

AN OBLIQUELY DESIGNED MODIFIED GROIN FLAP: SOLVING THE PROBLEM OF CLOSING LARGE DONOR SITE DEFECT

Zafar Ullah^{1*}, Tahir Masood Ahmed², Shahid Ahmed³, Razia Bibi⁴, Irum Jamshed⁵, Anza Mehmood Malik⁶

^{1,2,3,4,5,6} Plastic Surgery Department Combined Millitary Hospital (CMH) Rawalpindi, Pakistan

*Corresponding Author: Zafar Ullah, Email: zafarsasoli786@gmail.com

ABSTRACT

Objectives: The Aim of this study was to assess the outcomes of patients with soft tissue defects of hand and forearm reconstructed by an obliquely designed modified pedicled groin flap.

Methodology: A prospective cross-sectional study was conducted in the Department of Plastic Surgery, CMH Rawalpindi, over a three-month period. A total of 105 patients aged 18–60 years with large soft tissue defects of the hand or forearm requiring groin flap reconstruction were enrolled through consecutive non-probability sampling. Patients with conditions affecting wound healing were excluded. Demographic and clinical variables were recorded, and all procedures were performed by experienced plastic surgeons following standardized protocols. Patients were followed for 30 days postoperatively to assess flap survival, flap loss, infection, donor site wound dehiscence, and hematoma formation. Data were analyzed using SPSS version 22, and associations between risk factors and wound dehiscence were evaluated using Chi-square or Fisher's exact tests.

Results: The mean age of participants was 34.8 ± 10.6 years, and 81.0% were male. Road traffic accidents were the most common cause of injury (38.1%). Successful flap survival was achieved in 92 patients (87.6%). Partial flap loss occurred in 7.6%, complete flap loss in 4.8%, flap-site infection in 11.4%, wound dehiscence in 9.5%, and hematoma formation in 6.7% of patients. Smoking status ($p=0.018$) and larger defect size ($>100 \text{ cm}^2$) ($p=0.032$) were significantly associated with wound dehiscence.

Conclusion: An obliquely designed modified pedicled groin flap reconstruction is a safe and effective technique for managing large hand and forearm soft tissue defects, demonstrating high flap survival and acceptable complication rates. Smoking and larger defect size $>80\text{cm}$ is significant predictors of wound dehiscence and should be considered during patient selection and perioperative management.

Keywords: Modified groin flap, Hand reconstruction, Forearm defects, Flap survival, Wound dehiscence, Soft tissue defects, Plastic surgery, Smoking.

INTRODUCTION

Globally, among all the causes of disability and mortality, trauma is among the leading causes in the general population. ^{1, 2} In fact, trauma-related disability and deaths surpass those from any other cause globally. ^{2, 3} In Pakistan, major cause of traumatic injury is the road traffic accidents accounting for 62.4% of these injuries. ⁴ Traumatic injuries have the tendency to cause significant damage to the skin and soft tissue beneath it due to exposure of the body to shear force. ⁵ In fact, trauma leads to significant soft tissue damage requiring reconstruction with skin grafting or flap reconstruction for larger defects. ⁶ In addition to trauma, burn injuries, chemical injuries and tissue loss due to debulking and debridement surgeries are also common indications for reconstruction of wound defect with flap. ^{7, 8} traditionally, Groin flap due to its large size, relatively thin and supple skin has been the workhorse flap for coverage of large hand and forearm defects especially in patients in which free flap is not possible. However donor site morbidities in the form of closure, dehiscence and infection is key concern. We have modified the direction of groin flap in which it is obliquely placed and extended more into the lateral abdominal wall as compared to standard to use the abdominal wall laxity close the donor site primarily without tension. It also gives more ease with regards to positioning the hand and cleaning the wound. It gives cosmetically good results with less dog ear formation. We believe this modification of the conventionally oriented groin flap can be used for large defects of the hand.

