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ORIGINAL ARTICLE

Versatility and reliability of reverse posterior interosseous artery flap for coverage of soft tissue defects of hand and wrist.

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ABSTRACT… Objective: To evaluate reverse PIA flap in reconstruction of various types of soft tissue defects of the hand in terms of reliability, flap survival, total duration of hospital stay, patient's satisfaction and duration of return to work **Study Design:** Case Series study. **Setting:** Jinnah Burn and Reconstructive Surgery Center, Lahore. **Period:** January 2018 to July 2020. **Material & Methods:** Twenty three posterior interosseous artery flaps were used for coverage in patients who had soft tissue defects over hand dorsum, wrist and first web space. Both sexes were included with age group ranging between 15 to 60 years. **Results:** Twenty two flaps, out of total 23 survived completely. In one patient, there was partial flap necrosis for which skin grafting was done. Donor sites were successfully covered with skin grafts. All patients went on to resume their work within a month or two and were quite satisfied with aesthetic outcome. **Conclusion:** A well planned reverse PIA flap is not only a safe, versatile and reliable option for coverage of hand defects but also entire has the benefit of a shorter hospital stay, allowing early return of patient to work and superior aesthetic outcome.

Key words: Defects of Hand, Reverse PIA Flap, Reconstruction.

INTRODUCTON

Injury to the hand is often a challenging situation for plastic surgeons. Damage to the overlying soft tissue results in exposure of underlying tendon, bone, muscles and neurovascular structures which can get infected and undergo necrosis. Hence early coverage is necessary.[1] There are various options available in the gallery of a plastic surgeon to reconstruct a hand defect ranging from simple procedures like skin grafting to complex procedures like free tissue transfer.[2] Similar is the case with defects of upper extremity which can be covered with pedicled flaps as well as free flaps. However there are various advantages related with regional flaps of the forearm that make them a preferable option. These merits include the procedure being done in a single stage, lack of dependency of hand as seen in distant flaps, restriction of donor site deformity to involved extremity and finally the initiation of early mobilization and rehabilitation.[3]

Reverse posterior interosseous artery flap (PIA) is a much favored option among regional flaps of forearm to resurface defects of hand (especially dorsal hand up to metacarpophalangeal joint) and wrist as well as a versatile flap for reconstruction of thumb and contractures of first web space.[4,5] As reverse PIA flap is a regional forearm flap, it shares the common advantages of regional flaps described above. However compared to other regional flaps of upper limb, reverse PIA flap has additional advantages in hand and wrist defect reconstruction including excellent skin color match as well as likeness in pliability and texture. Additionally, with harvesting of reverse PIA flap, posterior interosseous artery, which is a branch of ulnar artery, is sacrificed thus sparing major blood vessels of hand (radial and ulnar arteries). This is a major benefit of reverse PIA flap when compared with other regional flaps of forearm such as radial artery or ulnar artery forearm flap.[6]

PIA flap was described separately by Penteado

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et al, Zancolli and Angrigiani. It is based on the anastomosis between the posterior and anterior interosseous artery and the reverse flow of blood that runs through them. The direction of this reverse flow is from volar to dorsal direction.[1,3,7,8]

The purpose of this study was to evaluate the versatility and reliability of reverse PIA flap in reconstruction of various types of soft tissue defects of the hand and wrist measured in terms of flap survival, total duration of hospital stay, patient's aesthetic satisfaction and duration of return to work.

MATERIAL & METHODS

This was a descriptive study conducted at Jinnah Burn and Reconstructive Surgery Center Lahore from January 2018 to July 2020. Twenty Three patients were included using purposive sampling technique. The age of the patients ranged between 15 to 60 years old. Average age is 36 years. Patients with age less than 15 years and greater than 60 years of age and those with advanced complicated diabetes, peripheral vascular disease and severe crush injuries of wrist were excluded from our study. There were four females and 19 males. The majority of the injuries sustained were secondary to road traffic accident, followed by machine injuries and firecracker injuries. The most common site of injury was dorsum of hand in 18 patients followed by thumb in 5 patients. Size of the defects ranged from 3 x 6cm and length to 6 x 12 cm.

Surgeries were performed by the same surgeon using the operating technique described below and the patients followed post operatively by the same team.

