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Original Research Article

A DESCRIPTIVE STUDY OF POSTERIOR INTEROSSEOUS ARTERY FLAPS FOR THE RESURFACING OF SOFT TISSUE DEFECTS OF THE HAND IN A TERTIARY CARE CENTRE

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ABSTRACT

Background: Soft-tissue defects of the hand require thin, stable, and functional coverage without compromising the major vessels. The posterior interosseous artery (PIA) flap provides a reliable regional option, especially in settings without microsurgical facilities. This study assessed the clinical outcomes, complication patterns and functional recovery following distally based PIA flap reconstruction. **Materials and Methods:** A prospective observational study was conducted on patients aged 18–60 years with traumatic or post-surgical hand defects. Preoperative Doppler mapping identified the posterior interosseous vascular axis and the pivot point. Intraoperative variables, postoperative complications, flap viability, donor site morbidity, aesthetic outcomes, and functional recovery were evaluated for six months. Functional recovery was assessed using the DASH-equivalent score (0–100), and aesthetic and satisfaction scores were measured using the Visual Analogue Scale (VAS 0–10). **Result:** Fifty patients were included (64% male; mean age, 38.2±11.6 years)10. Work spot injuries (54%) and road-traffic accidents (40%) were the common etiologies11. The mean operative time was 210±25 minutes, with minimal blood loss (60±20 ml), and a mean hospital stay of 5.6±1.4 days12. Donor sites required skin grafting in 98% of cases13. The flap survival rate was 100%14. Venous congestion occurred in 24% but resolved conservatively15. Marginal necrosis (6%), partial donor-site graft loss (4%), and suture-line dehiscence (2%) were minor and healed without functional compromise16. Functional outcomes were satisfactory (DASH 28.9±5.4), with a good texture match (VAS 8.1±0.7) and high patient satisfaction (VAS 7.8±0.9). **Conclusion:** The PIA flap is a dependable, vessel-sparing option for hand resurfacing, providing excellent survival, favorable aesthetics, and acceptable donor-site outcomes with low morbidity.

INTRODUCTION

Hand trauma commonly produces complex soft-tissue defects that affect tendon, joint, nerve and bone integrity and therefore require reconstructions that restore thin, sensate and durable coverage while preserving hand function. Early and appropriate resurfacing reduces infection, stiffness and long-term disability and is one of the main challenges in hand surgery.[1] Over the past decades, reconstructive surgeons have extended options from local random flaps to axial forearm flaps and free tissue transfers. Each has its own pros and cons: groin and abdominal flaps can be bulky and staged; radial forearm flaps provide reliable skin but sacrifice a major vessel and may cause donor-site morbidity; and free flaps require microsurgical resources that are not always available.[2] Due to these limitations, local pedicled fasciocutaneous options that can offer thin, well-matched skin without sacrificing the radial or ulnar arteries are usually preferred.[2,3]

The posterior interosseous artery (PIA) flap, first described as a clinical island flap in 1988, is based on the posterior interosseous vascular axis of the dorsal forearm. It can be used as a retrograde (distally based) island flap to resurface dorsal and palmar defects of the hand, the first web space, and the proximal phalanx.[4,5] The PIA flap has a better outcome because the donor site lies on the dorsal forearm and its harvest preserves the major palmar arteries; thus preserving the hand arterial inflow.[4] The posterior interosseous artery runs in the septum between the

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extensor carpi ulnaris and extensor digiti minimi muscles and provides reliable septocutaneous perforators. The connection with the anterior interosseous artery allows blood to flow back through the vessel, letting the flap reach most of the dorsal hand and some parts of the palm.[6,7]

Previous studies have reported high overall flap survival and acceptable donor-site outcomes when the flap is carefully planned and surgically implemented. Some common complications are transient venous congestion and occasional marginal necrosis that can usually be managed conservatively or with limited grafting.[2,8] However, some studies have suggested using fascia-only versions of the flap or refining techniques like pedicle dissection and avoiding tunnelling to help reduce venous congestion and improve results.[8,9] Even with such better outcomes, the PIA flap is underused in some locations because of the technical difficulty, difficulty in identifying the posterior interosseous neurovascular bundle and concerns about anatomical variability.[10] Therefore, several studies emphasise preoperative Doppler mapping, stepwise dissection techniques, and intraoperative strategies to preserve venous outflow and the posterior interosseous nerve branches to avoid extensor dysfunction.[10,11]

Regarding the perception of PIA flaps, there are only a limited number of studies evaluating PIA flaps to clarify outcomes, complication rates and provide practical tips for reliable harvest, particularly in centers where microsurgical free flap resources are limited. Therefore, this study aimed to assess the clinical outcomes, complication patterns, and functional recovery following distally based PIA flap reconstruction.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Plastic & Reconstructive Surgery, Tirunelveli Medical College, Tirunelveli. Written informed consent was obtained from all participating patients after explaining the surgical procedure, possible complications and postoperative care requirements.

