

Comparison of lateral arm flap and posterior interosseous artery flap for soft tissue reconstruction of the elbow

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ABSTRACT

BACKGROUND: The study aimed to evaluate and compare the two different flap techniques used for the reconstruction of soft tissue defects in the elbow region: the lateral arm flap (LAA) and posterior interosseous artery (PIA) flap.

METHODS: The retrospective study included 12 patients who underwent surgical treatment for soft tissue defects between 2012-2018 at the clinic. The study evaluated demographic data, flap size, operating time, donor site, flap complications, number of perforators, and functional and cosmetic outcomes.

RESULTS: Results showed that patients who underwent PIA flap had significantly smaller defect size than those who underwent LAA flap ($p < 0.001$). However, there were no significant differences between the two groups ($p > 0.05$). Patients who received PIA flaps had significantly lower QuickDASH scores, indicating better functional results ($p < 0.05$). The operating time was significantly shorter in the PIA group than in the LAA flap group ($p < 0.05$). Additionally, the range of motion (ROM) of the elbow joint was significantly higher among the patients who received the PIA flap ($p < 0.05$).

CONCLUSION: The study concludes that both flap techniques are easy to apply depending on the surgeon's experience, have low complication risk, and provide similar functional and cosmetic results in similar defect sizes.

Keywords: Elbow reconstruction; lateral arm flap; posterior interosseous artery flap.

INTRODUCTION

The elbow has a wide range of motion (ROM); therefore, the management of tissue defects around the elbow is challenging, and closing such defects require operations with free or local flaps.^[1,2] Many muscle and skin flaps that can be used in soft tissue reconstruction of the elbow region have been described, including muscle flaps, such as the brachioradial flap, extensor carpi radialis flap, and latissimus dorsi flap; moreover, fasciocutaneous flaps can also be applied as free or pedicled flaps, such as the radial forearm flap, posterior interosseous artery flap, and lateral arm flap.^[3,4]

Fasciocutaneous flaps have many advantages, such as providing adequate soft tissue coverage, good contour, less scarring,

potential gliding surface for tendons, and many variations of the flap inset. Furthermore, fasciocutaneous flaps are associated with virtually no functional deficits and secondary contouring is not technically difficult. On the other hand, well-known disadvantages of pedicled fasciocutaneous flaps, especially with regard to pedicled flaps, include limited usability on large defects, need for skin grafts to cover the donor site, and limited variations of flap type because of the proximity of the donor site to the recipient site.^[5,6]

Lateral and posterior interosseous flaps are among the most common flaps used to cover soft tissue defects in the upper extremity. Reports have shown that a lateral arm flap can be used as a reverse-flow flap in reconstruction of the elbow region.^[7,8] It can be applied as a reverse-flow or RCA

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perforator-based propeller flap.^[9] The posterior interosseous artery (PIA) flap is frequently used to reconstruct defects in the dorsum of the hand and wrist. In addition, it has been reported that antegrade PIA flaps can be used for soft tissue reconstruction of the elbow.^[10,11]

This study aimed to compare two different flaps used in soft tissue reconstruction of the elbow region: the lateral arm flap and posterior interosseous artery flap.

MATERIALS AND METHODS

This study was approved by the local ethics committee (No.2020/569), and was conducted in accordance with the principles of the 1964 Declaration of Helsinki. Patients who underwent treatment for soft tissue defects of the elbow region at our clinic between 2012 and 2018 were retrospectively evaluated. Patients who underwent reconstruction of elbow defects with lateral arm flap or PIA flap by the same author and were followed-up for at least 1 year, were included in the study. Patients who underwent at least one additional surgical procedure, such as a free muscle flap (e.g., latissimus dorsi), an additional fasciocutaneous flap (e.g., radial forearm), or both flaps (LARM and PIA) to cover the soft tissue around the elbow were excluded. The demographic data of the patients, flap size, operating time, complications, and number of perforators used were assessed. Functional and cosmetic results were evaluated using the QuickDASH and Likert scale,^[10] respectively, by an orthopedic surgeon specializing in hand and upper limb surgery.

Statistical Analysis

All data are expressed as median, 25–75 percentile, and minimum and maximum values. The two groups were assessed using the Shapiro-Wilk test, histogram, skewness, and kurtosis values to evaluate the normality of the distribution and for comparison of age, defect size, flap size, QuickDASH scores, Likert scores, number of perforators, and ROM. Data without a normal distribution were statistically analyzed using the Mann-Whitney U-test, while normally distributed data were assessed using Student's t-test. In addition, the chi-square test was used to evaluate the two groups in terms of the selection of fixation material, surgical side, and presence of complications. Statistical significance was set at p value <0.05.

