Systematic Review

Pedicled Flaps for Soft Tissue Defects Around Elbow Joint: Systematic Review

Ahmed T. S. Hassan, Mohamed M. Fareed, Sharaf F. A. E. Yaseen *

Department of Plastic and burn Surgery, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

Abstract

Background: ***The elbow is especially susceptible to high-energy damage because of its position and high movement. Elbow abnormalities occur from various etiologies, including infection, trauma, burn contracture release, or tumor removal.***

Aim: ***To investigate all pedicled flaps for elbow coverage and evaluation of the outcomes with clinical application.***

Materials and methods: ***This systematic review has been carried out on a total of 19 studies, including a total of 247 cases with soft tissue defects around the elbow undergoing coverage using pedicled flaps.***

Results: ***A total of 13 reconstruction techniques were described. The most used FCFs were the medial and lateral arm and forearm. Flaps, in 44 (17.8%) patients. The most used MFs were the anconeus flaps, in 40 (16.2%) patients. The most used DPFs were latissimus dorsi flaps, in 55 (22.3%) patients. The least commonly used FCFs, MFs, and DPFs were adipofascial flaps, brachioradialis flaps, and rectus abdominis flaps.***

Conclusion: ***Elbow flap reconstruction can be done with various approaches. Free Cash Flows represent the predominant reconstruction methodology. There were 13 reconstruction techniques; the most used FCFs were medial and lateral arm and forearm flaps, in 17.8% of patients. The most used MFs were the anconeus flaps, in 16.2% of patients. The most used DPFs were latissimus dorsi flaps, in 22.3% of patients.***

Keywords: Pedicled Flaps; Soft Tissue Defects; Elbow Joint

1. Introduction

The elbow is particularly vulnerable to high-energy damage due to its position and significant movement. Elbow abnormalities occur due to several factors, including infection, trauma, burn contracture release, or tumor removal. [1]

This region is surrounded by thin and mobile tissues that react to its heightened mobility. There are many important anatomical structures in the cubital area, including ulnar, brachial, and radial arteries, basilic, cephalic, and median cubital veins, and ulnar, median, and radial nerves. The elbow joint below exhibits a heightened propensity for ankylosis, or stiffness. [2]

The coverage type must be suitable for the magnitude and origin of the defect, as well as the patient's overall health and requirements.[3]

The skin graft was once the primary focus in elbow repair; however, it does not offer lasting coverage adequate to withstand repetitive elbow flexion and extension. We have utilized random, axial, and free myocutaneous and fasciocutaneous flaps. The pedicled flap represents an advancement in flap design, providing a simpler alternative to free flaps with reduced donor site morbidity.[4]

Koshima and Soeda characterized the inaugural pedicled flap as a free tissue transfer flap in 1989. Subsequently, a diverse array of local and regional pedicled flaps has been utilized. Pedicled flaps are at the forefront of reconstructive procedures. [5]

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* Corresponding author at: Plastic and burn Surgery, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt.
E-mail address: Sharafyaseen0@gmail.com (S. F. A. E. Yaseen).

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To fix small, medium, or sometimes large soft tissue problems in the elbow, pedicled flaps must be taken from the forearm or arm. The arteries that supply the pedicle can come from the brachial, radial, ulnar, or arterial anastomotic arcades of the elbow.[6]

It is highly advisable to implement early soft tissue covering, preferably within the initial five days post-injury. This facilitates serial débridement of the damage. This also provides time for surgical planning to enhance the treatment strategy for soft-tissue and functional deficiencies.[7]

This study aimed to systematically review literature on all pedicled flaps for elbow covering and assess the outcomes in clinical applications.

2. Materials and methods

This is a comparative clinical study conducted on 60 adult patients with septic shock according to Berlin guidelines admitted to the Emergency and Critical care departments of Al-Azhar University Hospitals from May 2021 to June 2022.

