Reverse flow posterior interosseous artery flap: A safe technique for reconstruction of wrist and hand defects

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ABSTRACT

Objective: To assess safety of Reverse Flow Posterior Interosseous Artery Flap in wrist and hand reconstruction regarding its complications.

Study Design: Descriptive longitudinal study

Place and Duration: Department of Plastic surgery and Burn Centre, Nishtar Medical University, Multan, 1st July 2016 to 30th June 2018.

Methodology: Total 70 patients from both sex were included after taking Informed consent. The reverse flow PIA flap was performed under general anesthesia. The donor site was closed by using a partial thickness graft of skin from thigh. All patients were discharged after seven days. In next twenty one days patients were followed on weekly basis. At each follow-up, any complications like Flap necrosis, Infection, seroma or hematoma and poor aesthetic outcome of flap and donor site were examined.

Results: In this series out of 70 cases complete flap survival were noted in 84.28% patients, in 1.4% patient there was marginal loss. Partial loss of PIA flaps in 11.4% cases and there was complete PIA flap loss in 2.85% patients. Infection was noted in 7.1% patient, Seroma in 2.85%, hematoma in 4.3%, Congestion in 7.1%. In 7.1% patients there was graft loss; whereas 8.6% developed aesthetic problem (contour irregularity) of the donor-site during the early postoperative period. Rest of 84.3% patients had no donor-site complications.

Conclusion: The Posterior Interosseous Artery (PIA) flap has very few post-operative complications when used for the coverage of the wounds of the wrist and hand.

Keywords: Posterior interosseous artery flap (PIAF), Flap complications, Flap necrosis, Hand/Wrist injuries, Upper limb reconstruction.

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INTRODUCTION

In human body the sensory and motor functions are highly developed in hand which make it a unique structure due to which numerous precise and gross functions are done by hand. But, Due to advancement in industry, the injury to hand is not uncommon and it is also found in domestic injuries and unfortunately more in children, so to treat these injuries and making the hand functional is always a top priority for surgeons; soft tissue coverage in case of wounds of hand is a real challenge as a thin pliable tissue is needed and sacrificing the major vessels of upper limb is not desirable. For this there are different flap options available. These flaps include free flaps, distant flaps like abdominal flap and the groin flap, reverse flow forearm flaps and local perforator based flaps. Each of these flaps has their own advantages and disadvantages. Reverse flow flaps have many distinct advantages such as being a single-stage procedure, not requiring micro-vascular anastomosis and easy to prepare. The posterior interosseous artery flap, first described in the mid-1980s[1], and its usefulness was demonstrated, now it is commonly used to reconstruct the dorsum of the hand[2]. Its advantages for hand surgery include reliable anatomy, a supply of soft and pliable tissue and a good arc of rotation[3]. In classification of flaps this flap is a type B fasciocutaneous flap.

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The main advantage of the flap is that the major arteries i.e radial and ulnar are not sacrificed as the arterial flow of this flap is through an anastomosis between the posterior and anterior interosseous artery near the wrist joint, this vascular supply if is compared to that of radial forearm flap is less reliable because variation in anatomy is reported[4]. There is another limitation in this flap as the reach of it is up to inter phalangeal joint of thumb and metacarpal head of fingers so cannot be used for finger coverage[5].

We conducted this study by using distally based reverse flow posterior interosseous artery flap for coverage of hand defects and noted complications associated with this surgery in post-operative period so that the safety of this flap can be established in light of aesthetic and functional outcome. This study also allowed us to have our own local data base for future references as this surgery is already in common practice in developed countries[6,7]. For Hand and Plastic surgeons who deal with the soft tissue defects of wrist and hand, a versatile, reliable coverage with manageable and minimum complications is highly desirable[6,8], we hope to fulfill this with our study. So we conducted this study to assess safety of Reverse Flow Posterior Interosseous Artery Flap in wrist and hand reconstruction regarding its complications like loss of flap in absence of major artery of upper limb and functional and aesthetic outcome.

METHODOLOGY

This descriptive longitudinal study was conducted in Pak Italian Burn Centre Nishtar Hospital Multan. The sample size was calculated as 70 adult patients from both sex, taking confidence level [%] 1-α as 95; anticipated population proportion P as 0.05; absolute precision required (d) as 0.05. The Non-Probability purposive sampling technique was used to include only patients who had wounds due to traumatic injuries and burns of hand and wrist with at least one of the major blood vessel of hand and wrist (Radial or Ulnar) arteries preserved and who presented within one month of injury; while those who had mutilating or crush hand injuries or wounds, old Scars or damage at the flap site, Peripheral vascular disease and diabetes mellitus and patients with malignant and irradiated wound on the flap site were excluded from the study. The informed consent was obtained from the patient. Pre-anesthesia evaluation was done. The pre-operative photographs of the wounds of the patient were taken. Defects were measured pre-operatively. Exact location and course of vessel was marked by a 10 MHZ hand held Doppler probe pre-operatively and flap design was outlined on the selected donor-site according to the dimensions of the defect. The procedures were performed under general anesthesia. The dimension of the wound was mapped out with the help of a template. The flap was elevated and inset into the defect, all surgeries was done by same team of surgeons. The donor site was closed with a graft of partial thickness from thigh. After surgical procedure the patients were shifted to the ward and appropriate postoperative care was done regarding fluid & electrolyte balance, pain control, nutritional status and antibiotic therapy.

