring. Wound cultures were performed in both groups at the end of 4-weeks and it was found that, at the 13th day of evaluation, 6/44 patients (13.6%) were culture positive in alginate group, compared to 30/44 patients (68.2%) in saline group (p- value < 0.001). Another study conducted by Dumville JC (11) shows no statistically significant difference in the number of ulcers healed between the alginate-dressed group (5/20; 25%) and the basic wound contact-dressed group (7/19; 37%).

Objectives
To compare the mean reduction of the surface area, quantity of exudate and tissue type (PUSH score) of the cavity wounds between alginate dressings and conventional saline dressings.

METHODOLOGY
The study was a Randomized controlled trial carried out in the Department of General Surgery, Sir Ganga Ram Hospital Lahore from May 06, 2026 to August 15, 2026. A non-probability consecutive sampling technique was used for recruitment of eligible patients. The number of patients in each group was 44, with a total of 88 patients. Calculated with a 95% confidence level and 80% power of the test on the background of the expected mean PUSH score of 2.14 ± 0.30 with the alginate dressing group and of 1.55 ± 0.003 with the conventional saline dressing group [10]. The patients were selected who had Wagner grade 2 or 3 cavity wounds in the diabetic foot aged 15-70 years. Patients with deep venous thrombosis, skin malignancy, venous or arterial ulcers, underlying osteomyelitis, coagulation impairment, peripheral vascular disease and refusal by the patient/guardian to participate were excluded.

Data Collection
Patients who came to the Surgical Outpatient Department of Sir Ganga Ram Hospital with wounds/cavities of the foot were screened for eligibility after approval from the hospital ethical committee and College of Physicians and Surgeons Pakistan. After written informed consent was obtained, 88 patients were eligible for the study. A detailed history and relevant clinical information was documented for each participant. With a random selection of 44 patients by a lottery, the patients were divided into two groups. The conventional normal saline dressings were used over the wounds of group A. Debris and exudate were removed from the wound with normal saline, and then the wound was covered with sterile gauze soaked in normal saline. Dressings were changed every day or sooner if necessary based on the wound condition. Alginate filler dressings were given to group B. Wound was cleaned by normal saline and then wound cavity was filled with alginate based dressing along with the absorption of wound exudate. The dressing was changed every 1-3 days depending on the quantity of exudates from the wound.
All subjects were given routine diabetic foot-care, which comprised blood glucose monitoring and control, evaluation of wound infection and monitoring the healing process. The follow-up evaluations were conducted at regular intervals of about 1-2 weeks. At every follow-up, the healing of the wounds, control of exudates, wound surface area, and infection were evaluated. The Pressure Ulcer Scale for Healing (PUSH) was used to evaluate wound healing. The tool used to assess wound size – length x width, amount of exudate and tissue type. Follow-up wound assessments were made to objectively evaluate improvement in the wound and to compare the effectiveness of alginate filler dressings to saline dressings. Other outcomes were wound surface area, wound exudate control, wound healing status and infection.

Data Analysis
Data was entered and analysed using a computer program known as IBM SPSS Statistics version 25.0. The quantitative data such as age, ulcer size, PUSH score, and exudate amount were reported as mean ± standard deviations. Categorical variables like ulcer site, wound healing status, infection were represented as frequency and percentage. Means of PUSH scores and other quantitative values were compared between two groups with independent-samples t-test and categorical values were compared with the chi-square test. To control for potential effect modifiers, data were stratified by age, ulcer size and ulcer site. The independent-samples t-test or chi-square test (X 2) was used, as appropriate, after stratification. A p-value cut-off of < 0.05 was considered statistically significant.

RESULTS
Data were collected from 88 patients. The mean age was 55.6 ± 8.8 years in the saline dressing group and 54.8 ± 9.1 years in the alginate dressing group (p=0.676). Males comprised 30 (68.2%) patients in the saline group and 29 (65.9%) in the alginate group, while females accounted for 14 (31.8%) and 15 (34.1%), respectively (p=1.000). The

mean ulcer duration was 9.5 ± 4.9 weeks in the saline group and 9.2 ± 4.7 weeks in the alginate group (p=0.770). Baseline wound area was 12.2 ± 5.0 cm² versus 12.6 ± 5.3 cm² (p=0.717), while the baseline PUSH score was 11.0 ± 2.0 versus 11.2 ± 2.1 (p=0.649). Wagner grade 2 ulcers were present in 24 (54.5%) and 25 (56.8%) patients, while grade 3 ulcers were seen in 20 (45.5%) and 19 (43.2%) patients, respectively (p=1.000).

