

Outcomes of Split-Thickness Skin Grafting in the Management of Non-Healing Ulcers: A Retrospective Evaluation of Patient and Ulcer-Related Factors

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Abstract:

Background: Chronic non-healing ulcers are a major clinical challenge, and split-thickness skin grafting (STSG) is widely used for definitive wound coverage.

Aim: To evaluate outcomes of STSG in non-healing ulcers and assess the influence of patient- and ulcer-related factors on graft success.

Methodology: This retrospective study included 80 patients with non-healing ulcers (>3 weeks) treated with STSG at Department of General Surgery, Jagannath Gupta Institute of medical Sciences, Budge Budge, Kolkata, West Bengal, India. Data regarding demographics, ulcer etiology, comorbidities, and graft outcomes were analysed using descriptive and inferential statistics.

Results: Most patients were aged 41–50 years (27.5%) and males (65%). Diabetic ulcers were the most common etiology (37.5%). Excellent graft uptake (>90%) was seen in 50% of cases, while 27.5% had good outcomes. Overall, 77.5% achieved satisfactory graft uptake. Patients without comorbidities showed significantly better outcomes (95.5% excellent/good) compared to those with comorbidities (55.6%). Comorbid conditions were associated with higher rates of fair/poor graft results.

Conclusion: STSG is an effective and reliable method for managing non-healing ulcers. However, outcomes are strongly influenced by comorbidities and systemic health status. Proper patient selection and optimization of underlying conditions are essential for improved graft success.

Keywords: Split-thickness skin grafting, non-healing ulcers, graft uptake, comorbidities, wound healing.

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Introduction

Chronic non-healing ulcers represent a significant clinical and public health challenge, particularly in surgical and wound care practice [1]. The ulcers persist for weeks to months after proper treatment because they do not progress through the normal wound healing process within the expected time period. Skin grafting stands out as the primary treatment method for complex wounds because it serves as the fundamental approach when other treatments do not lead to successful recovery. Healthcare professionals commonly use skin grafting as a surgical method to treat chronic ulcers which frequently occur in lower extremities that have experienced tissue damage from diabetes and venous insufficiency and trauma. The lower limb area becomes more prone to ulcer development because its blood circulation remains insufficient and its tissues easily experience

pressure and injury which hinders the healing process.

The medical treatment of persistent non-healing ulcers in these regions faces difficulties because the affected areas lack proper blood circulation, experience constant pressure, and patients have multiple medical conditions which result in extended healing times and recurring infections and decreased life quality. Patients with these ulcers experience both a major physical burden and psychological suffering which leads to reduced walking ability and higher medical expenses. The global prevalence of chronic leg ulcers is estimated to range between 1% and 2% in the general population, with higher rates observed among elderly and diabetic individuals, highlighting the substantial burden of this condition [2]. The growing number of people developing diabetes mellitus and peripheral vascular disease through

their lifestyle choices has resulted in an increase of chronic ulcers which now requires developing countries to implement effective urgent treatment programs.

STSG has become a standard surgical method for treating ongoing ulcers. The procedure requires the extraction of epidermis and dermal tissue which doctors use to create a skin graft that they apply to a prepared wound site. Medical professionals prefer Split-thickness skin grafting (STSG) because it enables them to treat extensive wounds through its fast-healing process and high success rates of grafting and wound recovery and minimal recurrence rates. The method shows between 85% and 95% success rates for graft acceptance in chronic ulcer treatment according to different research studies that have been conducted. The procedure is relatively simple, cost-effective, and can be repeated if necessary, making it particularly suitable for resource-limited settings [3].

The medical use of full-thickness skin grafts (FTSG) which contain both epidermis and complete dermis is restricted to treat smaller wounds that require better cosmetic and functional results according to study [4]. The application of these methods becomes restricted because of two main factors which include greater chances of donor site complications and the need for a recipient area that has proper blood supply. The decision between STSG and FTSG needs to consider multiple elements which include the size and depth and location of the ulcer and the patient health condition. STSG serves as the better treatment method for extensive chronic wounds with poor blood circulation because it achieves better graft success rates and allows more flexible treatment options.

Successful skin grafting depends on meticulous preparation of the wound bed. The wound bed needs to be properly prepared and medically clean and free of infections and protected by debridement and negative pressure wound therapy and prophylactic antibiotics before successful grafting can occur. The wound bed needs to be prepared properly because this process establishes the best conditions for grafting success which includes proper adhesion and blood vessel formation and tissue integration. The process of graft take involves several stages which include plasmatic imbibition and inosculation and revascularization, with each stage affected by both local wound conditions and systemic patient factors [5].

