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Original Article

Surgery Section

Factors Affecting Graft Uptake of Large Wound Surface, Covered by Mesh Split Skin Grafting: A Longitudinal Study

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ABSTRACT

Introduction: Skin grafting is one of the most indispensable techniques in surgery these days. In low resource settings, skin grafting using mesh, still forms the important technique of wound coverage.

Aim: To evaluate the factors affecting graft uptake of large wound surface covered by mesh split skin grafting on day 5, day 10 and day 21 of postoperative days.

Materials and Methods: This prospective longitudinal study was conducted at Indira Gandhi Government Medical College and Hospital, Nagpur, Maharashtra, India, from June 2017 to December 2019, among patients with large wound surface. After baseline evaluation and wound preparation; patients were posted for mesh skin grafting. Postoperatively, the graft uptake percentage was assessed on the day 5, day 10 and day 21. Other parameters that were assessed were demographic details, mean stay of the patients during the preoperative and postoperative period, effect of various factors (age, gender, co-morbidities, addictions, site and aetiology of raw area, preoperative cultures) influencing graft uptake and postoperative complications. Statistical Package for Social Sciences (SPSS) version 20.0 was used for statistical analysis.

Results: A total of 117 patients were enrolled in the study, out of which, 97 (82.9%) of the patients were males. The most common raw area was seen in lower limbs and accounted for 98 patients and the most common cause of raw area was cellulitis (n=91). Out of 117 patients, 105 (89.7%) had successful graft uptake on postoperative day 5, 102 patients (87.2%) on day 10 and 100 patients (85.4%) on day 21. Whereas, 17 (14.5%) patients had failed uptake of graft on postoperative day 21. It was observed that age (p-value=0.04) and preoperative cultures (p-value=0.01) were statistically significant factors influencing graft uptake.

Conclusion: The present study concluded that mesh split skin grafting is a reliable and useful technique with successful graft uptake. Hence, it can be considered for the management of large raw areas.

Keywords: Graft uptake, Graft failure, Mesh skin grafting, raw area, Split skin grafting, Wound management

INTRODUCTION

The first-ever documented use of skin grafting occurred more than 3000 years ago in India [1]. From this modest beginning, skin grafting evolved into one of the basic clinical tools in surgery. Skin grafts have progressed from the outmoded autograft and allograft preparations, to newer biosynthetic and tissue-engineered living skin equivalents [2]. In today's modern era, it is no longer considered as an option of last resort, rather it has become a technique that is routinely used and sometimes preferentially used during soft tissue reconstruction.

The mesh graft principle was first employed in the early 1900's, when a technique was described for use in humans, which utilised a die with blades notched at staggered intervals to cut short parallel "accordion" slits in grafts [3]. In 1958, the first method for skin graft expansion was developed by Meek CP, in the form of small postage stamp-sized islands of graft spread over the recipient site [4]. In 1964, Tanner introduced the mesh skin grafting technique [5].

Meshing a graft offers various advantages that play a vital role in wound management. Firstly, it provides a route for the escape of fluid that might otherwise accumulate between the graft and recipient bed. Secondly, it increases the flexibility of the grafts, allowing it to better conform to uneven recipient surfaces, ensuring that good contact between the graft and recipient bed is maintained. Thirdly, when grafts are placed on areas that might be difficult to immobilise, the mesh incisions provide a convenient site for placing "tacking" sutures between the graft and recipient bed [6].

Skin grafting is one of the most indispensable techniques in surgery these days. In low to middle-income countries like India, skin grafting using mesh, still forms the important technique of wound coverage. Currently, there is a paucity of research focused on skin graft using a mesh, that forms the mainstay in wound management in resource-constrained countries [7-9]. With this background, the present study was conducted with an aim to determine the percentage of graft uptake on various postoperative days i.e. day 5, day 10 and day 21 following mesh split skin grafting and the factors influencing the graft uptake.

MATERIALS AND METHODS

This prospective longitudinal study was conducted at Indira Gandhi Government Medical College and Hospital, Nagpur, Maharashtra, India, from June 2017 to December 2019, among patients with large wound surface. The Institute's Human Ethics Committee approved the study (IGGMC/ Pharm /IEC/206/2017). Informed consent was obtained from all the patients who participated in the study.

