e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(7); 95-100

Original Research Article

A Clinical Study to Determine the Role of Local Application of Insulin on Diabetic Foot Ulcer

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Received: 01-04-2026 / Revised: 15-05-2026 / Accepted: 21-06-2026

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Conflict of interest: Nil

Abstract

Background: Diabetic foot ulcer (DFU) is a major complication of diabetes mellitus associated with delayed healing, prolonged hospitalization, and increased risk of amputation. Topical insulin has emerged as a promising adjunct in wound management.

Methods: This interventional study was conducted in the Department of General Surgery, People's Hospital, Bhopal, from March 2024 to October 2025. Fifty patients with Wagner Grade I and II diabetic foot ulcers were enrolled and divided into two groups: topical insulin dressing (Group 1) and normal saline dressing (Group 2). Wound depth, ulcer size, granulation tissue formation, hospital stay, satisfaction, adverse events, and healing outcomes were assessed over 3 weeks.

Results: Baseline characteristics were comparable between groups. The insulin group showed significantly greater reduction in wound depth and ulcer size from Week 2 onward ($p<0.05$). Granulation tissue formation and overall patient satisfaction were higher in the insulin group. Mean hospital stay was significantly shorter in the insulin group (12.38 ± 2.14 days vs 22.72 ± 2.67 days; $p<0.0001$). No major adverse effects were observed.

Conclusion: Topical insulin dressing significantly accelerates healing of diabetic foot ulcers and appears safe, effective, and economical compared to normal saline dressing.

Keywords: Diabetis Foot, Insulin Application, Role Of Diabetes.

DOI: 10.25258/ijcpr.18.7.16

Introduction

Diabetic foot ulcer (DFU) is one of the most debilitating and costly complications of diabetes mellitus, contributing significantly to morbidity, hospitalization, and lower limb amputations worldwide. It is estimated that nearly 15–25% of diabetic patients develop a foot ulcer during their lifetime, with approximately 9.1–26.1 million new DFU cases reported annually across the globe. [1,2]

In India, the burden of diabetes is rapidly increasing, and the prevalence of DFUs is particularly high because of delayed diagnosis, poor glycemic control, inadequate foot care practices, barefoot walking, and limited healthcare accessibility [3]. According to the International Diabetes Federation, the global diabetic population is expected to exceed 642 million by 2040, with a substantial proportion residing in Southeast Asia, including India. [4]. The pathogenesis of DFU is multifactorial and involves peripheral neuropathy, peripheral vascular disease, infection, and impaired wound healing. Chronic hyperglycemia adversely affects wound repair mechanisms by impairing leukocyte function, reducing angiogenesis, altering collagen synthesis, and suppressing fibroblast and keratinocyte proliferation [5]. Furthermore, diabetic wounds exhibit prolonged inflammation, decreased growth factor activity, impaired macrophage function, and reduced extracellular matrix deposition, all of which contribute to delayed healing. [6]

Conventional management of DFU includes glycemic control, wound debridement, infection management, pressure offloading, and appropriate dressings. Despite advances in wound care, healing remains slow in many patients, leading to recurrent infection and amputation. [7] Therefore, there is a

growing interest in identifying cost-effective adjunctive therapies that can accelerate wound healing. Insulin, beyond its metabolic role, possesses anabolic and growth-promoting properties that enhance cellular proliferation, protein synthesis, angiogenesis, and collagen deposition. Experimental and clinical studies have demonstrated that topical insulin can accelerate wound healing by promoting granulation tissue formation and re-epithelialization while reducing inflammation [8, 9]. Local insulin therapy has emerged as a promising and economical approach for chronic non-healing diabetic ulcers; however, clinical evidence regarding its efficacy remains limited and inconsistent. Hence, the present study was undertaken to evaluate the role of local application of insulin in the management of diabetic foot ulcers.