All patients were followed , monitored for the survival of the PIA flaps, donor site skin grafts and post-operative complications were noted twice daily for first week(7days) in the ward. In these patients, if any post–operative complications of the PIA flap as well as donor-site complications were found, they were treated accordingly. The patients were discharged on 7th day of operation. At discharge, the study Performa was filled and the donor and recipient site were photographed.

The first follow-up visit was after one week. All the patients were subsequently followed-up at every seventh day for three weeks. At each follow-up, the flap and donor site were examined for any late complications like skin graft loss (partial or complete) and flap loss (partial or complete) and donor-site aesthetic appearance was observed.

Data Analysis: All the data regarding Postoperative Complications of Reverse Flow Posterior Interosseous Artery (PIA) Flap was compiled and analyzed through SPSS. Qualitative data like gender of the patients and Postoperative Complications of the PIA Flap (congestions, Hematoma, Seroma, Infection, Partial Flap Loss, Complete Flap Loss, Wound Separation, Skin Graft Loss, and Aesthetic outcome was analyzed by frequencies.

RESULTS

Seventy (N=70) patients were included in our study and results were collected in terms of Flap survival, infection, seroma formation, hematoma under the flap and congestion of flap while the donor site of the flap was assessed in terms of graft survival also called `Take` of graft and the aesthetic outcome like contour irregularities. Flap survival was checked by percentage of flap survived at the end by pink flap margins. In 1 (1.4%) patient, it was found that there is marginal loss of PIA flap. There is partial loss of PIA flap in 8 (11.4%) patients. The Complete flap loss was in 02 (2.85%) patients. In 59 (84.28%) patients, complete flap survival was noted as shown in Table-I.

Table-I: Frequency of cases by flap survival (N=70)

Flap Survival	Number (n)	Percentage (%)
Marginal Loss	1	1.4%
Partial Loss	8	11.4%
Complete Loss	2	2.85%
Complete Survival	59	84.28%
Total	70	100.0%

In the early postoperative period, Infection in 05 (7.1%) patients was noted which was treated by antibiotics and was controlled in all cases, Seroma in 02 (2.85%) cases was observed which settled at its own after two weeks; hematoma in 3(4.3%) patients was noticed and was evacuated, a corrugated drain was placed for three days to drain any blood collection; Congestion in 5 (7.1%) flaps was noticed and treated by strict elevation of hand and application of leeches for four days. In 55 (78.6%) patients no complication was observed as shown in Table-II.

Table-II: Frequency of cases by flap complication (N=70)

COMPLICATIONS	Number (n)	Percentage (%)
Congestion	5	7.1%
Hematoma	3	4.3%
Seroma	2	2.9%
Infection	5	7.1%
No Complication	55	78.6%
Total	70	100.0%

At the donor site 5 (7.1%) patients had graft loss, for which a split skin graft from thigh was reused to cover the donor site; whereas six 6 (8.6%) developed aesthetic issue (contour irregularity) of the donor-site during the early postoperative period, these patients were advised oil massage and pressure garment for period of six months. Rest of 59 (84.3%) patients had no donor-site complications as shown in Table-III.

Table-III: Frequency of cases by donor site complications (N=70)

	Number (n)	Percentage (%)
No Complications	59	84.3%
Skin Graft Loss	5	7.1%
Aesthetic Depression	6	8.6%
Total	70	100.0%

Figure-1: A male patient with electric injury at wrist of right hand.

Figure-2: A female patient with old electric injury at dorsum of right hand

DISCUSSION

The posterior interosseous artery flap (PIAF) is a very good quality tissue for coverage of defects of the hand[9] as this flap gives a thin and pliable skin which is comparable to that of dorsum of hand highlighted by Zhang et al, in 2013[10]. A literature review shows that this flap usually has good survival and few complications[6,11]. After its introduction by Angrigiani et al[12], the PIAF is widely used by Plastic and hand surgeons for the soft tissue coverage of hand and wrist. It is a reverse flow flap which is based on flow of blood through connection of anterior and posterior interosseous artery at the level of distal radioulnar joint[13]. Anatomy of the posterior interosseous artery and its perforators is constant so make surgery relatively easy and learning time very short.

