



Reconstruction of upper extremity defects with distant pedicled flaps

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Abstract

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Aim: Pedicled abdominal and groin flaps have been used for hand and forearm reconstruction for years. Nowadays, they are applied as a safe option when free flap is not suitable. In this study, we aimed to present cases in which soft tissue defects on hand and forearm were closed with pedicled groin and abdominal flaps, in the light of the literature.

Materials and Methods: Thirty-five patients whose soft hand tissue defects in the hand and forearm were treated with pedicled groin and abdominal flaps in the department of Plastic, Reconstructive and Aesthetic Surgery between 2010 and 2022 were included in the study. Data such as age, gender, cause of defect, localization of defect, size of defect, donor site closure method, flap division time, hospitalization time and complications which were obtained from patient files were evaluated.

Results: Our patients were between the ages of two and 65 and mean age was found as 33.9 ± 15.7 . Thirty-one (88.5%) of our patients were male, while four (11.5%) were female. When the causes of defects were examined, it was found as crush injuries of hand and fingers in 12 patients (34.29%), electrical burn in 11 patients (31.43%), gunshot wounds in five patients (14.28%), degloving injury in four patients (11.43%) and snake bite in three patients (8.57%). All flap donor sites were closed primarily. Flap loss was not recorded.

Conclusion: Pedicled abdominal and groin flaps, which are a fast and safe option, continue to be an important alternative in suitable patients despite the advances in microsurgery.



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Introduction

McGregor and Jackson described the pedicled groin flap in 1972 for soft tissue defects of the hand [1]. In the following years, pedicled abdominal and groin flaps became one of the flaps first referred to in hand and forearm reconstruction. There are various commonly performed local flaps options for reconstruction of small sized finger tip defects, whereas pedicled interpolation flaps or free flaps harvested from the groin-abdominal region may be required in order to cover larger sized defects [2]. With the use of microscope in surgeries and the increase in microsurgical experience, free flaps became the first choice. However, despite the half century that has passed, pedicled flaps are commonly used in cases when free flap is not suitable. In addition to having an easy and quick surgery, they have a safe circulation [3]. In this study, we aimed to present cases in which soft tissue defects on hand and forearm were closed

with pedicled groin and abdominal flaps, in the light of the literature.

Materials and Methods

Patients

Thirty-five patients whose soft hand tissue defects in the hand and forearm were treated with pedicled groin and abdominal flaps in the department of Plastic, Reconstructive and Aesthetic Surgery between 2010 and 2022 were included in the study. Data such as age, gender, cause of defect, localization of defect, size of defect, donor site closure method, flap division time, hospitalization time and complications which were obtained from patient files were evaluated. Partial flap necrosis, detachment of the flap from recipient site, bleeding and shoulder stiffness were defined as major complications, while delayed wound healing and wound dehiscence at the donor site were defined as minor complications. Permission for the study was obtained from the Ethics Committee of Inonu University with the decision number 2022/3204.

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Surgical planning

The wound was carefully debrided and prepared for closure. The flap was designed considering the defect localization and the arteries supplying the abdominal skin (figure 1). Pedicle compression and traction were avoided after flap adaptation. Extremity was fixed to the trunk by stitching between the extremities and the trunk and wrapped with bandages. In this way, wound separation by involuntary movements is prevented. At the end of two weeks, pedicle compression was started with a bowel clamp. It started with 10 minutes per hour and went up to 30 minutes. The pedicle was divided when it was found that the flap circulation was not impaired by compression.

Statistical analysis

The results were presented as percentage-frequency in general and the relationships between some variables were examined with correlation analysis. In the comparisons made in terms of the state of developing complications, Mann-Whitney U test was applied. IBM SPSS Statistics V21.0 (IBM Corp., Armonk, New York, USA) software package was used in the statistical analysis of data and $P < 0.05$ was considered as significant.

Results

Our patients were between the ages of 2 and 65 and mean age was found as 33.9 ± 15.7 . We had four patients who were younger than 18 years of age. One of these patients had crush injury, one had degloving injury and two had

