

Outcomes of Pedicled Groin Flaps for Upper Extremity Injuries

HAND

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Abstract

Background: Free flap reconstruction has become the more common treatment over pedicled groin flaps for reconstruction of upper extremity injuries in recent years. Groin flaps are still used for a variety of reasons, though limited literature is available to guide surgeons and patients regarding outcomes. This study aimed to investigate the epidemiology and outcomes of pedicled groin flaps for upper extremity pathology. **Methods:** The study was a single-institution retrospective case series at a level one trauma center including patients who underwent pedicled groin flaps for upper extremity soft tissue coverage between 1992 and 2022. The data collected included patient and injury characteristics, surgical management, and complication data. Ordinal logistic regression, univariate analysis, and bivariate analysis were performed to assess the relationship between the total number of groin flap surgeries and complications with patient and injury characteristics. **Results:** The analysis included 88 pedicled groin flaps performed for upper extremity injuries, with a median follow-up of 1.14 years after injury. Patients had a median age of 35 (interquartile range [IQR]: 22-49) years and underwent a median of 4 (IQR: 3-5.25) surgeries with stiffness (90.6%), partial flap loss (38%), and infection (32%) as the most common complications. High-energy injuries increased the risk of requiring more surgeries based on ordinal logistic regression. Univariate and bivariate analysis revealed no significant difference in wound complications based on patient or injury characteristics. **Conclusions:** Patients undergoing pedicled groin flaps for upper extremity injuries can expect to undergo an average of 4 surgeries, and high-energy injuries predict the need for more surgeries.

Keywords: soft tissue reconstruction, traumatic hand injury, hand reconstruction, pedicled flaps, groin flap

Introduction

Soft tissue coverage of the upper extremity remains a challenge for many surgeons.^{1,2} The goals of reconstruction include stable coverage, aesthetic appearance, and restoration of functionality. For many years, large complex defects of the hand were managed with pedicled flaps from the abdomen or groin. Described by McGregor and Jackson in the 1970s, the groin flap became a popular option for complex soft tissue coverage in the hand.³ This flap is based on the superficial circumflex iliac artery and has several advantages including a large zone of coverage, inconspicuous site of the secondary defect, adequate skin thickness, and minimal donor site morbidity.⁴

With the advent of microsurgery, free flaps, and local pedicled flap options, the groin flap has fallen out of favor due to prolonged immobility (classically for 2-3 weeks) and bulkiness of the flap which may require several surgeries.^{5,6} Several studies reinforce the indications for pedicled groin flaps in the era of microsurgery highlighting that they preserve the vasculature for future operative repair which can include a free flap, are less technically challenging, and decrease initial operative time compared with free flaps.⁶⁻⁸ These issues are

particularly accentuated in facilities within rural areas in the United States and globally that lack access to the resources needed for free flap microsurgery. There still appears to be a role for pedicled groin flaps in the current era though there is a scarcity of literature available to guide surgeons and effectively counsel patients regarding outcomes. This study aimed to investigate the epidemiology and outcomes associated with pedicled groin flaps for upper extremity injuries.

Materials and Methods

We collected the data of 331 consecutive patients who underwent ipsilateral pedicled groin flap reconstruction for

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an upper extremity injury at a single large tertiary hospital from the years 1992 to 2022. Using the electronic medical record, we performed a comprehensive textual search of all clinical notes and imaging reports with the term “groin flap.” After thorough review of each chart, 92 patients that underwent an ipsilateral pedicled groin flap for an upper extremity injury were identified. Four patients who had incomplete data regarding primary outcomes were excluded, leaving 88 patients included in the final analysis. Nearly, 60% of patients underwent this procedure before 2010.

Study data were collected and managed using our institution’s Research Electronic Data Capture (REDCap) tool.^{9,10} For the 88 patients meeting inclusion criteria, the following data were captured via retrospective chart review and stored in our REDCap database. Patient characteristics included age, body mass index (BMI), sex, occupation status, smoking status, comorbidities, and hand dominance. Injury characteristics included injured hand, type of injury, other nonorthopedic injuries, other orthopedic injuries, intensive care unit (ICU) admission status, vascular status, and the presence of nerve deficits. The number of surgeries for initial stabilization prior to the groin flap procedure, and the number of functional/aesthetic surgeries after the groin flap procedure were collected. Additionally, the number of days from flap inset to division, and each functional/aesthetic surgeries were also noted. Complications such as clinically significant stiffness, partial or complete flap loss, infection requiring surgery or the initiation of antibiotics, wound complications (dehiscence, hematoma, or abnormal donor site healing), traumatic avulsion, and amputation were noted. Finally, the length of follow-up and time to return to work were also included.