Material & Methodology

The present interventional study was conducted in the Department of General Surgery at People's Hospital over a period extending from March 2024 to October 2025. A total of 50 patients diagnosed with diabetic foot ulcers and admitted to the tertiary care center were enrolled in the study. The participants were divided into two groups: Group I (Insulin group) and Group II (Saline group). Patients aged more than 20 years with diabetic foot ulcers of Wagner's Grade 1 or Grade 2, irrespective of gender, type, or duration of diabetes mellitus, were included in the study. Newly diagnosed cases of diabetic foot ulcers were also included. Patients below 20 years of age, those diagnosed with osteomyelitis or Wagner's Grade 3 and above ulcers, patients receiving cytotoxic or immunosuppressive therapy, and those unwilling to provide informed consent were excluded from the study. Patients fulfilling the inclusion criteria were enrolled in a non-randomized manner after obtaining written informed consent. Approval from the Institutional Ethics Committee was obtained prior to commencement of the study. Detailed clinical history, thorough physical examination, and relevant laboratory investigations were performed for all patients. Ulcers were graded according to Wagner's classification, and surgical intervention such as debridement was carried out whenever required.

Topical application of human soluble insulin was performed during dressing of the ulcer in Group I patients. Insulin was administered in a dose of 0.1 units/kg body weight diluted in 0.9% normal saline and applied locally over the ulcer surface throughout the study period. Group II patients received normal saline dressing alone. The efficacy of treatment was assessed by comparing ulcer size and wound characteristics at admission and at discharge or completion of intervention. Wound progression was documented by ulcer tracing on paper along with pictorial representation of ulcer area, slough, margins, and granulation tissue.

Data were collected using a structured proforma and entered into Microsoft Excel. Statistical analysis was performed using IBM SPSS Statistics version 24.0 (IBM Corp., USA). Quantitative variables were expressed as mean ± standard deviation, while qualitative variables were represented as frequencies and percentages. The Chi-square test was used to assess the association between qualitative variables. A p-value of <0.05 was considered statistically significant, while a p-value of <0.001 was considered highly significant.

Result

A total of 50 patients with diabetic foot ulcers were included in the study, with 25 patients each in the Insulin and Saline groups. The mean age of participants was comparable between the Insulin group (54.34 ± 9.45 years) and the Saline group (52.89 ± 8.33 years), with the majority of patients belonging to the 41–60 years age group. Gender distribution and Wagner grade of ulcers were also comparable between the two groups, indicating similar baseline characteristics. (Table-1) Both groups showed reduction in wound depth and ulcer size during follow-up; however, the Insulin group demonstrated significantly greater improvement from the second week onward. By Week 3, wound depth and ulcer size reduction were significantly better in the Insulin group compared to the Saline group ($p < 0.001$).(Table-2) Granulation tissue formation was observed earlier and more extensively in patients treated with topical insulin. The duration of hospital stay was significantly shorter in the Insulin group (12.38 ± 2.14 days) than in the Saline group (22.72 ± 2.67 days; $p < 0.0001$). Better healing outcomes, reduced wound soakage, and higher patient satisfaction were also observed in the Insulin group. No major adverse effects or hypoglycemic episodes were noted, suggesting that topical insulin application was safe and effective in enhancing wound healing in diabetic foot ulcers. (Table-3)

Table 1: Baseline characteristics of study participants

Variable	Insulin Group (n=25)	Saline group (n=25)	p- value
Mean Age (Years)	54.34 ± 9.45	52.89 ± 8.33	0.56
Male	12 (48%)	10 (40%)	0.56
Female	13 (52 %)	15 (60%)	
Wagner Grade I	12 (48%)	10b (40%)	0.56

