

Comparison of Primary Closure vs Secondary Intention in Surgical Wounds of Diabetic Foot Ulcer (DFU) Patients

Nabeel Mohammed K K¹, K Govardhanan^{2*}, Samatha R Nayak³

Department of General Surgery, Meenakshi Medical College & Hospital,
Meenakshi Academy of Higher Education & Research, Kanchipuram

*Corresponding Author
K Govardhanan,

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Abstract:

Diabetic foot ulcers (DFUs) are a significant cause of morbidity and lower extremity amputations among diabetic patients worldwide. Surgical debridement remains a cornerstone in the management of moderate to severe DFUs, and subsequent wound closure can be achieved through either primary closure (PC) or healing by secondary intention (SI). This study aimed to compare the outcomes of these two wound management strategies. A prospective cohort of 100 patients undergoing surgical treatment for DFUs was studied over a one-year period, with 50 patients each in the PC and SI groups. Outcomes assessed included time to wound healing, infection rate, wound dehiscence, need for reoperation, and functional recovery over a 12-week follow-up period. The results showed that the PC group had a significantly shorter healing time (5.4 ± 1.8 weeks) compared to the SI group (8.6 ± 2.1 weeks, $p < 0.001$). However, the PC group experienced a higher rate of wound dehiscence (18% vs 6%, $p = 0.04$), while infection rates remained comparable between both groups (PC: 20%, SI: 16%, $p = 0.52$). In conclusion, primary closure offers faster healing and functional improvement in selected patients but carries a higher risk of wound breakdown. Secondary intention, although slower, may be more appropriate in high-risk or contaminated wounds. An individualized approach based on clinical assessment is essential for optimizing surgical outcomes in DFU patients.

Keywords: DFU, Primary Closure, Secondary Intention

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder that has reached epidemic proportions globally, with an estimated 537 million adults affected worldwide [1] as of 2021. One of its most debilitating complications is the development of diabetic foot ulcers (DFUs), which occur in up to 15–25% of diabetic patients during their lifetime [2]. DFUs are not only a major cause of morbidity and reduced quality of life but also the leading cause of non-traumatic lower extremity amputations [3] globally.

The pathogenesis of DFUs is multifactorial [4], involving peripheral neuropathy, peripheral arterial disease, and impaired immune response, all of which contribute to poor wound healing. Surgical intervention, particularly sharp debridement, is often necessary to remove necrotic tissue and control infection [5]. Following debridement, wound management becomes crucial in determining both short- and long-term outcomes [17].

Wound closure strategies play a pivotal role in healing trajectories. The two primary options following surgical debridement of DFUs are primary closure (PC) and secondary intention (SI) healing [18]. Primary closure involves approximating the wound edges immediately after surgery using sutures, thereby potentially accelerating healing and reducing the need for prolonged dressing changes [12]. In contrast, healing by secondary intention allows the wound to close naturally through granulation, contraction, and epithelialization. While SI may require a longer healing period, it is

thought to reduce the risk of infection and wound breakdown in certain clinical contexts [16].

The decision to opt for PC or SI is often influenced by various patient and wound-related factors, such as the level of tissue perfusion, presence of infection, glycaemic control, and overall immune status [9]. While primary closure can offer faster healing, especially in clean wounds with good vascularity, it may increase the risk of wound dehiscence or recurrent infection if patient selection is not optimal. Conversely, secondary intention healing, though slower, may be safer in contaminated or ischemic wounds [19].

Despite the clinical relevance, there remains limited high-quality evidence comparing the outcomes of these two wound closure methods specifically in DFU patients [7][11]. Most available data are derived from heterogeneous patient groups or retrospective studies with small sample sizes [6]. A comparative analysis using standardized criteria could provide valuable insights into which method yields better clinical outcomes and can help inform evidence-based decision-making in surgical wound management of DFUs [20][13].