Operating technique and Postoperative monitoring

All cases were performed under general anesthesia and under tourniquet control, applied over upper arm. With the elbow kept at 90° and wrist in full pronation, flap marking was done by first marking lateral epicondyle, then marking distal radioulnar joint and then joining these two points by drawing a straight line. Audio Doppler machine was used to locate distal perforator that usually lies at a distance of 2.5 cm proximal to distal radioulnar joint. This perforator not only denotes the point of anastomosis of posterior and anterior interosseous artery but is also the pivot point for rotation of reverse posterior interosseous artery flap. The defect was marked intra-operatively after surgical debridement, outlined over a sterile surgical glove wrap. This defect was then projected over the donor area on the proximal forearm where reverse PIA flap was designed accordingly.

Proximal 1/3rd of forearm was excluded from the flap. Incision was made through skin and deep fascia to expose the septum between Extensor Digiti Minimi and Extensor Carpi Ulnaris which contains the pedicle of posterior interosseous artery. After retracting muscle bellies of these two muscles, supinator muscle was visualized proximally, deep to which PIA was visualized. Posterior Interosseous Nerve (PIN) lying adjacent to it was carefully dissected and preserved. Posterior interosseous artery and vein were divided proximally, just distal to Supinator muscle and the flap was elevated. Segmental septocutaneous vessels of flaps were extending between ECU and EDM to overlying fascia and skin. A vertical incision was made at the inferior end to mobilize the pedicle. The PIA-AIA anastomosis was preserved (located 2.5 cm proximal to radio-ulnar joint). The dissected flap was then rotated over to cover the defect. Donor sites were covered with skin grafts.

Postoperatively, a splint with wrist extended at 20° and the metacarpophalangeal (MCP) joint flexed 70-80° was applied with limb kept elevated over pillow. Monitoring of flaps was done including assessment of vascularity of flap by checking color, temperature as well as pin pricking in few cases. The most important points summarized were:

1) Marking of proximal cutaneous perforator as well as distal perforator of PIA-AIA anastomosis in designed flap using Doppler device. 2) Use of loupe magnification during surgical dissection. 3) At least 2 or more cutaneous perforators were included. 4) Careful proximal dissection carried

out to avoid damaging PIN.

RESULTS

This study conducted at Jinnah Burn and Reconstructive surgery center, Lahore included a total of twenty three patients (19 male and 4 female) Modes of injuries included: from road traffic accidents-15 patients, from machine injuries-6 patients and from firecrackers- 2 patients. Range of age of included patients was between 15-60 years (mean age of 36 years). Range of width of soft tissue defects was from 3-6cm (mean width 4.5 cm) and range of length was 6-12 cm (mean length 8.33 cm). Clinical assessment of temperature and color of the flaps along with blanching and pricking was carried out in postoperative period.

Out of twenty three attempted flaps, one flap underwent partial necrosis of margins, all rest surviving completely. Debridement was done and skin grafting performed when granulation appeared. Range of hospital stay amongst patients was 8-15 days (mean stay 10.9 days). Twenty one patients were satisfied with final aesthetic outcome in terms of color match and texture. All patients under went physiotherapy in the early postoperative period to prevent joint stiffness. Donor areas were covered with split-thickness skin grafts. All cases healed well without any complication.

Number	Total Duration of Hospital Stay (Days)	Satisfaction (Aesthetic Outcome)	Time to Return to Normal Activities (Days)
1	8	Satisfied	44
2	14	Satisfied	51
3	11	Satisfied	39
4	15	Satisfied	38
5	11	Satisfied	49
6	9	Satisfied	60
7	8	Not Satisfied	47
8	8	Satisfied	33
9	10	Satisfied	39
10	14	Satisfied	43
11	14	Satisfied	36
12	13	Satisfied	47
13	14	Satisfied	55
14	10	Satisfied	54
15	8	Satisfied	44
16	10	Satisfied	41
17	9	Satisfied	36
18	11	Satisfied	38
19	13	Satisfied	40
20	12	Not Satisfied	50
21	8	Satisfied	60
22	10	Satisfied	59
23	11	Satisfied	49

Table-I. Showing total duration of hospital stay, patient satisfaction and time taken to return to normal activities.