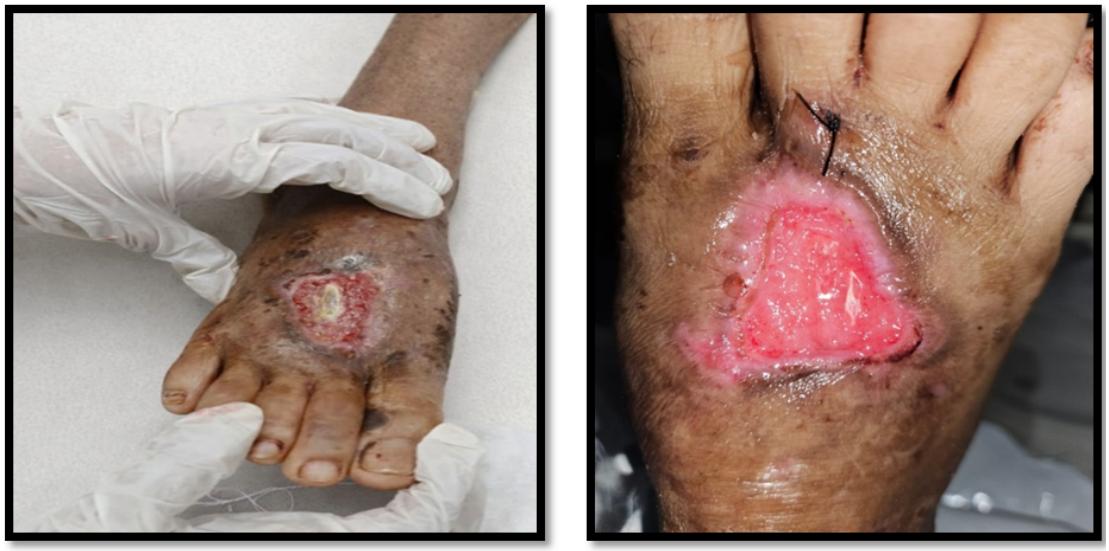
Wagner Grade II	13 (52%)	15 (60%)	

Table 2: Comparison of Wound healing parameters between Insulin and Saline groups.

Variable	Insulin Group (n=25)	Saline group (n=25)	p- value
Baseline wound Depth (Cm)	2.78 ± 0.46	2.81 ± 0.49	0.82
Week 3 Wound depth (Cm)	1.12 ± 0.34	1.54 ± 0.39	0.0002
Baseline Ulcer size (Cm^2)	8.36 ± 2.09	8.52 ± 2.25	0.76
Week 3 Ulcer size (Cm^2)	2.26 ± 0.65	3.62 ± 0.71	<0.0001
Granulation Tissue at week 3	24 (96%)	18 (72%)	0.35
Hospital stay (Days)	12.38 ± 2.14	22.72 ± 2.67	<0.0001

Table 3: Clinical Outcome and complications between study Groups.

Outcome	Insulin Group (n=25)	Saline group (n=25)	p- value
Complete healing with primary intention	7 (28%)	3 (12%)	0.05
STSG Required	15 (60%)	12 (48%)	
Partial Healing	3 (12%)	10 (40%)	
Mild Wound Soakage	15 (60%)	6 (24%)	0.006
Severe Wound Soakage	0 (0%)	6 (24%)	
Excellent Satisfaction	15 (60%)	6 924%)	0.03
Amputation Required	0 (0%)	2 (8%)	0.25
Adverse events	3 (12%)	5 (20%)	0.64



Pre-treatment **Post-treatment**

Figure 1:

Discussion

Diabetic foot ulcer (DFU) remains one of the most serious complications of diabetes mellitus and is associated with delayed wound healing, prolonged hospitalization, and increased risk of lower limb amputation (Armstrong DG et al. [1]). The local application of insulin has recently gained attention as an adjunctive therapy because of its anabolic, angiogenic, and growth-promoting properties that enhance tissue repair and epithelialization (Wang J et al. [10], Hrynyk M et al. [11]). The present study evaluated the efficacy of topical insulin dressing in comparison with normal saline dressing in patients with diabetic foot ulcers.

