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Original Research Article

A clinical study of the role of split-thickness skin autograft in management of wounds and identification of factors influencing the graft uptake

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ABSTRACT

Background: Wound management is a significant concern in surgical care, with split-thickness skin grafting (STSG) being a common treatment option. To evaluate the clinical outcomes of STSG in wound management and identify factors influencing graft uptake.
Methods: This observational descriptive study was conducted at a tertiary care center among patients requiring STSG for wound management. Patients were followed up for 3 months post-STSG.
Results: A total of 40 patients were enrolled. Diabetes, hypoproteinemia, and positive wound culture was significantly associated with partial graft loss ($p<0.05$). The duration of the ulcer was significantly longer in patients with graft loss ($p<0.05$). Pain scores improved significantly after grafting in both patients with and without graft loss. Complications such as serous discharge were more common in patients with partial graft loss.
Conclusions: This study highlights the importance of optimizing wound conditions and addressing underlying comorbidities to improve graft outcomes. Diabetes, hypoproteinemia, and positive wound culture were identified as significant factors influencing graft uptake.

Keywords: Split-thickness skin grafting, Wound Management, Graft uptake, Diabetes, Hypoproteinemia, Wound culture

INTRODUCTION

Wound refers to a sore in the skin or mucous membrane with associated tissue disintegration.[1] A wound is called chronic if it does not heal in a predictable timeframe (within 3 months) and in an organized sequence.[2] The current standard of treatment for wound closure in non-healing wounds is split- thickness skin grafting (STSG).[3]

STSG is defined as a graft containing the epidermis with a portion of dermis and does not have their own blood supply, depending on the wound bed's vascularity for graft absorption and healing. In an STSG graft, the recipient region (affected area) receives healthy skin transplanted from the donor location. The trunk and lateral thigh are the most common sites for STSG autografts because of their broad surfaces, which make them easy to harvest and virtually undetectable.[4]

Despite being a relatively simple procedure, implanting an STSG might be risky as the grafts often fail. The graft no longer gets oxygen and nutrients from the host blood supply once it is displaced. Graft failure is possible if it is unable to adhere to the wound site, revascularize via angiogenesis, or if any other factors prevent this process from occurring. The final take of the graft may be influenced by various preoperative, intra-operative and postoperative factors.[5] Preoperative factors affected graft

uptake include nutritional status, age, wound parameters, underlying comorbidities (e.g. diabetes and its control, chronic kidney disease, peripheral arterial disease) underlying infection as determined by positive wound culture prior to skin grafting, serum albumin levels etc.[6] Intraoperative factors affecting graft success are wound bed preparation whereas postoperative factors include , hematoma formation at the surgical site (most common), surgical dressing, seroma development and infection.[5]

Wounds are common and has significant surgical care load in department and are associated with significant morbidity and sufferings. Till date, no data have been assessed for split thickness skin autograft in management of chronic wounds at our study centre.

This study was therefore conducted at tertiary care centre to study the clinical outcomes of split-thickness skin autograft in management of wounds and identification of factors influencing the graft uptake in patients. This was a first study of this kind on split-thickness skin autograft in our centre, hence we wish to study what all are the other factors affecting the uptake of STSGs and thereby reducing the morbidity of the patient.

METHODS

The present observational descriptive study was conducted among 40 patients who were diagnosed as having wounds (traumatic, diabetic, pressure ulcer, infected wound, venous and arterial ulcers) and those requiring wound reconstructive surgery admitted in Department of Surgery, People's College of Medical Sciences & associated People's Hospital Bhopal during the study period of 18 months i.e. from 1st September 2022 to 29th February 2024.

Inclusion criteria

The Inclusion criteria for this study consisted of all patients above the age of 12 years who presented with wounds that required STSGs.

Exclusion criteria

The Exclusion criteria consisted of patients with malignant ulcers, those on immunosuppressive therapy, and wounds with exposed bone, joints, tendons, nerves, or blood vessels were also excluded. Furthermore, wounds resulting from post-burn contracture release and patients who did not provide informed consent for the study were excluded.

After obtaining ethical clearance from Institute's ethical committee, all the patients fulfilling the inclusion criteria were enrolled and written consent was obtained from all of them. Using the proforma, detailed data regarding sociodemographic variables was obtained. Their OPD and IPD registration number, and date of admission was documented. Detailed clinical history was obtained from all the study participants which included mode of presentation in detail, personal history, menstrual history in females, any serious previous illness, History of trauma, History of blood transfusion and past surgical history.