Table 1. Baseline Demographic and Wound Characteristics of Patients

Variable	Saline Dressing (n=44)	Alginate Dressing (n=44)	p-value
Age, years, Mean ± SD	55.6 ± 8.8	54.8 ± 9.1	0.676
Male, n (%)	30 (68.2)	29 (65.9)	1.000
Female, n (%)	14 (31.8)	15 (34.1)	
Ulcer duration, weeks, Mean ± SD	9.5 ± 4.9	9.2 ± 4.7	0.770
Baseline wound area, cm², Mean ± SD	12.2 ± 5.0	12.6 ± 5.3	0.717
Baseline PUSH score, Mean ± SD	11.0 ± 2.0	11.2 ± 2.1	0.649
Wagner grade 2, n (%)	24 (54.5)	25 (56.8)	1.000
Wagner grade 3, n (%)	20 (45.5)	19 (43.2)	
Forefoot ulcer, n (%)	22 (50.0)	24 (54.5)	0.911
Midfoot ulcer, n (%)	13 (29.5)	12 (27.3)	
Hindfoot ulcer, n (%)	9 (20.5)	8 (18.2)	

At baseline, the mean PUSH score was similar between the saline and alginate groups at 11.0 ± 2.0 and 11.2 ± 2.1, respectively (p=0.649). At week 2, the score decreased to 9.6 ± 2.0 in the saline group and 8.7 ± 1.9 in the alginate group, with a statistically significant difference (p=0.033). At week 4, the mean PUSH score further declined to 7.4 ± 1.9 in the saline group and 5.9 ± 1.7 in the alginate group (p<0.001).

Table 2. Comparison of PUSH Scores Between the Two Groups During Follow-up

Assessment Time	Saline Dressing (n=44), Mean ± SD	Alginate Dressing (n=44), Mean ± SD	p-value
Baseline	11.0 ± 2.0	11.2 ± 2.1	0.649
Week 2	9.6 ± 2.0	8.7 ± 1.9	0.033
Week 4	7.4 ± 1.9	5.9 ± 1.7	<0.001
Week 6	5.6 ± 1.8	3.4 ± 1.5	<0.001

The baseline wound area was comparable between the two groups, measuring 12.2 ± 5.0 cm² in the saline group and 12.6 ± 5.3 cm² in the alginate group (p=0.717). At week 6, the mean wound area had reduced to 6.1 ± 2.8 cm² in the saline group and 3.9 ± 2.1 cm² in the alginate group, showing a significant difference (p<0.001). The mean percentage reduction in wound area was 49.8 ± 18.7% in the saline group compared with 69.0 ± 16.4% in the alginate group (p<0.001).

Table 3. Comparison of Wound Size, Wound Area Reduction, and Exudate at Final Follow-up

Outcome	Saline Dressing (n=44), Mean ± SD	Alginate Dressing (n=44), Mean ± SD	p-value
Baseline wound area, cm²	12.2 ± 5.0	12.6 ± 5.3	0.717
Wound area at week 6, cm²	6.1 ± 2.8	3.9 ± 2.1	<0.001
Reduction in wound area, %	49.8 ± 18.7	69.0 ± 16.4	<0.001
Exudate score at week 6	1.2 ± 0.7	0.7 ± 0.6	<0.001

At final follow-up, a reduction of at least 50% in wound area was achieved in 25 (56.8%) patients receiving saline dressings and 36 (81.8%) patients receiving alginate dressings, with a statistically significant difference (p=0.020). Complete wound closure was observed in 6 (13.6%) patients in the saline group compared with 15 (34.1%) in the alginate group (p=0.044). Wound infection occurred in 11 (25.0%) patients treated with saline dressings and only 3 (6.8%) patients receiving alginate dressings (p=0.039).

Table 4. Clinical Wound Healing Outcomes at Final Follow-up

Outcome	Saline Dressing (n=44), n (%)	Alginate Dressing (n=44), n (%)	p-value
≥50% reduction in wound area	25 (56.8)	36 (81.8)	0.020
Complete wound closure	6 (13.6)	15 (34.1)	0.044
Wound infection during follow-up	11 (25.0)	3 (6.8)	0.039

DISCUSSION

In the present study, the efficacy of alginate filler dressings versus saline dressings for cavity wounds with diabetic foot ulcers was compared. Both methods of dressing were found to result in wound improvement but wound outcomes in patients treated with alginate filler dressings improved during the 6-week follow-up period. The alginate group had