Inclusion and Exclusion criteria: The study included all patients >18 years of age with a large raw area, having more than 4% of body surface area involvement. Wallace rule of nines and Lund-Browder chart were used, for estimating the total body surface area affected [10]. The study excluded patients with uncontrolled diabetes, raw areas due to burns, and not willing to participate in the study.

All the patients, with large raw areas fulfilling the study criteria during the study period formed the sample population. These cases were identified from Outpatient Department, admissions to the Surgery Wards and Emergency Wards. A total of 117 patients satisfying study criteria were enrolled in the study.

Primary outcome was, the percentage of graft uptake on various postoperative days (day 5, day 10 and day 21). Secondary outcome parameters included demographic details, mean stay of the patients in the hospital during the preoperative and postoperative period,

effect of various factors (age, gender, co-morbidities, addictions, site, aetiology of raw area, and preoperative cultures) influencing graft uptake and postoperative complications.

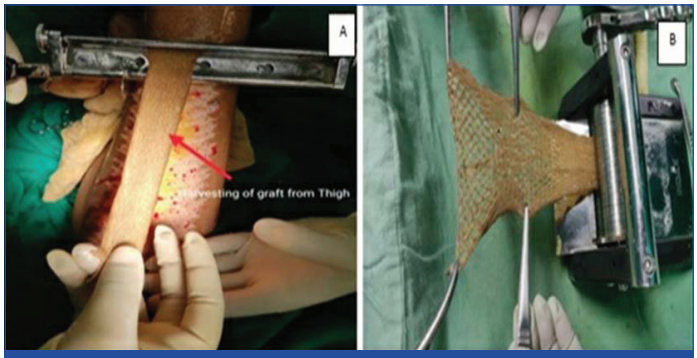
A successful skin graft was defined as, graft uptake of around 80% or more over the recipient wound bed. A failed split skin graft was defined, if more than 20% exposure of the dermis or devitalised tissue occurs, and which required prolonged care. This baseline measurement of 20% was chosen based on research by Henderson NJ et al., [11].

Procedure

Detailed history and thorough clinical examination was done in all the cases including site, size of the raw area. For all the patients haematological, biochemical, microbiological and radiological investigations were carried out. Ultrasound AV doppler study was done, to rule out peripheral vascular disease and other pathology.

Wound preparation was done for all the patients by adequate wound debridement. Empirical antibiotics were started which was titrated according to their respective wound culture sensitivity. Following, three consecutive cultures as sterile, patients were planned for split skin grafting. The conventional dressing (regular) was done using betadine, hydrogen peroxide which was replaced with normal saline, once healthy granulation tissue appeared. When healthy granulation tissue appeared, the patient was prepared for skin grafting.

All surgeries were performed under spinal anaesthesia with prophylactic antibiotics. They were typically meshed before application in the ratio of 1:1.5 as shown in [Table/Fig-1]. The grafts were fixed with sutures, staples. Bactigras total antiseptic gauze dressing was applied over the graft. Strict immobilisation of the affected raw area site was done using Plaster of Paris, till postoperative day 5. Postoperatively, on the day 5, the graft uptake percentage was assessed followed by day 10 and day 21.



[Table/Fig-1]: Preparation of graft. a) Harvesting of graft from donor thigh; b) Meshing of graft tissue.

STATISTICAL ANALYSIS

The data was analysed using Statistical Package for Social Sciences software version 20.0 (IBM SPSS Statistics for Windows, Armonk, NY, IBM Corp., USA) for Windows. Categorical variables were evaluated using the Chi-square test or Fisher's-exact test. Continuous variables were evaluated using either a t-test or Mann-Whitney U test, based on whether data distribution was normal or non normal. A p-value<0.05 was considered statistically significant.

RESULTS

A total of 117 patients were enrolled in the study. Out of 117 patients, 97 (82.9%) of the patients were males and 20 (17.1%) were females. The mean age of the study population was 48.4±15.2 years with a range of 19-81 years. Hypertension was the most common co-morbidity (17, 14.5%) followed by well-controlled diabetes (8, 6.8%) [Table/Fig-2].