All the patients were subjected to thorough examination. General examination, relevant medical history, thorough clinical examination and appropriate radiological and laboratories investigations were conducted.

Pre-STSGs- preparation included all the efforts required to make the wound bed suitable to accept a STSGs. All patients underwent conservative local wound care to promote uniform, healthy granulation tissue with minimal exudate or slough. This was achieved through a combination of surgical debridement, antibiotic coverage, wound dressing, and wound bacteriology assessments.

Split-thickness skin grafts (STSGs) were applied after optimizing wound conditions, ensuring resolution of local infection, malodor, purulent discharge, or edema. Patients with peripheral vascular concerns were cleared by vascular surgery prior to the procedure.

STSGs were performed in an operating room under general or local regional anesthesia by an experienced surgeon. The procedure involved surgical debridement, granulation tissue curettage, graft harvesting, meshing, and fixation with staples. Both the donor and recipient sites were dressed appropriately, with the recipient site further stabilized using a plaster of Paris (POP) dressing.

Meshing of the skin graft was performed using an 11 number surgical blade. This technique is primarily used to expand the graft's surface area and allow efficient drainage of underlying fluid, enhancing its effectiveness in reconstructive surgery.

Post-operative care involved immobilization and antibiotic coverage for the first few days. Dressings were changed on post-operative days 4, 8, and 12. Patients were followed up weekly for the first month, every 15 days for the next two months, and monthly for the final month. During postoperative period, patients were advised for- coconut oil massages, maintain local hygiene and care, and undergo physiotherapy. Morbidity was assessed by monitoring early and late post-operative complications.

Statistical analysis

Data was compiled using IBM SPSS software version 20. Categorical data was expressed as frequency and percentage whereas continuous data was expressed as mean and standard deviation. Factors affecting graft uptake were assessed using chi square test (for continuous variables) and independent t test (for continuous variables). P value of less than 0.05 was considered statistically significant.

RESULTS

In present study, majority of patients irrespective of graft loss belonged to 21 to 30 years of age and we found no significant association of graft loss with age in our study (p>0.05) (Table 1). In present study, all the cases with partial graft loss had diabetes and hypo proteinemia as compared to 27.8% cases with no graft loss. We found significant association of partial graft loss with diabetes and hypoproteinemia (p<0.05) (Table 2). Our study found a significant association of graft loss with growth on wound culture and sensitivity as all the cases with partial graft loss had positive growth on wound culture (100%) whereas only 11.1% cases with no graft loss had positive growth on culture (p<0.05) (Table 3).

Though mean size of ulcer was found to be higher in cases with partial graft loss (56±25.24 cm^2) as compared to patients with no graft loss (44.53±22.12 cm^2), the observed difference was statistically insignificant (p>0.05) (Table 4). In present study, mean duration of ulcer was found to be significantly longer in patients with partial graft loss as compared to patients with no graft loss (124.33±38.07 days vs 63.31±35 days, p<0.05) (Table 5). Mean VAS score at recipient site before grafting was 5.42±1.5 whereas that after graft was 3±0.95, and the observed difference was statistically significant (p<0.05) in patients with no graft loss. Similarly, mean pain at recipient site before and after grafting in patients with partial graft loss was 5.75±0.55 and 3.21±0.78 respectively, which was significant difference (p<0.05). Though mean VAS scores were found to be higher in cases with partial graft loss at both donor as well as recipient sites, the observed difference was found to be statistically insignificant (p>0.05) (Table 6).

As observed from the above table, split thickness skin autograft uptake was found to be significantly lower in cases with partial graft loss at all the follow ups postintervention as compared to patients with no graft loss (p<0.05) (Table 7). In present study, complications in the form of serous discharge were associated significantly with partial graft loss (100% vs 2.8% p<0.05). However, we found no such association with other complications (p>0.05) (Table 8).

Table 1: Association of graft loss with age.

Age (in years)	No graft loss		Partial graft loss	
	N	%	N	%
≤20	7	19.4	0	0
21-30	11	30.6	2	50
31-40	8	22.2	0	0
41-50	6	6.7	1	25
51-60	4	11.1	1	25
Mean±SD	43.11±14.6		49.00±20.69	
$\chi 2$	2.78			
P value	0.595			

Table 2: Association of graft loss with comorbidities.

