Original Article

Study Of Posterior Interosseous Artery (PIA) Flap For Reconstruction Of The Defects Of Wrist And Hand Over A Period Of 2 Years In Atertiary Care Centre.

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Abstract

The posterior interosseous artery (PIA) flap is one of the options for hand and upper extremity reconstruction. It does not sacrifice the main arteries of the hand, the radial and ulnar arteries and could be used even when either artery was damaged. The PIA is a branch of the common interosseous artery and runs down longitudinally in the intermuscular septum between the extensor carpi ulnaris and extensor digiti minimi. PIA appears to be relatively constant in position, and provides a reliable blood supply in the posterior aspect of the forearm. The PIA flap is reliable in its designs, even to making it possible to close the donor site primarily. It provides not only a thin, pliable coverage of the hand and upper extremity, but also a neurosensory flap. Technically, the dissection of the PIA pedicle along its course needs a high learning curve, because it might present the risk of venous congestion, ischemic flap necrosis, and injury to the PIN. Although the flap dissection seems to be difficult, it still offers increased versatility in reconstructions of the hand, foot, and upper extremity. Its popularity has increased, becoming a valuable flap due to its arc of rotation, due to its safety and low morbidity.

Keywords: Hand defects, Posterior interosseous artery

INTRODUCTION

Posterior interosseous artery flap (PIA) was concomitantly described in 1986 by Zancolli and Angrigiani and by Masquelet and Penteado. Skin flaps elevated on perforators from the posterior interosseous artery provide thin skin with excellent color and quality matching for covering soft tissue of the hand, especially on its dorsal aspect. It does not sacrifice the main arteries of the hand, the radial and ulnar arteries and could be used even when either artery was damaged. This is the biggest advantage of a PIA flap. As a type B fasciocutaneous flap according to the Lamberty and Cormack classification, it is also called the dorsal or posterior forearm flap. It could be used as proximally based for elbow coverage, and distally-based island flap for hand and wrist reconstruction, in addition to the free flap. The retrograde PIA (rPIA) flap has been originally reported for adduction contracture of the thumb and extensive defects of the hand dorsum. Besides the first web space, the reach of the retrograde PIA flap could enable reconstruction of the dorsal and palmar aspects of the hand, including the metacarpophalangeal joints and the dorsum of the thumb.

MATERIALS AND METHODS

PATIENT SELECTION- From March 2020 to February 2022, a retrospective review was performed on the patients who underwent rPIA flap for hand defects at IMS & SUM Hospital, Bhubaneswar, Odisha. For each patient, the data including sex, age, etiology, the size and region of the defect, flap size, operation results, and complication were collected.

ANATOMY- The PIA is a branch of the common interosseous artery, which is about 1 cm in distance from the ulnar artery, and runs down longitudinally in the intermuscular septum between the ECU and EDM. Normally the anterior and posterior interosseous arteries are united through two main anastomoses: one proximal (at the level of the distal border of the supinator muscle) and one distal (at the most distal part of the interosseous space). The distal anastomosis between them is located immediately proximal to the distal radioulnar joint. Posterior interosseous artery follows a line between the lateral epicondyle and the distal radioulnar joint. The PIA gives four to six cutaneous branches which run through the septum between the EDM and the ECU muscles. PIA gives off 3 to 9 septocutaneous perforators at the middle third and 2 to 5 at the distal third of the forearm. Therefore, the middle third of the forearm was called the “zone of security” of

harvesting the skin paddle. The PIA is closely related to the last motor branches of the posterior interosseous nerve (PIN), which gives a sensory branch to the carpus and the motor branches for the deep layer muscles on the dorsal forearm. The distal branches of PIN to the extensor pollicis longus and extensor indicis proprius muscle are known to be most vulnerable during the dissection of the PIA pedicle distally. The retrograde island flap is irrigated by the reverse arterial blood flow through the distal anastomosis once the proximal anastomosis has been ligated i.e. it has a retrograde pedicle. Venous drainage is though the venae comitantes of the posterior interosseous artery. The fulcrum point is 2cm proximal to the distal radio ulnar joint. The distance from the fulcrum to the proximal edge of the defect is the length of the pedicle.1,2

OPERATIVE TECHNIQUE- Under tourniquet, with the elbow in 90° flexion and the wrist in full pronation the flap is marked according to the defect size. The proximal edge of flap is kept 6 cm from the elbow crease. The fulcrum is marked at 2cm proximal to radio-ulnar joint. The midpoint of the axis between the lateral condyle and the distal radioulnar joint is marked. The main perforator generally lies 1cm distal to it. A doppler is used to confirm it. A preoperative Doppler is essential to confirm presence of distal perforator just lateral to the medial end of ulna. Dissection begins at the middle of the forearm starting at the ulnar border of the flap. Fascia is incised over the extensor carpi ulnaris muscle belly and dissection continues till reaching the septum between extensor carpi ulnaris and extensor digit iminimi where three to four constant muscle perforators from the posterior interosseous artery appear. The flap is then incised from the radial side as a fasciocutaneous flap till reaching the septum. Some musculocutaneous perforators have to be cauterized during dissection at the radial side. The flap is incised proximally with the deep fascia and the posterior interosseous artery and venae comitantes are dissected proximally from the posterior interosseous nerve The flap is dissected in a retrograde manner along its course till reaching the pivot point. The PIN is identified and spared. Dissection is then carried out from proximal to distal. Skin (tail) taken over the pedicle to avoid kinking while rotating it to the defect. The insetting of the flap is loose. The donor defect is skin grafted.3,4