The current surgical methods together with their associated medical practices still face challenges which prevent them from achieving optimal results in STSG procedures. The procedure faces major success threats from complications which include infection, hematoma formation, seroma accumulation, graft loss, and delayed healing. The

implemented measures fail to address two main problems which continue to affect patients with diabetes, vascular insufficiency, and compromised immunity: infection and graft failure and inadequate vascular integration. The factors related to patients create obstacles to wound healing by disrupting microcirculation and immune response and tissue regeneration processes which leads to increased chances of graft failure and ulcer recurrence [6].

In recent years, advancements in wound care technologies, including the use of bioengineered skin substitutes, growth factors, and regenerative therapies, have shown promising results in enhancing wound healing and graft survival [7]. The clinical use of bioengineered skin substitutes and growth factor therapies for wound care has shown potential to improve graft outcomes but their application in medical settings remains restricted. The high cost and limited availability of products together with missing standardized protocols have created obstacles for their implementation in areas with low resources which experience the highest incidence of chronic ulcers.

The chronic non-healing ulcer condition requires multiple factors to be examined because patients show different results after receiving STSG procedures. The success of grafts depends on multiple factors which need to be thoroughly assessed according to the research requirements. The age of patients together with their nutritional status and existing medical conditions and their immune system abilities, along with the ulcer size and duration and its cause and infection status, determine how skin grafting procedures will be successful. The treatment success together with graft survival and complication rates will remain dependent on how these variables interact with each other throughout the research process.

The current study investigates how split-thickness skin grafting procedures succeed in treating non-healing ulcers while studying how patient demographics and existing health conditions and ulcer characteristics affect the success of grafting and the healing process. The study analyzes these factors to provide clinicians with essential information that will help them choose suitable STSG candidates while they improve preoperative preparation and achieve better treatment outcomes for patients who have chronic non-healing ulcers.

Methodology

Study Design: The present study was designed as a retrospective observational study aimed at evaluating the outcomes of split-thickness skin grafting (STSG) in the management of non-healing ulcers. The study also focused on assessing the influence of patient-related and ulcer-related factors on graft uptake and healing outcomes by analyzing previously recorded clinical data.

Study Area: The study was conducted in the Department of General Surgery, Jagannath Gupta Institute of Medical Sciences, Budge Budge, Kolkata, West Bengal, India.

Study Duration: The study was carried out over a period of one year.

Study Participants

Inclusion Criteria:

- Patients aged between 20 and 60 years
- Patients presenting with non-healing ulcers of more than three weeks duration
- Patients who underwent split-thickness skin grafting (STSG)
- Patients with adequately prepared wound beds showing healthy granulation tissue
- Patients with controlled systemic conditions, including controlled diabetes mellitus

Exclusion Criteria:

- Patients aged below 20 years or above 60 years
- Patients with malignant ulcers or suspected malignancy
- Patients with severely infected wounds not suitable for grafting
- Patients with peripheral vascular disease or critical limb ischemia
- Patients requiring reconstructive procedures other than STSG
- Patients with uncontrolled systemic illnesses such as uncontrolled diabetes or severe comorbidities

Sample Size: A total of 80 patients were included in the study. The sample size was determined based on feasibility and availability of complete medical records within the study duration.

Procedure: Data for the present study were obtained retrospectively from hospital medical records, operative notes, and follow-up registers of patients who underwent treatment for non-healing ulcers. A non-healing ulcer was defined as a wound that failed to demonstrate satisfactory healing after three weeks of standard wound care, including regular dressing, debridement, and infection control measures. All patients underwent a detailed preoperative evaluation, which included documentation of demographic details such as age and sex, as well as clinical parameters including comorbidities (e.g., diabetes mellitus), duration of ulcer, and etiology of the ulcer. Ulcers were categorized based on their underlying cause, such as diabetic, traumatic, infective, venous, or post-burn ulcers.

Wound assessment was carried out prior to grafting, focusing on ulcer size, location, depth, and the condition of the wound bed. Only ulcers with healthy granulation tissue and absence of active infection

were selected for grafting. In cases where infection was suspected, appropriate wound swab cultures were reviewed, and targeted antibiotic therapy was administered before proceeding with the grafting procedure. Split-thickness skin grafting was performed under aseptic conditions in the operation theatre. The graft was harvested from a suitable donor site, typically the thigh, using a dermatome or Humby's knife. The harvested graft was then appropriately prepared, sometimes meshed to allow better drainage and expansion, and placed over the prepared recipient wound bed. The graft was secured with sutures or staples and covered with sterile dressings. Donor sites were managed with appropriate dressings to facilitate healing.

