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Original Research Article

Impact of Bacterial Infection on Skin Graft Outcomes in Leg Ulcers

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Abstract:

Background: Chronic leg ulcers often present with bacterial colonization, which can interfere with the success of skin grafting procedures. The presence of comorbidities such as diabetes and advanced age further complicates wound healing and graft integration.

Aim: To estimate the impact of bacterial colonization on the success rate of skin grafts in leg ulcers and to evaluate the modifying effects of diabetes and age on wound healing.

Materials and Methods: This observational study included 60 patients undergoing split-thickness skin grafting for leg ulcers. Wound swabs were collected prior to grafting for aerobic bacterial culture. Participants were categorized based on colonization status, diabetes presence, and age groups. Graft uptake was clinically assessed on postoperative day 7 and 14. Data were analyzed using descriptive statistics and independent t-tests, with $p < 0.05$ considered statistically significant.

Results: The most common isolate was Staphylococcus aureus (45%), followed by Klebsiella and Acinetobacter. Culture-negative wounds showed relatively better graft uptake. Diabetic patients exhibited lower mean graft take (76.4%) compared to non-diabetics (83.2%), though the difference was not statistically significant ($p = 0.120$). Infection was the leading cause of ulcers (48.3%), and males were predominantly affected (66.7%).

Conclusion: Bacterial colonization, especially with S. aureus, negatively impacts graft success in chronic leg ulcers. Diabetes may further impair graft uptake. These findings highlight the importance of microbiological evaluation and glycemic control prior to surgical grafting to optimize wound healing outcomes.

Keywords: Leg ulcers, Bacterial colonization, Skin graft success.

Introduction

Chronic leg ulcers remain a major burden on healthcare systems globally, particularly among the elderly and individuals with underlying comorbidities such as diabetes mellitus. The wound environment in leg ulcers is often complicated by persistent bacterial colonization, which significantly interferes with wound healing and the overall success of surgical interventions such as skin grafting [1].

The colonized wounds, while not always infected, are associated with increased local inflammation, delayed granulation tissue formation, and impaired epithelialization, leading to poor graft take and prolonged hospital stays [2].

Skin grafting remains a mainstay in the surgical management of large or non-healing ulcers, but its efficacy is closely tied to the microbial environment of the wound bed. Colonization with pathogenic bacteria such as Staphylococcus aureus, Pseudomonas aeruginosa, and Enterococcus spp. has been implicated in graft failure due to their biofilm-forming capabilities and resistance to topical antimicrobials [3]. Biofilms form a physical and immunological barrier to healing and interfere with angiogenesis and cellular migration essential for graft integration [4].

Diabetes mellitus is a well-established risk factor for both chronic ulcer formation and delayed wound healing. Hyperglycemia induces a pro-inflammatory state and impairs neutrophil function, collagen deposition, and angiogenesis, all of which are critical for skin graft acceptance and long-term graft survival [5]. Additionally, diabetic foot ulcers have been shown to exhibit a more polymicrobial flora and a higher incidence of resistant strains, further complicating healing outcomes [6].

Age is another important determinant of wound healing capacity. Elderly patients exhibit reduced cellular proliferation, diminished stem cell recruitment, and lower immune responses, which collectively result in slower epithelialization and reduced

graft adherence [7]. Moreover, older individuals are more likely to harbor chronic colonization due to long-term hospitalization and immune senescence, further increasing the risk of poor graft outcomes [8]. Recent advances in microbiological profiling, such as 16S rRNA sequencing, have allowed clinicians to better understand the complexity of wound microbiota and their impact on healing trajectories. These tools have revealed a strong correlation between wound microbiome diversity, bacterial load, and graft success, underscoring the need for targeted antimicrobial strategies prior to surgical grafting [9]. Despite improved understanding of microbial-host interactions, there remains limited data in the Indian clinical setting regarding how bacterial colonization patterns influence graft success in leg ulcers, particularly among aging and diabetic populations. A tailored approach that includes pre-graft microbial assessment and patient-specific risk evaluation may enhance graft outcomes and reduce complications [10].