POSTOPERATIVE- Elevation of the hand and avoidance of pressure on the flap protects the flap from oedema and congestion and reduce hospital stay. The dorsum of the hand was placed on a 10–20° extension of the wrist. Intravenous antibiotic prophylaxis.

OBSERVATION

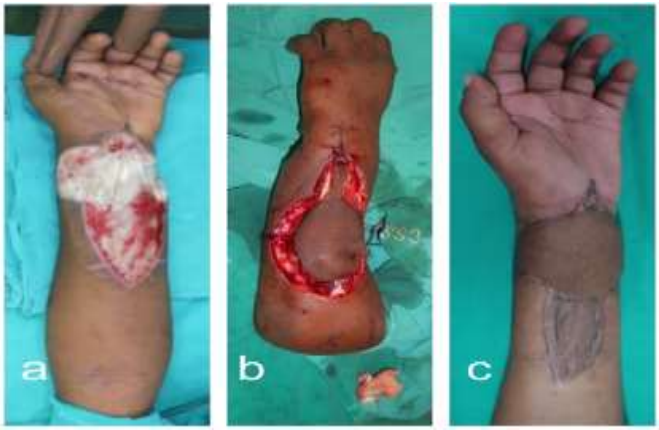
CASES	AGE/ SEX	DIAGNOSIS	MODE OF INJURY	DEFECT SIZE in cm	FLAP SIZE	Duration of surgery (min)	Hospital stay	COMPLICATIONS	FOLLOW UP PERIOD (months)
1	22 M	First web space contracture of rt hand	Thermal burn	5×4	6×5	180	9	nil	12
2	56 F	Post snake bite raw area over dorsum of lt hand	Snake bite	11×6	12×7	150	14	Nil	7
3	26 F	Raw area over volar aspect of left wrist	Electric burn	12×6	13×7	160	10	nil	14
4	60 M	Amputation stump of rt hand	Machiner y injury	10×6	11×7	140	11	nil	6
5	32 F	Raw area over dorsum of rt hand	Electric burn	10×7	11×8	140	12	nil	10
6	62 M	Raw area over dorsum of rt hand	Road traffic accident	11×7	12×8	150	14	nil	12
7	19 M	First web space contracture of rt hand	Electric burn	5×4	6×5	140	13	Nil	7
8	23 F	Raw area over volar aspect of left distal forearm	Road traffic accident	6×4	7×5	155	12	nil	8
9	63 M	Amputation stump of rt hand	Road traffic accident	8×6	9×7	160	10	nil	11
10	44 F	Post snake bite raw area over dorsum of rt hand	Snake bite	9×7	10×8	140	10	Partial flap necrosis	10
11	36 M	First web space contracture of rt hand	Electric burn	6×4	7×5	150	10	nil	13
12	46 F	Raw area over volar aspect of rt wrist	Machiner y injury	10×6	11×7	150	9	nil	14
13	41 M	Raw area over dorsum of rt hand	Thermal burn	11×6	12×8	145	11	nil	12
14	22 F	First web space contracture of lt hand	Electric burn	5×5	8×6	155	12	nil	8
15	37 M	Raw area over dorsum of lt hand	Road traffic accident	9×7	10×8	150	14	nil	

Figure/table 1. Table showing the distribution of patients with age and sex, etiology of injury , size of defect reconstructed with rPIA flap , the size of flap , duration of surgery , complications and the period of follow-up

RESULTS

Fifteen patients (eight males and seven females) were included in this study conducted at our hospital in the department of plastic and reconstructive surgery IMS SUM Hospital. Four patients had histories of road traffic accidents, two had injuries from firecrackers, five had electric burn injuries, two patients suffered snake bite injuries and two had suffered injuries from machines. Their mean age was 38.4 years, ranging from 19 to 62 years. Mean length of the defect was 8.66 cm (range, 5–12 cm) and mean breath was 5.66 cm (range, 4-7 cm). The mean duration of operation was 150 minutes. In the postoperative period the flaps were assessed clinically by noting temperature, color of the flap, blanching or pricking of the flap. When in doubt, the pre-marked perforator was heard with an audio Doppler using a sterile probe. All flaps

