

Evaluation of the Posterior Interosseous Artery Flap in Reconstructing Hand Defects

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ABSTRACT:

BACKGROUND:

The posterior interosseous artery flap is now increasingly considered as an alternative to the radial and ulnar forearm flap because the later required disruption of major arterial supply of the hand.

OBJECTIVE:

To evaluate the posterior interosseous artery faciocutaneous flap in reconstruction of hand defects as regard to durability, color match and donor site morbidity.

METHODS:

During a period of 21 months, 10 patients with age ranging between 22-54 years underwent reconstruction of hand defects by distally based posterior interosseous artery flap in Al-Wasity Teaching Hospital.

RESULT:

All the flaps survived completely. One case developed partial graft failure due to early mobilization. Two cases developed temporary weakness of extensor muscles of the hand due to neuropraxia of the posterior interosseous nerve. The over all result is good functionally and acceptable aesthetically.

CONCLUSION:

Posterior interosseous flap is a good option in well selected patients and meticulous planning and delicate dissection as well as adequate immobilization minimize the complications like nerve injury, edema and graft loss.

KEY WORDS: posterior interosseous artery flap, dorsal hand defect, fist web space.

INTRODUCTION:

Soft tissue reconstruction of the hand remains a challenge to the plastic and reconstructive surgeon partly due to the shortage of skin in the hand and partly to the relative extensiveness of soft tissue defects in that region⁽¹⁾.

For this purpose a distally based dorsal forearm faciocutaneous flap based on posterior interosseous artery (PIA) was developed and described by Zancolli (1986) and Penteado et al. (1986) for hand reconstruction^(2,3,4). The authors reinforced the theoretical advantage of the anatomical basis of the retrograde flow of this flap via the anastomoses between the anterior and posterior interosseous arteries, which allows the flap to be used even with damage of the radial or ulnar arteries or palmar

arches⁽⁵⁾. This flap allows coverage of sites as far distal as the dorsum of the proximal interphalangeal joint⁽⁶⁾.

Surgical anatomy:

The PIA arises from the common interosseous artery, a branch of the ulnar artery. It passes backward above the superior border of the interosseous membrane between radius and ulna. It then pass downward between the supinator and abductor pollicis longus and reaches the interval between the superficial and deep group of the forearm muscles in the posterior compartment. It ends by anastomosis with anterior interosseous artery and takes part in the arterial anastomosis around the wrist joint⁽⁸⁾, fig (1).

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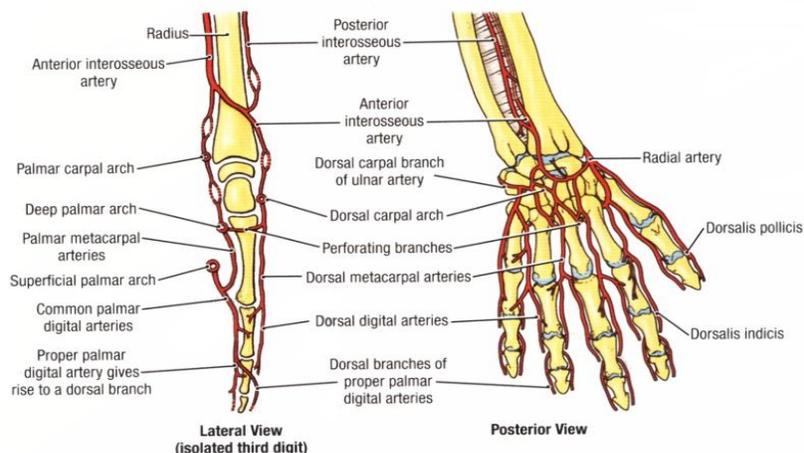


Fig. 1. Anastomosis around the wrist and distal radio ulnar joint.

The PIA runs along a line drawn between the lateral epicondyle of the humerus and the distal radioulnar joint⁽⁸⁾. It runs in the intermuscular septum between the extensor carpi ulnaris and the extensor digiti minimi giving off perforators all along its course⁽⁶⁾.