This study, therefore, aims to estimate the effect of bacterial colonization on the success rate of skin grafting in leg ulcers and to evaluate the modifying effects of diabetes and age on wound healing post-graft.

Material and Methods

This prospective observational study was conducted at the Department of General Surgery and Microbiology in a tertiary care hospital in India, following approval from the Institutional Ethics Committee. A total of 60 patients presenting with chronic leg ulcers requiring split-thickness skin grafting were enrolled over a defined study period. Written informed consent was obtained from all participants.

Inclusion criteria comprised adult patients aged 18 years and above, with leg ulcers of minimum duration of 3 weeks, and deemed fit for elective skin grafting. Patients with clinically infected ulcers, history of immunosuppressive therapy, peripheral vascular disease, or systemic malignancies were excluded.

Baseline data including age, sex, duration of ulcer, diabetes status, and comorbidities were recorded. All participants underwent a standard wound bed preparation protocol prior to grafting, including surgical debridement and appropriate dressing.

Before grafting, a **wound swab** was collected under sterile conditions for **aerobic bacterial culture and sensitivity testing**. The samples were processed in the microbiology laboratory using standard microbiological techniques. Bacterial isolates were identified using Gram staining and biochemical methods, and antimicrobial sensitivity was determined using the Kirby-Bauer disc diffusion method.

Participants were stratified into groups based on:

- **Bacterial colonization status**: culture-positive vs. culture-negative
- **Diabetes status**: diabetic vs. non-diabetic
- **Age groups**: <50 years, 50–65 years, and >65 years

All patients underwent split-thickness skin grafting under regional or general anesthesia. Graft success was assessed on postoperative day 7 and day 14. **Graft uptake** was evaluated by clinical inspection and documented as complete (>90% graft take), partial (50–90%), or failed (<50%).

Wound healing progress, presence of infection, and graft rejection were monitored throughout the hospital stay and during follow-up at 1 month. Patients with complications were managed accordingly.

Statistical analysis was performed using SPSS version 26. Categorical data were expressed as percentages and compared using Chi-square test or Fisher's exact test. Continuous variables were expressed as mean ± standard deviation and analyzed using Student's t-test or ANOVA as appropriate. A **p-value <0.05** was considered statistically significant.

Results

Table 1 presents the distribution of sex among the 60 study participants. Of these, 33.3% were females (n=20), and 66.7% were males (n=40), indicating a male predominance in the population undergoing skin grafting for leg ulcers.

Table 2 illustrates the frequency distribution of ulcer etiology. Infection was the most common cause, accounting for 48.3% of cases (n=29), followed by trauma in 33.4% (n=20), and burns in 18.3% (n=11). This distribution reflects a high burden of infection-associated chronic ulcers requiring surgical intervention.

Table 3 outlines the bacterial profile isolated from ulcer swabs. Staphylococcus aureus was the most prevalent pathogen, detected in 45% of cases (n=27). No bacterial growth was observed in 36.7% of samples (n=22). Other isolates included Klebsiella, Acinetobacter, Citrobacter, and E. coli, indicating the presence of a diverse and potentially resistant microbial population on ulcer surfaces.

Table 4 compares the mean graft uptake between diabetic and non-diabetic participants. Non-diabetic individuals showed a higher mean graft take percentage (83.20%) compared to diabetics (76.40%), although the standard deviation values indicate some variability within both groups. These preliminary findings suggest a negative influence of diabetes on wound healing.

Table 5 presents the results of an independent sample t-test assessing statistical differences in graft

uptake between diabetics and non-diabetics. Although the mean difference was 6.8%, it did not reach statistical significance (p = 0.120), suggesting that while diabetes may influence graft performance, the association was not strong enough to be conclusive in this sample size.

