CASE REPORT

Extended use of Posterior Interosseous Artery (PIA) based flap

Junaid Khan, Soomal Rafique, Fateh A. Janjua, S. Hashir Hasan, Pervaiz M. Hashmi

Abstract:
A posterior interosseous artery (PIA) based flap is a good solution for surgical reconstruction of soft tissue defects of the hand. The largest PIA flap reported in the literature is 11-13cm in length.

We have successfully utilized a 20cmx8cm PIA flap for soft tissue defect on the dorsum of the hand, up to the distal interphalangeal joints (DIPJs), in a 35-year-old poly-trauma patient, as staged procedure as there was complex bony injuries besides soft tissue defect. Flap has good uptake and patient wad followed multiple times in clinic after surgery.

Keywords: Soft tissue defects, posterior interosseous artery-based flap, extended flap, local perforator-based flap.

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DHQ Hospital, Charsadda
J Khan

Aga Khan University Hospital, Karachi
S Rafique,
SH Hasan,
FA Janjua,
PM Hashmi

Correspondence:
Dr. Junaid Khan
Muhallah Aziz Kheil,
Tehsil and Disctrict
Charsadda, KPK, Pakistan
(25000).
Cell No:+92 334-9021902
email: drjunaid89@
hotmail.com

Introduction:
Hand soft tissue defects pose a challenge when it comes to surgical reconstruction. The options available are local perforator-based flaps, reverse flow forearm flaps, distant flaps like the groin and abdominal flaps, and free flaps.[1]

A local rotational flap is most suitable in the majority of the cases, in terms of cosmetic appearance. A reverse flow pedicle flap of the posterior interosseous artery is commonly used to cover soft tissue defects on the dorsal and volar aspects of the hand.[2-4]

This method can be utilized to yield flaps up to 11-13 cm in length.[1,3,4] Larger flaps can have poor outcomes, mainly due to venous congestion, and are therefore avoided.[3,5] The distal reach of such flaps is limited to the dorsum of the hand (rarely up-to-the metacarpophalangeal joint (MCP joint)).[1] Brunelli et al obtained coverage up to DIP levels by extending the wrist and exteriorizing the pedicle as a two-stage procedure.[5]

Case presentation:
A 35 years old left-handed gentleman, with no known co-morbidities, presented to us in the emergency room in December 2020 with poly-trauma following a road traffic accident including multiple right-sided rib fractures, pulmonary contusions, L2 vertebral body fracture, right sacroiliac joint, and pelvic diastasis, and left-hand de-gloving injury with multiple fractures visualized in the phalanges of second to the fifth finger.

The patient was admitted under orthopedic surgery service after clearance from other specialties. He underwent surgical fixation of the pubic symphysis and right sacroiliac joint. In the same-admission, his left hand debridement was done and K-wires were inserted from metacarpals to distal phalanges of all four fingers(excluding the thumb) in bayonet fashion. He was discharged and followed up in the clinic.

In January 2021, he was re-admitted, a week after discharge, when he underwent two procedures.

Figure 1: A) extensive degloving of the dorsum of the hand

Figure 1: B) Deformities of fingers because of fractures

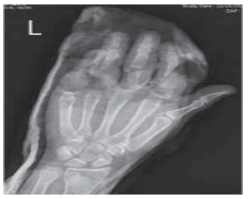

Figure 1: C) Initial radiograph of left hand showing Fractures of 2nd and 3r proximal phalanx and loss of 4th proximal phalanx, proximal part of 4th distal phalanx, and loss of proximal phalanx of the little finger.

Figure 2: A). After removal of 5th phalanx k-wire and re-look debribment

Figure B) Radiograph after removal of 4th phalanx k-wire removal and fillet+PIA flap

Figure# 3. A & B 20x8 cm PIA flap, 13thPOD, viable flap with good uptake and non-necrotic margins.

First, the left hand wound debridement was done and K-wire from the 5th metacarpal was removed (see Fig#2A). After 4 days, another procedure was done when 5th metacarpal bone was excised, 5th digit was rotated on the dorsal wound to cover it for fillet flap, K-wire from 4th phalanx was removed (Fig #2B)

A posterior interosseous artery flap was raised and rotated tocover the dorsum of the left hand. The dimensions of the posterior interosseous artery flap that was raised were 20 centimeters from the pedicle up to the distal interphalangeal joint of the left middle finger distally and 08 centimeters in width.

Left hand tissue taken intra-operatively was sent for cultures that grew Escherichia coli, Corynebacterium, and Aspergillus. Antibiotics were adjusted according to the sensitivities. On the third post-operative day, the patient was discharged on IV piperacillin-tazobactam.

