RESEARCH PAPER

Association Between Local Insulin Injection and Wound Healing Outcomes in Diabetic Foot Ulcers: A Cross-Sectional Study

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ABSTRACT

Background: Diabetic foot ulcers are a major complication of diabetes mellitus, associated with delayed wound healing, infection, and risk of amputation. Impaired angiogenesis, reduced cellular proliferation, and poor glycemic control contribute to prolonged healing. Local insulin injection has been proposed as a potential therapeutic approach due to its anabolic and growth-promoting effects.

Aim: To assess the association between local insulin injection and wound healing outcomes in patients with diabetic foot ulcers.

Materials and Methods: This hospital-based cross-sectional study was conducted at Meenakshi Medical College Hospital, Kanchipuram, over one year. A total of 50 patients with diabetic foot ulcers were included and categorized into two groups: local insulin group (n = 25) and non-insulin group (n = 25). Outcomes assessed included reduction in ulcer size, time to granulation tissue formation, duration of healing, infection control, and need for surgical intervention. Statistical analysis was performed using SPSS, and a p value < 0.05 was considered statistically significant.

Results: Patients receiving local insulin showed significantly greater reduction in ulcer size (p = 0.001), earlier granulation tissue formation (p = 0.001), and shorter healing time (p = 0.001). Infection resolution was higher in the insulin group (88% vs 60%; p = 0.02), and the need for surgical intervention was significantly lower (p = 0.04).

Conclusion: Local insulin injection is associated with improved wound healing outcomes in diabetic foot ulcers and may serve as a simple and effective adjunct therapy.

Keywords: Diabetic foot ulcer, local insulin injection, wound healing, granulation tissue, infection control, cross-sectional study

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Introduction

Diabetic foot ulcers are one of the most serious complications of diabetes mellitus and are associated with significant morbidity, risk of infection, and lower limb amputation. The pathogenesis of diabetic foot ulcers is multifactorial, involving peripheral neuropathy, peripheral vascular disease, impaired immunity, and delayed wound healing. Effective wound management is essential to reduce complications and improve patient outcomes [1].

Wound healing in diabetic patients is often impaired due to reduced growth factor activity, poor angiogenesis, and decreased cellular proliferation. Conventional management strategies include glycemic control, debridement, infection control, and appropriate wound dressings. Despite these measures, healing is often prolonged, necessitating the exploration of novel therapeutic approaches [2].

Insulin, apart from its metabolic effects, has been shown to possess anabolic and growth-promoting properties. It enhances protein synthesis, promotes cellular proliferation, and stimulates angiogenesis, all of which are essential for wound healing. Local administration of insulin directly at the wound site has

been proposed as a method to enhance healing while minimizing systemic effects [3].

Several experimental and clinical studies have suggested that topical or local insulin therapy may accelerate wound healing by improving granulation tissue formation and epithelialization. It has also been reported to enhance collagen synthesis and reduce inflammation at the wound site [4].

Randomized controlled trials have provided evidence supporting the beneficial effects of local insulin in diabetic wound management. However, the available data are still limited, and further studies are required to establish its efficacy and safety in routine clinical practice [5–6].

The use of local insulin injection offers a promising, cost-effective, and easily accessible intervention for improving wound healing outcomes in diabetic patients. Evaluating its effectiveness in a randomized controlled setting provides high-quality evidence that can guide clinical decision-making [7].

Therefore, the present study was undertaken to evaluate the effect of local insulin injection on wound healing in diabetic foot ulcers through a cross-sectional study.

Materials and Methods

This hospital-based cross-sectional study was conducted in the Department of General Surgery at Meenakshi Medical College Hospital and Research Institute, Kanchipuram, Tamil Nadu, over a period of one year. The study aimed to assess the association between local insulin injection and wound healing outcomes in patients with diabetic foot ulcers.

A total of 50 patients diagnosed with diabetic foot ulcers were included in the study. Patients aged 18 years and above with clinically diagnosed diabetic foot ulcers of Wagner grade I and II were considered eligible. Patients with advanced ulcers (Wagner grade III and above), osteomyelitis, severe peripheral arterial disease, uncontrolled diabetes, or those unwilling to participate were excluded from the study.

All patients underwent detailed clinical evaluation including history taking, physical examination, and relevant laboratory investigations. Baseline assessment of the ulcer included size, duration, presence of infection, and wound characteristics.

Based on routine clinical practice, patients were categorized into two groups: those receiving local insulin injection (Group A) and those managed without local insulin (Group B). No randomization was performed, as this was a cross-sectional observational study.

In Group A, insulin was administered locally at the wound site in addition to standard wound care. Group B received standard wound care including saline dressing, debridement, and infection control measures. All patients received appropriate glycemic control and supportive management.

Outcome measures assessed included reduction in ulcer size, time to appearance of healthy granulation tissue, infection status, and overall wound healing progress. Patients were evaluated at regular intervals during their hospital stay.

All data collected during the study were systematically entered into Microsoft Excel and subsequently analyzed using Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics including mean, standard deviation, frequencies, and percentages were used to summarize the variables. Comparative analysis between groups was performed using the independent t test for continuous variables and the Chi square test for categorical variables. A p value of less than 0.05 was considered statistically significant.

Results

A total of 50 patients with diabetic foot ulcers were included in the study, with 25 patients receiving local insulin injection (Group A) and 25 patients receiving standard care without insulin (Group B).

Table 1: Demographic Characteristics of Study Participants (n = 50)

Variable	Local Insulin (n = 25)	No Insulin (n = 25)	p value
Mean age (years)	53.2 ± 10.1	52.6 ± 9.8	0.81
Male	15 (60%)	14 (56%)	0.78
Female	10 (40%)	11 (44%)	

The mean age and gender distribution were comparable between the two groups. There was no statistically significant difference ($p > 0.05$), indicating that both groups were similar at baseline.

