Research Article

Addressing Soft Tissue Defects of Hand and Forearm Using Posterior Interosseous Artery Flap: An Observational Study

Shiza Mehak Sohail*,[1], Faisal Akhlaq Ali Khan[1], Waqas Sami[1], Sumaira Sattar[2], Erum Naz[2]

[1]Department of Plastic Surgery, Civil Hospital, Dow University of Health Sciences (DUHS), Karachi, Pakistan.
[2]Department of Plastic Surgery, Shaheed Mohtarma Benazir Bhutto Institute of Trauma (SMBBIT), Karachi, Pakistan.

Abstract: Background: Covering large wounds in a stable, long-lasting, and aesthetically pleasing manner is the primary task for a hand surgeon. Because the posterior interosseous artery (PIA) flap produces thin, malleable skin, it is an excellent tissue for covering hand deformities.

Objective: To determine frequency of successful flap survival based on PIA flap in patients with soft tissue injuries of the dorsum of the forearm and hand.

Materials and Methods: The prospective observational study was conducted at Plastic & Reconstructive Surgery Department of Dr. KM Ruth Pfau Civil Hospital in Karachi, Pakistan. After obtaining approval from the institutional review board's official, (IRB-3378/DUHS/clearance/2024/24), the study took place from 1st May to 30th October of 2024.The follow-up was done two weeks after their surgery. Clinical examination was used to monitor the flaps including assessment of flap color, skin turgor and absence of venous congestion. If patients were found normal and recovering during the follow-up, the flaps were marked as successful.

Result: A total of 32 patients were studied with average age of 31.4 ± 9.9 years. Age range of patients was 18-50 years. Three-fourth of study participants were males (75%).Average duration of injury was 15.8 ± 4.6 days. More than three-fourth were accident cases (84.4%) and had injury in hand (78.1%).Out of 32 patients, flap was successful in 31 patients. Only one flap was unsuccessful while complications were observed in 2 patients only. One had complication of wound infection and other had complication of marginal flap necrosis.

Conclusion: This study concludes that PIA flap is a safe and reliable technique in reconstruction of soft tissue defects of hand and forearm. However, patients should be closely monitored post-operatively to detect any complications for timely surgical intervention.

Keywords: Hand injury, Posterior interosseous artery flap, Plastic reconstruction surgery, Soft tissue defects, Venous congestion, Wrist Joint.

INTRODUCTION

Road traffic accidents, domestic or work-related injuries, burns, electrical, chemical, or thermal trauma to the upper limbs frequently cause severe and difficult wounds that affect several compartments, including the skin, tendons, arteries, bone and neurovascular systems [1, 2]. Covering these damages in an enduring and aesthetically pleasing manner is the primary task for a hand surgeon [3].

Numerous localized and regional flap methods that can address these flaws have been outlined in literature; each has benefits and shortcomings of its own [4, 5]. With a greater knowledge of the hand's vascular structure, flap alternatives have emerged as the recommended therapeutic approach. Formerly, staged pedicle flaps were frequently applied to treat similar soft tissue abnormalities in the upper limbs, but the results were not good [6].

Despite the availability of numerous local and regional flaps, the dorsal hand's skin needs a thin, supple, and soft layer of skin covering, which is not readily available [7]. The posterior interosseous artery (PIA) flap has been a viable choice for hand and upper extremity anaplasty since Zancolli and Angrigiani originally described it in 1988 [8]. In addition to meeting these criteria, PIA flap preserves the two main forearm arteries. It can be extended to cover defects on fingers in addition to the dorsum of the hand [9, 10].

At the inferior border of the supinator muscle, the PIA artery branches off from the common interosseous artery and enters the posterior compartment of the forearm. Between the extensor digiti minimi (EDM) and extensor carpi ulnaris (ECU) tendons, it is located in the septum. It extends superficially in the distal half of the forearm and deeply to muscles proximally [11]. In addition to the initial web space, the retrograde PIA flap's reach may allow for the reconstruction of the hand's dorsal and palmar features, such as the thumb's dorsum and the metacarpophalangeal joints. Even when there is significant vascular injury to the hand, the PIA flap is still accessible due to the anastomosis between the anterior interosseous artery (AIA) and the PIA at the proximal portion of the wrist joint [12].