Surgical Technique

Before explaining the surgical technique, it should be noted that we prefer pedicled fasciocutaneous flaps over muscle flaps with the aim of soft tissue coverage around joints owing to the well-recognized benefits mentioned in the introduction section. However, some large defects require muscle flaps or multiple procedures. Therefore, we usually adhere to literature suggestions while making our decisions regarding flap type.^[12,13] To clarify, we generally use pedicled fasciocutaneous flaps to cover soft tissue defects, which are smaller

than 40 cm² on the upper extremity, we also prefer free fasciocutaneous flaps to cover larger defects. We also prefer free muscle flaps if we need to cover a fracture site on the diaphyseal region of the bone because muscle flaps provide better blood flow than other flaps.^[14–16]

Lateral Arm Flap

A lateral arm flap was planned as a posterior radial collateral artery-based and reverse-flow flap. Before dissection, the perforators on the line between the lateral epicondyle and the deltoid insertion were identified using a handheld Doppler device. Appropriate skin incisions were made, and after dissection, the posterior radial artery was dissected and clamped proximally. The pedicle was dissected from the distal region to the brachial artery. The flap was completely dissected and raised. Coverage was achieved by applying sufficient flap rotation. Primary closure of the donor site was performed in all cases (Fig. 1).

Posterior Interosseous Artery Flap

Perforators were identified using a handheld Doppler at the line between the lateral epicondyle and distal radioulnar joint. The defect size was measured while the elbow was at maximum flexion. A pneumatic tourniquet cuff was inflated without draining the blood from the limb. Necessary outlines were made according to the flap size. Starting radial and distal to the flap, dissection was performed towards the proximal and ulnar sides. The pedicle was found between the ECU and EDC tendons. The skin island flap was raised distally and the pedicle was dissected proximally. The PIA was found where it pierced the interosseous membrane most proximally. The posterior interosseous nerve was preserved during pedicle dissection. The tourniquet was deflated after dissection was completed. After checking flap circulation, the PIA was at-



Figure 1. Lateral arm flap.



Figure 2. Posterior interosseous artery flap.

tached distally. The flap was then adapted to the site of the defect. Closure of the donor site was performed with a split-thickness skin graft harvested from the anterolateral thigh in three patients, while primary closure was performed in the other nine patients (Fig. 2).

Postoperative Care and Rehabilitation

Flap circulation was monitored at 1-h intervals during the first 24 h in both groups. The arm was elevated to prevent congestion. Patients with no circulatory or additional prob-

lems within the first 48 h were discharged. No splints were applied to the patients. Passive range of motion (ROM) exercises were initiated in the first week after discharge. Active ROM exercises were initiated in the second week.

RESULTS

A total of 21 patients who underwent reconstruction of soft tissue defects of the elbow with PIA flap (n=12) and lateral arm flap (n=9) were included in the study. Six patients who underwent additional coverage procedures were excluded; the procedures included muscle flaps, two cases of latissimus dorsi and brachioradial flaps combined with pedicled fasciocutaneous flaps, and a combination of lateral arm flaps and PIA flaps in three patients.

The defect size was significantly smaller in patients who were treated with a PIA flap than in those who received a lateral arm flap ($p<0.001$). There were no significant differences between the two groups ($p>0.05$). Patients who received PIA flaps had significantly lower QuickDASH scores, indicating better functional results ($p<0.05$). The operating time was significantly shorter in the PIA group than in the lateral arm flap group ($p<0.05$). The ROM of the elbow joint was significantly higher among the patients who received the PIA flap ($p<0.05$). No significant difference was observed in terms of the materials used for fracture fixation among the patients in the two groups who required reconstruction due to traumatic soft tissue defects. There was no significant difference