Comorbidities	No graft loss		Partial graft loss		$\chi 2$	P value
	N	%	N	%		
Anaemia	6	16.7	2	50	2.5	0.114
Diabetes	10	27.8	4	100	8.254	0.004
Hypoproteinaemia	10	27.8	4	100	8.25	0.004
Peripheral vascular disease	1	2.8	1	25	3.74	0.053
Cerebrovascular accidents	1	2.8	0	0		
Hypertension	6	16.7	1	25	0.36	0,947
Sickle cell anaemia	1	2.8	0	0		

Table 3: Association of graft loss with wound culture and sensitivity.

Wound culture and sensitivity	No graft loss		Partial graft loss	
	N	%	N	%
Staphylococcus aureus	4	11.1	2	50
Pseudomonas aeruginosa	0	0	2	50
Sterile	32	88.9	0	0
$\chi 2$	25.18			
P value	0.001			

Table 4: Association of graft loss with size of ulcer.

Size (cm^2)	No graft loss	Partial graft loss
Mean	44.53	56
SD	22.12	25.24
T value	0.53	
P value	0.599	

Table 5: Association of graft loss with duration of ulcer.

Duration of ulcer	No graft loss	Partial graft loss
Mean	63.31	124.33
SD	35	38.07
T value	12.33	
P value	0.034	

Table 6: Association of graft loss with pain at donor and recipient site.

Pain		No graft loss		Partial graft loss		T value	P value
		Mean	SD	Mean	SD		
Recipient	Before graft	5.42	1.5	5.75	0.55	1.75	0.917
	After graft	3	0.95	3.21	0.78	0.43	0.673
	T value	8.3		5.34			
	P value	0.001		0.0018			
Donor	After graft	4.47	1.13	5	0	0.92	0.363

Table 7: Association of graft loss with split-thickness skin autograft uptake.

Split-thickness skin autograft uptake (%)	No graft loss		Partial graft loss		$\chi 2$	P value
	Mean	SD	Mean	SD		
1 week	98.94	0.92	96.25	0.95	5.51	0.001
2 weeks	97.92	1.15	92.5	0.57	9.16	0.001
3 weeks	97.44	1.44	87.25	1.5	13.36	0.001

Table 8: Association of graft loss with complications.

Complications	No graft loss		Partial graft loss		$\chi 2$	P value
	N	%	N	%		
Serous discharge	1	2.8	4	100	31.1	0.001
Hypertrophic scar	7	19.4	2	50	1.92	0.165
Hyperpigmentation	8	22.2	1	25	0.01	0.901

DISCUSSION

Ageing is one of the factors associated with delayed wound healing. Reactive oxygen species (ROS) generation and an extended inflammatory phase are two ways that aging significantly affects the skin's ability to recover. This causes a change in the healing process that favors increased protein breakdown and increases the risk of chronic wound healing and its associated consequences.[7] We enrolled a total of 40 cases with chronic wounds with mean age of 43.70±14.57 years. The majority of patients with wounds belonged to 21 to 30 years (32.5%) of age and 20% of them belonged to 31to 40 years of age. These findings suggest chronic wounds to be more common in patients belonging to young and middle-aged individuals. This could be attributed to inclusion of cases with traumatic ulcers as well. As patients belonging to young and middle age are engaged in various occupation and are at high risk of trauma. Also, the prevalence of early onset diabetes is increasing and more, number of patients are being diagnosed with diabetes at younger age. We included patients with various aetiologies of ulcer and majority of patients were non diabetic.

Literature suggests that comorbidities such as diabetes, obesity, bed ridden state, nutritional status, stress, uremia, alcoholism, smoking etc. are associated with poor graft uptake.5,6,8 In our study, graft uptake was significantly poor as evidenced from partial graft loss in significantly

higher proportions of underweight individuals (7% vs 16.7% p<0.05), presence of diabetes (100% vs 27.8% p<0.05) and hypoproteinemia (100% vs 27.8%, p<0.05). However, we found no significant association of graft loss with history of addiction and other comorbidities such as anaemia, peripheral vascular disease, CVA, hypertension and sickle cell anemia (p>0.05). Our findings are consistent with the study by Dias et al, which demonstrated significantly lower mean serum albumin levels in patients with graft failure (2.81±0.35) compared to those with successful graft uptake (3.24±0.53, p<0.05), highlighting the potential role of hypoalbuminemia in poor graft outcomes.[6] Serum albumin, as an indicator of nutritional status, appears to influence graft success, whereas no significant association was found between haemoglobin levels and graft uptake (p>0.05).