The mean haemoglobin of the study population was reported to be 10.6±2.1 g/dL. As per World Health Organization (WHO), cut-off haemoglobin <12 g/dL in females, and <13 g/dL in males were taken as criteria for labelling anaemia [12]. Around 37 (31.6%) were anaemic, out of which 35 (29.9%) required transfusion. Twelve patients required more than a unit of packed cells before posting for surgery. Hypoalbuminaemia (67, 57.3%) followed by hypoproteinaemia (57, 48.7%) was seen in the study population.

Characteristics	Frequency (n)	Percentage (%)
Gender		
Male	97	82.9%
Female	20	17.1%
Age (years)		
19-25	10	8.6%
26-35	16	13.6%
36-45	21	17.8%
46-55	35	29.9%
56-65	19	16.2%
66-75	13	11.1%
76-85	03	2.6%
Occupation		
Farmer	33	28.2
Skilled worker	31	26.5
Home maker	12	10.3
Not occupied	10	8.5
Miscellaneous	31	26.5
Preexisting co-morbidity		
Hypertension	17	14.5%
Diabetes	08	6.8%
Both diabetes and hypertension	11	9.5%
Hypothyroid	02	1.7%
No co-morbidity	79	67.5%
Addiction		
Smokeless tobacco	21	17.9%
Smoking	18	15.4%
Alcoholic	22	18.8%
More than one addiction		
Alcohol + smoking	15	12.8%
Alcohol + smoking + smokeless tobacco	7	5.9%
Nil	34	29.1%

[Table/Fig-2]: Demographics and medical history of patients receiving mesh split thickness skin grafts.

The most common raw area was seen, in lower limbs due to various aetiologies and accounted for 98 patients. Most common cause of the raw area was cellulitis, which accounted for a maximum of 91 patients. *Pseudomonas aeruginosa* (19, 16.3%) was the most common organism isolated, followed by *Klebsiella pneumoniae* (15, 12.8%) [Table/Fig-3]. The majority of the patients received amoxicillin and clavulanic acid combination (80, 68.4%) as prophylactic antibiotics and later guided by culture sensitivity reports.

Wound parameters	Frequency (n)	Percentage (%)
Site of raw area		
Neck and Shoulder	1	0.85%
Chest	2	1.7%
Abdominopelvic region	3	2.6%
Upper arm	6	5.1%
Upper forearm and Hand	7	5.9%
Thigh	19	16.2%
Leg and foot	79	67.5%
Aetiology of raw area		
Infective aetiology	96	82.1%

Trauma	12	10.3%
Clean surgical wound	4	3.3%
Diabetic foot	5	4.3%
Wound dressings		
Vacuum assisted closure	34	29.1%
Conventional	83	70.9%
Organisms isolated from preoperative wound cultures		
Pseudomonas	19	16.3%
Klebsiella	15	12.8%
E. coli	5	4.3%
Enterobacteriaceae	5	4.3%
No growth	73	62.3%

[Table/Fig-3]: Wound parameters of the patients undergoing mesh split skin grafting.

On postoperative day 5, the graft uptake was analysed in which 105 (89.7%) patients had successful graft uptake and 12 (10.3%) had graft failure. About 102 patients (87.2%) on day 10 had successful uptake of graft. It was observed that, 100 (85.4%) patients had successful graft uptake, while 17 (14.5%) had graft failure on postoperative day 21 [Table/Fig-4]. [Table/Fig-5] shows graft uptake following mesh split skin grafting in lower limb raw area on postoperative day 5, 10, 21.

Percentage of graft uptake (%)	Day 5	Day 10	Day 21
<40	6 (5.1%)	8 (6.8%)	8 (6.8%)
41-50	1 (0.9%)	2 (1.7%)	2 (1.7%)
51-60	2 (1.7%)	1 (0.9%)	2 (1.7%)
61-70	2 (1.7%)	1 (0.9%)	1 (0.9%)
71-80	1 (0.96%)	3 (2.6%)	4 (3.4%)
81-90	47 (40.1%)	87 (74.3%)	88 (75.2%)
91-100	58 (49.6%)	15 (12.8%)	12 (10.3%)

[Table/Fig-4]: Percentage of graft uptake (%) on various postoperative days.