Table 1. Patient demographics

Characteristics	Grup PIN (n=12)		Grup LARM (n=9)		p-value
	Median (25–50 percentile)	Min-Max	Median (25–50 percentile)	Min-Max	
Age	41.50 (32.50–52.50)	19.00–64.00	41.00 (32.00–56.00)	18.00–63.00	0.972*
Defect size	15.87 (14.25–18.00)	12.00–20.00	24.00 (22.50–25.00)	20.25–30.00	0.000*
Flap size	28.00 (22.00–30.00)	20.00–40.00	35.00 (30.00–36.00)	20.00–42.00	0.057*
Quick DASH	2.30 (0.00–4.50)	0.00–11.40	6.8 (4.5–11.40)	0.00–15.90	0.039*
Number of perforator	2.00 (2.00–3.00)	1.00–3.00	2.00 (2.00–3.00)	1.00–3.00	0.875*
Elbow ROM	95.00 (90.00–100.00)	90.00–100.00	80.00 (80.00–90.00)	60.00–110.00	0.047*
Likert scale	18.00 (17.00–20.00)	15.00–20.00	17.00 (14.00–18.00)	12.00–20.00	0.112*
Operationtime	91.00 (84.50–103.50)	71.00–121.00	103.00 (98.00–111.00)	91.00–132.00	0.036*
Fixation material, n (%)					
Plate	8 (66.7)		7 (77.8)		0.433**
Tension	2 (16.7)		2 (22.2)		
ExFix	2 (16.7)		0 (0.0)		
Minimal complication, n (%)					
No	8 (66.7)		6 (66.7)		1.000**
Yes	4 (33.3)		3 (33.3)		

PIN: Posterior interosseous artery flap; LARM: Lateral arm flap; DASH: Disabilities of arm, shoulder and hand; ROM: Range of motion.

between the groups in terms of cosmetic results evaluated using a Likert scale or number of perforators (Table 1).

Complications

Partial or total flap loss did not occur in any of the patients. Three patients who received a PIA flap and one patient who received a lateral arm flap developed venous congestion. In one patient who received a PIA flap, wound dehiscence occurred on postoperative day 10, which was thought to be due to a soft tissue infection proximal to the defect. Serous discharge was observed distal to the site of the defect and this continued until postoperative day 6. A hematoma was observed at the donor site in one patient from each group.

DISCUSSION

Fasciocutaneous flaps consist of skin, subcutaneous tissue, and fascia. Prefascial and subfascial vascular plexuses, which are protected by the inclusion of the fascia flap, play important roles in the blood supply to the flap. Some types of fasciocutaneous flaps are used in rotation, while other types that have perforators can be separated as island flaps and used as free flaps, if necessary. In some cases, small perforators from the main artery reach the skin by passing through the fascial septum. The main artery can be included in the flap and used as a free flap. Fasciocutaneous flaps were first defined and then used in the lower extremities. In 1981, a saphenous flap obtained from the medial region of the knee and used as a free flap was described by Acland et al.^[17] The best-known and most commonly used technique is the reverse sural flap. This fasciocutaneous flap, containing the sural nerve, superficial sural artery, and small saphenous vein, is often dissected with a wide facial pedicle. It is widely used in the management of soft tissue defects around the ankle and foot with the help of tunneling or additional incisions.^[18,19]

In the closure of soft tissue defects surrounding the elbow joint, primary closure procedures are usually insufficient because of excessive ROM and high tension that occurs in such wound; therefore, local or free tissue transfers are required. Local applications are frequently preferred for defects smaller than 40 cm² owing to reasons such as short operating time, low complication risk, and low cost.^[20,21] The posterior RCA, which is the main artery of the lateral arm flap, has an average of three perforators and shows little variation.^[22,23] Therefore, it is considered a flap with easy anatomical management and can even be reliably applied by surgeons at the start of their learning curve. In this study, a pedicled flap with reverse flow was used in all patients who received a lateral arm flap. However, the PIA flap is preferred, especially for soft tissue defects of the dorsal hand, because it is a thin, aesthetic flap. It is also being used in the reconstruction of soft tissue defects in the elbow region.^[24] The largest defect size among patients in our study was 30 cm². Although the defect size was significantly larger in the lateral arm flap group, there was no significant difference between flap sizes. This contradiction may be related

to the decisions made by the surgeon based on his/her experience or may be related to the extent of the area supplied by the RCA and the notion that it may be more useful in closing larger defects. In conclusion, it appears that both flaps can be raised to similar sizes and can provide adequate defect closure.

From a functional standpoint, the lateral arm flap is associated with excellent outcomes.^[9] Although it has been stated that the PIA flap can be used in elbow reconstruction, data related to the functional results of this approach are limited.^[11] In the present study, QuickDASH score and ROM were used to evaluate the functional outcomes of these two flaps in the reconstruction of trauma-related soft tissue defects of the elbow. According to these results, cases in which the PIA flap was applied had significantly better functional outcomes. The highest QuickDASH scores among patients who received PIA and left arm flaps were 11.4 and 15.9, respectively. Considering that individuals with QuickDASH scores of between 0 and 29 do not experience any serious problems with their upper extremities (Outcome Measures e-Bulletin Summer-2013), the results were excellent. Patients who received a PIA flap had a significantly shorter operating time. Although both flaps involved pedicle dissection and similar techniques were preferred, this difference may be attributed to the use of tourniquets during PIA flap dissection, which has a positive effect on reducing operating time.