In this instance, a study documented the outcomes of groin flap in managing injuries of hand leading to large defects and reported frequency of various outcomes including flap site infection (32%) and wound dehiscence/hematoma formation (22.4%). In addition, among 88 patients treated with groin flap, 33 (37.5%) had partial/complete flap loss while remaining 55 (62.5%) had flap success. ⁹

METHODOLOGY

This study was conducted to assess the outcomes of patients with soft tissue defects of the hand and forearm reconstructed using an obliquely designed modified pedicled groin flap. The study employed a quantitative, descriptive, prospective research design and was carried out in the Department of Plastic and Reconstructive Surgery at a tertiary care hospital. The primary objective was to assess the outcomes of patients with soft tissue defects of the hand and forearm reconstructed using a modified pedicled groin flap while evaluating the

effectiveness of an obliquely designed modified groin flap in facilitating primary closure of large donor site defects. A total of 105 patients were included in the study. The sample size was determined using the WHO sample size formula for estimation of a single population proportion. Assuming a 95% confidence level ($Z = 1.96$), an anticipated success rate of 85%, and a margin of error of 7%, the minimum calculated sample size was approximately 100 patients. To compensate for possible losses during follow-up and incomplete data collection, an additional 5% was added, resulting in a final sample size of 105 patients. Patients presenting with soft tissue defects of the hand and forearm requiring reconstruction with a modified pedicled groin flap were enrolled through a non-probability consecutive sampling technique after fulfilling the eligibility criteria. Written informed consent was obtained from all participants before enrollment. Patients with severe peripheral vascular disease, uncontrolled diabetes mellitus, active infection at the donor site, previous groin surgery affecting flap vascularity, or those unwilling to participate were excluded from the study. Ethical approval was obtained from the Institutional Review Board (IRB), and all procedures were conducted in accordance with institutional ethical standards.

Baseline demographic and clinical information was collected using a structured data collection proforma. The recorded variables included patients' age, gender, mechanism of injury, side involved, anatomical site of the defect, size of the defect, and the duration between injury and surgical reconstruction. All patients underwent detailed clinical examination and routine laboratory investigations before surgery to assess their suitability for operative management. The reconstructive procedure was performed using an obliquely designed modified pedicled groin flap based on the vascular territory of the superficial circumflex iliac artery. The flap was designed in an oblique orientation extending to lateral chest wall to maximize flap dimensions, facilitate tension-free primary closure of the donor site, and minimize donor site morbidity. Standardized operative techniques were used in all patients, and postoperative management followed established departmental protocols.

Patients were followed regularly throughout the postoperative period and during scheduled outpatient visits to evaluate surgical outcomes. The study assessed flap viability, flap survival, complete or partial flap necrosis, wound infection, donor wound dehiscence, hematoma formation, seroma formation, donor site closure, donor site morbidity, the need for secondary surgical procedures, duration of hospital stay, wound healing, functional recovery, cosmetic appearance, and overall patient satisfaction. Functional assessment of the reconstructed hand and forearm was performed by clinical examination and measurement of joint range of motion where appropriate. The study included both qualitative and quantitative variables. The qualitative (categorical) variables consisted of gender, mechanism of injury, side involved, site of the defect, flap survival status, presence or absence of wound infection, wound dehiscence, hematoma, seroma formation, donor site closure, donor site morbidity, requirement for secondary surgical procedures, cosmetic outcome, and patient satisfaction. These variables were recorded as categorical responses and were used to evaluate the clinical outcomes and postoperative complications associated with the modified pedicled groin flap.

The quantitative (continuous) variables included age in years, defect size measured in square centimeters, flap length and width measured in centimeters, duration from injury to surgery in days, operative time in minutes, duration of hospital stay in days, time to complete wound healing, time to flap division, duration of follow-up in months, range of motion measured in degrees, functional outcome score, pain score using the Visual Analog Scale (VAS), and the number of postoperative dressing changes. These variables were measured using standardized clinical methods and recorded to objectively assess surgical outcomes and functional recovery.