Despite its benefits, the dissecting procedure that was initially described made it an unpopular flap, particularly among less experienced surgeons. A varying venous congestion incidence is also reported by several publications, who attribute it to the

* Address correspondence to this author at the Department of Plastic Surgery, Civil Hospital, Dow University of Health Sciences (DUHS), Karachi, Pakistan. Email: shiza_mehak@yahoo.com

flap's reverse flow vascularity. These findings have prevented this flap from spreading, however when performed by skilled surgeons, the method has a very low rate of problems [11, 13]. Few studies have been conducted yet exploring the outcomes of PIA flap in Pakistani settings [14, 15]. Thus, we performed the current study to determine frequency of successful flap survival based on posterior interosseous artery in patients with soft tissue injuries of the back of the forearm and hand.

MATERIALS AND METHODS

The Plastic & Reconstructive Surgery Department of Dr. KM Ruth Pfau Civil Hospital in Karachi, Pakistan, was the site of this prospective observational study. With the institutional review board's official written clearance, the study got underway (IRB-3378/DUHS/clearance/2024/24). The study took place from 1st May to 30th October of 2024 and included patients of either sex, ages 18 to 60, who presented with a soft tissue defect of the dorsum on the hand and forearm. Patients who underwent neurovascular surgery or had several abnormalities, such as bone fractures, were not included.

Patients were enlisted with their verbal consent. Sample size of 32 patients was calculated taking flap of 83.3% [14] at 95% confidence interval and 13% margin of error. Sample size calculation was performed using Open-Epi sample size calculator.

Under tourniquet control, the procedure was carried out under regional and general anesthesia. All patients received intravenous injections of Cefuroxime 1.2 gm as preoperative antibiotics. We used a negative microbiological swab for culture and sensitivity to determine that the recipient site was granulating, clean, and free of microorganisms. Standard PIA flap markings were completed following appropriate appraisal. The posterior cutaneous nerve of the forearm, the posterior interosseous artery, and the cephalic vein were all protected during the dissection and raising of the flap on the ulnar side. The perforators, which extended up to the posterior interosseous artery, were identified and protected after the flap was dissected all the way to the distal forearm. At the same time, the posterior interosseous nerve was carefully dissected and protected. After that, the PIA flap was rotated to cover the wrist and forearm defects. A meshed split-thickness skin graft was applied to the donor site, and the hand was splinted for seven days at an extension of 10 to 20°. Antibiotics were administered intravenously for seven days.

Before surgery, pertinent clinical features were noted. Flap thickness, size, and pedicle length were measured during surgery, and two weeks following surgery, problems were assessed. After two weeks, all of the patients were evaluated during follow-up. Clinical examination was used to monitor the flaps, and if there was no venous congestion and the flap's color and skin turgor were both normal, the flaps were marked as surviving.

STATISTICAL ANAYLSIS

Data was analyzed using SPSS version 27. Descriptive statistics were computed. Frequencies with proportions were reported for qualitative variables. Quantitative variables were reported as mean ± standard deviation.

RESULT

Total 32 patients were studied with average age of 31.4 ± 9.9 years. Age range of patients was 18-50 years. Average injury duration of 15.8 ± 4.6 days. Three-fourth of study participants were males. More than three-fourth were accident cases (84.4%) and had injury in hand (78.1%). Table **1** outlines patients' features.

Table 1. Descriptive Statistics of Patients' Features.