According to cosmetic results, venous flaps have been associated with the best outcomes, whereas fasciocutaneous flaps have been associated with the worst outcomes.^[12] Di Summa et al.^[9] assessed the cosmetic outcomes of two different lateral arm flap techniques and reported that patients who received pedicled-propeller flaps yielded better cosmetic results than those who underwent reverse-flow flaps. Akdag et al.^[25] yielded similar results when they examined the cosmetic results of cases in which PIA flaps were used along with a reverse-flow radial forearm flap on the dorsum of the hand. The two flaps compared in our study yielded similar cosmetic results.

Conclusion

The lateral arm flap and posterior interosseous artery flap are functionally and aesthetically satisfactory flaps that allow easy anatomical management because of the low variation of perforator structures do not require the sacrifice of a major artery and can provide defect coverage in a short time without the need for microvascular anastomosis. Considering the present data, we believe that these flaps do not have significant advantages over each other in the reconstruction of soft tissue defects in the elbow region and can be preferred in similar defects depending on the surgeon's experience. The fact that the donor site of the lateral arm flap can be covered more easily than that of the PIA flap may be considered an advantage.

Ethics Committee Approval: This study was approved by the Selçuk University Faculty of Medicine Clinical Research Ethics Committee (Date: 30.12.2020, Decision No: 2020/569).

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REFERENCES

- Patel KM, Higgins JP. Posterior elbow wounds: soft tissue coverage options and techniques. *Orthop Clin North Am* 2013;44:409–17. [CrossRef]
- Jensen M, Moran SL. Soft tissue coverage of the elbow: a reconstructive algorithm. *Orthop Clin North Am* 2008;39:251–64. [CrossRef]
- Nakao J, Umezawa H, Ogawa R, Mateev MA. Reconstruction of elbow skin and soft tissue defects using perforator-pedicled propeller flaps. *Microsurgery* 2018;38:473–8. [CrossRef]
- Gupta A, Lakhiani C, Lim BH, et al. Free tissue transfer to the traumatized upper extremity: risk factors for postoperative complications in 282 cases. *J Plast Reconstr Aesthet Surg* 2015;68:1184–90. [CrossRef]
- Pribaz JJ, Chan RK. Where do perforator flaps fit in our armamentarium? *Clin Plast Surg* 2010;37:571–9. [CrossRef]
- Orgill DP, Pribaz JJ, Morris DJ. Local fasciocutaneous flaps for olecranon coverage. *Ann Plast Surg* 1994;32:27–31. [CrossRef]
- Tung TC, Wang KC, Fang CM, Lee CM. Reverse pedicled lateral arm flap for reconstruction of posterior soft-tissue defects of the elbow. *Ann Plast Surg* 1997;38:635–41. [CrossRef]
- Coessens B, Vico P, De Mey A. Clinical experience with the reverse lateral arm flap in soft-tissue coverage of the elbow. *Plast Reconstr Surg* 1993;92:1133–6. [CrossRef]
- Di Summa PG, Sapino G, Guillier D, Dash J, Hart A, Raffoul W. Reverse-flow versus perforator propeller lateral arm flap for elbow reconstruction. *Ann Plast Surg* 2020;84:535–40. [CrossRef]
- Mirza AB, Shah IH, Hussain M, Saeed MB, Ali A, Ahmed N. Reverse flow posterior interosseous artery flap: A safe technique for reconstruction of wrist and hand defects. *Isra Med J* 2019;11:434–8.
- Gupta A, Yenna Z. Soft tissue coverage of the elbow. *Hand Clin* 2014;30:479–85. [CrossRef]
- Parrett BM, Bou-Merhi JS, Buntic RE, Safa B, Buncke GM, Brooks D. Refining outcomes in dorsal hand coverage: consideration of aesthetics and donor-site morbidity. *Plast Reconstr Surg* 2010;126:1630–38. [CrossRef]
- Orgill DP, Pribaz JJ, Morris DJ. Local fasciocutaneous flaps for olecranon coverage. *Ann Plast Surg* 1994;32:27–31. [CrossRef]
- Geddes CR, Morris SF, Neligan PC. Perforator flaps: evolution, classification, and applications. *Ann Plast Surg* 2003;50:90–9. [CrossRef]
- Davami B, Porkhamene G. Versatility of local fasciocutaneous flaps for coverage of soft tissue defects in upper extremity. *J Hand Microsurg* 2011;3:58–62. [CrossRef]
- Adkinson JM, Chung KC. Flap reconstruction of the elbow and forearm: a case-based approach. *Hand Clin* 2014;30:153–63. [CrossRef]
- Acland RD, Schusterman M, Godina M, Eder E, Taylor GI, Carlisle I. The saphenous neurovascular free flap. *Plast Reconstr Surg* 1981;67:763–74.
- Sarı A, Özçelik IB. Reverse sural flap: Our clinical experience with car tire injuries in the anterolateral aspect of the foot. *Ulus Travma Acil Cerrahi Derg* 2021;27:583–9. [CrossRef]
- Korompilias A, Gkiatas I, Korompilia M, Kosmas D, Kostas-Agnantis I. Reverse sural artery flap: a reliable alternative for foot and ankle soft tissue reconstruction. *Eur J Orthop Surg Traumatol* 2019;29:367–72.
- Murakami M, Ono S, Ishii N, Hyakusoku H. Reconstruction of elbow region defects using radial collateral artery perforator (RCAP)-based propeller flaps. *J Plast Reconstr Aesthet Surg* 2012;65:1418–21. [CrossRef]
- Choudry UH, Moran SL, Li S, Khan S. Soft-tissue coverage of the elbow: an outcome analysis and reconstructive algorithm. *Plast Reconstr Surg* 2007;119:1852–7. [CrossRef]
- Hennerbichler A, Etzer C, Gruber S, Brenner E, Papp C, Gaber O. Lateral arm flap: analysis of its anatomy and modification using a vascularized fragment of the distal humerus. *Clin Anat* 2003;16:204–14. [CrossRef]
- Hwang K, Lee WJ, Jung CY, Chung IH. Cutaneous perforators of the upper arm and clinical applications. *J Reconstr Microsurg* 2005;21:463–9.
- Penteado C, Masquelet A, Chevrel J. The anatomic basis of the fascio-cutaneous flap of the posterior interosseous artery. *Surg Radiol Anat* 1986;8:209–15. [CrossRef]
- Akdag O, Yildiran G, Sutcu M, Karamese M. Posterior interosseous flap versus reverse adipofascial radial forearm flap for soft tissue reconstruction of dorsal hand defects. *Ulus Travma Acil Cerrahi Derg* 2018;24:43–8.