Patients were divided into two equal groups, each of 30 randomly using computer-generated numbers and sealed opaque envelopes, with one group receiving saline (S group) and the other group receiving 20% albumin solution (A group) for initial fluid resuscitation. Baseline demographic data, suspected source of infection, hemodynamic parameters, and biomarker levels were recorded. These parameters were reassessed 3 hours after initiating protocol-driven resuscitation with 30 ml/kg intravenous crystalloid fluid, and vasopressors titrated to achieve the target MAP.

The cardiac index is measured using transthoracic echocardiography through the following equation (CI = COP[SV X HR]/BSA). ScvO2 was measured through a blood sample withdrawn from CVC and measured by an ABG analyzer device.

Sample size calculation

The sample size calculation for the study was based on assumptions from Guarracino et al. (2019), using a 95% two-sided confidence level, 80% power, and a 5% alpha error. The calculation employed the following equation:

Although specific effect size and standard deviation values were not provided, the calculation using Epi Info STATCALC software determined a sample size of 52 per group. This was increased to 60 to account for potential dropouts during follow-up, ensuring the study's robustness and reliability.

Statistical Analysis

Statistical analysis was performed using SPSS version 22. Normality was assessed using the Kolmogorov-Smirnov test. Continuous variables were presented as mean and standard deviation and compared between groups using the student's t-test or Mann-Whitney U test as appropriate. Categorical variables were compared using the chi-square test. P-values <0.05 were considered statistically significant.

3. Results

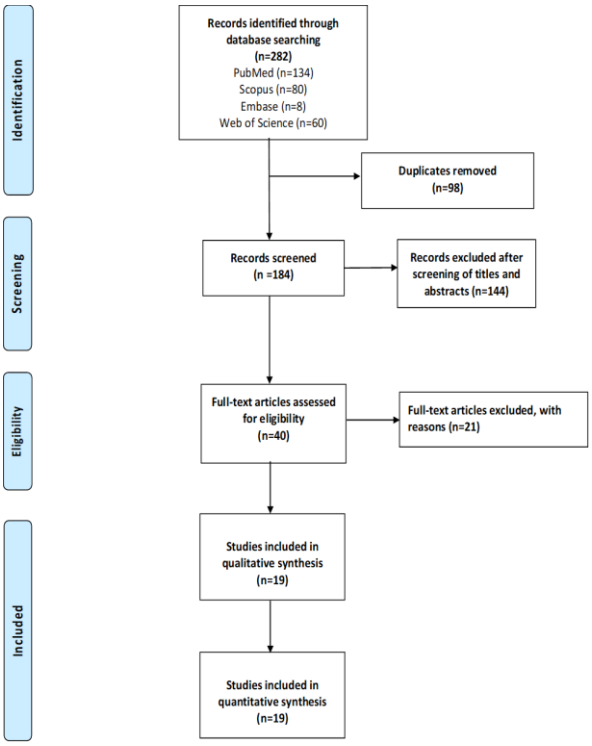

Figure 1. PRISMA Flow Diagram of the Study Selection Process

Participants' age was reported in 18 studies ranging from 11.3 to 74 years. Gender distribution was reported in all studies. The majority of participants were males. A total of 169 (68%) patients were males, while 78 (32%) patients were females (Table 1)