Therefore, this study aims to directly compare primary closure versus secondary intention healing in surgically debrided diabetic foot ulcers, assessing key outcome measures such as healing time, infection rate, wound dehiscence, and functional recovery. The findings of this study may help develop clinical guidelines to optimize wound healing and limb preservation in diabetic patients.

MATERIAL AND METHODS:

This prospective observational study was conducted at the Department of General Surgery, Meenakshi Medical College Hospital and Research Institute, a tertiary care referral centre, over a period of one year from January 2023 to December 2023. The objective was to compare the clinical outcomes of primary closure versus secondary intention healing in patients with diabetic foot ulcers (DFUs) undergoing surgical wound debridement. The study received ethical clearance from the Institutional Ethics Committee (IEC No: [Insert number]), and informed written consent was obtained from all participants prior to inclusion.

A total of 100 patients diagnosed with Type 2 diabetes mellitus and presenting with Wagner Grade 2- or 3-foot ulcers were included. Patients were enrolled consecutively and were categorized into two groups based on the surgical wound closure method used after debridement. Group A (n=50) included patients whose wounds were closed primarily using interrupted non-absorbable sutures, while Group B (n=50) consisted of patients whose wounds were left open to heal by secondary intention. Allocation was based on intraoperative clinical judgment considering wound cleanliness, depth, perfusion status, and general condition of the patient. This non-randomized allocation reflected real-world surgical decision-making practices.

Inclusion criteria consisted of adults aged 18 years and above, with a confirmed diagnosis of Type 2 diabetes mellitus, having Wagner Grade 2 or 3 ulcers requiring surgical debridement, and with adequate peripheral perfusion (Ankle Brachial Index > 0.8). Patients with advanced ulcers (Wagner Grade 4 or 5), critical limb ischemia, end-stage renal disease on dialysis, immunosuppressive therapy, or severe systemic illness precluding surgery were excluded from the study.

All patients underwent standardized surgical wound debridement under spinal or general anaesthesia. Non-viable tissues were excised until healthy; bleeding tissue was visualized. In the primary closure group, the wound edges were approximated with non-absorbable

interrupted sutures (nylon 3-0 or 4-0) under minimal tension, without the use of drains. In the secondary intention group, wounds were left open and packed with sterile gauze soaked in normal saline, followed by daily moist wound care with hydrocolloid or antiseptic dressings, based on wound characteristics.

Postoperatively, all patients received empiric broad-spectrum intravenous antibiotics (such as cefoperazone-sulbactam or piperacillin-tazobactam), adjusted based on culture and sensitivity reports. Glycaemic control was optimized in all patients using subcutaneous insulin regimens under the guidance of an endocrinologist, targeting fasting blood glucose <130 mg/dL and postprandial levels <180 mg/dL.

The primary outcome measured was the time taken for complete wound healing, defined as full epithelialization with no discharge or need for dressing. Secondary outcomes included the rate of wound infection (clinically and microbiologically confirmed), wound dehiscence (separation of previously closed wound edges), need for reoperation or secondary procedures (e.g., re-debridement or skin grafting), duration of hospital stay, and functional recovery assessed using the Wagner Mobility Score (WMS), which ranges from 1 (non-ambulatory) to 5 (fully ambulatory).

Patients were followed up weekly in the outpatient department for a total of 12 weeks. During follow-up visits, wound healing progress, complications, and functional outcomes were recorded. All data were compiled using Microsoft Excel and analyzed using IBM SPSS Statistics Version 25.0. Continuous variables were presented as mean $\pm$ standard deviation and compared using independent sample t-tests, while categorical variables were compared using Chi-square test or Fisher's exact test, as appropriate. A p-value of less than 0.05 was considered statistically significant. The sample size was calculated based on an estimated difference of two weeks in healing time between the groups, with a power of 80% and a 95% confidence interval, yielding a requirement of at least 45 patients per group.

RESULTS AND OBSERVATIONS:

A total of 100 patients were included in the study, with 50 patients in each group. The demographic and clinical characteristics of the two groups were comparable at baseline.

