EFFECTIVENESS OF POSTERIOR INTRAOSSEOUS ARTERY FLAP IN COVERAGE OF DORSAL HAND DEFECTS

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ABSTRACT

Background: Hand injuries are a challenging issue, frequently encountered by orthopedic and plastic surgeons. These injuries often involve soft tissue defects that expose muscles, tendons, bones, and neurovascular structures. Prompt coverage of these defects is crucial to prevent infection and necrosis of the exposed tissues.
Objective: To determine the effectiveness of the posterior intraosseous artery flap in coverage of dorsal hand defects.
Methodology: This descriptive study was carried out at the Burns and Plastic Surgery Unit of Lady Reading Hospital Peshawar, from November 2022 to August 2024 after ethical approval. The sample size was determined to be 75 patients (95% CI, success rate 83.3%)[8]. The study included patients aged 18-60 years of either gender who presented with dorsal hand defects. Patients were followed up for up to a minimum of 6 months. Data was collected in Proforma and analyzed using SPSS 22.
Results: The mean age was 39.13±12.06 years. The male-to-female ratio was 2.1:1. The average duration since trauma was 3.03±1.23 hours. The right hand was most frequently affected (61.3%). The most common mechanism was crush injury (38.7%), followed by degloving (26.7%). The overall flap success rate was 81.3% (Two-tailed p value 0.70 ± 0.045) indicating no significant difference between the observed flap success rate of 81.3% and the expected rate of 83%.[8]
Conclusion: The posterior interosseous artery flap is beneficial for covering dorsal hand defects due to its single-stage procedure and the ability to provide pliable coverage without the need to sacrifice any major vessels.
Keywords: hand reconstruction, Posterior interosseous artery, Flaps surgery, effectiveness

INTRODUCTION

The hand is a complex and vital organ crucial for daily activities like grasping, manipulating objects, and making expressive gestures. Its intricate anatomical structure makes it especially susceptible to injuries which can involve soft tissue damage alone or in combination with exposed underlying structures requiring immediate coverage. The wound coverage techniques range from simple split-thickness skin grafting to more complex flaps. [1]

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Covering large soft tissue defects in the dorsal aspect of the hand and wrist after trauma is a frequent challenge for hand surgeons. These defects require coverage with soft, pliable, full-thickness skin, which can be achieved through distant or regional flaps. The posterior interosseous artery flap fulfills all the necessary criteria and offers considerable benefits compared to other flaps. As a single-stage procedure, it preserves the hand's main blood supply, including the radial and ulnar arteries, and can be used even if one of these arteries is compromised, as the posterior interosseous artery reliably supplies blood to the posterior forearm.[2,3] However, the dissection is complex and requires precise surgical skills.[4] Additionally, the flap's reach is limited to the metacarpophalangeal joints of the four ulnar digits.[5] Flap congestion is a common complication, but delaying the flap enhances its overall survival.[6]

A study conducted in Pakistan in 2012 found that the posterior interosseous artery flap was effective in 98% of patients with dorsal hand defects, with marginal necrosis occurring in only 2% of cases.[7] However, a follow-up study in Pakistan in 2020 reported a flap survival rate of 83.3%. In this study, partial flap loss was

noted in 12.5% of cases, which required debridement and Split Thickness Skin Grafting, while complete flap loss was seen in 4.1% of cases.[8]

This study aims to assess the effectiveness of the posterior interosseous artery flap for covering dorsal hand defects. Previous research, including studies from Pakistan, has shown varying success rates. By providing local evidence on the flap's effectiveness, this study intends to support its adoption in clinical practice, to improve success rates in covering dorsal hand wounds.

MATERIALS AND METHODS

This descriptive study was carried out at the Burns and Plastic Surgery Unit of Lady Reading Hospital in Peshawar, from November 2022 to August 2024 after obtaining ethical approval from the institutional review board (Ref.no: 572/LRH/MTI). The sample size was determined to be 75 patients, with a 95% confidence interval and taking an expected success rate of 83.3%[8] using the WHO calculator. Non-probability Consecutive sampling technique was used. patients were followed for up to a minimum of 6 months (maximum 10 months) after surgery.

Inclusion criteria: patients aged 18 to 60 years of either gender who presented with dorsal hand defects (trauma occurred to dorsal aspect of hand from wrist to metacarpophalangeal joint resulting in skin loss with exposed tendons and bone) and were willing to undergo surgery were included in the study.