Table 1. Patient Characteristics

FIRST AUTHOR	Age, yr	Gender		Indication					Defect Size, cm^2
		M	F	Burn	Trauma	Infection	Hardware Coverage	Others	
EL-KHATIB[8]	11.3	8	5	13	0	0	0	0	57.1
MEARS[9]	41.2	8	2	0	10	0	0	0	21.7
TUREGUN[10]	20	11	0	11	0	0	0	0	37.6
PRANTL[11]	55	7	3	1	0	6	0	3	53.8
TRIPATHY[12]	24.3	5	5	7	2	0	0	1	103
UYGUR[13]	21.4	9	0	9	0	0	0	0	160
FARBER[14]	NA	7	0	0	7	0	0	0	NA
SAJJAD[15]	38.5	20	8	4	24	0	0	0	NA
ELHASSAN[16]	57	12	8	0	0	16	4	0	12
FLEAGER[17]	69.8	3	17	0	0	1	19	0	NA
SHARPE[18]	44.8	4	4	0	4	0	4	0	NA
OOI[19]	40.5	9	3	0	6	1	2	3	96
HACQUEBORD[20]	33	16	2	0	18	0	0	0	422
NAKAO[21]	27	21	3	12	11	0	0	1	NA
HEIDEKRUEGER[22]	74	6	7	0	0	13	0	0	20
DEGLOVE[23]	70.6	5	3	0	7	1	0	0	17
ZAMPELI[24]	61.4	3	2	0	0	0	4	1	6.2
DI SUMMA[25]	60	9	6	0	2	9	2	2	35
GURBUZ[26]	39.8	6	0	0	6	0	0	0	285

NA, NOT AVAILABLE

Figure 2 describes a total of 13 reconstruction techniques. The most used FCFs were medial

and lateral arm and forearm flaps, in 44 (17.8%) patients. The most used MFs were the anconeus flaps, in 40 (16.2%) patients. The most used DPFs were latissimus dorsi flaps, in 55 (22.3%) patients. The least commonly used FCFs, MFs, and DPFs were adipofascial flaps, brachioradialis flaps, and rectus abdominis flaps.

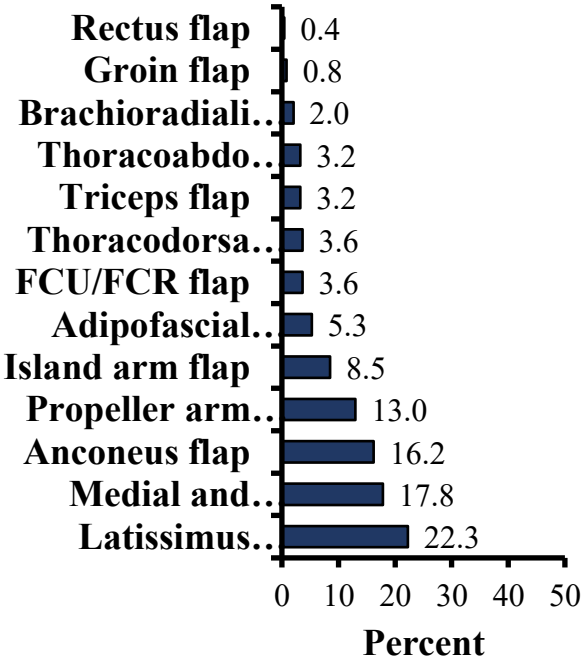

Figure 2. Reconstruction Techniques

Table 2 reviews the perioperative variables, including operating time and length of hospital stay. The mean operating time was reported by six studies, ranging from 83 to 268 minutes. Three studies reported hospital stays ranging from 17.5 to 21 days.

Table 2. Surgical Outcomes

FIRST AUTHOR	Operating Time, min	Hospital Stay, days
PRANTL[11]	90	NA
UYGUR[13]	185 ± 12.5	NA
HEIDEKRUEGER[22]	123 ± 47.6	17.5 ± 14.8
DELGOVE[23]	83 ± 14	NA
DI SUMMA[25]	117 ± 21	21 ± 12
GURBUZ[26]	268 ± 160	18.7 ± 5.3

NA, NOT AVAILABLE

To calculate the overall estimate, a fixed-effect model was used as no significant heterogeneity was detected (I^2 = 0%, P = .414). The overall survival rate of pedicled flaps ranged from 0.77 to 1.0, with the pooled estimate being 0.90 (95% CI: 0.84–0.93) (Figure 3).

