



Orthoplastics Tips & Tricks: The Posterior Interosseous Artery Reverse Flap for Coverage of Distal Upper Extremity Defects

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Introduction

First described in 1985 by Zancolli and Angrigiani at the 6th European Hand Surgery Course and published in 1986, the posterior interosseous artery flap is a regional fasciocutaneous flap from the posterior forearm that can be used to cover distal defects in the hand and fingers.¹ The vascular supply is based on reverse arterial flow from the anterior interosseous artery (AIA) to the posterior interosseous artery (PIA) via its distal anastomosis classically described 2cm proximal to the dorsal distal radioulnar joint (DRUJ). Blood supply is provided superficially via septocutaneous perforator branches. Venous drainage occurs through one or two large interconnecting venous perforators that connect to the venae comitantes of the posterior interosseous artery.^{1,2} The flap centers on an axis between the lateral epicondyle of the humerus and the DRUJ. A point is marked 1cm distal to the middle of this line, marking the medial pedicle which includes the medial cutaneous branch of the PIA and venous perforator.² Proximally, the flap can extend up to 4 cm distal to interepicondylar line.^{3,4} Distally, it can extend up to the wrist joint.² Originally described up to 7-8cm wide,¹ the largest reported dimensions to date have been 16cm x 10cm with respect to width⁵ and 22cm x 6cm with respect to length.⁶

Indications/ Contraindications

Originally described to electively address severe adduction contractures of the thumb and dorsal hand defects, its indications have since expanded to include treating emergent traumatic hand defects,⁴ volar hand defects, distal digital reconstruction,^{7,8} and deep three-dimensional defects of the hand.⁹

Contraindications are mainly limited to pre-operative identification of possibly poor vascular perfusion either due to anatomic variability described below or traumatic soft tissue injury to the dorsal wrist or forearm. Cosmetically, it is contraindicated if the patient self-identifies hair growth at the recipient site as an intolerable cosmetic outcome, such as women with hairy forearms.

Advantages

This flap provides several advantages over other reconstructive options when considering distal upper extremity coverage. As a regional flap, it can be performed under a regional block as a same-day outpatient surgery. With respect to donor site morbidity, it does not sacrifice a major artery in the forearm. Furthermore, if the flap is limited to 3-4cm in width, the surgeon can close the donor site primarily.¹ For larger defects where the donor site cannot be primarily closed, a split thickness skin graft will suffice over the exposed extensor carpi ulnaris (ECU) and extensor digiti quinti (EDQ) muscle bellies. Cosmetically, it is a thin flap and requires few, if any, revision surgeries for debulking. As a fasciocutaneous flap, the fascial and cutaneous segments can be separated partially to have the fascia serve as a gliding surface for a tendon over bone or hardware or fill in deeper hand defects.⁹ More recently, Jakubietz et al described use of the flap as a pure fascial flap with a split thickness skin graft for final coverage.¹⁰

Disadvantages

This flap is a more technically challenging dissection compared to some of the other regional alternatives as demonstrated by increased reported operative times in the literature, averaging to 2 hours 40 minutes.¹¹⁻¹³

This can be further complicated by variant anatomy of the posterior interosseous artery and its distal anastomosis to the anterior interosseous artery. The PIA has been reported to be absent anywhere from 1-5.7% of the time.^{2, 14, 15} However, it has been proposed that in those cases, the dorsal aspect of the forearm is supplied by the dorsal recurrent branch of the AIA and its cutaneous branches.² In those with a complete PIA, the distal anastomosis was found to be absent 1.5-3% of the time^{14, 16} and inadequate in caliber 3% of the time.¹⁶ In one early reported case in a 29 year-old blacksmith, inadequate retrograde flow necessitated conversion to a free flap.¹⁷ In that case, the surgical team anastomosed the proximal aspect of the PIA to the radial artery in the anatomic snuffbox and the venae comitantes of the PIA to one of the radial artery.¹⁷ As such, pre-operative planning and proper informed consent are of the utmost importance.

Pre-Operative Assessment

As with any soft-tissue coverage planning in an elective setting, optimization of patient risk factors, such as nutrition and smoking cessation, is advised.