Statistical Methods

Descriptive statistics were used to summarize patient characteristics, injury characteristics, surgical management, and complications and outcomes. An ordinal logistic regression was used to predict the total number of groin flap surgeries from patient and injury characteristics. Univariate analysis using Wilcoxon and Kruskal-Wallis rank sum tests was conducted, where appropriate, to assess the relationship of the total number of groin flap surgeries with patient and injury characteristics. Multivariable analysis using Wilcoxon rank sum, Pearson’s chi-squared, and Fisher’s exact tests was conducted, where appropriate, to assess if there were any differences in outcomes (infection and flap loss) due to patient and injury characteristics. The 95% confidence level was utilized for all analyses in the study.

Results

Of the 88 patients meeting inclusion criteria, 72% were men, 43% were smokers, and 48% had at least 1 comorbidity (diabetes, hypertension, cardiovascular, etc). Patients had a

Table 1. Descriptive Statistics of Patient and Injury Characteristics.

Patient and Injury Characteristics	Median (IQR)
Age at time of injury, y	35 (22-49)
BMI, kg/m ²	27 (23-31)
	N (%)
Sex	
Male	63 (72)
Female	25 (28)
Current smoking status	
Yes	32 (36)
No	50 (57)
Unknown	6 (6.8)
Comorbidities	
Diabetes	6 (7)
Hypertension	22 (25.6)
Cardiovascular (CAD, CHF, etc)	11 (12.8)
Pulmonary	12 (14)
Neurologic	9 (10.5)
Psychiatric	16 (18.6)
None	44 (52)
Injured hand	
Right	44 (50)
Left	44 (50)
Type of injury	
High energy (crush, MVC, ballistic, explosive)	43 (49)
Burn	25 (28)
Sharp	11 (12)
Other	9 (10)
Vascular status	
Perfused	44 (50)
Dysvascular	17 (19)
Complete amputation	22 (25)
Unknown	5 (5.7)
Nerve deficits	
Yes	43 (49)
No	26 (30)
Unknown	19 (22)

Note. IQR = interquartile range; BMI = body mass index; CAD = coronary artery disease; CHF = congestive heart failure; MVC = motor vehicle collision.

median age of 35 (interquartile range [IQR]: 22- 49) years and BMI of 27 (IQR: 23-31) kg/m². Injuries were equally likely to occur to either hand, due to a high-energy mechanism of injury (crush, motor vehicle collision, ballistic, explosive; 49%), in the absence of other nonorthopedic (73%) and orthopedic injuries (74%). Patients were admitted to the ICU in 44% of cases and neurovascular injuries were common involving the injured extremity. Detailed patient and injury characteristics are summarized in Table 1.

Patients had a median of 2 (IQR: 1.5-3.5) surgeries for initial stabilization prior to the two planned groin flap procedures

Table 2. Descriptive Statistics of Surgical Management.

Operative Characteristics	Median (IQR)
No. of surgeries	
Prior to groin flap surgeries	2 (1.5-3.5)
Groin flap inset and division surgeries	2
After groin flap surgeries (functional/aesthetic)	2 (1-3.25)
Total	7 (5-9)
Total excluding surgeries prior to groin flap surgeries	4 (3-5.25)
Days to division	21 (18-25.25)
	N (%)
After groin flap surgeries	
Debulking	49 (64.5)
Debridement	47 (61.8)
Tissue advancement	32 (42.1)
Web space contouring/deepening	15 (19.7)
Flexor/extensor tenolysis	15 (19.7)
Z-plasty	10 (13.2)
Tendon graft/transfer	10 (13.2)
Syndactyly separation	7 (9.2)
Reattachment	7 (9.2)
ORIF	6 (7.9)

Note. IQR = interquartile range; ORIF = open reduction and internal fixation.

for flap inset and subsequent division. Afterward, patients underwent a median of 2 (IQR: 1-3.25) surgeries for functional/aesthetic purposes. The 3 most common functional/aesthetic surgeries performed were debulking (64.5%), debridement (61.8%), and tissue advancement (42.1%). Overall, patients had a median of 7 (IQR: 5-9) total surgeries including initial stabilization and a median of 4 (IQR: 3-5.25) total surgeries excluding any surgeries prior to flap inset. Detailed surgical management is summarized in Table 2.

Patients were followed for a median of 1.14 (IQR: 0.67-2.08) years. In those patients that returned to work, there was a median return to work time of 8.5 (IQR: 4.8-13.7) months. During the follow-up period, stiffness (90.6%) was the most common complication observed. Additional post-surgical complications included partial or complete flap loss (38%), infection requiring antibiotics or surgical intervention (32%), and wound complications such as dehiscence, hematoma, or abnormal donor site healing (22%). Two less frequent complications that were also observed include traumatic avulsion (13%) and partial or complete amputation of the injured extremity (9.1%). Complications and other outcomes are summarized in Table 3.