Mowlavi et al, studied the impact of hyperglycemia on split-thickness skin graft (STSG) uptake, reporting reduced graft survival in patients with elevated serum glucose levels. However, their analysis did not account for the presence of diabetes-associated comorbidities, focusing solely on preoperative glucose levels.[9]

Diabetes, being a systemic disease, significantly impairs both local and systemic factors critical for wound healing. Peripheral neuropathy, tissue hypoxia, aberrant inflammatory responses, and increased infection susceptibility hinder the repair process, especially in diabetic foot ulcers. Additionally, microangiopathy in diabetes compromises angiogenesis at the graft site, vital for graft survival, increasing the risk of graft failure. Factors like under-perfusion, veno arteriolar reflex failure, dependent edema, and increased capillary permeability further exacerbate delayed healing in diabetic patients. Consequently, these systemic and local effects collectively contribute to the poor outcomes observed in STSG uptake in diabetic patients.[10,11]

Most chronic wounds have some microorganisms on them. Bacteria can be due to contamination or infection; the impact of the bacteria is contingent upon their quantity and variety as well as the patient's capacity for generating an immune response. Chronic wound infection can result from normal skin flora in persons with compromised immune systems. Persistent infection can exacerbate an inflammatory condition that is often the cause of chronic wounds. High concentrations of polymorphonuclear leukocytes (PMNL), macrophages, and lymphocytes near the wound bed, together with an imbalance of inflammatory cytokines that leads to an imbalance in the creation and destruction of extracellular matrix (ECM), are frequently observed in chronic inflammation.[5]

Our study found that presence of growth on wound culture and sensitivity was significantly associated with partial graft loss as all the patients with partial graft loss showed positive growth (50% staphylococcus and 50% pseudomonas) as compared to 11.1% cases with positive growth with no graft loss (p<0.05). Similarly, presence of secondary infection and serous discharge at recipient site was significantly associated with partial graft loss (100% vs 2.8%, p<0.05). Our study documented no such association with hypertrophic scar and hyperpigmentation (p>0.05). In cases where serous discharge was present after the first dressing (that is after 5 days), we conducted a swab culture. A positive result for *S aureus* or Pseudomonas increased the risk of partial graft loss in our study. Pseudomonas infections cause a significant loss of graft. The organism's high virulence is caused by a variety of mechanisms, such as evading host phagocyte uptake, developing antibiotic resistance and biofilms, and producing toxins, such as endotoxin A and pyocyanin, which also cause complete lysis of skin grafts.[6]

Turissini et al, documented a significant association of predebridement culture positivity to significantly associated with high failure rate (81.7% vs 64.5%, p<0.05). The authors also found significantly higher failure rate in patients with infection (5.7% vs 0.7%, p<0.05). However, they documented no impact of post debridement culture during STSG placement or prior to STSG placement, hematoma and seroma with graft success (p>0.05).[5] Hogsberg et al in their retrospective study on patients with chronic venous leg ulcers documented healing in only 33.3% cases with *P aeruginosa* infection by 12 weeks as compared to healing of 73.1% ulcers without *P aeruginosa* infection during the same time (p<0.05).[12] Our study findings were contrasting to the findings of Dias et al, in which the authors found positive pre-operative wound culture in 64.5% cases with graft success as compared to 88.9% cases with graft failure, but the observed difference was statistically insignificant (p>0.05).

However, the further subdivision of the positive culture swab revealed infection by Pseudomonas species, Klebsiella species, Staphylococcal species, Acinetobacter species, and Citrobacter species and the observed association of various micro-organisms with graft success was statistically insignificant (p>0.05).[6] Nsaful et al, found incidence of infected grafted wound as 79.2% and the failure rate among infected wound was 24.6%. *Pseudomonas aeruginosa* was identified as the most common organism associated with graft failure.[13]

The study's limitations include a small sample size and single-center design. The three-month follow-up period restricted the assessment of long-term outcomes, recurrence, and complications. A cost-effectiveness analysis was also not conducted.

CONCLUSION

This study evaluated the outcomes of split-thickness skin grafting (STSG) in patients with wounds. Diabetes, hypoproteinemia, and positive wound culture were significantly associated with partial graft loss, and patients with partial graft loss had a longer ulcer duration.

Pain scores improved significantly after grafting in both groups, regardless of graft loss, though complications like serous discharge were more frequent in those with partial graft loss. Notably, hospital stay after STSG was reduced, contributing to lower healthcare costs. These findings emphasize the importance of optimizing wound conditions and managing underlying comorbidities to enhance graft outcomes. Larger studies with extended follow-up are needed to validate these results and identify additional factors affecting graft success.

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