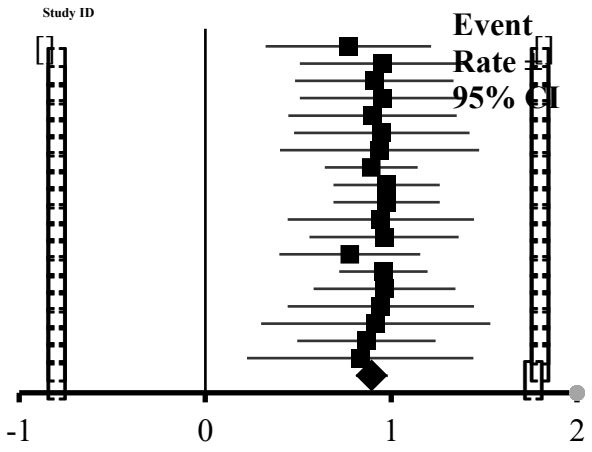

Figure 3. Forest Plot for Overall Survival Rate

The overall complication rates for FCFs, MFs, and DPFs were 13.3%, 8.3%, and 15.7%, respectively. To calculate the overall estimate, a fixed-effect model was used as no significant heterogeneity was detected (I^2 = 0%, P = .231). As shown in Figure 12, the overall complication rate ranged from 0.05 to 0.40, with the pooled estimate being 0.21 (95% CI: 0.15–0.29) (Figure 4).

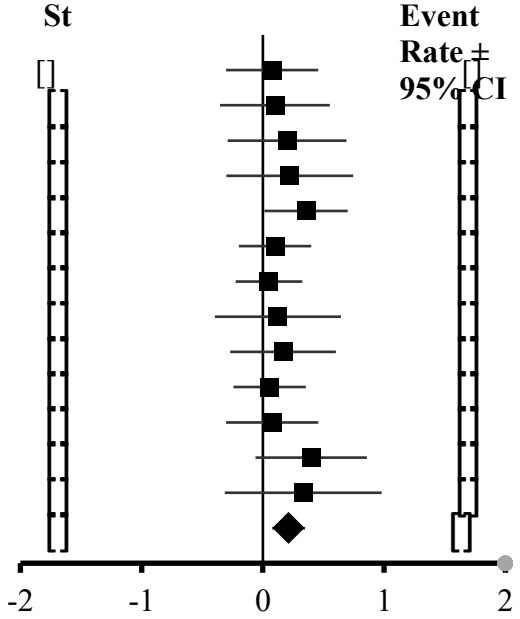

Figure 4. Forest Plot for Overall Complication Rate

4. Discussion

Regarding patients' characteristics, the age of participants in 18 studies was reported to be 11.3 to 74 years. Most participants were males. A total of 169 (68%) patients were males. While 78 (32%) patients were females. The indication for soft tissue coverage was reported in all studies. 57 (23%) had burn scar contractures, 97 (39%) were post-traumatic, 47 (19%) were caused by infections, 35 (14%) required hardware coverage, and 11 (4%) reported other causes. The average defect size was reported in 14 studies, ranging from 6.2 to 422 cm^2. The defect size was classified into four categories, including 37 patients with small defects (<10 cm^2), 48 patients with medium defects (10–30 cm^2), patients with large defects (30–100 cm^2), and 79 cases with massive defects (> 100 cm^2).

Our findings have been confirmed by the research conducted by Delgove et al.[23], which indicated that the surgery has been performed on eight cases (three females, five males). The subjects were 70.6 ± 17.7 years of age at the time of the surgical procedure. The defect has been attributed to postoperative scar problems in four cases following traumatic surgery, one case with chronic olecranon bursitis, skin necrosis resulting from an underlying olecranon fracture in one case, and direct open fractures in two cases. The median surface area of soft tissue damage was 17 (14-22) cm^2.