In our study total 70 cases were operated, the complete flap survival was noted in 59 (84.28%) patients. In 1 (1.4%) patient, there was marginal loss. There was partial loss of PIA flaps in 08 (11.4%) cases and complete PIA flap loss in 02 (2.85%) patients. As a low arterial pressure is received by PIAF from anterior interosseous artery so the distal most part of flap that is the proximal skin of forearm is unreliable and necrosis can occur. There have been many different reports regarding the incidence of necrosis in this distally based PIA flap. Brunelli F et al conducted a study on 113 cases, in 98 patients PIA flap survived, 12 patients had partial necrosis of distal part of flap & 3 flaps were lost and alternate coverage was done. A study published by Mago Vishal, in which PIA flap was used in 20 cases and 16 cases were without any complication but there was partial loss in one and complete flap loss in 2 (10%) cases. In the same year, Lu et al reported the largest series of 201 patients with forearm, wrist, and hand soft tissue defects. Only 1 out of 201 patients showed complete necrosis and 16 cases had partial necrosis, these results are very close to that of ours. In a study on PIA flap done by El-Sabbagh et al[14], they used to do 15 flaps and results were very encouraging as they didn`t find any partial or complete loss of flap, this difference of results might be due to less number of cases included in this study. The results are very similar in studies done locally published by Shahzad from Nishtar hospital[15], 50 cases were presented in this study with partial loss of flap in one case although they noted congestion in all cases but it subsided with time without any loss to flap. In 2016 study conducted by Reyad et al[8] showed 5 % complete flap loss and 10 % partial loss with inclusion of one perforator in flap, with increase in number of perforators the survival of flap increased. A study was presented by Bilal et al from CMH Rawalpindi[16], total 31 patients were included in the study and the complete flap necrosis was seen in one case while in four cases there was partial loss of flap. A very interesting variation was published by Zaidenberg[13] who presented an anastomosis of posterior interosseous artery with dorsal intercarpal arch and raised all 17 flaps based on this anastomosis with 100% success, although the number of cases in the study ware less as compared to our study but they have shown the usefulness of this flap for reconstruction of even the fingers[17].

The major problem with PIA flap is venous congestion as it is reverse flow flap and presence of unidirectional valves in veins make it very difficult for the blood to drain out, most of the time this congestion leads to loss of flap, in our study this problem was encountered in 5 cases which was treated by strict elevation of hand and use of leeches for four days. Several authors has mentioned this problem in their study. Brunelli reported venous

congestion in 15% of cases. Fong presented venous congestion in 21% cases which also resulted in partial loss of flap[18]. As this is an important issue in this surgery many techniques are proposed by different authors to overcome it like Ozalp et al, added a superficial vein in the pedicle of flap[19], while Acharya et al. have suggested other modifications, such as not tunneling the flap adding a cutaneous handle with the pedicle[20].

Another important complication noted with this surgery was infection which might result in loss of flap or poor functional or aesthetic results, In our study out of 70 cases infection was experienced in 5 (7.1%) cases, Gavaskar presented a series of 52 cases and infection was noted and successfully treated in two cases. while in a small series of eight cases presented by Tiengo in which no signs of infection noted in any of the case[5] while in Zaidenberg EE et al reported infection in one case out of 19 cases while no loss of flap or partial necrosis was noted[13]. In a series of 20 cases published by Eo SR, infection was noted in one case[7] which is about 5% and is close to our results of 7%. These results of all the studies shows the importance and usefulness of PIA flap with very few complications.

As a plastic surgeon another important consideration of reconstruction is aesthetic outcome and the aesthetics of the donor site is even more important for both patient and plastic surgeon as the donor site was not an injured part so special consideration is made to have excellent results aesthetically at donor site, in our study 5 (7.1%) patient had graft loss; whereas 6 (8.60%) developed contour irregularity of the donor-site during the early postoperative period, Puri, conducted a study comprising of 25 cases, 1 partial donor graft loss was noted. Acharya presented a series of 21 cases and no donor site complication was noted[(20)]. In a local study of 53 cases presented by Shahzad , there was donor site problems seen only in one case which is a very encouraging result indeed[(15)]. Zhang et al. propose a modification by raising a bi-paddle flap to minimize donor site morbidity[(10)]. Keeping in view of importance of donor site aesthetic results a study was done by Neuwirth[21], out of 40 cases split skin graft for coverage of donor site was used in 20 cases rest all were closed primarily due small size of flap, out of these 20 cases only 8 were available for follow up and 50% of these had contour irregularity at donor site. It was further highlighted in this study that donor site aesthetics are even poorer with other available options in the region like Radial forearm or ulnar artery flaps.

CONCLUSION

The Posterior Interosseous Artery (PIA) flap has very few post-operative complications when used for the coverage of the wounds of the wrist and hand so it is concluded that doing this reconstruction in our patients is a safe decision to be made.

AUTHOR'S CONTRIBUTION

Mirza AB: Conceived idea, Designed study, Data analysis
Shah IH: Manuscript drafting, Manuscript writing, Literature Search
Hussain M: Data Collection, Designed research methodology
Saeed MB: Final critical review of manuscript
Ali A: Data collection and compilation
Ahmed N: Manuscript final reading and approval

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