Patients' Features	Frequency	Percentage
Age Group		
18-19 years	4	12.5
20-29 years	12	37.5
30-39 years	8	25.0
40-49 years	7	21.9
>49 years	1	3.1
Gender		
Male	24	75.0
Female	8	25.0
Comorbidity		
Diabetes	2	6.3
Hypertension	5	15.6
Obesity	5	15.6
Smoking Status		
Smoker	5	15.6
Non-smoker	27	84.4
Injury Cause		
Accident	27	84.4
Infection	5	15.6
Defect Site		
Hand	25	78.1
Forearm	7	21.9

Out of 32 patients, flap was successful in 31 patients. One patient with no survival of flap had accidental injury in hand with injury duration of 18 days. Complications were seen in 2 patients only. Both the cases were accidental. One case had injury duration of 18 days and other had injury duration of 25 days. Table **2** displays patient details who had failed survival and complication. One patient had flap failure and 2 had complications. One had complication of wound infection and other had complication of marginal flap necrosis. Fig. **1**(**a-c**) displays preoperative hand wound, coverage defect and post-operative status at 2 weeks follow-up.

Table 2. Patient Details who had Failed Survival and Complication.

Age (in years)	Comorbidity	Duration on injury (days)	Defect site	Defect length (cm)	Defect width (cm)	Flap length (cm)	Flap width (cm)	Outcome
51	Diabetes, Hypertension	18	Forearm	5	4	5	4	Flap failure
46	Hypertension	18	Hand	10	5	10	6	Complication
26	None	25	Hand	6	4	6	4	Complication

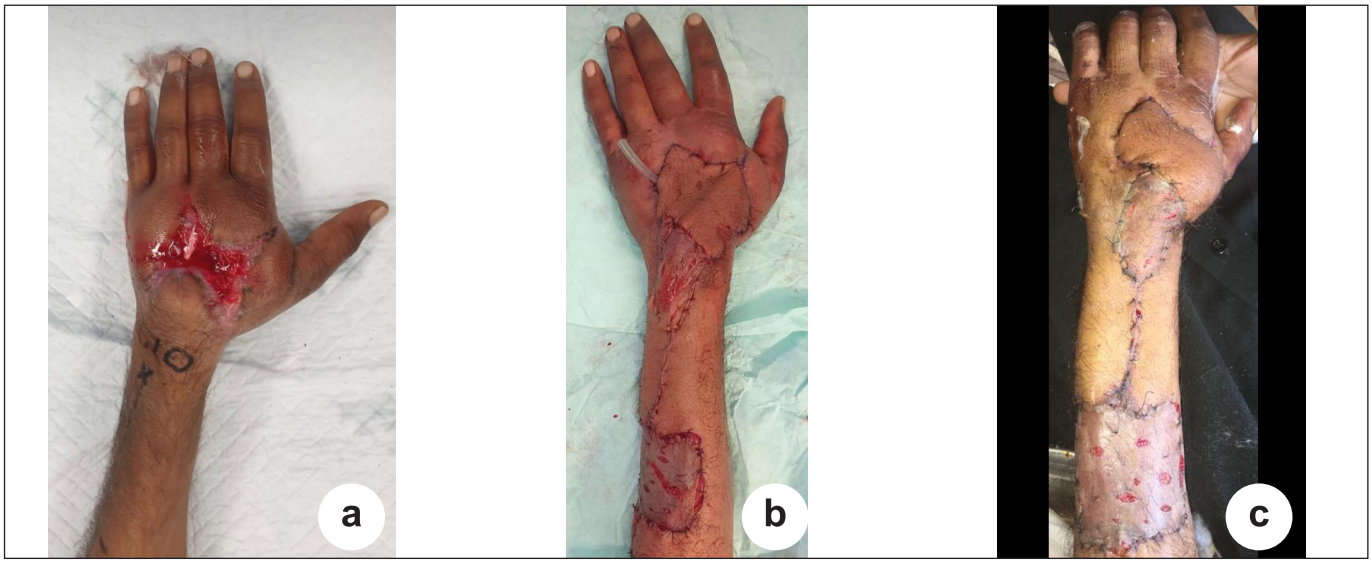

Fig. 1(a): Pre-operative image of open wound over hand dorsum, **(b)**: Coverage of defect with posterior interosseous artery flap, **(c)**: Post-operative status at two weeks follow-up visit.