PATIENTS AND METHODES:

This is a prospective study in which ten patients (nine males and one female) with hand injuries (all were war injuries, bullet or shell) involving skin defect as well as injuries in other deep tissues like tendons, bones or joints that require reconstruction have been managed in Al-Wasity Teaching Hospital using a distally based PIA flap procedure for reconstruction from October 2005 to July 2007.

The patients were thoroughly examined regarding the donor site, the defect site, size, and depth and tissue layers involved. Allen's test was performed to ensure the adequacy of hand perfusion. Donor site examination is mandatory to exclude any trauma that may prevent use of this flap.

Surgical procedure:

All Patients operated under general anesthesia with application of tourniquet without exsanguinations.

The marking should be done after wound excision to allow the execution of the correct dimensions of the flap according to the defect size. The defect results from wound excision drawn on a paper patron with the use of magnification.

Marking of the flap is shown in (Figure 2). Start with two points, "A" at the lateral epicondyle and "B" at distal radioulnar joint. A straight line joins these two points while the forearm in full pronation roughly represents the course of the PIA. The length and width of the defect transfer by a patron and drawn on the line AB so that the center of flap is randomly about 9 cm distal to point A.

The site of the anastomosis between the anterior and PIA is about 2 cm proximal to point B and the distance from this point to the defect should be equal to the flap pedicle length.

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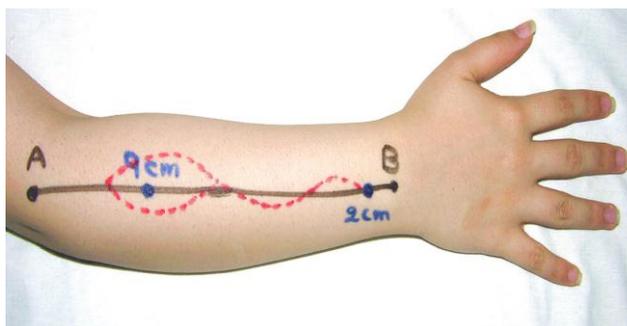


Fig.2. Flap design.

The skin is incised in a lazy S or zigzag fashion along the central axis of the proposed flap pedicle and the flaps are carefully elevated down to the deep fascia and the skin edges elevated from it until identification of the fascia that cover the extensor digiti minimi and extensor carpi ulnaris muscles, incising the fascia on both muscles, part of this fascia included with the flap pedicle and the dissection continue between the muscle and the fascia until the posterior interosseous artery become obvious. This is assisted by the septocutaneous perforators which guide the dissection down to its origin.

The dissection proceed proximally on the radial side of the flap design with cauterization of all muscular branches until the dissection reach the proximal end of the flap, then continues along the ulnar side of the flap distally toward the wrist.

The proximal end of the artery is clamped and the tourniquet is deflated; haemostasis is achieved, waiting for 15 minutes ensure adequate retrograde flow in the flap and give time for limb perfusion. Then the tourniquet is re-inflated and the proximal end of the artery is ligated and divided and the flap is then elevated carefully to avoid injury to the artery or the posterior interosseous nerve which should be separated intact from the neurovascular bundle. The flap then tunneled through the subcutaneous tissue and set into the defect.

The flap is fixed to the defect in two layers. The donor site is closed directly unless large flap is elevated in which split thickness skin graft is required.

Corrugated drain inserted in the donor site and under the flap, and volar slab in 30 degrees wrist extension is applied for seven days.

Most of the patients were discharged after 24 hours after removal of the drains to be seen at the seventh postoperative day for slab removal and change of dressing with physiotherapy started as indicated.

RESULTS:

Ten patients were treated with PIA flap, all were in the young and middle age group ranging between 22 to 54 years old, mean 38 years.

In four patients the defects were in the dorsum of the hand, two patients had a soft tissue involvement overlying the metacarpophalangeal joints of the fingers and four patients had defects involving the first web space. Male to female ratio was 9:1.

All flaps survived completely and healing were uneventful.