No	Age	Sex	Mode of Injury	Defect Area	Size of Defect (cm)	Size of Flap (cm)	Follow up Period (Months)
1	18	M	Road traffic accident	Dorsum of right hand	6 x 11	7 x 12	6
2	23	M	Road traffic accident	Dorsum of right hand	3 x 7.5	4 x 8.5	9
3	45	M	Road traffic accident	Dorsum of left hand	4 x 8.5	5 x 9.5	12
4	58	F	Road traffic accident	Dorsum of right hand	4.5 x 11.5	5.5 x 12.5	5
5	59	M	Road traffic accident	Dorsum of right hand	3.5 x 8	4.5 x 9	6
6	37	M	Machine injury	Dorsum of right hand	6 x 10.5	7 x 11.5	9
7	39	M	Machine injury	Left thumb	5.5 x 10.5	6.5 x 11.5	9
8	31	M	Road traffic accident	Dorsum of right hand	6 x 8	7 x 9	11
9	28	M	Road traffic accident	Dorsum of right hand	3 x 8	4 x 9	9
10	22	M	Road traffic accident	Right thumb	5 x 8.5	6 x 9.5	8
11	30	F	Machine injury	Left dorsum of hand	4 x 6	5 x 7	6
12	33	M	Firecracker injury	Dorsum of right hand	4.5 x 8	5.5 x 9	5
13	44	M	Road traffic accident	Dorsum of left hand	4 x 8.5	5 x 9.5	5
14	42	M	Road traffic accident	Dorsum of left hand	5.5 x 11.5	6.5 x 12.5	5
15	27	F	Road traffic accident	Dorsum of right hand	3 x 6	4 x 7	12
16	22	F	Road traffic accident	Dorsum of right hand	4.5 x 7	5.5 x 8	10
17	19	M	Firecracker injury	Dorsum of left hand	3.5 x 8.5	4.5 x 9.5	10
18	33	M	Road traffic accident	Dorsum of right hand	5.5 x 8	6.5 x 9	6
19	34	M	Road traffic accident	Right thumb	6 x 7.5	7 x 8.5	9
20	39	M	Road traffic accident	Dorsum of right hand	3.5 x 6.5	4.5 x 7.5	9
21	41	M	Machine injury	Dorsum of right hand	5.5 x 10.5	6.5 x 11.5	12
22	57	M	Machine injury	Right thumb	4.5 x 6.5	5.5 x 7.5	5
23	50	M	Machine injury	Dorsum of left hand	3.5 x 7	4.5 x 8	5

Table-II. Patient distribution according to age, sex, mode of injury, site and size of defect and size of the flap.

DISCUSSION

According to recent statistics, hand injury occurs in 25-48% of reported industrial as well as agricultural accidents.[10] Extensive studies have been done on hand injuries, especially soft tissue injuries, as hand carries a great significance with respect to function and aesthetics.[11] Thus a good soft tissue coverage is required for soft tissue defects of hand in the form of a flap that provides an adequate color match as well as allowing early rehabilitation and return to work. Forearm offers quite a few regional flaps for reconstruction of the soft tissue defects of hand in general.[12] Amongst them, the reverse flow flaps have certain advantages over others including the procedure being done in a single stage, lack of dependency of hand as seen in distant flaps, restriction of donor site deformity to involved extremity and initiation of early mobilization.[3] Thus overall hospital stay becomes shorter and earlier rehabilitation can be initiated which makes it a well acceptable option to patients. Regional flaps of forearm based on major arteries i.e. radial artery-based reverse flow flap and ulnar artery-based reverse flow flaps have above mentioned advantages. However with harvesting of these flaps, major vessels of hand i.e. radial and ulnar artery are sacrificed. In contrast, with surgical dissection of reverse flow posterior interosseous artery flap, posterior interosseous artery is sacrificed which is a branch of ulnar artery. Thus with the harvesting of reverse PIA flap, there is a significant advantage of not sacrificing major vascular axis of hand compared to above mentioned regional reverse flow flaps.[14,15] Additionally, reverse PIA flap provides a good and durable skin with adequate color match for coverage of soft tissue hand defects. Penteado et al. reported 10 cases with reverse flow pedicled PIA flaps.[7] In our study, we have used 23 reverse posterior interosseous flaps for coverage of soft tissue hand defects. Only one flap underwent partial necrosis with rest of flaps completely surviving. In this case of partial flap necrosis, the proximal cutaneous perforator from PIA, which is roughly located at the junction of upper and middle third of forearm, was sacrificed. This was because of crossing of posterior interosseous nerve (PIN) distal to the perforator. Thus the flap was based on distal PIA-AIA anastomotic perforator that was incorporated into the flap during dissection. Despite these measures, the distal portion of the flap underwent partial necrosis. Debridement of area was done and when granulation appeared, skin grafting was done.