DISCUSSION

The reconstructive ladder approach can be used to cover the hand's flaws, but a supple, strong, and well-vascularized tissue makes it easier to maintain and return hand functionality. Soft tissue restoration ought to be easy, adaptable, and secure. In the shortest amount of time, the ideal repair should be made from deep to surface planes and from hard to soft tissues. Therefore, depending on the needs, it requires soft tissue covering after bone, tendon, nerve, and vascular repairs [16].

Flap coverage is necessary for severe hand injuries with composite tissue loss. The pedicled PIA flap, one of the popular conventional skin flaps, has emerged as the standard procedure for reconstructing intricate hand soft tissue lesions in numerous institutions [6, 17].Because PIAF creates a thin, elastic skin that is similar to the dorsum of the hand, it is an excellent tissue for covering hand deformities [18]. Because of the consistent anatomy of the PIA and its perforators, surgery is very simple, and learning is quick. The ability of the PIA flap to conceal large defects with no morbidity to the donor area is another benefit [12, 19, 20].

One of the complications of PIA reported in literature is venous congestion [21]. PIA functioning as a reverse-flow flap and the presence of unidirectional valves in the veins hinder blood drainage, resulting in venous congestion, a serious concern. Usually, this congestion results in flap loss [22]. Venous congestion can be avoided by evading the dissection of the PIA and AIA communication branch, venous supercharging when necessary, covering a distal flap pedicle with a cutaneous handle, and evading subcutaneous tunneling of the pedicle [23].

In this study we did not find this complication of venous congestion. Masood K, *et al.* [14], testified complete loss (4.1%) and partial loss (12.5%)but there was no incidence of congestion. However, this finding is contradictory and not seen by some authors in their study [1].

Numerous cutaneous and muscle branches are provided by the PIA. The abundant arborizing and linked plexus beneath the skin of the posterior portion of the forearm is fed by the vertically arising septocutaneous branches. To guarantee flap survival, there is enough reverse-flow venous drainage via the venae comitantes and the superficial veins inside the pedicle [17].

In present study, there was only one case of non-survival of flap due to necrosis which was later corrected with secondary management. Khurram MF, *et al.* [24], published their experience with 12 cases of reverse PIA flap, out of which only one flap was failed. This patient had marginal necrosis, which was rehabilitated by ancillary intervention. In this case the PIA was found to

be located more ulnar underneath the muscle rather than distally between EDM and ECU tendons; thus, the flap was elevated proximally to upsurge the reach. Barin EZ, *et al.* also reported that out of 25 patients there was only failure due to partial necrosis which was also healed in secondary management. No complications such as wound dehiscence, infection or hematoma was seen [1]. Masood K, *et al.* [14], reported experience with management of 24 cases of dorsum with PIA flap, that complete coverage was accomplished in all cases whereas successful graft survival was 83.3%. Jiyan Ren and coworker [25], reported flap failure rate of 13.3% (4/30). Kelada MN, *et al.* [6], reported that 18 out of 20 patients had excellent results.

CONCLUSION

The present study analyzed that PIA flap is a safe and reliable technique in reconstruction of soft defects of hand and forearm. However, patients should be closely monitored post-operatively to detect any complications for timely surgical intervention.

AUTHORS' CONTRIBUTION

Shiza Mehak Sohail: Conceptualization, Study Design, Methodology, Data analysis and interpretation, Writing draft, Critical review and revision the manuscript.

Faisal Akhlaq Ali Khan: Conceptualization, Critical review and revision the manuscript.

Waqas Sami: Methodology, Data analysis and interpretation.

Sumaira Sattar: Writing draft, Critical review and revision the manuscript.

Erum Naz: Writing draft.

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CONFLICT OF INTEREST

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