Inclusion and exclusion criteria

Patients aged 18–60 years with soft tissue defects of the hand were included. Patients with post-infective soft tissue defects, children and very old patients (> 60 years) were excluded.

Methods

All 50 patients included underwent thorough presurgical counselling, clinical evaluation and preoperative vascular mapping was performed using a Nicolet 8-MHz handheld Doppler. The probe was held at an angle of approximately 45° to the skin surface to identify the vascular axis extending from the lateral epicondyle to the distal radioulnar joint (DRUJ). The distal communication between the Anterior interosseous artery (AIA) and PIA was identified approximately 2 cm proximal to the DRUJ and this perforator served as a pivot point. The distance between the pivot point and the proximal edge of the defect was measured and transposed proximally along the vascular axis to determine flap length. After surgical debridement, the defect was outlined on sterile linen and replicated on the mid-forearm, with an additional 1 cm added to the flap length. The width of the flap was determined by measuring the width of the defect and adding 0.5 cm to compensate for flap contraction and ensure a tension-free inset of the flap.

All surgeries were performed under supraclavicular block anesthesia, with the patient positioned with the elbow flexed to 90° and the wrist fully pronated. Flap elevation was performed under tourniquet control using loupe magnification. A straight incision was made along the ulnar border of the flap down to the deep fascia and the flap was elevated suprafascially over the extensor compartments. The extensor carpi ulnaris (ECU) muscle was identified first, followed by the extensor digitorum communis (EDC) muscle. The extensor digiti minimi (EDM) compartment was located 6–8 cm distal to the lateral epicondyle. The flap was elevated superficially until it crossed the ulna, after which the deep fascia was incised to expose the ECU. Dissection continued radially to expose the EDM, and gentle retraction of these muscles revealed the posterior interosseous artery and terminal branches of the posterior interosseous nerve within the intermuscular septum. The nerve was carefully separated from the artery by incising the thin fascial sheath surrounding the neurovascular bundle. The PIA was dissected proximally, with ligation of the muscular branches.

The proximal origin of the PIA was ligated after the branches of the ECU and EDM and preserving the posterior interosseous nerve. The flap was elevated including 1 cm of the skin paddle, subcutaneous tissue, fascia, PIA, and septum between the ECU and EDM. As dissection approached the pivot point, the “heart attack point”, where vessels become extremely small, the pedicle was elevated close to the ulna to avoid injury. Once mobilized, the flap was rotated 180° after waiting for at least 20 minutes for circulation to stabilize. Both clockwise and counterclockwise rotations were tested to avoid pedicle twisting, and the optimal direction of rotation was documented for possible re-exploration. The intervening skin bridge was incised and elevated in a subcuticular plane approximately 1 inch on either side of the flap handle to prevent venous congestion associated with tunneling. The donor site was closed primarily when possible or skin grafted. Postoperatively, the wrist was immobilized in 20° extension and the MCP joints in 70° flexion with POP for 10 days.

The limb was kept elevated on a coir foam pillow and flap vascularity was monitored by assessing the colour, temperature, capillary refill and pinprick bleeding. Intravenous antibiotics were administered for 5-7 days and analgesics were administered as required. The POP and sutures were removed on

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postoperative day 10 and physiotherapy was initiated. Patients were followed up for six months to assess flap survival, vascular complications, donor-site outcomes and functional recovery. No anticoagulants, such as heparin, were administered postoperatively.

The intraoperative and postoperative parameters recorded included operative time, intraoperative blood loss, hospital stay duration, donor-site closure method, flap dimensions and pedicle length. Postoperative outcomes included flap viability, vascular complications, donor site morbidity, aesthetic appearance (VAS [0-10]), patient satisfaction (VAS [0-10]), and functional recovery (DASH-equivalent score [0-100]).