The ordinal logistic regression that was performed to predict the total number of groin flap surgeries from patient and injury characteristics resulted in a R^2 of 0.187 with nontraumatic injuries having an odds ratio of 0.16 (confidence interval [CI], 0.0-0.71). Univariate and multivariate analysis

Table 3. Descriptive Statistics of Complications and Outcomes.

Complications and Outcomes	Median (IQR)
Follow-up, y	1.14 (0.67-2.08)
Return to work, y	0.71 (0.4-1.14)
	N (%)
Complications	
Stiffness	77 (90.6)
Partial or complete flap loss	33 (38)
Infection requiring antibiotics or irrigation & debridement	28 (32)
Wound complication (dehiscence, hematoma, abnormal donor site healing)	19 (22.4)
Traumatic avulsion	11 (12.9)
Partial or complete amputation	8 (9.1)
Total number of complications	
None	2 (2.3)
1 complication	35 (40)
2 complications	28 (32)
3 complications	16 (18)
4 or more complications	7 (8)
Return to work	
Yes	40 (45)
No	5 (5.7)
Not applicable	26 (30)
Unknown	17 (19)

Note. IQR = interquartile range.

Table 4. Ordinal Logistic Regression Assessing the Relationship Between Patient and Injury Characteristics and Total Number of Surgeries.

Predictors	Total number of surgeries		
	Odds ratio	CI	P value
Age	0.99	0.97-1.02	.692
Sex = male	0.70	0.29-1.72	.440
Comorbidities = none	1.39	0.51-3.76	.522
Type of injury = burn	2.23	0.83-6.00	.116
Type of injury = sharp	0.84	0.24-2.93	.785
Type of injury = other	0.16	0.03-0.71	.019
R^2		0.187	

Note. Type of injury = other includes high energy and oncology as mechanisms of injury. CI = confidence interval.

showed no significant differences in total number of complications due to patient and injury characteristics. These analyses are summarized in Tables 4-6.

Discussion

Nearly, 10% of all traumas in the United States involve the upper extremity, and soft tissue coverage remains a major

Table 5. Univariate Comparisons of Patient and Injury Characteristics and Total Number of Complications.

Patient and Injury Characteristics	Total number of complications	P value
Sex		.10
Male	2 (1-3)	
Female	2 (1-2)	
Injured hand		.7
Right	2 (1-3)	
Left	2 (1-2)	
Current smoking status		.5
Yes	2 (1-3)	
No	2 (1-2)	
Unknown	1.5 (1-2.75)	
Type of injury		>.9
High velocity (crush, MVC, ballistic, explosive)	2 (1-2.5)	
Burn	2 (1-2.5)	
Sharp	2 (1-2)	
Other	1 (1-3)	
Vascular status		.052
Perfused	2 (1-2.25)	
Dysvascular	2 (2-2)	
Complete amputation	2 (1-3)	
Unknown	1 (1-1)	
Nerve deficits		.2
Yes	2 (1-3)	
No	1.5 (1-2)	
Unknown	1 (1-2.5)	

Note. MVC = motor vehicle collision.

obstacle in the management of these injuries.^{1,2,11} Although free flaps have been preferred for the reconstruction of upper extremity injuries in recent decades, the pedicled groin flap continues to be used, particularly in low resource settings within the United States and internationally where the experience and equipment required for microsurgery may be unavailable.¹²⁻¹⁴ In one study, the authors report performing approximately 200 pedicled groin flaps for this purpose.¹⁵ In addition to the large size and reliability of the vascular pedicle, the pedicled groin flap is particularly well suited for use in acute settings due to the decreased operative time and the simplicity of the procedure.^{6,8,15-19} These advantages contribute to the versatility and sustained use of pedicled groin in the current era.