The present study showed that the most used FCFs were medial and lateral. Arm and forearm flaps, in 44 (17.8%) patients. The most commonly used MFs were the anconeus flaps, in 40 (16.2%) patients. The most commonly used DPFs were latissimus dorsi flaps, in 55 (22.3%) patients. The least commonly used FCFs, MFs, and DPFs were adipofascial flaps, brachioradialis flaps, and rectus abdominis flaps.

Our findings align with the research of Prantl et al.,[11], which documented clinical experience with the distal pedicled reversed upper arm flap in ten cases with significant elbow abnormalities. The case group comprised six cases with chronic ulcers, two with tissue defects resulting from the excision of a histiocytoma, and one case with a burn contracture. In both cases of histiocytoma, closure of the lesion in the ulnar region of the elbow was accomplished by utilizing a recurrent medial upper arm flap.

In the study by di Summa et al.,[25] lateral arm flaps (LAFs) were elevated in a reverse-flow manner, whereas eight were radial collateral artery perforator (RCAP) flaps.

The secondary outcomes were surgical complications and passive range of motion (PROM). Minor faults were predominantly restored using MFs (83%), medium defects utilized MFs (52%) or FCFs (46%), while major defects were primarily reconstructed with FCFs (91%). Significant faults primarily necessitated DPFs (sixty percent) and FFs (twenty-six percent). Free tissue flaps were the predominant restoration technique for burn contractures (eighty-four percent), infections (fifty-five percent), and traumatic abnormalities (fifty-one percent).

In the study by Ooi et al.,[19] anterolateral thigh (ALT) flaps, 1 free latissimus dorsi myocutaneous flap, and 1 free rectus abdominis flap were utilized.

The current study showed that the mean operating time was reported by six studies, ranging from 83 to 268 minutes. The length of hospital stay was reported by three studies, ranging from 17.5 to 21 days.

Our findings were confirmed by the research conducted by Gürbüz & Ekinci,[25], which indicated that two cases were transferred to a ward following a two-day surgery monitoring period in the critical care unit, with an average surgical length of 268.8±160.14 minutes (ranging from 128 to 563) and a mean hospitalization of 18.6±5.31 days (ranging from fourteen to twenty-nine). Furthermore, the cases exhibited comparable periods for return to work, specifically 6.3±2.73 months.

In the study on survival rate, a total of 231 (94%) patients showed complete survival, whereas 14 (6%) patients showed partial flap necrosis. The overall survival rates for FCFs, MFs, and DPFs were 93%, 100%, and 92%, respectively. The rate of partial necrosis was 7% for the FCFs, 0% for the MFs, and 8% for the DPFs. To calculate the overall estimate, a fixed-effect model was used as no significant heterogeneity was detected (I^2 = 0%, P = .414). The overall survival rate of pedicled flaps ranged from 0.77 to 1.0, with the pooled estimate being 0.90 (95% CI: 0.84–0.93).

In the research conducted by Sharpe et al.,[18], the clinical follow-up of seven cases needing flexor carpi ulnaris (FCU) rotational flaps for posterior elbow coverage showed that all flaps were successful and sufficiently covered the defect.

Similarly, Zampeli et al.[24], demonstrated that all cases had viable and functional soft tissue coverage.

4. Conclusion

There are several ways to carry out elbow flap reconstructions. Free Cash Flows represent the predominant reconstruction methodology. There were 13 reconstruction techniques; the most used FCFs were medial and lateral arm and forearm flaps, in 17.8% of patients. The most used MFs were the anconeus flaps, in 16.2% of patients. The most used DPFs were latissimus dorsi flaps, in 22.3% of patients. The least commonly used FCFs, MFs, and DPFs were adipofascial flaps, brachioradialis flaps, and rectus abdominis flaps.

MFs are beneficial for smaller flaws and hardware coverage. DPFs and FFs are essential for severe injuries. The pedicled flap is reliable, versatile, and rapid to perform and possesses a broad range of rotations. We suggest it as the preferred flap for significant soft tissue abnormalities surrounding the elbow.

Disclosure

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Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

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