Postoperatively, patients were monitored regularly for graft uptake, signs of infection, and other complications. The first dressing change was typically performed on the fifth postoperative day to assess graft adherence. Follow-up data were collected from records up to four weeks post-surgery to evaluate healing progress, graft take percentage, and complications such as graft failure, infection, or partial loss.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics. Descriptive statistics were used to summarize demographic and clinical variables. Continuous variables were expressed as mean \pm standard deviation, while categorical variables were presented as frequency and percentage. Inferential statistical tests were applied to determine associations between variables. The Student's t-test or one-way ANOVA was used for comparison of continuous variables, while the Chi-square test or Fisher's exact test was used for categorical variables. A p-value of less than 0.05 was considered statistically significant. The analysis focused on identifying significant correlations between graft outcomes and various patient- and ulcer-related factors, thereby providing insights into predictors of successful healing following split-thickness skin grafting.

Result

Table 1 shows the distribution of patients according to age group. Out of the total 80 patients, the highest proportion was observed in the 41–50 years age group, comprising 22 patients (27.5%), indicating that middle-aged individuals were most commonly affected in the study population. This was followed by the 31–40 years and 51–60 years age groups, each contributing 20 patients (25%), suggesting a relatively similar prevalence in these age ranges. The lowest proportion was seen in the 20–30 years age group, with 18 patients (22.5%). Overall, the findings indicate that the majority of cases were concentrated in the middle to older age groups, with a gradual increase from younger to middle age, followed by a slight decline in the older age category.

Age Group (Years)	Number of Patients	Percentage (%)
20–30	18	22.5
31–40	20	25
41–50	22	27.5
51–60	20	25
Total	80	100

Table 2 shows the distribution of patients according to gender. Out of the total 80 patients included in the study, the majority were males, accounting for 52 patients (65%), while females constituted 28 patients (35%). This indicates a clear male

predominance in the study population, suggesting that the condition under investigation was more commonly observed among male patients compared to females in the present study.

Gender	Number of Patients	Percentage (%)
Male	52	65
Female	28	35
Total	80	100

Table 3 shows the distribution of ulcers based on etiology among the study participants. Out of the total 80 patients, diabetic ulcers constituted the largest proportion, accounting for 30 cases (37.5%), indicating that diabetes was the most common underlying cause of non-healing ulcers in the study population. This was followed by traumatic ulcers, observed in 18 patients (22.5%), suggesting trauma as

the second most frequent etiology. Infective ulcers were present in 12 patients (15%), while venous ulcers and burn ulcers each accounted for 10 cases (12.5%) respectively. Overall, the findings highlight that metabolic and injury-related causes were predominant contributors, with relatively fewer cases attributed to vascular and burn-related etiologies.

Ulcer Etiology	Number of Patients	Percentage (%)
Diabetic Ulcer	30	37.5
Traumatic Ulcer	18	22.5
Infective Ulcer	12	15
Venous Ulcer	10	12.5
Burn Ulcer	10	12.5
Total	80	100

Table 4 shows the graft uptake outcomes after split-thickness skin grafting among the study participants. Out of the total 80 patients, the majority demonstrated excellent graft uptake (>90%), accounting for 40 patients (50%), indicating a high success rate of the procedure. This was followed by good graft uptake (70–90%) observed in 22 patients (27.5%), suggesting satisfactory healing in a considerable

proportion of cases. Fair uptake (50–69%) was seen in 10 patients (12.5%), reflecting moderate graft acceptance, while poor graft uptake (<50%) was recorded in only 8 patients (10%). Overall, the findings indicate that most patients experienced favorable graft uptake outcomes, with a relatively small proportion showing suboptimal healing.

Graft Uptake (%)	Number of Patients	Percentage (%)
>90% (Excellent)	40	50
70–90% (Good)	22	27.5
50–69% (Fair)	10	12.5
<50% (Poor)	8	10
Total	80	100

Table 5 shows the association between comorbidities and graft outcome among the study participants. Out of 36 patients with comorbidities, 20 (55.6%) had excellent/good outcomes while a relatively high

proportion, 16 (44.4%), experienced fair/poor outcomes. In contrast, among the 44 patients without comorbidities, a majority of 42 (95.5%) achieved excellent/good outcomes, with only 2 (4.5%)

showing fair/poor results. Overall, of the total 80 patients, 62 had excellent/good outcomes and 18 had fair/poor outcomes. These findings indicate that the presence of comorbidities is associated with

comparatively poorer graft outcomes, suggesting that underlying health conditions may negatively influence the success of split-thickness skin grafting.