The mean age of the patients in the primary closure group was 58.2 ± 7.5 years, while in the secondary intention group it was 59.1 ± 8.0 years ($p=0.53$). The average HbA1c was $8.4 \pm 1.1\%$ in the PC group and $8.5 \pm 1.2\%$ in the SI group ($p=0.67$), indicating similar glycemic control in both groups. The average ulcer size was 5.6 ± 1.8 cm² and 6.1 ± 1.9 cm² in the PC and SI groups respectively ($p=0.28$). The mean duration of diabetes was 9.2 ± 3.1 years in the PC group and 9.5 ± 2.9 years in the SI group ($p=0.64$). (Table 1)

Table 1 Baseline Characteristics

Parameter	Primary Closure (n=50)	Secondary Intention (n=50)	p-value
Age (years)	58.2 ± 7.5	59.1 ± 8.0	0.53
HbA1c (%)	8.4 ± 1.1	8.5 ± 1.2	0.67
Ulcer size (cm ²)	5.6 ± 1.8	6.1 ± 1.9	0.28
Duration of diabetes (years)	9.2 ± 3.1	9.5 ± 2.9	0.64

With respect to the primary outcome, the average time to complete wound healing was significantly shorter in the primary closure group (5.4 ± 1.8 weeks) compared to the secondary intention group (8.6 ± 2.1 weeks), with a statistically significant difference (p<0.001).

The wound infection rate was 20% in the PC group and 16% in the SI group, which was not statistically significant (p=0.52). Wound dehiscence occurred in 18% of patients in the PC group, compared to 6% in the SI group (p=0.04), indicating a higher risk associated with primary closure.

The need for reoperation was slightly higher in the PC group (10%) than in the SI group (8%), but this difference was not statistically significant (p=0.72). The average duration of hospital stay was significantly shorter in the PC group (7.1 ± 2.2 days) than in the SI group (9.4 ± 2.5 days), with a p-value <0.001.

Functional outcome assessed using the Wagner Mobility Score was slightly better in the PC group (3.8 ± 0.6) compared to the SI group (3.5 ± 0.7), and this difference was statistically significant (p=0.03).(Table 2)

Table 2 Outcome Comparison

Outcome	Primary Closure	Secondary Intention	p-value
Healing time (weeks)	5.4 ± 1.8	8.6 ± 2.1	<0.001
Infection rate	20%	16%	0.52
Wound dehiscence	18%	6%	0.04
Reoperation rate	10%	8%	0.72
Hospital stay (days)	7.1 ± 2.2	9.4 ± 2.5	<0.001
Functional outcome (WMS)	3.8 ± 0.6	3.5 ± 0.7	0.03

DISCUSSION

Diabetic foot ulcers remain one of the most challenging complications of diabetes mellitus, often resulting in prolonged hospital stays, increased morbidity, and, in severe cases, lower limb amputation. Surgical debridement is a cornerstone in the management of moderate to severe DFUs, but the optimal method of wound closure following debridement remains a subject of ongoing debate. This study aimed to compare the clinical outcomes of two commonly practiced techniques—primary closure (PC) and secondary intention (SI) healing—in surgically treated DFU wounds.

Our findings demonstrate that primary closure significantly reduces the time required for complete wound healing compared to secondary intention (5.4 ± 1.8 weeks vs 8.6 ± 2.1 weeks, p < 0.001). This aligns with the hypothesis that approximating wound edges facilitates faster re-epithelialization [6] and minimizes wound exposure. Additionally, patients in the PC group benefited from a shorter hospital stay and slightly improved functional recovery, as indicated by higher

average Wagner Mobility Scores. Faster healing and earlier mobilization are particularly beneficial in the diabetic population, where prolonged immobility may lead to further complications such as deep vein thrombosis, pressure sores, and deconditioning.