ORIJİNAL ÇALIŞMA - ÖZ

Dirsek yumuşak doku rekonstrüksiyonu için lateral kol flebi ve posterior interosseöz arter flebinin karşılaştırılması

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AMAÇ: Bu çalışma, dirsek bölgesindeki yumuşak doku defektlerinin rekonstrüksiyonunda iki farklı flep tekniğinin tüm yönlerini karşılaştırmayı ve değerlendirmeyi amaçlamaktadır: lateral kol flebi (LAA) ve posterior interosseöz arter (PIA) flebi.

GEREÇ VE YÖNTEM: Kliniğimizde 2012–2018 yılları arasında dirsek bölgesi yumuşak doku defektleri nedeniyle cerrahi tedavi uygulanan 12 hasta geriye dönük olarak değerlendirildi. Hastaların demografik verileri, flep boyutu, operasyon süresi, donör alan ve flep komplikasyonları, perforatör sayısı, fonksiyonel ve kozmetik sonuçları incelendi.

BULGULAR: PIA flebi ile tedavi edilen hastalarda defekt boyutu, LAA flebi uygulanan hastalara göre anlamlı olarak daha küçüktü ($p<0.001$). İki grup arasında anlamlı fark yoktu ($p>0.05$). PIA flepleri uygulanan hastalarda QuickDASH skorları önemli ölçüde daha düşüktü, bu da daha iyi fonksiyonel sonuçlara işaret ediyordu ($p<0.05$). Operasyon süresi PIA grubunda lateral kol flep grubuna göre anlamlı olarak daha kısaydı ($p<0.05$). Dirsek eklemi EHA'sı PIA flebi uygulanan hastalarda anlamlı olarak daha yüksekti ($p<0.05$).

TARTIŞMA: Çalışmamızın sonuçları, her iki flebin de cerrahin deneyimine bağlı olarak uygulanması kolay, komplikasyon riski düşük, benzer defekt boyutlarında benzer fonksiyonel ve kozmetik sonuçlar sağlayan teknikler olduğunu göstermektedir.

Anahtar sözcükler: Dirsek rekonstrüksiyonu; lateral kol flebi; posterior interosseöz arter flebi.

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