Original Article

Reverse flow posterior interosseous flap: Experience with 53 flaps at Nishtar Hospital, Multan

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Abstract

Objective: To assess the efficacy of reverse flow posterior interosseous artery flap for the coverage of large variety of hand/wrist defects.

Methods: The prospective study was conducted a the Department of Plastic Surgery and the Burns Unit of Nishtar Hospital, Multan, Pakistan, from June 2008 to June 2010. The study comprised 53 reverse flow posterior interosseous artery flaps in 50 patients for the coverage of hand/wrist defects both in emergency and elective settings. Data was analysed using SPSS 10.

Results: The hand/wrist defects in the study population were caused by different etiologies. All the flaps survived in all the patients. Marginal loss over the distal edge of the flap was noted in one patient. Mild oedema developed in all patients, but it subsided except in one case. None of our cases showed any evidence of venous congestion. Regarding the donor site morbidity, only one case had partial STSG loss. Mean hospital stay post-flap coverage in the patients ranged from 7 to 21 days.

Conclusion: Reverse flow posterior interosseous artery flap in experienced hands is safe, versatile and reliable for the coverage of hand/wrist defects.

Keywords: Hand defects, Reverse flow posterior interosseous artery flap. (JPMA 62: 950; 2012)

Introduction

Intricate in design and function, the hand is an amazing work of anatomy. Therefore, any injury to the hand carries the potential for serious handicap. Reconstruction of hand defects requires early cover. For plastic and hand surgeons, reconstruction of soft tissue defect of hand is a challenge. The choices are local flaps or distant flaps or free flap using microvascular techniques. Free flaps are time-consuming, require specialised equipments, and intensive post-operative care. Distant flaps may require multiple-stage reconstruction, prolonged hospitalisation and immobilisation. Single-stage procedure to reconstruct soft tissue defects of the hand, minimise infection, allow early mobilisation and reduce hospital stay. If the local flaps are insufficient to meet the requirement, then regional flaps need to be used.

Distally based island fasciocutaneous flaps in the forearm offer simple and effective wound coverage. Radial forearm flap[1-6] is based on septocutaneous perforating branches of radial artery in the forearm, while ulnar artery forearm[6-8] flap is based on septocutaneous perforator of ulnar artery. Both are popular for soft tissue coverage of hand although with clear disadvantage of sacrifising a major artery of the hand.

The posterior interosseous artery flap is a type B fasciocutaneous flap according to the Cormak and Lamberty classification.[9-11] Its main advantage is that it avoids sacrifising the two main arteries of the forearm. This flap can be proximally or distally based as an island flap. It has been reported useful by a number of studies.[12-16] Osteofasciocutaneous variety of the posterior interosseous flap was described by a study for the reconstruction of thumb defects.[17]

Traditionally, its indications are to cover defects up to metacarpo-phalangeal joints and for first web space. Now it has been considered to be the workhorse for coverage of skin defects over distal forearm, wrist and hand.

In this paper we present our experience of reverse flow posterior interosseous artery flap with respect to its indications, range of coverage and therapeutic results.

Patients and Method

The prospective study was conducted at the Department of Plastic Surgery and Burns Unit of the Nishtar Hospital, Multan, from June 2008 to June 2010. We performed 53 flaps in 50 patients, as in 3 patients posterior interosseous artery (PIA) flaps were done bilaterally both in emergency and elective settings. Patients who had a soft tissue defect in hand and distal forearm exposing the underlying structures and at least one of the major arteries of

hand (ulnar or radial) spared were included in the study. We excluded those who had both the major arteries of the hand (ulnar and radial) involved; or had medical co-morbidities; or were debilitated or very old patients.

The study was approved by the ethical committee of the institution. As informed written consent was obtained from all the patients, parents or guardians. During the study period, all details of patients regarding their medical report, operative notes, pre and post-operative photographs, duration of hospital stay and outcome were filed individually.

Road traffic accident (RTA) was the prime cause of the defect of hand and distal forearm, were classified in to four categories: category 1 included non-crushed soft tissue injuries of hand and distal forearm with exposed tendons and bone, but without any injuries to tendons or bones; in category 2 included non-crushed soft tissue injuries of hand and distal forearm with injuries to tendons, bones and nerves; category 3 comprised crush injuries for which we initially did wound debridement with delayed flap cover. The reason of delay was unclear vascular status of the soft tissue of hand. Category 4 represented complex wounds requiring vascular repairs. In wounds falling in category 1 and 2, mostly we performed flap in the Accident and Emergency Department of the hospital.

Pre-operatively, we performed hand-held doppler in all cases as a part of essential clinical examination of the flap to locate the cutaneous perforators.