Cheema et al. reported survival rate of 88.24% with 64 reverse PIA flaps performed for hand defects with the reason for failure of four flaps being skeletonization of the pedicle.[16] Fujiwara et al. suggested inclusion of fascial sleeve with the posterior interosseous artery pedicle during flap raising that prevents complication of vessel kinking.[10] In our study, we initiated the surgical dissections distally, identifying the distal perforator over anastomotic connection between the anterior and posterior interosseous artery, roughly located 2.5 cm proximal to the distal radioulnar joint as has been documented by most authors. Having followed this principle we identified this perforator in all of our cases. Meticulous dissection is required in proximal flap because of close association of posterior interosseous nerve and artery. Gong and Lu suggested to include proximal cutaneous perforators of PIA flap that would help to increase the reach of the flap. They had used reverse PIA flap for reconstruction in several complex cases including severe contractures of the first web space.[17] Rab and Prommersberger used this flap for reconstruction of defects of first web space, wrist, thumb and dorsum of hand with excellent results.[18]

A few anatomical discrepancies regarding posterior interosseous artery have been described by few authors that surgeons should keep in mind while harvesting reverse PIA flap. Penteado et al reported finding no PIA beyond the middle third of the forearm in 4 cases while there was no anastomotic perforator was found in 1 case.[7] Angrigiani et al. noted in 74 cases out of total 80 dissections performed that there was narrowing of PIA beyond the middle third of the forearm.[19] Buchler and Frey, similar to Penteado et al, did not find PIA beyond the middle third of the forearm in 2 cases out of total 36 surgical dissections performed.[20] We also noted an anatomical variation in our study in which

posterior interosseous nerve was found to cross dominant cutaneous perforator distally.

In our study of 23 patients, 21 were quite satisfied from aesthetic point of view. This was because of "like" skin of reverse PIA flap that closely matches with that of hand, especially the dorsum.

Our suggestions to obtain optimum results are, especially with regards to flap reliability are:

1) Preoperative identification of two perforators should be done by operating surgeon, the proximal cutaneous dominant perforator at junction of proximal and middle third of forearm (over proposed skin paddle) and the distal perforator arising from anastomotic connection between posterior and anterior interosseous branches of ulnar artery, arising roughly at a distance of 2.5 cm proximal to distal radioulnar joint. Dissection be carried out as planned only when good Doppler signals are detected.

2) Inclusion of fascial sleeve around pedicle that would prevent complication of vessel kinking, especially near the pivot point of flap.

3) Inclusion of at least two perforators in flap if a large flap is to be harvested to increasing reliability of flap survival.

4) In cases of anatomical variations such crossing of PIN distal to dominant cutaneous perforator, requiring sacrificing of this dominant perforator to allow for flap harvest, another reliable perforator must be looked for to incorporate in flap such as inclusion of distal perforator of PIA-AIA anastomosis in above mentioned case to increase flap reliability and prevent complications such as flap necrosis.[21]

5) Regular monitoring, limb elevation and splintage in immediate postoperative period with early initiation of range of motion exercises to allow rehabilitation and return to work.

CONCLUSION

The reverse posterior interosseous flap is a versatile, safe as well as a reliable option for coverage of soft tissue defects of hand and wrist defects. Important requisites to increase flap reliability include perforator identification (with Doppler device preoperatively and visual identification intraoperatively), carrying out meticulous dissection under loupe magnification, preserving fascial sleeve around vessels and incorporating dominant perforators. Being a single staged procedure, it shortens the total hospital stay and allows for early mobilization and rehabilitation along with additional advantages of having a superior aesthetic outcome and not sacrificing major artery of hand. All these features make it a preferable option for patients in terms of coverage of soft tissue defects of hand.

REFERENCES

1. Khurram MF, Maurya SK, Yaseen M, Chowdhry M. **Reverse posterior interosseous artery flap: A reliable, comfortable and versatile flap for coverage of soft tissue defects of hand.** Journal of Wound Management and Research. 2020 Jun 30; 16(2): 73-9.

2. Bilal, M., Ahmed, T. M., Dar, M. F., & Ahmed, N. **Reverse posterior interosseous flap; useful but problematic flap.** Pakistan Armed Forces Medical Journal, 2016; 66(3): 341-45.

3. Zancolli, E. A., & Angrigiani, C. **Posterior interosseous island forearm flap.** The Journal of Hand Surgery: British & European Volume, 1988; 13(2): 130-135.