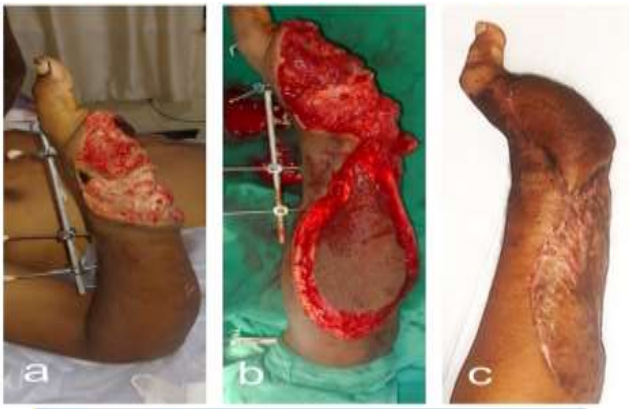
survived completely except one, which had marginal necrosis of 1.5 cm, but it healed by secondary intention. The flap settled subsequently with conservative management. In this patient the PIA was located more ulnar beneath the muscle rather than distally between ECU and EDM tendons; therefore, the flap was raised more proximally to increase the reach. The patients' mean stay in the hospital was 12.33 days, ranging between 9 to 19 days. 14 out of the 15 cases had good results and only one patient had fair result. All patients were put on early postoperative physiotherapy to prevent joint stiffness. Donor areas in all cases healed well. The flap settled nicely over the recipient area in all cases.



Figure/table 2. a) Post-Electric Burn defect left wrist after debridement. b) PIA flap harvested c) Post-op 3 months- well settled flap with residual area skin graft

Figure/table 3. a) severe crush injury rt hand. **b)** post debridement defect over dorsum of hand **c)** Post-op 3 months- well settled PIA flap over the dorsum.

Figure / table 4. a) Post-Burn contracture lt hand dorsum. Release of contracture band done. Defect in dorsum of lt hand **b)** Reconstructed with PIA flap with donor site primary closure. Post-op 3 months.



Figure/table 5. a) Post-traumatic auto-amputation of right hand with loss of palm and all fingers except thumb **b)** debridement of stump with harvesting of PIA flap **c)** Post-op 3 months- well settled flap with donor area skin graft.

DISCUSSION

The forearm flaps based on the radial/ulnar artery are criticized for breaking the main circulation to the hand, which results in cold intolerance, hand stiffness, and varying degree of sensory loss. PIA flaps are much more attractive, with lower donor site morbidity, and higher patient acceptance. Possibility of primary closure of the donor area if it is not too big, good quality of the skin paddle, ability to perform all the surgical procedures in a single surgical-stage and the flap does not interrupt any major vascular axis are the various other advantage of the PIA flap. One of the merits of the reverse posterior interosseous flap is good quality of the skin paddle that match with the volar wrist, dorsum of the hand up to base of fingers and dorsum of the thumb. In addition, being a small vessel with a secondary importance to the vascular supply of the hand, moderate to large sized flaps can be harvested to cover these areas. The PIA flap as a distally based retrograde pattern has been suitable for the repair of various soft tissue defects in the dorsal surface of the proximal phalanges, flexor aspect of the wrist, palm, hand dorsum, and first web space. Limit is till PIP joint of fingers and IP joint of thumb. The other limitations of the flap include relatively small size, difficulty of dissection (needs learning curve), possible injury of posterior interosseous nerve, venous congestion and it leaves a skin grafted area of the donor site. Venous congestion is the main concern of the rPIA flap, which has been reported to range 3% to 37%. The proximal axis of rotation of the rPIA flap limits the distal reach to the MCP joint level, which imposes a venous congestion and ischemic necrosis of the flap. It seems to be related to the width of the pedicle, and the narrowness of the subcutaneous tunnel. To avoid subcutaneous tunnel compression, Zaidenberg et al.5 recommended detaching the pedicle with the septum included, and splitting the skin bridge between the rotation point and the recipient. Puri et al.6 also took a wide strip of fascia and subcutaneous tissue in the rPIA flap. To increase the rPIA flap survival, Acharya et al.7 avoided the dissection of the anastomotic arc between the AIA and PIA, while Chen et al.8 suggested the additional venous anastomosis and change into a free flap. Reyad et al.9 designed the racquet-shaped flap to avoid tunneling, and to add more superficial veins. Cavadas10 and Liu et al.11 include the posterior cutaneous nerve of the forearm to the PIA flap, called a neurocutaneous flap, and this perineural arterial network might have contributed to its viability in the absence of the distal artery.

CONCLUSION

Posterior interosseous flap is a reliable and effective alternative for wound coverage within the range of its pedicle. The great advantage of the PIA flap is that it does not sacrifice the main arteries to the hand. The PIA flap not only provides a thin, pliable coverage of the hand and wrist, but also a neurosensory flap with the posterior antebrachial cutaneous nerve. Although the flap dissection seems to be tedious and difficult due to its frequent anatomical variations, it still offers increased versatility in reconstructions of the hand and upper extremity. Careful planning and meticulous dissection really gives good end results.

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