Statistical analysis: The collected data were analyzed using simple descriptive statistics. Categorical variables were expressed as frequencies and percentages; continuous variables were summarized as means and standard deviations.

RESULTS

The majority of the patients were male (64%), and most belonged to the 31-60 years age group, with a mean age of 38.2 ± 11.6 years. Work spot injuries (54%) and road traffic accidents (40%) were the common etiologies [Table 1].

Table 1: Baseline demographic and clinical characteristics

Categories	Parameters	Count (%)
Gender	Male	32 (64%)
	Female	18 (36%)
Age (years)	≤30	10 (20%)
	31-45	22 (44%)
	46-60	18 (36%)
Aetiology of Defect	Work spot injury	27 (54%)
	Road traffic accident	20 (40%)
	IV extravasation	2 (4%)
	Post-burn contracture/web release	1 (2%)

The mean operative time was 210 ± 25 minutes, with a minimal blood loss (60 ± 20 ml) and a hospital stay of 5.6 ± 1.4 days. The mean flap dimensions were 7.8 × 6.2 cm and the pedicle length was 6.0 ± 1.2 cm, while only 2% of donor sites were closed primarily [Table 2].

Table 2: Operative characteristics and perioperative parameters

Parameters	Values
Mean flap size (cm)	7.8 × 6.2
Pedicle length (cm)	6.0 ± 1.2
Operating time (minutes)	210 ± 25
Mean blood loss (ml)	60 ± 20
Hospital stays (days)	5.6 ± 1.4
Donor site is primarily closed	1 (2%)
Donor site skin grafted	49 (98%)

Venous congestion occurred in 24% of the patients and was successfully treated with limb elevation, dependent drainage, and selective suture release. One patient required a puncture, but all patients recovered without sequelae. Marginal necrosis in 6% of patients was managed with debridement and split-skin grafting, resulting in complete healing. Suture line dehiscence in one patient was cured by postoperative day 15 with conservative care. Partial donor-site graft loss affected two patients, which healed after secondary grafting. No cases of flap loss or PIN palsy/ECU–EDM weakness were observed [Table 3].

Table 3: Postoperative complications and their incidence

Complications	Count (%)
Venous congestion	12 (24%)
Marginal necrosis	3 (6%)
Suture line dehiscence	1 (2%)
Partial graft loss (donor site)	2 (4%)
Flap loss	0
PIN palsy/ECU-EDM weakness	0

There was a 100% flap survival rate, with a high VAS score for flap texture match and patient satisfaction (8.1 ± 0.7 and 7.8 ± 0.9). The DASH-equivalent score for hand function recovery was 28.9 ± 5.4, whereas the VAS score for donor site morbidity was 6.9 ± 1.1 [Table 4].

Table 4: Functional, aesthetic, and patient-reported outcome measures

Outcome measure	Mean ± SD
Flap survival (%)	100%
Flap texture match (VAS, 1–10)	8.1 ± 0.7
Patient satisfaction score (VAS, 1–10)	7.8 ± 0.9

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Return of hand function (DASH equivalent)	28.9 ± 5.4
Donor site morbidity (VAS)	6.9 ± 1.1

DISCUSSION

Posterior interosseous artery flap reconstruction is an important option for resurfacing complex hand defects, providing thin and durable coverage without sacrificing major forearm vessels. This study evaluated the clinical outcomes, complication profiles and functional recovery associated with distally based PIA flaps. We found that venous congestion was a frequent postoperative issue, but all cases resolved with conservative management and no patient experienced flap loss. Marginal necrosis, donor-site graft issues and suture line complications were rare and healed completely with minor interventions. Overall, the patients had excellent flap survival, good aesthetic results, high satisfaction scores and satisfactory functional restoration.

The majority of patients were male and most belonged to the 31-60 years age group. Work spot injuries and road traffic accidents were the common etiologies in our study. Abebe et al. reported that 80% of hand injury cases were reported among males (4:1 ratio), with a mean age of 24.5 years and home or machine injuries as the most common causes.12 Febopras et al. similarly reported a mean patient age of 40.4 years (range: 10–69), with work-related accidents as the leading etiology for hand/wrist soft-tissue defects.[13] Fong and Chew reported a majority of males (78.6%) with an age range of 25-58 years and a mean age of 43 years. Their etiologies included six crush injuries, two pressure injection injuries, two infections, one RTA, one electric saw injury and two machine injuries.[14] The demographic and etiological patterns in our study are comparable to those in previous studies, suggesting that hand injuries predominantly affect young males and are commonly caused by occupational and high-energy trauma.