In the initial 5 cases, we followed the original operative technique available in literature.[13] We later modified it as we ascertained the presence of anastomosis between PIA and anterior interosseous artery ((AIA) by pre-operative doppler. Straightaway elevated the flap that saved operative time. This modification has also been described in literature.[18] We also included a generous sleeve of fibro fatty tissue on each side of pedicle, as has been recommended by studies.[19]

All the patients were followed up weekly in the first month, then monthly afterwards. During the follow-up period we recorded the flap progression and its outcome. Cosmetic outcome was assessed based on three parametres: flap thickness, colour match and appearance of the donor site defect. During that period, details with photographs were recorded in individual files.

All the data was analyzed using SPSS 10 software. Descriptive statistics were used to calculate percentages.

Results

Of the 50 patients, there were 36 (72%) males and 4 (28%) females. The ages ranged from 7 to 65 years (Table). Of the 10 (18.86%) patients who had electrical injuries, 9 (90%) had high-voltage electrical trauma. In all these patients negligence was the sole factor behind the accidents. In 3 (6%) patients there was bilateral involvement of wrist. Most of the patients in our series were operated between the third and fourth weeks of injury. The earliest operation was done after the second week and maximum delay was 4.5 weeks. Hospital stay after flap coverage in our patients ranged from 7 to 21 days.

Figure-1: (A) Patient having road traffic accident showing a defect on the dorsum of hand. (B) Posterior Interosseous Artery Flap coverage (after 7 days).

The majority of the patients with RTA had associated injury. In 9 (39%) cases, there were associated tendon injuries. In 7 (30.5%) cases there were associated bone fractures and there was a bone loss in 2 (8.7%) cases. All of our Flaps were fasciocutaneous. No composite osteofasciocutaneous flap was used for reconstruction of hand defects in our study.

Seven cases were done in accident and emergency department of Nishtar Hospital Multan. The mean time of delay in these patients who got cover in A & E department was 36.4 hours. In all of these cases, the only cause was Road Traffic Accident. In all Patients who were operated in A & E department, the wound were not grossly contaminated and there was no doubt about the vascular insult.

Table: Demographic characteristics of patients and the etiology of soft tissue defects of hand/wrist (n=50).

Sex	No of Cases	Percaentages
Male	36	72 %
Female	14	28 %
Age of Patients		
6-10 years	1	2 %
11-20 years	5	10 %
21-30 years	20	40 %
31-40 years	10	20 %
41-50 years	9	18 %
51-60 years	4	8 %
> 60 years	1	2%
Minimum age of the patient included in our study=7 years		
Maximum age of the patient included in our study=65 years		
Mean= 32.82 ± 13.13		

Etiology of soft tissue defect of hand	Number of flaps in 50 patients (n=53)	
Road Traffic Accident	23	43.39%
Electrical injury	10	18.86%
In 3 patients with electrical injury flaps were done bilaterally		
Blast injury	3	5.66%
Machine injury	8	15%
Gun shot	4	7.54%
Contracture of 1st web space	3	5.66%
◆ Road Traffic Accident	◆ 2	
◆ Post burn	◆ 1	
Skin NECROSIS SECONDARY to extravasations of chemotherapy	1	1.88%
Post diathermy (iatrogenic)	1	1.88%

Site of Defect	No of Cases	
Dorsum of Hand	10	18.86%
1st web Space	3	5.66%
Thumb	3	5.66%
◆ Volar	◆ 2	
◆ Dorsal	◆ 1	
Palm	2	3.77%
◆ Volar	◆ 2	
◆ Dorsal	◆ -	
Wrist	21	39.62%
◆ Volar	◆ 15	
◆ Dorsal	◆ 6	
Fingers	7	13.20%
◆ Volar	◆ 3	
◆ Dorsal	◆ 4	
Distal forearm	7	13.20%

The flaps survived in all patients. We were able to cover the hand defects on volar and palmer wrist, palm, thumb, first web space and fingers up to the level of proximal interphalangeal joints (PIP joints).

Flap size varied in width 2-8cm and in length 4-14cm in our study. We raised smallest flap of 2-4cm size, and flap of largest dimensions in our study was 14x8.5cm (1 case) and 14x7cm (3 cases 6%). In 2 (4%) cases we closed donor site primarily where the defect size was < 4 cm, otherwise in remaining cases we grafted the donor area. Route of transposition of our flaps were "tunneling" in 08 (16%) cases. Otherwise in the remaining cases, we opened the skin bridge for flap transposition.

We immobilised wrist and hand post-operatively for 14 days and removed all stitches/staples 8 to 10 days post-operatively. We monitored the flap survival clinically, based on skin colour, temperature, skin turgor, capillary refill and colour of blood and pin-prick. These assessments were 6 hourly for the first 24 hours and later on 8-hourly for the next four days.

Figure-2: (a) High-voltage electrical injury of the wrist in a young man. (b) Posterior Interosseous Artery Flap (after 3 days). (c) After 7 days.