The dimensions of the flaps used ranging from 3 x 3.5 cm to 6 x 8 cm, and pedicle length up to 11cm were required for most distal defects.

In five cases the donor site defect was closed primarily, the other cases required skin graft for closure.

Immediate skin grafting of the donor area was performed in all cases in which graft was required and split thickness skin grafts were harvested from the upper lateral thigh.

Unacceptable scar at the donor site of the flap was one of the complaints in 2 patients treated with this flap but no hypertrophic scar or keloid was seen.

Hairy flap in an area of the hand that is originally of little or no hair, as first web space or the distal part of the dorsum of the hand, was seen in three patients.

Neuropraxia of the posterior interosseous nerve was a major complaint of three patients range in its severity from weakness to complete loss of finger extension which lasted for 4 to 6 weeks and recovered completely.

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No hematoma or seroma at the recipient or the donor site was noted.

Partial skin graft loss at the dorsum of the forearm occurred in one case. Complete healing of all recipient and donor areas was achieved at the time of final evaluation.

DISCUSSION:

To perform the best reconstruction of the soft tissue in the upper extremity the characteristics of color match, sensibility, durability and the ability to preserve joint function must be kept in mind⁽⁹⁾.

The PIA flap is now increasingly considered as an alternative to the radial and ulnar forearm flap because these flaps required disruption of major arterial supply of the hand⁽⁶⁾. In this series no ischemic change of the hand was noted after harvesting of this flap. Jones reported acute ischemia of the hand after harvest of a radial forearm flap⁽¹⁰⁾.

Good planning and precise execution is required to ensure minimal local morbidity and decrease the incidence of partial or total flap loss.

In this series eight patients treated with PIA flap were in the young age group of 20 to 40 year and two of them in middle age group of 40 to 60 year (mean 38 years). Buchler and Frey (1991) used this flap for 15 patients with ages ranging from 5 to 68 years (mean 37 years)⁽¹¹⁾.

In this series, males outnumbered females in ratio of 9:1. Other authors' series showed similar male dominance like Zancolli & Angrigiani (1988)⁽²⁾; Buchler & Frey (1991)⁽¹¹⁾; Costa H et al. (1991)⁽⁵⁾; and Dap F et al. (1993)⁽¹²⁾, and this can be explained by higher incidence of hand injuries in males.

The lazy S incision that we use to identify the vascular pedicle gives a greater exposure than the straight incision and heals in a scar that has a contractile effect less evident than that of the straight scar. The size of the defect increases after wound debridement so that the flap template should be designed after preparation of the recipient site.

The dissection of the vascular pedicle was frequently tedious and time consuming, especially in the proximal area of the pedicle because of the intermingling of the branches of the posterior interosseous nerve with that of the PIA and careful dissection is required to separate the proximal perforator supplying the island flap from the branches of the nerve. Landi A. in his series of 8 patients reported the same⁽⁷⁾.

In this series extension of the distal incision beyond the safe point of two centimeters proximal to the

distal radioulnar joint was avoided to prevent damaging the anastomosis between the anterior and PIA which is regarded as the most important anastomosis in the wrist for survival of this flap⁽²⁾.

In this series, the largest flap was 6 x 9 cm and smallest one was 3 x 4 cm. In Costa's series (2001), the skin flaps varied in size from 4 x 5 cm to 9 x 14 cm⁽⁶⁾.

The donor area was closed directly in 3-5 cm wide flaps, while larger flaps required skin grafting of the donor site; this is also noted by Brunelli⁽¹³⁾. Direct closure of the donor site in 50% of the cases reflects a small size of the defects for which this flap was used in this series. In Landi A. series of 8 patients, primary closure of the donor sites has always been possible⁽⁷⁾.

All flaps survived completely with very minor venous congestion noted in one patient that resolved completely on the second post operative day, while Dap (1991) noted partial necrosis in seven (21%) of the 34 flaps which result from venous congestion⁽¹²⁾, and Chen H. et al. (1998) reported a failure rate of 21.3% (three out of 14 flaps)⁽¹⁴⁾. This can be explained by not dissecting the pedicle more than 2 cm proximal to the wrist joint to preserve as much distal anastomosis as possible for the retrograde perfusion, which actually limit the flap use to defects not distal to the metacarpophalangeal joints of the fingers.