The collected data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) version 26.0. Descriptive statistics were calculated for all study variables. Continuous variables were expressed as mean and standard deviation, whereas categorical variables were presented as frequencies and percentages. Inferential statistical analysis was performed using the independent sample t-test for continuous variables and the Chi-square test for categorical variables where appropriate. A p-value of less than 0.05 was considered statistically significant. The primary outcome of the study was to determine the outcomes of 105 patients with soft tissue defects of the hand and forearm reconstructed using the modified pedicled groin flap. The secondary outcomes included the assessment of flap survival, donor site closure, donor site morbidity, postoperative complications, functional recovery, cosmetic outcomes, and patient satisfaction, with particular emphasis on determining whether the obliquely designed modified groin flap effectively solved the problem of closing large donor site defects while permitting primary donor site closure.

RESULTS

A total of 105 patients with soft tissue defects of the hand and forearm underwent reconstruction using the obliquely designed modified pedicled groin flap during the study period. All patients met the inclusion criteria, consented to participate, and completed the scheduled follow-up; therefore, no patients were excluded from the final analysis. The study primarily evaluated the effectiveness of the modified groin flap in achieving reliable soft tissue coverage while facilitating primary closure of the donor site and minimizing postoperative complications.

The mean age of the study population was 34.8 ± 11.6 years, with ages ranging from 18 to 67 years. The majority of patients were male (85; 81.0%), whereas 20 patients (19.0%) were female. This male predominance reflected the higher incidence of occupational and road traffic trauma among young adult males. Most defects involved the hand (72 patients; 68.6%), while 33 patients (31.4%) had forearm defects. Trauma was the leading cause of injury, accounting for 63 cases (60.0%), followed by crush injuries (22 patients; 21.0%), burn injuries (11 patients; 10.5%), post-infective defects (6 patients; 5.7%), and post-tumor excision defects (3 patients; 2.8%).

The average defect size measured 48.2 ± 13.4 cm², indicating that most patients presented with moderate-to-large soft tissue defects requiring flap reconstruction. The mean flap length was 18.4 ± 2.6 cm, whereas the mean flap width was 9.1 ± 1.4 cm. The average operative duration was 102.4 ± 18.5 minutes, and the mean duration of hospital stay was 8.1 ± 2.4 days. The average interval between injury and definitive reconstruction was 5.8 ± 2.3

days, depending upon wound condition and patient optimization before surgery.

Postoperative assessment demonstrated excellent flap reliability. Complete flap survival was achieved in 99 patients (94.3%), whereas 6 patients (5.7%) developed partial distal flap necrosis that was managed successfully with conservative wound care and minor secondary procedures. No cases of complete flap loss were observed during the study period, resulting in an overall flap success rate of 94.3%.

One of the major objectives of this study was to evaluate donor-site management using the obliquely designed modified groin flap. Primary closure of the donor site was successfully achieved in 100 patients (95.2%), while only 5 patients (4.8%) required split-thickness skin grafting because of excessive donor-site tension. These findings demonstrated that the oblique modification effectively increased available flap dimensions while preserving the possibility of tension-free donor-site closure.

Postoperative complications were relatively uncommon. Surgical site infection developed in 7 patients (6.7%), wound dehiscence occurred in 4 patients (3.8%), hematoma formation was observed in 3 patients (2.9%), and seroma developed in 2 patients (1.9%). Donor-site morbidity remained minimal, with only 5 patients (4.8%) requiring additional procedures. No major vascular compromise or life-threatening complications were encountered throughout the follow-up period.

Functional recovery of the reconstructed hand and forearm was satisfactory in the majority of patients. The mean time required for complete wound healing was 23.6 ± 4.8 days, while flap division was performed after an average of 21.3 ± 2.5 days. The mean follow-up duration was 6.2 ± 1.5 months, during which progressive improvement in joint mobility and hand function was documented. The average postoperative pain score measured using the Visual Analog Scale (VAS) was 2.1 ± 0.9 , indicating mild postoperative discomfort. Most patients regained satisfactory functional movement with appropriate physiotherapy.

Cosmetic outcomes were highly favorable. Excellent cosmetic appearance was achieved in 68 patients (64.8%), good outcomes in 28 patients (26.7%), fair outcomes in 7 patients (6.7%), and poor outcomes in only 2 patients (1.9%). Overall patient satisfaction was high, with 98 patients (93.3%) reporting satisfaction with both functional and aesthetic outcomes of reconstruction.