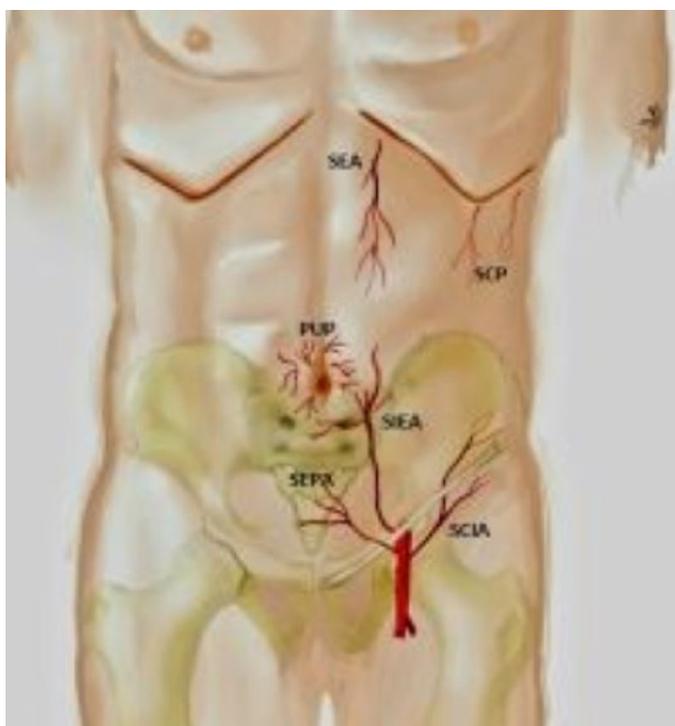


Figure 1. Vascular anatomy of the abdominal skin (SCIA, superficial circumflex iliac artery; SIEA, superficial inferior epigastric artery; SEPA, superficial external pudental artery; PUP, paraumbilical perforators; SCP, subcostal perforators; SEA, superficial epigastric artery).

Table 1. Demographic and clinical data of patients.

		n	%
Gender	Male	31	88.57
	Female	4	11.43
Cause of defect	Crush injuries of hand and fingers	12	34.29
	Degloving injuries	4	11.43
	Electrical burns	11	31.43
	Gunshot wounds	5	14.28
	Snake bites	3	8.57
Localization of defect	Hand	30	85.71
	Forearm	5	14.29
Extremity with defect	Right	21	60
	Left	14	40
Which side was the flap turned from?	Right	24	68.57
	Left	11	31.43
Flap thinning		11	31.42
Complication	Major	3	8.57
	Minor	1	2.86
		Mean \pm SD	Min-Max
Age		33.94 ± 15.78	2-65
Hospital stay (days)	Electrical burns (n=6)	85.5 ± 45.05	30-153
	Other causes (n=29)	8.03 ± 8.22	2-33
	All patients (n=35)	21.31 ± 35.09	2-153
Number of operations		2.57 ± 0.88	2-5
Defect size (cm ²)		19.43 ± 16.78	2-60
Flap division time (days)		23.34 ± 7.96	14-45

electrical burn. Thirty-one (88.5%) of our patients were male, while four (11.5%) were female. When the causes of defects were examined, it was found as crush injuries of hand and fingers in 12 patients (34.29%), electrical burn in 11 patients (31.43%), gunshot wounds in 5 patients (14.28%), degloving injury in 4 patients (11.43%) and snake bite in 3 patients (8.57%). All flap donor sites



Figure 2. a) Degloving injury of left hand second finger b) appearance of the groin flap c) after flap inset d,e,f) second month after operation.



Figure 3. a,b) Tissue defect in the left elbow region as a result of gunshot wounds c) abdominal flap design d,e,f) Postoperative 1st month view.



Figure 4. Postoperative 3rd month view of the abdominal flap made for the tissue defect in the right hand dorsum.

were closed primarily. When hospitalization time was examined, it was found that the patients who were hospitalized due to electrical burn stayed longer than the other groups. Mean hospitalization time was found as 85.5 days in 6 patients who were hospitalized due to electrical burn, while it was found as 8.03 days in the remaining 29 patients. The patients were found to undergo surgery with a mean of 2.57 times. Mean flap size was 19.43 cm² and flap division time was 23.34 days. Flap thinning was required in 11 (31.4%) of our patients. Three (8.57%) of our patients had major complication, while one had (2.86%) minor complication. As major complication, one patient had partial necrosis in the flap, one had active bleeding in the flap and one had complete detachment of the flap with bleeding. As minor complication, one patient had wound dehiscence (Table 1). No significant correlation was found between complication and defect length ($p=0.56$), defect area ($p=0.42$), flap division time ($p=0.30$) and hospitalization time ($p=0.16$).

Discussion

Pedicled groin flap has been used in upper extremity reconstruction for many years. It is supplied by the superficial circumflex iliac artery (SCIA). As the blood supply of flap in the axial pattern began to be understood, different flaps were defined based on other arteries supplying the abdominal skin. Abdominal flaps are supplied by superficial inferior epigastric artery (SIEA), superficial external

pubudental artery (SEPA), paraumbilical perforators (PUP); while thoracic flaps are supplied by subcostal and lumbar perforators. They are generally used in closing exposed structures such as bone, tendon and nerves in ipsilateral upper extremity reconstruction [3]. In addition to advantages such as being reliable and short surgery time, they also have disadvantages such as requiring extremity stabilization for 3-4 weeks and the need for more than one surgery [4].

Pedicled groin and abdominal flap indications:

a) *Complex hand injuries in children younger than 2 years of age:* Small vessel diameter and the tendency for vasospasm following anastomosis make free flap difficult [5]. We had only one two-year-old patient. He had finger defect due to electrical burn.

b) *To preserve length in multiple finger amputations:* In amputations not suitable for replantations and in multiple distal phalangeal injuries, the skin can be excised and closed with flap following bone fixation [6,7].

c) *Degloving injuries of fingers:* The finger is reconstructed by shaping the thin groin flap into a tube [8]. Flap was performed in four of our patients due to a degloving injury in the finger.

d) *Multiple tissue defects in finger, hand and forearm:* Groin flap may be used by separating into multiple parts or in combination with abdominal flap [9,10].

e) *Defects in the hand supplied by collateral circulation in high voltage electrical burns:* Dissection for free flap may disrupt circulation and lead the hand to necrosis. Pedicled flaps are used as a safe choice in these patients [8].