[Table/Fig-5]: Graft uptake following mesh split skin grafting in lower limb raw area.

The mean duration of preoperative hospital stay was 15.5±9.4 days and postoperative stay was 8.2±5.6 days. Thus, the length of hospital stay in the postoperative period has come down to nearly 50% of the preoperative duration [Table/Fig-6].

Duration of hospital stay (days)	Preoperative period n (%)	Postoperative period n (%)
<5	3 (2.7%)	3 (2.7%)
5-10	41 (35%)	79 (67.5%)
11-15	32 (27.4%)	26 (22.2%)
16-20	17 (14.5)	1 (0.9%)
21-25	8 (6.8%)	1 (0.9%)
26-30	3 (2.7%)	1 (0.9%)
>30	13 (11.1%)	6 (5.1%)

[Table/Fig-6]: Duration of the hospital stay in preoperative and postoperative period.

Pain (n=67) was the most common complication experienced in postoperative period. Other complications reported, hyperpigmentation (17, 14.5%), graft contractures (7, 5.9%), decreased sensation (12, 10.3%) and lymphoedema (3, 2.6%) [Table/Fig-7]. It was observed that age (p-value=0.04) and preoperative cultures (p-value=0.01) were statistically significant with graft uptake [Table/Fig-8].

[Table/Fig-7]: Long term complications following mesh split skin grafting: a) and b) Contractures with lymphoedema along with hyperpigmentation.

Variables	Graft uptake on day 21		p-value
	Successful	Failed	
Age groups (years)			
<35	19	2	0.04
35-50	42	4	
>50	39	11	
Gender			
Male	81	16	0.18
Female	19	1	
Co-morbidities			
Non diabetic	85	13	0.37
Diabetes (well controlled)	15	4	
Normotensive	81	8	0.26
Hypertensive	19	9	
Addictions			
Oral tobacco	17	2	0.58
Smoking	13	3	
Alcohol	18	3	
More than one addiction	22	5	
No addictions	30	4	
Site of raw area			
Neck and Shoulder	1	0	0.70
Chest	2	0	
Upper limb	10	3	
Abdomen pelvic	2	1	
Lower limb	85	13	
Aetiology of raw area			
Cellulitis	79	12	0.77
Trauma	12	1	
Postinsect bite Cellulitis	3	2	
Diabetic foot	4	1	
Surgical wound	2	1	
Preoperative cultures			
Pseudomonas	15	4	0.01
Klebsiella	14	1	
E. coli	2	3	
Enterobacteriaceae	3	2	
No growth	66	7	

[Table/Fig-8]: Association of various factors with graft uptake.
p-value <0.05 was considered as statistically significant

DISCUSSION

Split thickness skin grafting is an indispensable technique, employed by surgeons to resurface wounds that are predicted to heal poorly. Considering the utility and feasibility for developing countries, meshed grafts being easy to use, remain the most utilised tool for skin expansion. In the present study, the mean age of the study population was 48.4±15.2 years with a range of 19-81 years which was similar to a study done by Swaminathan SP et al., who reported mean age as 50.8 years [7]. On the contrary, Cornwall JV et al., found in their study that 70% of the patients were over the age of 70 years [13]. In the present study, the male to female ratio was 4.9:1 which was similar to Narwade P et al., [8]. However, it was higher than concluded in the study by Gireboinwad S et al., (2:1), Turissini JD et al., (1.6:1) and Kim SW et al., (1.3:1) [9,14,15]. This might be because most of the females were homemakers and with resultant restriction of outdoor activity, thereby less exposure for trauma.

In the present study, it was found that 96 (82%) of patients undergoing mesh split skin grafting for lower limb wounds being the most common site. This was higher, as compared with the study by Gireboinwad S et al., where lower limbs were the most common site of the raw area in both infective and traumatic aetiology (74.6%) [9].