4. Ceruso, M., Angeloni, R., Innocenti, M., Lauri, G., Capanna, R., & Bufalini, C. **Reconstruction with free vascularized or island flaps of soft tissue loss in the upper limb after tumor resection. 16 cases.** Annales de chirurgie de la main et du membre superieur: organe officiel des societes de chirurgie de la main= Annals of hand and upper limb surgery, 1995; 14(1): 21.

5. Dap, F., Dautel, G., Voche, P., Thomas, C., & Merle, M. **The posterior interosseous flap in primary repair of hand injuries: A review of 23 cases.** Journal of Hand Surgery, 1993; 18(4): 437-445.

6. Tiengo, C., Dalla Venezia, E., Lombardi, M., & Bassetto, F.. **Improvement of the rotation arch of the posterior interosseous pedicle flap preserving both reverse posterior and anterior interosseous vascular sources.** Plastic and Reconstructive Surgery Global Open, 2016; 4(7):.

7. Penteado, C. V., Masquelet, A. C., & Chevrel, J. P. **The anatomic basis of the fascio-cutaneous flap of the posterior interosseous artery.** Surgical and Radiologic Anatomy, 1986; 8(4): 209-215.

8. Masquelet, A. C., & Penteado, C. V. **The posterior interosseous flap.** Annales de chirurgie de la main: organe officiel des societes de chirurgie de la main, 1987; 6(2): 131.

9. El-Sabbagh, A. H., Zeina, A. A. E. M., El-Hadidy, A. M., & El-Din, A. B. **Reversed posterior interosseous flap: safe and easy method for hand reconstruction.** Journal of hand and microsurgery, 2011; 3(2): 66-72.

10. Fujiwara M, Kawakatsu M, Yoshida Y, Sumiya A. **Modified posterior interosseous flap in hand reconstruction.** Techniques in hand & upper extremity surgery. 2003 Sep 1; 7(3):102-9.

11. Kilgore ES, Graham WP, editors. **The hand: surgical and non-surgical management.** Lea & Febiger; 1977.

12. Khurram MF, Masoodi Z, Yaseen M, Bariar LM, Haq A. **Hand amputations: Epidemiology, management and resurfacing options for soft tissue coverage.** Journal of wound care. 2015 Oct 2; 24(10):452-8.

13. Jeng SF, Wei FC. **The distally based forearm island flap in hand reconstruction.** Plastic and reconstructive surgery. 1998 Aug 1; 102(2):400-6.

14. Cormack GC, Lamberty BG. **The arterial anatomy of skin flaps.** In The arterial anatomy of skin flaps 1994 (pp. 538-538).

15. Cormack GC, Duncan MJ, Lamberty G. **The blood supply of the bone component of the compound osteo-cutaneous radial artery forearm flap—an anatomical study.** British journal of plastic surgery. 1986 Apr 1; 39(2):173-5.

16. Cheema TA, Lakshman S, Cheema MA, Durrani SF. **Reverse-flow posterior interosseous flap—a review of 68 cases.** Hand. 2007 Sep; 2(3):112-6.

17. Gong X, Lu LJ. **Reconstruction of severe contracture of the first web space using the reverse posterior interosseous artery flap.** Journal of Trauma and Acute Care Surgery. 2011 Dec 1; 71(6):1745-9.

18. Rab M, Prommersberger KJ. **Distally pedicled posterior interosseous artery flap for the coverage of defects on the wrist and hand.** Operative Orthopadie und Traumatologie. 2008 Jun 1; 20(2):111-8.

19. Angrigiani C, Grilli D, Dominikow D, Zancolli EA. **Posterior interosseous reverse forearm flap: Experience with 80 consecutive cases.** Plastic and Reconstructive Surgery. 1993 Aug 1; 92(2):285-93.

20. Büchler U, Frey HP. **Retrograde posterior interosseous flap.** The Journal of hand surgery. 1991 Mar 1; 16(2):283-92.

21. Luo S, Raffoul W, Luo J, Luo L, Gao J, Chen L, Egloff DV. **Anterolateral thigh flap: A review of 168 cases. Microsurgery: Official Journal of the International Microsurgical Society and the European Federation of Societies for Microsurgery.** 1999; 19(5):232-8.

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2	Imaan Tahir	Results.	
3	Bushra Akram	Discussion, Proof reading.	