With respect to assessing variant arterial anatomy, a portable Doppler during the clinic visit can be used to assess the distal anastomosis and trace the perforators of the posterior interosseous artery proximally. If there is doubt, some investigators will order color Duplexes or CT arteriograms, the results of which have significantly impacted surgical plans when variant anatomy has been identified.^{18,19}

Surgical Technique

The patient is placed supine on a bed with a hand table extension and is inducted under regional anesthesia. The extremity is prepped and draped in a standard fashion. A sterile Doppler can be used to confirm the distal anastomosis 2cm proximal to the DRUJ and the PIA perforators proximally. The tourniquet is inflated to 250 mm Hg with an Esmarch bandage for exsanguination. Loupe magnification can be used for the procedure. The recipient site is prepared, ensuring a healthy viable soft tissue bed. The size of the defect can be traced on sterile surgical glove paper and cut out to be traced over the donor site. The dimensions of the flap should be increased 10% to account for flap thickness.

Attention is then turned to flap harvesting. A longitudinal incision from the ulnar head proximally is carried out designing a posterior interosseous flap over the middle third of the forearm centered over the axis between the lateral epicondyle and DRUJ. The skin and subcutaneous tissue are divided on the proximal aspect of the forearm over the ECU muscle. Dissection is carried down subfascially to the level of perforators to the posterior interosseous artery. An ulnar-based incision is made around the flap, with the dissection taken down to the ECU fascia from ulnar to radial, coming down on the intermuscular septum between the EDQ and the ECU, thereby identifying the perforators to the posterior interosseous artery flap. Continue dissecting on either side of the septum, laterally and medially, taking care to avoid injury to the posterior interosseous nerve fibers to the extensor compartment. Clip the proximal pedicle with double hemoclips and divide it. Continue dissecting distally to identify the perforator at the level of the ulnar head where the two arteries anastomose. The tourniquet should be let down at this point to confirm flap perfusion. The remainder skin bridge to the defect can then be incised to bring the flap over for inseting. Alternatively, the flap can be carefully tunneled subcutaneously to the recipient site but this is not recommended because tunneling can compromise venous outflow. Inseting and closure can be done in a standard fashion with post-operative immobilization type dependent on the recipient site where one would like to provide soft-tissue immobilization.

Post-Operative Care

The same institutional protocol can be followed as other regional flaps.

Complications

Partial flap necrosis has been reported to occur in 4-21% of cases, most of which do not seem to warrant treatment other than local wound care or at most a split thickness skin graft.^{2, 5-8, 12, 15, 20-23} Complete flap necrosis has been reported to occur in 1-12% of cases.^{2, 7, 15, 20, 22} Extensor weakness or paralysis is a rarely reported complication cited in few papers with incidences of 5-9%.^{5, 7}

Case Report

To highlight the versatility of the fasciocutaneous nature of this flap and its utility in the hand, we present the case of a 40 year-old right-hand dominant police officer who presented to us with right small finger extrinsic tightness as a complication of a prior right 5th metacarpal shaft fracture treated at an outside hospital 2 years prior with open reduction internal fixation, followed by removal of hardware 6 months later, and extensor tenolysis 8 months after that. Given his deficient, contracted soft-tissue envelope over the 5th metacarpal, the decision was made to proceed with an extensor tenolysis, 5th MCP joint capsulotomy, and posterior interosseous artery reverse flap to provide adequate soft-tissue coverage. At time of inseting, given the extensive scarring over the metacarpal bone, the fascia of the PIA flap was interposed between the bone and extensor tendon to allow for a smooth gliding surface and minimize post-operative tendon adhesions (Fig 1). The patient improved dramatically with increased digital flexion, primarily due to the augmentation of the hand's soft tissue envelope with a well-vascularized soft tissue flap.

Final Considerations

In summary, the posterior interosseous artery flap can be a powerful tool in the Hand Surgeon's armamentarium in addressing distal soft-tissue defects in the volar and dorsal hand and fingers. While a technically challenging procedure, it can provide superb cosmesis to both donor and recipient sites and restore an adequate soft-tissue envelope to the recipient site while minimizing the need for future surgical interventions.

Since its original description 35 years ago, numerous variations and technical tricks have been described to tackle different problems. Many advocate raising the flap with a wide base or surrounding fibrofatty sleeve to both increase the perforating branches from the AIA and PIA and the venous/lymphatic drainage.^{8, 20, 21} To increase pedicle length and allow the flap to reach more distal areas, a myriad of modifications have been recommended. Some describe carrying the dissection distally along the transverse anastomotic branch¹⁶ or extending the pivot point to the anastomosis of the PIA to the dorsal intercarpal artery via the fifth extensor compartment artery.²⁴ Others have described immobilizing the wrist in extension³ or exteriorizing the pedicle, wrapping it in a split thickness skin graft, and immobilizing in plaster with a plan to return for delayed flap sectioning.^{7, 8} If there is concern for development of venous congestion, the flap can be designed with a superficial venous anastomosis.^{20, 25} Lastly,