Follow up on 13th post-op day showed good flap uptake with no necrotic margins and no signs of wound

Surgical techniques for the PIA flap:
The PIA flap was done as a staged procedure in this patient due to soft tissue as well as bony involvement and a high level of contamination of the wound. The defect on the dorsum of the hand was initially debrided under general anesthesia. Once the wound was adequately debrided, the resultant defect was used as a template for the flap. To identify the donor zone, a line was drawn starting at the lateral epicondyle and ending at the Distal Radioulnar Joint (DRUJ). The middle third of this line was used as a general demarcation of the donor site as it is known to have the most perforators.

The presence of two perforators was confirmed with the help of a doppler study, which was found approximately 2cm distal to the midpoint of this line. These perforators were exposed by careful dissection of the fascia of the Extensor Carpi Ulnaris.

The vascular axis of the flap was then identified by exploring the inter-muscular septum between the ECU and the Extensor Digit Quinti. Once

isolated, the PIA was dissected and ligated just proximal to the dominant perforators. The flap was then raised starting from the radial end of the elbow to the wrist. The proximal and medial cutaneous branches, as well as the interconnecting venous branches of the PIA, were identified and preserved while raising the flap. Dissection was continued distally until the anastomosis between the PIA and the dorsal branch of the Anterior Interosseus Artery, approximately two centimeters proximal to the DRUJ.

The base of the fourth metacarpal bone was used as a reference point for the incision on the wrist. The extensor retinaculum underneath was divided and released between the fourth and fifth metacarpal, while the adjacent tendons were separated using retraction. The pedicle was carefully released up until the point where the PIA connects the DIA at the level of the carpometacarpal joint. Once the flap was secured along with its vascular pedicle, it was rotated at the level of the anastomosis of the PIA and DIA and used to cover up the defect. Primary closure was performed at the donor site.

Further plan: In the next stage we will remove the k-wires from the 2nd and 3rd phalanx, will do arthrodesis of the distal interphalangeal joint (DIPJ) of the index finger because of the OA changes and syndactyly between 2nd-3rd and 3rd - 4th, because of the flap will also be released. Additionally, we will transfer vascularized 2nd and 3rd metatarsophalangeal joints (MTPJ) from the left foot to replace the middle and ring fingers metacarpo-phalangeal joints (MCPJ). To fill the defects of toes after transfer of 2nd and 3rd MTPJs, we will use non-vascularized fibula graft from the left leg.

Discussion:

The reconstruction of soft tissue defects of the hand, along-with bony injuries can be a challenging task that requires complicated procedures to allow for a better outcome in terms of both cosmesis and long-term functioning. Well-vascularized wound closure is needed to prevent the growth of infections, rapid healing, better morphologyand to lessen the time of suffering. The forearm is a versatile local donor site for the reconstruction of thehand due to its perfusion. The PIA flap was first described by Zancolli and Angrigiani in 1985, as a versatile island flap originating from the posterior aspect of the forearm, that can be utilized for reconstruction of soft tissue defects on the dorsum of the hand, wrist, and first webspace.[7] Dorsal hand defects up to the metacarpal joints, reconstruction of the first web space up to the inter-phalangeal joint of the thumb, and extensive lesions on the ulnar border of the hand are the primary indications forusing this flap.[6]

The posterior interosseous artery, the smallest terminal branch of the common interosseous artery, gives off various septo-cutaneous and muscular branches and direct septo-periosteal branches to the ulna in the lower third of the posterior forearm, hence making the flap reasonable enough for the coverage of 3-dimensional defects of the hand. In most of the cases studied so far, the dimensions of the flap raised were up to 15centimeters in length, reaching up to the head of the first metacarpal.[6] In our case the flap raised was designed like the tear drop, the tip of which corresponds to the pedicle, the flap raised and rotated 180 degrees from donor site to the recipient site up to the level of the distal inter-phalangeal joint. Since the wound was caused by a high impact major injury and the 5th metacarpal had to be excised, a major area wasexposed that needed reconstruction. Therefore, the flap was brought distally, measuring a length of a total of 20centimeters, the longest posterior interosseous artery flap studied in the last 10 years. The flap was monitored on outpatient visits, cleaned and dressed, recovery and healing were adequate as expected on each follow-up visit.

This case report aimed to highlight the chance taken to harvest the longest flap (20centimeters in length and 8 centimeters in width), improvising in the indications and technique of the traditional posterior interosseous artery flap. The success of the flap has shown that the disabling and debilitating hand injuries can be reconstructed by the same old procedure, giving optimum

functional and cosmetic results. In our case, the patient might never be able to write with his left hand, but the overall functionality and cosmesis are better than an amputated dominant upper extremity.

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Role and contribution of authors:
Junaid Khan, collected the data, references and did the initial write up.

Soomal Rafique, collected the data, references and helped in introductin writing.

Fateh A. Janjua, collected the references and helped in discussion writing.

S. Hashir Hasan, collected the data and helped in result writing.

Pervaiz M. Hashmi, critically review the article and made final changes.

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