In the present study, the mean age of patients was 55.3 ± 7.2 years in the insulin group and 53.7 ± 11.9 years in the saline group, with most patients belonging to the 41–60 years age group. Similar findings were reported by Srivastava A et al. [12], Biradar D et al. [13], Uddin MA et al. [14], and Mishra B et al. [15], who also observed that diabetic foot ulcers were more common among middle-aged and elderly individuals. This may be attributed to longer duration of diabetes, peripheral neuropathy, and vascular insufficiency associated with advancing age. Gender distribution in the present study was relatively balanced between males and females. Comparable observations were made by Khan A et al. [16] and Biradar D et al. [13]. However, studies by Kamali M et al. [17] and Bhamre S et al. [18] demonstrated male predominance among DFU patients, probably due to increased occupational exposure, trauma,

smoking, and poor foot care practices among males.

Most ulcers in the present study belonged to Wagner Grade I and II, indicating early-stage disease. Similar observations were reported by Shah P et al. [19] and Saleem MN et al. [20], who found that lower Wagner grades were more frequently encountered. Early presentation and prompt management likely contributed to improved healing outcomes in the present study.

A significant reduction in wound depth was observed in the insulin group from the second week onwards. These findings are parallel to studies by Bhamre S et al. [18], Stephen S et al. [21], Nagaraj J et al. [22], and Thakur PB et al. [23], all of whom reported faster wound contraction and depth reduction with topical insulin therapy. Insulin promotes fibroblast proliferation, collagen synthesis, angiogenesis, and keratinocyte migration, thereby accelerating wound healing (Lima MHM et al. [24], Zhang Z et al. [2]).

Similarly, ulcer size reduction was significantly greater in the insulin group compared to the saline group. Comparable findings were documented by Biradar D et al. [13], Deepthi SS et al. [25], Soujanya M et al. [26], and Praveen JRA et al. [27]. The enhanced healing response may be due to activation of the AKT and ERK pathways by insulin, which improve granulation tissue formation and cellular proliferation. [24] Granulation tissue formation was consistently higher in the insulin group throughout follow-up. Similar results were reported by Baid S et al. [28] and Mishra B et al. [29]. Experimental and clinical studies by Rezvani O et al. [30] and Lima MHM et al. [24] further demonstrated accelerated angiogenesis and enhanced granulation tissue formation with topical insulin therapy.

The duration of hospital stay was significantly shorter in the insulin group in the present study. Similar findings were observed by Deepthi SS et al. [25], Srivastava A et al. [31], and Sanjay P et al. [32], suggesting that faster wound healing with insulin therapy contributes to early recovery and reduced healthcare burden.

Patient satisfaction was better in the insulin group, with a higher proportion reporting excellent outcomes. Similar trends were reported by Bhamre S et al. [18], Deepthi SS et al. [25], and Khan A et al. [16], indicating improved patient-perceived healing and comfort with insulin dressing. Adverse events were minimal and comparable between both groups, with no cases of hypoglycemia reported. Similar safety profiles were documented by Khan A et al. [16] and Jha SC et al. [33], confirming that topical insulin is generally safe and well tolerated when used locally in diabetic wounds. No patient in the insulin group required amputation, whereas amputations were observed in the saline group. Comparable findings were reported by Sanjay P et al. [32]. Previous studies by Wang X et al. [10] also emphasized that higher Wagner grades are strongly associated with increased amputation risk, indicating the importance of early intervention.

The ulcer healing rate was significantly better in the insulin group, with higher rates of complete healing and lower rates of partial healing. Similar observations were reported by Srivastava A et al. [31], Bhamre S et al. [18], and Zhang Z et al. [2]. These findings support the role of topical insulin in enhancing epithelialization, collagen deposition, and angiogenesis, thereby improving overall wound healing outcomes.

It also demonstrated significantly lower wound soakage in the insulin group. Although limited literature is available regarding wound exudate control with topical insulin, studies on wound management have emphasized that reduced exudate contributes to an optimal healing environment. [34, 35] The reduction in soakage observed in the present study further supports the beneficial effect of insulin dressing in maintaining wound bed balance and promoting faster recovery.