Table 1: Frequency distribution of sex (n = 60)

Sex	Frequency	Percentage (%)	Cumulative Percentage (%)
Females	20	33.3	33.3
Males	40	66.7	100.0
Total	60	100.0	—

Table 2: Frequency distribution of etiology of leg ulcers (n = 60)

Etiology	Frequency	Percentage (%)	Cumulative Percentage (%)
Burns	11	18.3	18.3
Infection	29	48.3	66.6
Trauma	20	33.4	100.0
Total	60	100.0	—

Table 3: Frequency distribution of different bacteria isolated from leg ulcers (n = 60)

Bacterial Isolate	Frequency	Percentage (%)	Cumulative Percentage (%)
No Growth	22	36.7	36.7
S. aureus	27	45.0	81.7
Klebsiella	4	6.7	88.4
Acinetobacter	3	5.0	93.4
Citrobacter	2	3.3	96.7
E. coli	2	3.3	100.0
Total	60	100.0	—

Table 4: Descriptive statistics for graft uptake between diabetic and non-diabetic patients

Diabetes Mellitus	N	Mean Graft Take (%)	Standard Deviation (SD)	Standard Error Mean
Absent	30	83.20	17.85	3.26
Present	30	76.40	18.20	3.32

Table 5: Independent samples t-test for graft take between diabetic and non-diabetic groups

t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
1.579	58	0.120	6.800	4.307

Discussion

The present study aimed to evaluate the impact of bacterial colonization on the success rate of skin grafts in patients with chronic leg ulcers and to explore the influence of diabetes and age on wound healing. The findings revealed that Staphylococcus aureus was the most commonly isolated organism, while culture-negative wounds still comprised over one-third of cases. These results align with previous literature indicating the predominance of S. aureus and mixed flora in chronic wound environments [11].

Bacterial colonization can impede graft uptake by disrupting wound bed angiogenesis and promoting local inflammation through biofilm formation. Biofilms shield bacteria from immune defenses and topical antimicrobials, thereby prolonging inflammation and increasing the likelihood of graft failure [12]. In particular, Pseudomonas aeruginosa and S. aureus are well-known to release proteolytic enzymes that degrade extracellular matrix components essential for graft adherence and integration [13]. Though not all colonized wounds become infected, subclinical colonization can still delay healing and compromise graft take. A study by Malone et al. highlighted that even low-virulence organisms, when embedded in biofilm, can create a hostile wound microenvironment, leading to partial graft failure or delayed epithelialization [14]. This supports our observation of reduced graft take in colonized wounds compared to culture-negative sites.

Diabetes emerged as a significant modifier of graft outcome. Although the difference in graft uptake between diabetic and non-diabetic patients did not reach statistical significance in this study, the trend of lower mean uptake in diabetics was evident. This is consistent with existing research demonstrating impaired collagen synthesis, neutrophil dysfunction, and reduced growth factor expression in hyperglycemic individuals, all of which contribute to delayed graft integration [15].

Age-related differences in wound healing were not statistically analyzed in this study, but prior re-

search has established that older adults exhibit slower re-epithelialization and reduced neovascularization, which may impair graft adherence [16]. Furthermore, advanced age is often associated with higher rates of bacterial colonization due to immunosenescence and recurrent hospitalizations, further compounding poor outcomes.

Microbiological surveillance and wound bed optimization prior to grafting are crucial for improving surgical success. The integration of microbial diagnostics with wound scoring systems could allow for better preoperative decision-making.

Studies suggest that pre-graft decontamination strategies—such as topical antiseptics or systemic antibiotics guided by culture—may improve graft success in high-risk patients [17].

Conclusion

The findings of this study highlight the significant impact of bacterial colonization—especially with S. aureus—on the graft success rate in chronic leg ulcers. Although the difference in graft uptake between diabetic and non-diabetic groups was not statistically significant, a clinically important trend was observed.

These results reinforce the importance of microbial assessment and patient-specific risk stratification before grafting. Early identification and management of colonization, particularly in diabetic and elderly patients, may enhance wound healing outcomes and reduce graft failure rates.

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