Marginal loss over the distal edge of the flap was noted in one (2%) patient, who had developed severe infection in the post-operative period that caused the marginal flap loss. When we had culture and sensitivity report, it turned to be Methicillin-resistant staphylococcus aureus (MRSA) which responded well to antibiotics. This was managed with flap advancement and suturing. Mild oedema developed in all patients and subsided over a time of two weeks except in one where oedema was moderate and subsided in about three months. None of our cases showed any evidence of venous congestion. Regarding the donor site morbidity, only one (2%) case had partial split-thickness skin graft (STSG) loss. We had no complete loss of flap in any of our cases. Long-term follow-up demonstrated excellent colour and texture match with reliable soft-tissue coverage.

Among 50 patients, 42 (84%) were available for followup for 6 months or more. Among the remaining 8 (16%) cases, 3 (6%) patients were followed up for 2 months or less, and 5 patients never came for followup.

Discussion

Hand is a highly developed sensory and motor organ capable of performing enormous function. In industrial and civilian settings hand injury is common and this results in a great deal of morbidity and dysfunction. The fasciocutaneous flaps like radial, ulnar and PIA forearm flaps had proved to be simple versatile and reliable in the reconstruction of great variety of soft-tissue defects of hand.

PIA flap is extremely useful and superior because it preserves vascularity of hand. The distally based PIA flap depends on retrograde flow from complex vascular arcade at the level of dorsum of wrist between the PIA and the dorsal branches of radial and ulnar arteries.

Several authors[5,16,17,20] have studied the anatomy of flap. Rare anatomical variations described by various authors are; failure of the middle third of the posterior interosseous flap;[14] absence of anastomosis between recurrent dorsal branch of anterior interosseous artery and posterior interosseous artery at the level of middle third of the posterior forearm;[21] narrowing of PIA in the middle third of forearm;[13] and termination of PIA in the middle third of the forearm.[16] However, we did not find any anatomical variation in our study of 53 PIA flaps.

Primarily the indications of posterior interosseous flap were dorsal hand defects and defect of the first web space. A study[22] also described its use for wrist defects. Other authors used PIA flap for digital reconstruction (both volar and dorsal defects) and covering defects up to distal interphangeal DIP Joint other than its use in dorsal hand, first web space, thumb, distal forearm and palmar defects. In our series, we were able to cover the hand defects on volar and palmar wrist, palm, thumb, first web space and fingers up to the level of proximal interphalangeal PIP joints.

Others[18,22] were able to cover DIP joints by exteriorising the flap pedicle and extension of wrist. However, we were able to cover PIP joints without exteriorising the extending pedicle.

One study[23] described a case of PIA flap to gain sufficient pedicle length. It passed the pedicle through a hole in the interosseous membrane to cover a volar wrist defect following an electrical burn injury. However, this made the procedure more difficult.

One study[13] recommended primary closure of donor site only when the flap raised is 3-4 cm wide. We followed the same method.

Regarding complications, we had no complete loss of flap in any of our cases. There was partial flap necrosis in two cases. One of the cases had severe infection in the post-

operative period leading to 30% flap loss and needed debridement and split thickness skin graft as a secondary procedure. In one case, only marginal superficial flap necrosis occurred due to poor bed and did not need any secondary procedure. This is similar to an earlier series which reported no complications whatsoever in 25 cases.[13] Another study[14] reported only one case of partial necrosis of flap in a series of eight cases. Another study[16] reported only three cases of venous congestion, but no flap necrosis.

The venous outflow of the distally based PIA flap is in a retrograde fashion through venae comitantes. Literature has described 34% incidence of oedema and congestion of the flap inset.[24] None of our cases showed any evidence of venous congestion. In our opinion maintaining the sleeve of deep fascia around pedicle maintains the integrity of arterial and venous channels and reduces these complications.

Other authors have reported a higher incidence of complications. One reported high incidence of ischaemic flap necrosis of 13% (15/113), of which 12 had partial flap necrosis and three had complete flap necrosis.[22] We did not encounter any anatomical variation of the anastomotic branch in our series; neither did we find any variation in the middle third of PIA. In our series, preoperative assessment of the anastomotic branch, continuity of the PIA and the presence of perforators was done by doppler study. We recommend that doppler is essential in pre-operative planning as it not only shortens tourniquet time, but it also saves tedious and exhausting dissection.

Including a generous sleeve of fibro fatty tissue on each side of pedicle reduces flap congestion which is fairly common mentioned event in post-operative period. It is our recommendation that at least 0.5cm of fibrofatty sleeve should be left on each side of pedicle.

Conclusion

PIA flap is a versatile, reliable and a very useful tool for the coverage of large varieties of hand and wrist defects. Though elevation of this flap is tedious, it is the top option to cover soft-tissue defects of hand and distal forearm.

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