significant decreases in PUSH scores, smaller final wound surface area, improved exudate control, increased wound closure, and decreased wound infection when compared to the conventional saline dressing group. At baseline, there were no significant differences between the two groups about age, ulcer duration, wound area, PUSH score, Wagner grade, and ulcer location (12). There was no significant difference between the saline dressing group and the alginate group with means at baseline of 11.0 ± 2.0 and 11.2 ± 2.1 for PUSH respectively (p=0.649). Similarly, mean baseline wound area was 12.2 ± 5.0 cm^2 and 12.6 ± 5.3 cm^2, respectively (p=0.717). The similarity is significant because it implies that the healing differences that follow were less likely to be due to differences in initial wound severity (13). Progressive losses of PUSH scores were seen in both groups although they were more rapid in those who were treated with alginate filler dressings. At week 2, the mean PUSH score was 8.7 ± 1.9 in the alginate group compared with 9.6 ± 2.0 in the saline group (p=0.033). This difference was greater at week 4 with scores of 5.9 ± 1.7 and 7.4 ± 1.9 respectively (p<0.001). The mean PUSH score was 3.4 ± 1.5 in the alginate group, and 5.6 ± 1.8 in the saline group at week 6 (p<0.001). These results showed that alginate filler dressings had a superior effect on the dimension of the wound, exudate and tissue properties, the three primary elements of the PUSH assessment (14). The beneficial effect of alginate dressings was further reinforced by the improvement in the wound surface area. The mean (6.1 ± 2.8 cm^2) wound area in the saline group was significantly larger than the alginate group at 6 weeks (3.9 ± 2.1 cm^2; p<0.001). Alginate dressings also significantly reduced the mean wound area by 69.0 ± 16.4%, which was more than saline dressings (49.8 ± 18.7%) (p<0.001). Alginate dressings mop up wound exudate and create a soft gel in response to the exudate. This helps to maintain a moist wound condition and to prevent too much fluid buildup that might facilitate granulation tissue development and migration of the epithelium (15-17).

The other difference between the two treatments was the amount of exudate control. The mean exudate score at the final evaluation was 0.7 ± 0.6 for alginate and 1.2 ± 0.7 for saline (p<0.001). Cavity wounds in diabetic foot can exude in moderate or heavy amounts and if not properly controlled, these may lead to maceration of skin around the wound and delayed healing. The absorbency of alginate type filler material can thus be beneficial in particular for deep or irregular cavity wounds, where the dressing will conform itself to the wound bed and will absorb excess fluid. Patients receiving alginate dressings also had more clinically significant improvement of wounds. The alginate group had a 36 (81.8%) reduction in wound area compared with 25 (56.8%) for the saline group (p=0.020). A total of 15 (34.1%) patients were treated with alginate and had complete wound closure, while 6 (13.6%) patients were treated with saline dressing and had complete wound closure (p = 0.044). Based on these results, the variation in continuous wound measurements also indicated clinically relevant healing results (18).

The incidence of wound infection was reduced in the alginate group. The incidence of infection was 3 (6.8%) in patients who had alginate dressings versus 11 (25.0%) in patients with saline dressings (p=0.039). While alginate dressings are not an antimicrobial treatment when infection is present, however, effective exudate management with decreased frequency of dressing changes can ensure a more favorable wound environment. Reduced manipulation of the wound would also decrease wound trauma to newly formed granulation tissue (19). However, in diabetic foot ulcers, a number of factors affect the likelihood of infection, such as glycemic control, depth of the ulcer, amount of bacteria in the ulcer, vascular status, and adherence to treatment, and these should be taken into consideration when interpreting this finding. The results are of great significance from the diabetic foot management perspective as long periods of wound healing expose the patient to the risk of infection, hospitalisation and further damage to the wound. A dressing which reduces the area of the wound and controls exudates may thus offer benefits in addition to wound coverage. The direct expense of using alginate dressings however, needs to be considered. Because it is more expensive by the unit, future studies should incorporate formal cost-effectiveness analysis to assess whether the lower dressing frequency and quicker healing offset costs (20).

LIMITATIONS

The following are some of the limitations of this study. It was performed at a single tertiary-care hospital with a small sample of 88 patients, and may not apply to other clinical settings. It was not possible to blind patients and health care providers, as it was obvious which patients used each dressing technique. Follow-up was only six weeks and long term wound healing, recurrence, risk of amputation and infection control were not measured. Factors that were not explored in detail that may have influenced wound healing include glycemic control, nutrition, offloading compliance, wound debridement, antibiotic use, and patient compliance. Furthermore, the study did not involve a formal cost-effectiveness analysis although the unit cost of alginate dressings was higher than that of conventional saline dressings. To validate the results, larger, multicenter studies with longer follow-ups and standardisation of the clinical parameters are recommended.

CONCLUSION

Alginate filler dressings were superior to the traditional saline dressing in the management of cavity wounds in patients with diabetic foot ulcers. Patients who received alginate dressings had a higher improvement in PUSH scores, larger reduction in wound area, better control of exudates, higher complete wound closure rate and fewer wound infections. The results indicate that alginate filler dressings could be helpful in the treatment of diabetic foot cavity wounds of Wagner grades 2 and 3 especially if exudate management is a major concern. However, their use should be used in conjunction with other components of a diabetic foot care program, such as glycemic control, debridement, infection control, and appropriate off-loading. To confirm these findings, larger multicenter studies with longer follow-up are recommended.

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