Exclusion Criteria:

1. Prior unsuccessful flap coverage, flap necrosis, or the need for revision surgery (as determined by clinical examination).
2. Involvement of both major hand arteries (ulnar and radial) (as assessed during clinical examination).
3. Presence of diabetes (BSR > 200 mg/dl), anemia (Hb < 8 g/dl), peripheral vascular disease or peripheral neuropathy (based on medical records), as it negatively affects the post-operative outcomes.
4. Presence of forearm and hand fractures

Operative Technique: Pre-operative assessment (history, physical examination, and laboratory tests) was performed to rule out comorbidities and to optimize patients before surgery. Under general anesthesia, the patient was positioned supine, and flap markings were made. Tourniquet was applied. A thorough debridement was performed at the recipient site. A line was drawn from the lateral epicondyle of the humerus to the distal radioulnar joint with the forearm in full pronation. The flap was centered in the middle third of this line approximately 2-4 cm proximal to the radioulnar joint to avoid damage to the dorsal branch of the ulnar nerve. The incision was given at the radial border and dissection proceeded to intermuscular septum between extensor carpi ulnaris (ECU) and extensor digiti minimi (EDM). Posterior interosseous artery and nerve was identified after retracting EDM radially. A communicating vein that run along the perforators of PIA, was included in the flap to improve venous drainage of the flap. The proximal end of the vascular pedicle was ligated after releasing the tourniquet and the flap was transferred to the recipient side. The donor side was closed either primarily or by split-thickness skin graft. The antiseptic dressing was done. And hand elevation was advised to all the patients. Patients were discharged in 24 – 48 hours post operatively after dressing change. Patients with grafts on donor sites had their dressing changed after 7 days. Flap success was defined clinically as a fully healed and viable flap that provided adequate skin coverage, met functional and cosmetic expectations acceptable to the patient, and showed no signs of necrosis or partial or complete flap failure. (FIG 1 and 2)

Figure 1: Pre and Postoperative

Figure 2: Completely Healed Donor and Recipient Sites (Day 25)

Data Collection: After obtaining approval from the ethical committee, data was collected on structured Proforma from patients who provided informed written consent. Demographic details, including name, age, gender, duration of trauma, site, and mechanism of trauma, as well as wound size, were recorded. Surgery was performed under general anesthesia by a single surgical team. Operative time and blood loss were noted. Post-surgery, patients were monitored in the ward and followed up for up to a minimum of 6 months and a maximum of 10 months. The flap was assessed for success (defined as wound healing without necrosis, infection, or flap failure). Patients with flap failure were managed as per the standard protocol of wound management.

Data Analysis: Data was analyzed using SPSS VERSION 22. Quantitative variables such as age, duration of trauma, wound size, blood loss, and operative time were expressed as mean ± standard deviation (SD). Categorical variables, including gender, injury site, mechanism of injury, and effectiveness, were presented as frequencies and percentages. Data was stratified by age, gender, side of injury, duration of trauma, mechanism of injury, wound size, and operative time. Post-stratification, the effectiveness across these groups was compared using the chi-square test, with a p-value ≤ 0.05 considered statistically significant.

RESULTS

The mean age of the patients recorded was 39.13±12.06 years with 44% of patients in the age group 18-35 years. Figure 3 presents the age distribution of the patients.

The duration of trauma was a minimum of 1 day to a maximum of 16 days. The mean size of the wound was 16.60±2.38 cm. The mean operating time was 59.97±10.45 min. Mean blood loss was 764.45±83.17 ml.

In our study 51 (68%) patients were male while 24 (32%) were female patients.

The most frequent mechanism of injury observed was crush injury (38.7%) followed by degloving (26.7%). (Table 1)

We observed that the right side was involved in the majority of the patients 46 (61.3%). However, the result was not significant. ($p>0.05$)

In our study, the overall flap success rate was 81.3% (n=61). (Two-tailed p value 0.70 ± 0.045) indicating that there is no statistically significant difference between the observed flap success rate of 81.3% and the expected rate of 83% at the 95% confidence level.

While in the remaining 14 patients (18.6%), 5 patients experienced marginal necrosis, 5 patients (6.7%) had partial flap failure requiring debridement and split-thickness skin grafting, and 4 patients (5.3%) had complete flap failure.

Stratification of effectiveness with the mechanism of injury can be seen in Table 2.