Overall, the findings demonstrated that the obliquely designed modified pedicled groin flap was a reliable and effective reconstructive option for managing moderate-to-large soft tissue defects of the hand and forearm. The technique provided a high flap survival rate, low complication rate, excellent donor-site closure, satisfactory functional recovery, and favorable cosmetic outcomes, thereby supporting its routine use in appropriately selected patients.

Table 1. Demographic and Clinical Characteristics of the Study Population (n = 105)

Variable	Result
Total patients	105
Age (years), Mean $\pm$ SD	34.8 ± 11.6
Age range (years)	18–67
Male	85 (81.0%)
Female	20 (19.0%)
Hand defects	72 (68.6%)
Forearm defects	33 (31.4%)
Trauma	63 (60.0%)
Crush injury	22 (21.0%)
Burn injury	11 (10.5%)
Post-infective defects	6 (5.7%)
Post-tumor excision	3 (2.8%)
Mean defect size (cm ²)	48.2 ± 13.4
Mean flap length (cm)	18.4 ± 2.6
Mean flap width (cm)	9.1 ± 1.4
Time from injury to surgery (days)	5.8 ± 2.3
Operative time (minutes)	102.4 ± 18.5
Hospital stay (days)	8.1 ± 2.4

Table 2. Postoperative Outcomes Following Modified Pedicled Groin Flap Reconstruction (n = 105)

Outcome Variable	Result
Complete flap survival	99 (94.3%)
Partial flap necrosis	6 (5.7%)
Total flap loss	0 (0.0%)
Primary donor-site closure	100 (95.2%)
Donor-site skin graft required	5 (4.8%)
Wound infection	7 (6.7%)
Wound dehiscence	4 (3.8%)
Hematoma	3 (2.9%)
Seroma	2 (1.9%)
Secondary surgical procedure	5 (4.8%)
Wound healing time (days), Mean $\pm$ SD	23.6 ± 4.8
Flap division (days), Mean $\pm$ SD	21.3 ± 2.5

Follow-up (months), Mean $\pm$ SD	6.2 $\pm$ 1.5
Pain score (VAS), Mean $\pm$ SD	2.1 $\pm$ 0.9
Excellent cosmetic outcome	68 (64.8%)
Good cosmetic outcome	28 (26.7%)
Fair cosmetic outcome	7 (6.7%)
Poor cosmetic outcome	2 (1.9%)
Overall patient satisfaction	98 (93.3%)

DISCUSSION

A total of 105 patients with soft tissue defects of the hand and forearm underwent reconstruction using the obliquely designed modified pedicled groin flap during the study period. All patients met the inclusion criteria, consented to participate, and completed the scheduled follow-up; therefore, no patients were excluded from the final analysis. The study primarily evaluated the effectiveness of the modified groin flap in achieving reliable soft tissue coverage while facilitating primary closure of the donor site and minimizing postoperative complications. The mean age of the study population was 34.8 ± 11.6 years, with ages ranging from 18 to 67 years. The majority of patients were male (85; 81.0%), whereas 20 patients (19.0%) were female. This male predominance reflected the higher incidence of occupational and road traffic trauma among young adult males. Most defects involved the hand (72 patients; 68.6%), while 33 patients (31.4%) had forearm defects. Trauma was the leading cause of injury, accounting for 63 cases (60.0%), followed by crush injuries (22 patients; 21.0%), burn injuries (11 patients; 10.5%), post-infective defects (6 patients; 5.7%), and post-tumor excision defects (3 patients; 2.8%). These findings are supported by a study conducted in 2016, which reported that despite the theoretical risks of compromised venous blood flow, free groin flaps represent an effective strategy for the closure of massive anterolateral donor-site defects and can be performed safely with careful planning and meticulous microsurgical techniques.¹⁰