Nerve injury occurred in three of the younger age group who were followed by nerve conduction study and was found to be neuropraxia as a complete recovery of nerve function was achieved within 4-6 weeks from the time of operation.

Limitation of the use of this flap include: injury at the wrist endangering the distal anastomosis, injury at the proximal forearm endangering the vascular supply of an island flap and location of the defect or part of it at more distal location than the metacarpophalangeal joints of the fingers.

The long-term follow-up show good flap durability and elasticity, acceptable appearance, good texture for skin resurfacing as reported also by Zancolli et al⁽¹⁵⁾.

CONCLUSION AND RECOMMENDATION:

1. The flap is thin, has good color match, excellent texture and contours easily for skin resurfacing. It offers the benefits of being single-stage, reliable with acceptable donor site morbidity.

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2. The risk of posterior interosseous nerve injury is a possibility that the patient should be warned of and could be avoided with meticulous dissection and the use of magnification.
3. The distally-based PIA flap has proven to be reliable and useful for reconstruction of the first web space as well as the dorsum of the hand.



Fig: 3. A, bullet injury at the dorsum of the hand with exposed and fractured metacarpal bones and extensor tendons. B, posterior interosseous flap done in preparation for extensor tendon graft.

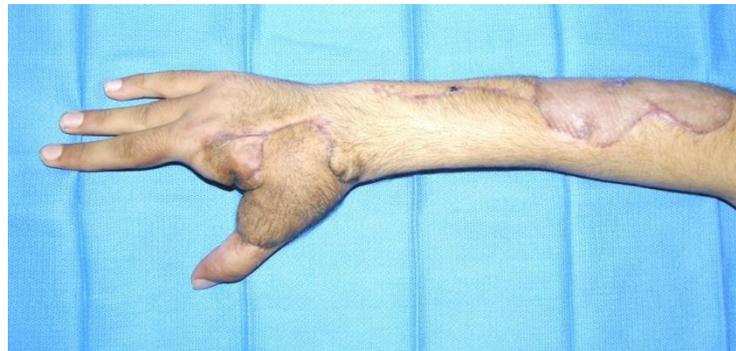
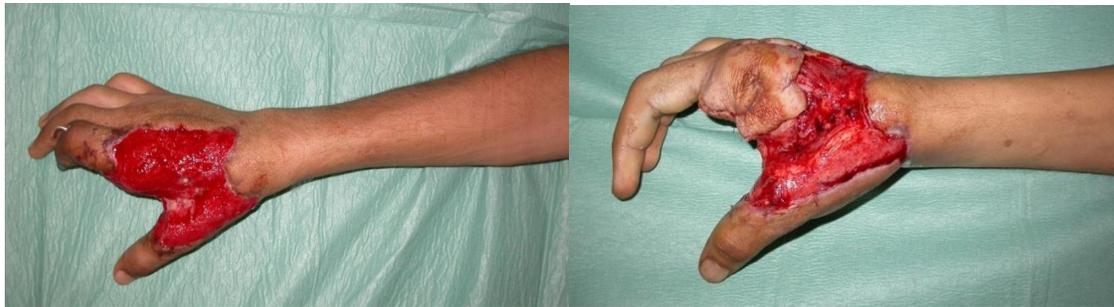


Fig 4: Shell injury to the first web and volar aspect of the index finger involving flexor tendons and digital nerves with comminuted fracture of the second metacarpal, the index finger was filleted and the skin used to cover part of the defect while the rest was covered by posterior interosseous flap.

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Fig 5: A, traumatic contracture of the dorsum of the first web with tendon adhesion and metacarpophalangeal joint stiffness. B, excision of scar tissues, tenolysis and metacarpophalangeal joint capsulotomy. C, posterior interosseous flap cover.



Fig 6: bullet injury to the dorsum of the hand causing open comminuted fracture of the first metacarpal bone and skin loss.

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