Conclusion

The study demonstrated that topical insulin dressing is an effective adjunct in the management of diabetic foot ulcers. Patients treated with topical insulin showed significantly faster reduction in wound depth and ulcer size, improved granulation tissue formation, reduced wound soakage, and shorter hospital stay compared to normal saline dressing. Better overall healing outcomes and higher patient satisfaction were also observed in the insulin group. Importantly, topical insulin was found to be safe and well tolerated, with minimal adverse effects and no episodes of hypoglycemia. The findings suggest that topical insulin promotes enhanced wound healing and may help reduce the risk of complications and amputation in diabetic foot ulcer patients. Therefore, topical insulin dressing can be considered a simple, economical, and effective therapeutic option in diabetic foot ulcer management.

Acknowledgement:

The authors sincerely thank the Department of General Surgery, People's College of Medical Sciences & Research Centre, Bhopal, for their guidance and support throughout the study. We are also grateful to all the patients who participated in this research.

References

1. Armstrong DG, Boulton AJM, Bus SA. Diabetic foot ulcers and their recurrence. N Engl J Med. 2017;376(24):2367-75.
2. Zhang Z, Lv L. Effect of local insulin injection on wound vascularization in patients with diabetic foot ulcer. Exp Ther Med. 2016;11(2):397-402.
3. Shahi SK, Kumar A, Kumar S, et al. Prevalence of diabetic foot ulcer and associated risk factors in diabetic patients from north India. J Diabetes Foot Complications. 2012;4:83-91.
4. International Diabetes Federation. IDF Diabetes Atlas. 8th ed. International Diabetes Federation; 2017. http://www.diabetesatlas.org
5. Brem H, Tomic-Canic M. Cellular and molecular basis of wound healing in diabetes. J Clin Invest. 2007;117(5):1219-1222.
6. Falanga V. Wound healing and its impairment in the diabetic foot. Lancet. 2005;366(9498): 1736-1743.
7. Singh N, Armstrong DG, Lipsky BA. Preventing foot ulcers in patients with diabetes. JAMA. 2005;293(2):217-228.
8. Liu Y, Petreaca M, Martins-Green M. Cell and molecular mechanisms of insulin-induced wound healing. Cell Tissue Res. 2009;335(3):531-539.
9. Rezvani O, Shabbak E, Aslani A, Bidar R, Jafari M, Safarnezhad S. Topical insulin accelerates wound healing in diabetic rats. J Wound Care. 2009;18(10):425-428.
10. Wang J, Xu J. Effects of topical insulin on wound healing: a review of animal and human evidences. Diabetes Metab Syndr Obes. 2020;13:719-727.
11. Hrynyk M, Neufeld RJ. Insulin and wound healing. Burns. 2014;40(8):1433-1446.
12. Srivastava A, Madhivanan S, Nelson AA. Effect of local insulin injection for wound healing in cases of diabetic foot ulcers – a randomized control trial. J Chem Health Risks. 2024;14(5):2105-2110.
13. Biradar D, Patil MB, Baloorkar R, Sindagikar V, Manoop K. Topical insulin and normal saline in chronic diabetic foot ulcers - a prospective analytical study. J Clin Diagn Res. 2020;14(8):11-13.
14. Uddin MA, Hasina A, Kumar Shill S. Effect of topical insulin versus normal saline dressing in healing of diabetic foot ulcers. Cent Med Coll J. 2021;5(2):94-101.
15. Mishra B, Iyer V, Jadhav S. A comparative study to see efficacy of local insulin dressing over normal saline dressing in diabetic ulcer of Grade 1 and Grade 2 of Wagner's classification in type 2 diabetes mellitus. Int J Pharm Clin Res. 2023;15(12):941-950.
16. Khan A, Zarin M, Khadeeja. Effectiveness of topical insulin dressings versus normal saline dressing in the management of diabetic foot ulcer. Biol Clin Sci Res J. 2024;2024:897. doi:10.54112/bcsrj.v2024i1.897.
17. Kamali M, Thenmozhi R, Kalabarathi S. Effect of topical insulin versus normal saline dressing on diabetic wound healing: an experimental comparative study. Cardiometry. 2023;(26):712-718.
18. Bhamre S, Godbole Y. Clinical study of local application of insulin on diabetic foot ulcer healing. MVP J Med Sci. 2022;18-23.
19. Shah P, Inturi R, Anne D, et al. Wagner's classification as a tool for treating diabetic foot ulcers: our observations at a suburban teaching hospital. Cureus. 2022;14(1):e21501.
20. Saleem MN, Mir A, Ullah U, et al. The association of Wagner classification, microbial resistance, immune markers, and glycemic control with diabetic foot ulcer severity: a multidisciplinary approach to predict severity and outcome. Cureus. 2025;17(8):e90914.
21. Stephen S, Agnihotri M, Kaur S. A randomized, controlled trial to assess the effect of topical insulin versus normal saline in pressure ulcer healing. Ostomy Wound Manage. 2016;62(6):16-23.
22. Nagaraj J, Subbiah V. The efficacy of local insulin versus topical phenytoin or normal saline in diabetic foot ulcer management: a prospective comparative study. Cureus. 2022;14(10):e30476.
23. Thakur PB, Ramachandrudu T, Takalkar AA. A study of effectiveness of topical insulin on healing of diabetic ulcers at tertiary health care centre: a cross sectional study from Puducherry. Int Surg J. 2020;7:857-860.
24. Lima MHM, Caricilli AM, de Abreu LL, Araújo EP, Pelegrinelli FF, Thirone ACP, et al. Topical insulin accelerates wound healing in diabetes by enhancing the AKT and ERK pathways: a double-blind placebo-controlled clinical trial. PLoS One. 2012;7(5):e36974.
25. Deepthi SS, Rojaramani K, Siva Kumar P, Padmaja Rani G, Bhagya Raja G. To study the efficacy of topical insulin application in wound healing in diabetic ulcers. Int J Curr Pharm Rev Res. 2025;17(6):889-894.
26. Soujanya M, Kruthi SR, Pratheek KC, Venkatesh S. Clinical study to compare the effectiveness of topical insulin versus topical phenytoin application in healing of chronic diabetic ulcers. Int J Acad Med Pharm. 2023;5(3):783-787.
27. Praveen JRA, Kumar PN. Topical application of insulin in the diabetic wound ulcer of foot and its comparison with regular normal saline dressing. J Evol Med Dent Sci. 2017;6(95):7020-7025.
28. Baid S, Sharma RK, Sharma M, Sharma S. Efficacy of topical insulin versus normal saline