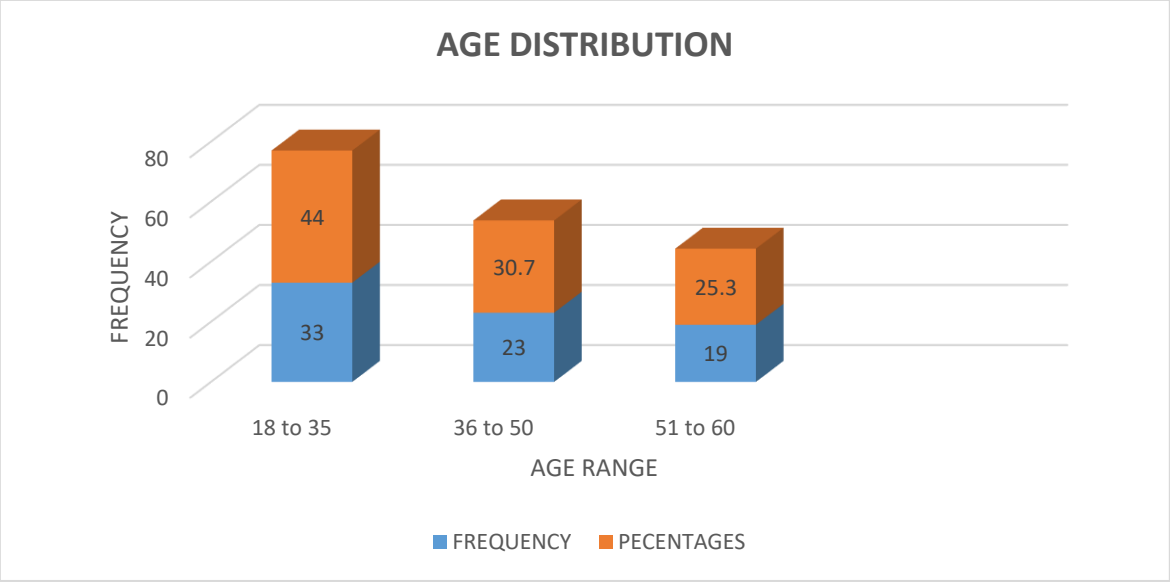

Figure 3: Age Ranges and Frequencies

Table 1: Frequency of Mechanism Of Injury

Mechanism of injury	Total patients (n)	Percentage (%)
Crush	29	38.7
Degloving	20	26.7
Hot press	18	24.0
Friction	8	10.7
Total	75	100.0

Table 2: Stratification of Effectiveness with Mechanism of Injury

	MECHANISM OF INJURY					
EFFECTIVENESS	**CRUSH**	**DEGLOVING**	**HOT PRESS**	**FRICTION**	**TOTAL**	**P- VALUE**
YES (%age)	37.7	29.5	23.0	9.8	100	0.7
NO (%age)	42.9	14.3	28.6	14.3	100	

DISCUSSION

The hand is an important functional organ, and wounds in the hands (palmar or dorsal) present a significant challenge for plastic surgeons. Ensuring proper coverage of these defects is essential to maintain hand function.

Various techniques have been employed to cover dorsal hand defects with exposed vital structures, including the radial forearm flap and the reverse ulnar artery flap; however, these approaches sacrifice major arteries of the hand. Free flaps, while effective, demand advanced microvascular expertise. In comparison, the posterior interosseous artery flap provides effective coverage, preserving the major arteries of the hand and utilizing its reliable and consistent vascular anatomy.[9,10] which greatly minimizes the risk of flap necrosis which is a common complication in reconstructive surgery.[11]

We observed a mean age of 39.13 years, with the majority of cases involving young males. Industrial and road traffic accidents (RTAs), resulting in crush and degloving injuries, were identified as the most common mechanisms of injury. These demographics align with findings reported by Puri and Fujiwara.[12,13]

The posterior artery flap yields the best outcomes due to its reliable blood supply and the rarity of anatomical variations.[14] A complication-free, flap survival rate of 81.3% was observed in our study, which is comparable with the success rates reported by khan et al, mirza et al, and labeb et al. [8,15,16,17] The flap can also be neurotized by incorporating the posterior antebrachial cutaneous nerve and can be raised as an osteocutaneous flap by including a portion of the ulna.[8]

Venous congestion, a major complication of this flap (occurring in 3-37%),[18,19] can lead to flap necrosis and loss, as reported by mirza et al and labeb .[16,17] In our study, we observed flap congestion in 8 patients, resulting in partial loss in 1 patient and complete loss in 2 patients. The remaining 5 patients improved with conservative management. However, Bilal and Ahmed concluded in their study that venous congestion can be avoided by delaying the flap.[23]

Given the significance of venous congestion, various techniques have been proposed to minimize this complication. Ozalp et al. incorporated a superficial vein into the flap pedicle[20] while Acharya et al. recommended modifications such as creating a wider pedicle with a cutaneous handle and avoiding tunneling during the inset.[21]

Kelada et al, Bilal et al and Mirza et al have reported various complications such as marginal necrosis, complete flap necrosis, and partial flap loss, which have been addressed following standard wound management protocols. [15,22,23] In our study, 5 Patients with marginal necrosis were allowed to heal by secondary intention, while 5 patients with partial flap loss underwent debridement followed by skin grafting.

Covering vital structures with a well-vascularized flap, whether through a single-stage or two-stage procedure, is crucial for ensuring proper hand function. Split-thickness or full-thickness skin grafting is generally not recommended for covering vital structures of

the hand such as exposed tendons, bones, nerves, or vessels.

CONCLUSION

The posterior interosseous artery flap is a reliable and effective method for covering dorsal hand defects, offering the advantage of preserving major hand arteries and providing pliable full-thickness skin coverage. While the success rate of 81.3% is promising, complications such as venous congestion and partial flap loss were observed. Future research should focus on refining surgical techniques to reduce these complications and evaluating long-term functional outcomes. Larger, multicenter studies are needed to establish definitive guidelines and further validate the flap's clinical effectiveness in hand reconstruction.

LIMITATIONS

The small sample size and the experience of a single team of plastic surgeons are limitations of our study. These issues could be addressed by undertaking a large-scale multicenter study to assess the effectiveness of this flap for hand and wrist defects, along with its complications and management strategies.

DECLARATIONS

Authors' contributions

Zahra Tauqeer: Concept, design, data collection and data analysis

Drafting: Zahra Tauqeer , Riaz Ahmed Khan Afridi, Firdous Khan

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CONFLICT OF INTEREST

None

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