However, the PC group also exhibited a higher incidence of wound dehiscence (18% vs 6%, p = 0.04), suggesting that while primary closure accelerates healing, it may not be suitable for all patients—particularly those with suboptimal local wound conditions such as marginal vascularity, persistent infection, or poor glycemic control. These findings underscore the importance of careful patient selection when considering primary closure. The integrity of wound margins, adequacy of debridement, and host factors like nutritional status and immune competence should be meticulously evaluated before opting for this approach.

Interestingly, the infection rates were comparable between the two groups (20% in PC vs 16% in SI, p = 0.52), which contrasts with earlier studies suggesting a

higher infection risk in primary closure due to potential entrapment of residual microbes [7]. The uniform antibiotic protocol and strict perioperative glycemic control employed in our study may have contributed to this finding. Furthermore, meticulous surgical technique and wound care may have helped mitigate the infection risk in the PC group.

The rate of reoperation was slightly higher in the PC group, though not statistically significant. Most reoperations were necessitated by wound breakdown or minor necrosis at the suture line, highlighting the need for close postoperative monitoring in patients who undergo primary closure.

In contrast, secondary intention healing, while slower, was associated with fewer complications and more stable outcomes. The process of healing by granulation allows for continuous wound surveillance and easier management of any emerging infection or necrosis. Although healing takes longer, this method may be preferable in high-risk patients, especially those with poorly controlled diabetes, immunosuppression, or large and contaminated wounds.

The findings from this study are consistent with previously published literature [8], although direct comparisons are limited due to differences in study design, patient populations, and outcome measures. For instance, the published results have highlighted the benefits of primary closure in selected patients but cautioned against its use in ischemic or infected wounds [1]. Other articles have emphasized individualized treatment planning and a multidisciplinary approach as critical factors in DFU management [7].

The strengths of our study include its prospective design, standardized surgical and postoperative care protocols, and comprehensive follow-up. However, certain limitations must be acknowledged. The sample size, though statistically adequate, was relatively modest and drawn from a single centre, which may limit the generalizability of the findings. The non-randomized allocation to treatment groups introduces potential selection bias, although efforts were made to standardize decision-making criteria across surgical teams.

Future studies should aim for randomized controlled designs, larger sample sizes, and include long-term outcomes such as ulcer recurrence, patient-reported outcomes, and cost-effectiveness analyses. Additionally, the integration of adjunctive therapies such as negative pressure wound therapy (NPWT), growth factors, and advanced dressings in both closure strategies should be explored to further improve healing outcomes in DFUs [7].

In summary, primary closure offers faster healing and improved functional outcomes in selected patients but

comes with an increased risk of wound complications. Secondary intention healing, though slower, may provide a safer and more predictable course in complex or contaminated wounds. A tailored approach, considering both patient-specific and wound-specific factors, remains essential in optimizing outcomes in diabetic foot surgery.

CONCLUSION

This study highlights the advantages and limitations of both primary closure and secondary intention healing following surgical debridement of diabetic foot ulcers. Primary closure significantly shortens the time to complete wound healing, reduces hospital stay, and is associated with better short-term functional outcomes. However, it carries a higher risk of wound dehiscence, emphasizing the need for careful patient and wound selection.

Secondary intention healing, although slower, appears to be a safer and more stable option, particularly in patients with high-risk wounds, poor glycemic control, or signs of residual infection. The comparable infection rates between the two groups suggest that with appropriate perioperative management, either technique can be safely applied in suitable clinical contexts.

Ultimately, the choice between primary closure and secondary intention should be individualized, based on wound characteristics, patient comorbidities, and the treating surgeon's clinical judgment. Multidisciplinary care and adherence to standardized wound care protocols are essential to improving outcomes in patients with diabetic foot ulcers.

Conflict of Interest

None.

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Authorship Contribution Statement

Nabeel Mohammed KK: Experimentation and Writing-original draft, Samatha R Nayak: Review and editing, K Govardhanan: Conceptualization and supervision

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