In our study, the mean operative time was 210 ± 25 minutes, with minimal blood loss and a shorter hospital stay. The mean flap dimensions were 7.8 × 6.2 cm and the pedicle length was 6.0 ± 1.2 cm, while most of the donor sites required grafting. Wang et al. analyzed 6 patients with soft tissue defects in the hand, and reported an average defect size of 53.1 ± 27.9 cm2 and flap size ranged from 7 × 6 cm to 14 × 9 cm (mean 71.8 ± 29.1 cm^2). The mean skin thickness was 32.5 ± 4.8 mm and the mean deep fascia thickness was 2.5 ± 0.5 mm, with complete flap survival in all six patients and only one case of partial graft necrosis.[15] Hagiga et al., in a systematic review of seven studies, reported a mean flap dimension ranging from 7 × 6 cm to 14 × 9 cm.[16] Gupta et al. reported a mean flap dimension of 33.57 ± 10.5 cm2, whereas 75% of the donor sites required skin grafting. Their mean surgical duration was 159.5 ± 10.77 minutes and 137.94 ± 10.35 minutes and postoperative hospital stay was 7.35 ± 1.14 days.[17] These findings indicate that the flap dimensions, donor-site requirements and postoperative course observed in our study are similar to previous studies. It is also suggested that PIA flaps are safe and are associated with minimal operative time, hospital stay and blood loss.

In our study, venous congestion was the most common postoperative complication, although all cases responded well to conservative management and none had flap loss. Marginal necrosis, donor-site issues, partial graft loss and suture line complications were rare and resolved completely following minor surgical intervention. Overall, the functional and aesthetic outcomes were favorable, with complete flap survival, good texture match, high levels of patient satisfaction, satisfactory hand-function recovery and acceptable donor-site comfort. Similarly, Cheema et al. (68 PIA flaps) reported 88.2% complete uneventful flap takes, 5.9% partial necrosis and 5.9% complete necrosis.[18] Fong and Chew had no complete flap failures but noted partial distal flap necrosis in 21.4%. These partial necrosis cases were due to venous congestion and they were managed conservatively or with limited re-exploration.[14] Gavaskar et al. observed uneventful healing in 93.8%, with 6.25% cases of marginal necrosis and 6.25% partial donor-site SSG loss. They observed a mean QuickDASH score of 18.12 (range 2.5-59.1) and donor-site cosmetic scores of 7.15/10 (range 5.3-9).[19] Dogra et al. reported flap settlement in 83.3%, with 16.7% developing superficial/partial necrosis that healed with conservative care.1 Gupta et al. observed 100% flap survival; 2.7% of venous congestion cases required leech therapy. The mean recipient-site satisfaction score was 7.0 ± 0.69, while donor-site satisfaction was 6.9 ± 1.0 and their DASH score for functional result was 34.95 ± 5.67.17 Thus, indicating that PIA flaps have low complication rates and favorable functional and aesthetic outcomes across studies.

Our findings highlight the reliability of the posterior interosseous artery flap as a useful option for resurfacing hand defects. The flap provides high survival rates, minimal donor-site morbidity and good functional and aesthetic outcomes. These results highlight that careful planning, dissection along the intermuscular septum and avoidance of pedicle compression can improve flap survival. We recommend considering the PIA flap as a dependable, vessel-sparing reconstructive option for dorsal and selected palmar hand defects in routine clinical practice.

CONCLUSION

The PIA flap has the advantage of preserving the main arteries of the hand while providing thin, pliable and reliable coverage. Although dissection can be difficult because of anatomical variations, the flap remains adaptable, has a dependable vascular pedicle and allows mobilization without the need for

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microsurgical facilities. With careful patient selection, proper planning and careful dissection, complications can be minimized. In centers where microsurgery is limited, the PIA flap serves as a practical and effective option for hand resurfacing. Its ease of harvest, flexibility in design, minimal donor site morbidity, and preservation of major vessels make it a better alternative to free flaps for hand defect reconstruction.

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