Table 5: Association of Comorbidities with Graft Outcome

Comorbidity	Excellent/Good Outcome	Fair/Poor Outcome	Total
Present (n = 36)	20	16	36
Absent (n = 44)	42	2	44
Total	62	18	80

Discussion

The current research examined how split-thickness skin grafting (STSG) affects non-healing ulcers through analysis of patient demographic data, the causes of their ulcers, their medical conditions, and their skin graft success rates. The results show that STSG functions as an effective surgical method whose results depend on various factors related to both the patient and their medical condition. The study observed that non-healing ulcers most commonly occurred among individuals aged 41 to 50 years with a rate of 27.5% followed by the 31 to 40 and 51 to 60 age groups which both showed a rate of 25%. Frykberg and Banks (2015) [8] reported that chronic ulcers have become more common among working-age adults because of increasing diabetes rates and their job-related exposure to risk factors and these conditions now affect all age groups. The age distribution pattern found here matches with research conducted by Margolis et al. (2005) [9], which documented that middle-aged diabetic individuals experience a high incidence of chronic ulcers that develop from metabolic disorders instead of age-related factors.

The current investigation demonstrated that males made up 65% of the study population while females made up 35% of the population. Mosti et al. (2020) [10] found that men experienced higher ulcer rates because they spent more time outdoors which increased their risk of suffering both traumatic injuries and work-related dangers. Schreml (2017) [11] found that diabetic men developed foot ulcers at higher rates because they waited too long to seek medical treatment and they did not follow proper foot care procedures. The research findings support the gender difference which we discovered in our research.

The most common type of ulcer for ulcer etiology assessment was diabetic ulcers which accounted for 37.5% of cases. The second most common type was traumatic ulcers which accounted for 22.5% of cases. The study found that the third most common type of ulcer was infective ulcers which accounted for 15% of cases. The study found that the fourth most common type of ulcer was venous ulcers which accounted for 12.5% of cases. The study found that burn ulcers made up 12.5% of all cases

examined in the research. The predominant occurrence of diabetic ulcers in this study confirms the findings of Armstrong et al. 2011 [12] which showed that diabetes leads to non-healing chronic wounds because of three medical conditions. Reiber et al. 1998 [13] showed that diabetic foot ulcers create more than 60% of worldwide chronic wound problems which lead to serious limb damage. The study found that the high number of traumatic ulcers matched the findings of Frykberg and Banks 2015 because the research showed that trauma causes most ulcer cases in both rural and occupational environments.

The study results showed successful graft outcomes because 50 percent of patients received excellent graft uptake which exceeded 90 percent of their grafts and 27.5 percent of patients reached good uptake between 70 and 90 percent while 12.5 percent and 10 percent of patients achieved fair and poor results. The results show that more than 77.5 percent of patients received satisfactory graft uptake. Gurtner et al. (2008) [14] showed that STSG treatment for chronic wounds achieved high success rates when medical staff performed proper wound bed preparation and infection control measures. The study by Rodriguez KM. (2013) [15] showed that well-managed ulcer beds allowed STSG to achieve successful graft uptake rates above 70 percent which confirmed STSG as a standard reconstructive treatment method.

The study discovered that comorbid conditions affected graft outcomes which emerged as a critical research finding. Patients without comorbidities had excellent to good outcomes in 95.5% cases whereas only 55.6% of patients with comorbidities achieved similar results with 44.4% experiencing fair to poor outcomes. The finding is strongly supported by Margolis et al. (2005) who reported that diabetes vascular disease and systemic comorbidities significantly delay wound healing and reduce graft success.

The current study shows a low rate of poor graft results which amounts to 10% and this result matches Rodriguez KM. (2013) [16] who observed graft failure rates that varied between 5 and 15 percent based on wound healing status and patient readiness. The better outcomes in our study may be attributed to proper patient selection and preoperative wound

preparation, which are critical determinants of graft success as highlighted by Gurtner et al. (2008).

The present research shows that STSG functions as a dependable and efficient treatment method for diabetic and traumatic non-healing ulcers. The research findings show that systemic health conditions and additional medical conditions determine treatment results, which matches existing worldwide studies. The studies by Falanga (2005) [17] and Armstrong et al. (2011) demonstrate that researchers must achieve three treatment goals of controlling metabolic functions, improving blood circulation, and treating infections to obtain better graft survival rates and fewer medical complications. The surgical process requires both complete preoperative evaluation and team-based patient management for doctors to achieve their best surgical results.

Conclusion

This retrospective study evaluated outcomes of split-thickness skin grafting (STSG) in 80 patients with chronic non-healing ulcers and demonstrated favorable results. Most were middle-aged males, with diabetic ulcers being the predominant etiology. Overall graft success was high, with majority achieving excellent to good uptake, indicating STSG as an effective modality for wound coverage and healing. However outcomes were significantly influenced by patient comorbidities, as individuals without systemic diseases showed markedly better graft take compared to those with comorbid conditions. These findings highlight that careful patient selection, adequate wound bed preparation, and control underlying diseases are crucial for optimizing results. Despite a small proportion of fair to poor outcomes, STSG remains a reliable and practical surgical option for managing complex non-healing ulcers in resource-limited settings with appropriate perioperative care and multidisciplinary management strategies.

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