The most common aetiology of the raw area reported in the present study was infection (82.1%) followed by traumatic causes (10.3%). Gireboinwad S et al., noticed infective cause in 38%, Narwade P et al., in 21.6% and Sundresh NJ et al., in 6.4% of the patients, which was much lower as compared to the current study [9,8,16]. Traumatic cause noticed in present study was 10.3% which was much lower as compared to Swaminathan SP et al., (34.4%), and Sundresh NJ et al., (26%) [7,16].

Hypertension was the most common co-morbidity in the present study, seen in 14.5% which was similar to Narwade P et al., in 13.33% and higher as compared to Sundresh NJ et al., in 2% [8,16]. Diabetes was seen in 6.8% of the patients in the present study which was similar to study by Sundresh NJ et al., i.e, 8% [16].

Various factors like anaemia, hypoproteinaemia is known to cause impaired wound healing. Around 37 (31.6%) patients were anaemic, out of which 35 (29.9%) required transfusion which was similar to Narwade P et al., where the prevalence of anaemia was reported as 35% [8]. Hypoproteinaemia in the present series, found in 48.7% which was similar to James SM et al., (46.8%) [17]. *Pseudomonas aeruginosa* (16.3%) was the most common organism isolated followed by *Klebsiella pneumoniae* (12.8%). It was similar to the study by Ünal S et al., where Pseudomonas was isolated as the most common pathogen [18].

Out of 117 patients, 105 (89.7%) patients had successful graft uptake on postoperative day 5 which was similar as compared to the study by Lari AR and Gang RK, (90%) and Kreis RW et al., (92%) [19,20]. However, this was slightly lower than the study by Zermani RG et al., (93%) and Reddy S et al., (94%) [21,22]. In the present study, mean graft uptake on postoperative day 10 was 87.2% which was similar to Munasinghe N et al., (87%), Lumenta DB et al., (85%) [23,24]. In the current study, graft uptake on postoperative day 21 was 89.4% which was similar to the study by Henderson NJ et al., [11].

Association of various factors influencing graft uptake: In the present study, age-wise graft acceptance of patients was analysed which was found statistically significant (p-value=0.04). This observation could be attributed to the fact that, aging produces intrinsic physiologic changes that result in delayed or impaired wound healing. Similar findings were reported by Gireboinwad S et al., where age was statistically significant with graft uptake [9]. In the current study, there was no association between tobacco, smoking and alcoholism with graft acceptance (p-value=0.58), which was similar to the study done by Gireboinwad S et al., [9]. However, the significant association could not be deduced due to inadequate evaluation about dose and duration of these substances consumed by patients. Co-morbidities such as diabetes mellitus and hypertension plays a pivotal role in the impairment of healing processes, that lead to graft failure; however, the present study did not show a significant association of co-morbidities with graft uptake, which was similar to the study done by Gireboinwad S et al., [9]. This might be attributed to the fact that according to the inclusion criteria of the study, only well-controlled diabetics were included.

The study also found no significant association between the site of ulcer and percentage of graft acceptance (p-value=0.70), and was similar to the findings by Swaminathan SP et al., and Gireboinwad S et al., [7,9]. It was found that there was not much difference in the percentage of patients, who had graft accepted in traumatic, infective, controlled diabetics, postsurgical. This might be explained that they had included ischaemic, malignant and venous causes of raw areas also, which were excluded in our study.

A prospective design was the main strength of this study. This topic needs to be further explored among a larger sample. Authors recommend this as the standard for the management of large raw areas, especially in low resource settings where costs limit the usage of other advanced novel procedures.

Limitation(s)

Present study results were limited by the single-centre study design. Long-term follow-up was not done. Other important aspects which could have been assessed, included cost-effectiveness of the procedure, quality of life and patient satisfaction.

CONCLUSION(S)

In resource constrained settings, people with wounds having large raw areas, due to the various aetiologies are common and are difficult to heal on its own. Certain modifiable factors can be done during surgical intervention to promote the wound healing. One such procedure is, application of meshed split skin graft over these raw areas. The present study concludes that mesh split skin grafting is a reliable and useful technique with successful graft uptake.

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