While the hospitalization time of patients whose upper extremity defects were repaired with pedicled flaps was found to vary between 6 and 46 days in previous studies [4,11,12], it was found as 21 days in our study. When examined in terms of the causes of defect, hospitalization period was found to be longer in patients who had tissue defect due to electrical burn. Six of 11 patients with electrical burn were treated in our hospital starting from the acute period and mean hospitalization time was 85 days. It was found as eight days in the remaining 29 patients. Electrical burns increase the length of hospitalization significantly [13]. Long hospitalization may be attributed to the morbidity of electrical burns.

While designing abdominal and thoracic flaps, side of the defect, vascular anatomy and patient's comfort should be taken into account. Keeping the flap base narrow and the pedicle long increases patient comfort. Flaps are generally removed from the same side as defects [3]. In 32 (91.4%) of our patients, the flap was removed from the same side as the defect. One or more arteries supplying the abdominal skin are included in the flap. Flap donor sites are usually closed primarily. In groin flaps larger than 12 cm or in abdominal flaps that cannot be closed primarily, donor sites are grafted. Expander can be used for thinner flaps in

obese patients or to protect from graft scarring. Hip flexion has been recommended in some studies to support primary closure [12]. In line with the literature, we closed all flap donor sites primarily without encountering any problems. Flaps detached on the mean 23rd post-operative day and this result was consistent with the 3-week period given in literature. However, this period was reduced to 9 days with the controlled ischemia created by pedicle clamping [14]. The larger inset area of the flap is, the safer it will be for pedicle to separate [4]. It is the living tissue in the defected area that establishes vascular connection with the flap. Therefore, the safety of pedicle separation depends not on the size of the entire defected area, but on the width of blood supply in the defected area. The result that there were no significant correlations between complication and the defect area in our patients ($p=0.42$) is in parallel with literature findings. While the mean number of surgeries our patients underwent was 2.5, the mean number of surgeries was 4.6 in Goertz et al.'s study. Although surgery time is short in pedicled flaps, they do not have superiority over free flaps in terms of total surgery time [4]. In patients who complain about flap thickness, flap can be thinned or can be used by expanding the flap. In both cases, it brings an additional operative morbidity to the patient [15]. Flap thinning was performed on 11 (31%) of our patients. Three of the patients (8.57%) had major complications, while one (2.86%) had minor complications. As major complication, one patient had partial necrosis in the flap, one patient had active bleeding in the flap and one patient had complete detachment of the flap with bleeding. One patient had wound dehiscence as minor complication. In the patient who developed partial necrosis in the flap, groin flap was performed due to snake bite and our patient had a history of smoking. We think that necrosis may be due to smoking. Negative effects of smoking are known on flap viability and wound healing. In elective flap surgeries, negative effects of smoking on flap surgery can be avoided by stopping smoking two weeks before surgery [16]. However, patient compliance can be a problem, as in our patient. Active bleeding developed in two of our patients who underwent pedicled groin flap for tissue defect in the wrists due to electrical burns. There were recurrent bleedings under the flap. Spontaneous ruptures can be seen in electrical burns due to vascular destruction. In a study by Reinbold et al. [17], spontaneous ruptures were seen in three patients with electrical burns. While two patients had bleeding in tibial arteries, one patient had bleeding from radial artery. Two of our patients had spontaneous bleeding and both had bleeding from the radial artery. This situation should be considered in the follow-up of patients with electrical burn. An involuntary movement during recovery from anesthesia may cause the flap to detach. In order to avoid this, the patient should be informed about the surgery in preoperative period and should be woken up after the extremity is sufficiently fixed on the body [7]. Helping stabilization from the outside until the patient wakes up completely may also prevent this problem. Thanks to these measures we took, we did not experience flap detachment due to lack of immobilization. The wound was made ready for closure with repetitive debridements performed on our patients. When using

abdominal flaps in hand and forearm reconstructions, adequate debridements are essential for a good surgical result [8,18]. Long-term immobilization may cause shoulder stiffness in old patients. We did not experience this problem in our patients. Wound dehiscence in the donor site was evaluated as minor complication. Wound dehiscence was seen in one of our patients who took steroid for lupus and who had a history of smoking. The negative effects of steroid and smoking on wound healing are known [19]. The patient recovered secondarily without intervention.

Conclusion

Pedicled abdominal and groin flaps are important choices in hand and forearm defects due to being safe and easy surgery. Despite the widespread use of microsurgery, they still remain an important alternative in suitable patients.

Ethics approval

The study was obtained from the Ethics Committee of Inonu University with the decision number 2022/3204.

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