Table 2: Reduction in Ulcer Size (cm²)

Parameter	Local Insulin	No Insulin	p value
Initial ulcer size	6.5 ± 2.0	6.3 ± 2.2	0.72
Final ulcer size	2.0 ± 1.3	3.9 ± 1.8	0.001

Both groups showed reduction in ulcer size; however, the reduction was significantly greater in the local insulin group. The difference in final ulcer size was statistically significant ($p = 0.001$), indicating improved wound healing with local insulin.

Table 3: Time to Appearance of Granulation Tissue

Parameter	Local Insulin	No Insulin	p value
Mean days	6.2 ± 2.1	10.5 ± 3.2	0.001

The time required for appearance of healthy granulation tissue was significantly shorter in the local insulin group compared to the non-insulin group. This difference was statistically significant (p = 0.001), indicating faster wound healing initiation.

Table 4: Duration of Complete Healing

Parameter	Local Insulin	No Insulin	p value
Mean healing time (days)	17.8 ± 4.6	26.8 ± 6.4	0.001

Patients treated with local insulin showed significantly faster complete healing compared to those receiving standard care. The difference was statistically significant (p = 0.001).

Table 5: Infection Control

Outcome	Local Insulin	No Insulin	p value
Infection resolved	22 (88%)	15 (60%)	0.02
Persistent infection	3 (12%)	10 (40%)	

A significantly higher proportion of patients in the local insulin group showed resolution of infection compared to the non-insulin group. This difference was statistically significant (p = 0.02), indicating better infection control.

Table 6: Need for Surgical Intervention

Parameter	Local Insulin	No Insulin	p value
Required debridement/amputation	2 (8%)	7 (28%)	0.04
No surgical intervention	23 (92%)	18 (72%)	

The need for surgical intervention was significantly lower in the local insulin group compared to the non-insulin group. This difference was statistically significant (p = 0.04), suggesting improved clinical outcomes with local insulin injection.

Discussion

The present cross-sectional study evaluated the association between local insulin injection and wound healing outcomes in patients with diabetic foot ulcers. The findings demonstrated that local insulin administration was associated with significantly improved wound healing parameters, including reduction in ulcer size, faster granulation tissue formation, shorter healing duration, better infection control, and reduced need for surgical intervention.

In the present study, baseline characteristics such as age and gender were comparable between the two groups (p = 0.81 and p = 0.78), ensuring homogeneity. Similar findings were reported by Armstrong DG et al [8], who emphasized the importance of comparable baseline characteristics in studies evaluating diabetic foot ulcer outcomes.

The reduction in ulcer size was significantly greater in the local insulin group, with final ulcer size measuring 2.0 ± 1.3 cm^2 compared to 3.9 ± 1.8 cm^2 in the non-insulin group (p = 0.001). This finding is consistent with Lipsky BA et al [9], who reported that improved local wound care and targeted therapies contribute to enhanced wound contraction and healing.

The time to appearance of healthy granulation tissue was significantly shorter in the local insulin group (6.2 ± 2.1 days) compared to the non-insulin group (10.5 ± 3.2 days), with a statistically significant difference (p = 0.001). Similar observations were reported by Game FL et al [10], who highlighted the role of advanced therapeutic interventions in promoting early granulation tissue formation.

The duration of complete healing was significantly reduced in the local insulin group (17.8 ± 4.6 days vs 26.8 ± 6.4 days; p = 0.001). This aligns with the findings of Jeffcoate WJ et al [11], who emphasized that effective wound management strategies significantly reduce healing time in diabetic foot ulcers.

In terms of infection control, a significantly higher proportion of patients in the local insulin group showed resolution of infection (88% vs 60%; p = 0.02). This may be attributed to improved local tissue repair and immune response. Similar findings were reported by Lavery LA et al [12], who demonstrated that effective local interventions reduce infection rates in diabetic wounds.

The need for surgical intervention was significantly lower in the local insulin group (8% vs 28%; p = 0.04), indicating improved overall outcomes. This finding is supported by Prompers L et al [13], who reported that better wound care strategies reduce the likelihood of surgical procedures and amputation.

Local insulin therapy may enhance wound healing through its anabolic effects, including increased protein synthesis, improved angiogenesis, and enhanced fibroblast activity. Edmonds M et al [14] highlighted that improved microcirculation and tissue oxygenation are key factors in wound healing.

Recent guidelines have emphasized the importance of advanced wound care strategies in diabetic foot management. Hinchliffe RJ et al [15] recommended the use of effective local therapies to enhance healing and reduce complications.

Furthermore, Lipsky BA et al [16] reported that targeted therapeutic interventions play a crucial role in improving outcomes in diabetic foot ulcers, particularly in terms of infection control and healing.

Additional support for the role of insulin in wound healing has been provided by Zhang X et al [17], who demonstrated that local insulin application enhances epithelialization and accelerates tissue repair through increased cellular proliferation. Similarly, Liu Y et al [18] reported that insulin promotes angiogenesis and collagen synthesis, thereby improving wound healing outcomes in diabetic patients.

Conclusion

The present cross-sectional study demonstrated that local insulin injection is significantly associated with improved wound healing outcomes in patients with diabetic foot ulcers. Patients receiving local insulin showed greater reduction in ulcer size, faster appearance of granulation tissue ($p = 0.001$), shorter duration of healing ($p = 0.001$), better infection control ($p = 0.02$), and reduced need for surgical intervention ($p = 0.04$) compared to those receiving standard care alone. These findings suggest that local insulin therapy may serve as a simple, cost-effective, and effective adjunct in the management of diabetic foot ulcers. However, further large-scale studies are required to establish its definitive role in clinical practice.

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