The results of our study demonstrate that patients undergo a median of 4 (IQR: 3-5.25) surgeries when undergoing pedicled groin flaps. This consisted of 2 surgeries for flap inset and division with a median of 21 (IQR: 18-25) days to division, followed by 2 additional surgeries for functional/aesthetics purposes. Although this was higher than we originally anticipated from clinical experience and the mean of 2.8 surgeries reported by Katsaros et al, this is similar to number of operations reported by Goertz et al with 4.6 ± 1.7 surgeries

and an average of 24 ± 5 days to division.^{8,20} Nearly, all our patients reported some clinically significant stiffness (90.6%) which is consistent with literature and can be related to the severity of the injury or to prolonged immobilization required for total reconstruction. We experienced partial or complete flap loss in 38% of patients which is on the higher end of the 5% to 40% range reported in the literature for pedicled groin flaps.⁸ This is particularly noteworthy when compared with the lower incidence of partial or complete flap loss following free flaps for the upper extremity, which was reported to be 14% in a recent meta-analysis by Zhang et al.²¹ However, it is important to acknowledge that the rate of flap loss with free flaps has been increasing, with one study reporting similarly elevated values of 38%.²² This rise may be attributed to independent risk factors such as high BMI and male gender, as demonstrated in various studies.^{23,24}

We did find a higher incidence of infection requiring either medical or surgical intervention approximately double that reported previously in most studies (32% vs 14-18%).^{8,20,25,26} However, it is worth noting that a study by Freedlander et al reported an infection rate of 33%.²⁷ Our higher rate, compared with other studies (with the exception of the study by Freedlander et al), may be attributed to differences in the definition of infection as other studies never strictly defined what they considered infection. Interestingly, a complication that has not been previously reported in other pedicled groin flap series that we observed was the traumatic avulsion of the flap occurred in 11 patients (12.9%). This typically happened either when the patient was asleep or in the setting of hospital-associated delirium. We do not routinely use external fixators or spica casting to immobilize the operative extremity to the pelvis; however, this could be considered in the patient who may be at risk for postoperative delirium or noncompliance. Whereas flaps were subsequently reattached for most patients, in cases where avulsion occurred close to the scheduled division of the flap and there was obvious flap survival on the injured extremity, we did not reattach the groin flap.

Something of note that should be considered when evaluating our results is that all our pedicled groin flaps were based on the ipsilateral groin. Some authors have reported using the contralateral groin for donor tissue with success and a low rate of flap loss.²⁸ We believe that groin flaps should be considered the primary method of reconstruction in pediatric populations where free flaps may be exceptionally challenging due to vessel size; low-resource settings where free flaps may not be available; and certain injuries where patient characteristics (hemodynamic status, habits, etc), injury location, and soft tissue requirements easily lend themselves to a groin flap. This article serves to show that even with more modern surgical techniques among all surgeons at a tertiary care hospital, we are still experiencing high complication rates relative to prior literature.

Although this study represents the largest investigation of pedicled groin flaps to date, the sample size remains relatively

Table 6. Bivariate Comparisons of Patient and Injury Characteristics and Infection and Flap Loss.

Patient and Injury Characteristics	Infection requiring antibiotics or irrigation & debridement			Partial or complete flap loss		
	Yes	No	P value	Yes	No	P value
Age	37 (23, 50)	31 (21, 48)	.4	37 (23, 53)	31 (21, 47)	.2
Sex			.5			.14
Male	23 (68%)	40 (74%)		22 (63%)	41 (77%)	
Female	11 (32%)	14 (26%)		13 (37%)	12 (23%)	
Comorbidities			.5			.5
Yes	18 (53%)	23 (45%)		18 (53%)	23 (45%)	
No	16 (47%)	28 (55%)		16 (47%)	28 (55%)	
Type of injury			>.9			.8
High velocity (crush, MVC, ballistic, explosive)	17 (50%)	26 (48%)		16 (46%)	27 (51%)	
Sharp	4 (12%)	7 (13%)		4 (11%)	7 (13%)	
Burn	10 (29%)	15 (28%)		10 (29%)	15 (28%)	
Other	3 (8.8%)	6 (11%)		5 (14%)	4 (7.5%)	

Note. MVC = motor vehicle collision.

small. As a single-institution study, the generalizability of the findings to pedicled groin flaps performed at other institutions may be reduced as this is still a surgery used by multiple surgeons at our institution for upper extremity coverage. Finally, the retrospective nature of the study raises the possibility of incomplete data, although every effort was made to minimize this potential limitation using our text search to identify all patients and charts associated with the intended encounters.

Future directions include building a database for comparison of outcomes with a cohort of patients who underwent free flaps for upper extremity injuries. This would provide a more robust and direct evaluation of the utility of pedicled groin flaps in the current era. Furthermore, a multicenter collaboration could be established to increase the sample size and generalizability of the study. These future directions will provide a more comprehensive understanding of the best surgical approaches to upper extremity reconstruction and improve patient outcomes.

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Ethical Approval

This study was approved by our Institutional Review Board.

Statement of Human and Animal Rights

This article does not contain any studies with human or animal subjects. Our Institution's Review Board (no. 221782) deemed the study to be exempt from review.

Statement of Informed Consent

Informed consent was obtained from all individual participants included in the study.

Declaration of Conflicting Interests

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