in promoting granulation tissue formation and healing in diabetic foot ulcers: a prospective non-randomized interventional comparative study. Int Surg J. 2025;12:1492-1496.
29. Mishra B, Iyer V, Jadhav S. A comparative study to see efficacy of local insulin dressing over normal saline dressing in diabetic ulcer of Grade 1 and Grade 2 of Wagner's classification in type 2 diabetes mellitus. Int J Pharm Clin Res. 2023;15(12):941-950.
30. Rezvani O, Kamrani RS, Mobayen MR, Araghi A, Golchi F. Topical insulin as a novel treatment in wound healing in the animal model: a randomized controlled trial. World J Plast Surg. 2019;8(2):200-206.
31. Srivastava A, Madhivanan S, Nelson AA. Effect of local insulin injection for wound healing in cases of diabetic foot ulcers – a randomized control trial. J Chem Health Risks. 2024;14(5):2105-2110.
32. Sanjay P, Sandeep K, Vishal M, Sumit K, Avirl T, Ankit G. Efficacy of topical insulin dressings versus normal saline dressing on diabetic foot ulcer: a hospital based study. IOSR J Dent Med Sci. 2018;17:47-50.
33. Jha SC, Panchal HA. Local wound insulin infiltration (injection) and topical timolol gel versus normal saline and povidone iodine in treatment of diabetic foot ulcer. Int Surg J. 2025;12:961-967.
34. McIntosh C, Ivory JD, Gethin G. Managing wound exudate in diabetic foot ulcers. Diabet Foot J. 2019;22(1):46-52.
35. Beldon P. How to recognise, assess and control wound exudate. J Community Nurs. 2016;30(2):24-30