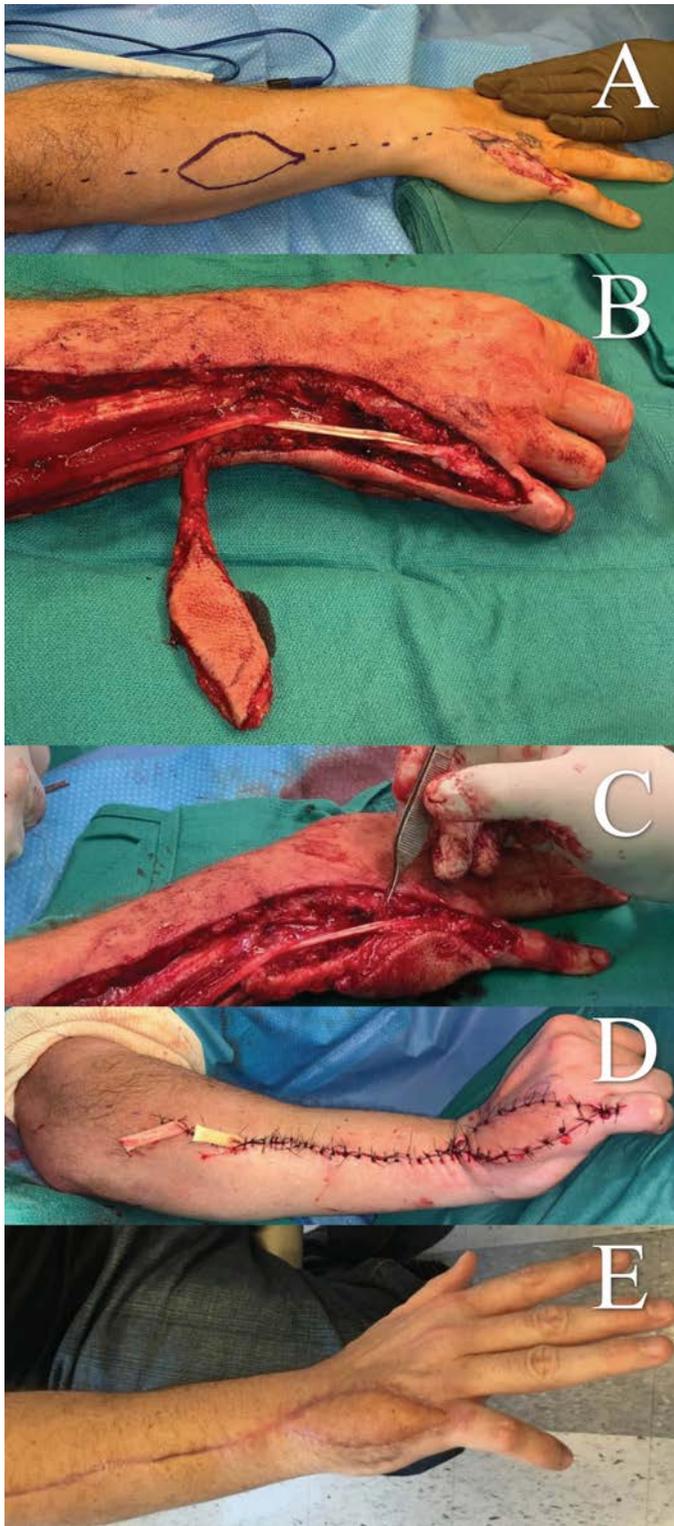


Figure 1. 40 year-old male police officer with extensive scarring of the small finger extensor tendons and dorsal overlying soft-tissue contracture. **(A)** Intra-operative marking of the flap parameters based off the dimensions of the soft-tissue defect; **(B)** Elevation of the PIA reverse flap after further recipient wound bed preparation; **(C)** Insetting the PIA reverse flap with the fascia under the extensor tendon to facilitate tendon glide and reduce post-operative tendon adhesion formation; **(D)** Cosmetic appearance and demonstration of improved small finger flexion immediately post-operatively; **(E)** 3.5 weeks post-operatively, the flap has incorporated well and the patient continues to work with Hand therapists to maintain finger flexion and prevent scar formation.

despite the best pre-operative planning, in the worst case scenario of inadequate intra-operative perfusion, this flap can be converted to a free flap with the proximal perforator as the site of anastomosis.²⁰

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