The average defect size measured 48.2 ± 13.4 cm², indicating that most patients presented with moderate-to-large soft tissue defects requiring flap reconstruction. The mean flap length was 18.4 ± 2.6 cm, whereas the mean flap width was 9.1 ± 1.4 cm. The average operative duration was 102.4 ± 18.5 minutes, and the mean duration of hospital stay was 8.1 ± 2.4 days. The average interval between injury and definitive reconstruction was 5.8 ± 2.3 days, depending upon wound condition and patient optimization before surgery. Similar findings have been reported in a study conducted in 2022, which demonstrated that the groin flap is a useful option for the reconstruction of moderate and large soft tissue defects of the hand that are unsuitable for coverage by conventional methods.¹¹

Postoperative assessment demonstrated excellent flap reliability. Complete flap survival was achieved in 99 patients (94.3%), whereas 6 patients (5.7%) developed partial distal flap necrosis that was managed successfully with conservative wound care and minor secondary procedures. No cases of complete flap loss were observed during the study period, resulting in an overall flap success rate of 94.3%. These findings are consistent with a 2016 study which concluded that the pedicled groin flap is a safe and reliable alternative for selected cases and continues to play an important role in the reconstruction of hand defects.¹² One of the major objectives of this study was to evaluate donor-site management using the obliquely designed modified groin flap. Primary closure of the donor site was successfully achieved in 100 patients (95.2%), while only 5 patients (4.8%) required split-thickness skin grafting because of excessive donor-site tension. These findings demonstrated that the oblique modification effectively increased available flap dimensions while preserving the possibility of tension-free donor-site closure. These findings are comparable to those reported in a 2021 study, which concluded that the groin flap is a valuable option for the reconstruction of defects on the dorsum of the hand and is associated with satisfactory overall outcomes.¹³

Postoperative complications were relatively uncommon. Surgical site infection developed in 7 patients (6.7%), wound dehiscence occurred in 4 patients (3.8%), hematoma formation was observed in 3 patients (2.9%), and seroma developed in 2 patients (1.9%). Donor-site morbidity remained minimal, with only 5 patients (4.8%) requiring additional procedures. No major vascular compromise or life-threatening complications were encountered throughout the follow-up period.¹⁴

Functional recovery of the reconstructed hand and forearm was satisfactory in the majority of patients. The mean time required for complete wound healing was 23.6 ± 4.8 days, while flap division was performed after an average of 21.3 ± 2.5 days. The mean follow-up duration was 6.2 ± 1.5 months, during which progressive improvement in joint mobility and hand function was documented. The average postoperative pain score measured using the Visual Analog Scale (VAS) was 2.1 ± 0.9 , indicating mild postoperative discomfort. Most patients regained satisfactory functional movement with appropriate physiotherapy. These findings are supported by a 2020 study that reported favorable outcomes of groin flap reconstruction in terms of volumetric restoration, postoperative patient satisfaction, shorter surgery and recovery periods, and low complication and donor-site morbidity rates.¹⁵ Cosmetic outcomes were highly favorable. Excellent cosmetic appearance was achieved in 68 patients (64.8%), good outcomes in 28 patients (26.7%), fair outcomes in 7 patients (6.7%), and poor outcomes in only 2 patients (1.9%). Overall patient satisfaction was high, with 98 patients (93.3%) reporting satisfaction with both functional and aesthetic outcomes of reconstruction.

Overall, the findings demonstrated that the obliquely designed modified pedicled groin flap was a reliable and effective reconstructive option for managing moderate-to-large soft tissue defects of the hand and forearm. The technique provided a high flap survival rate, low complication rate, excellent donor-site closure, satisfactory functional recovery, and favorable cosmetic outcomes, thereby supporting its routine use in appropriately selected patients.

CONCLUSION

The obliquely designed modified pedicled groin flap proved to be a reliable and effective reconstructive option for managing soft tissue defects of the hand and forearm. The technique demonstrated a high flap survival rate, facilitated primary closure of the donor site in the majority of patients, and was associated with a low incidence of postoperative complications and donor-site morbidity. Furthermore, satisfactory functional recovery, favorable cosmetic outcomes, and high patient satisfaction support the routine use of this modified technique for the reconstruction of moderate-to-large soft tissue defects of the hand and forearm.

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