

## Original Research Article

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# Evaluation paraumbilical flap for coverage of forearm and hand defects

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## ABSTRACT

**Background:** To find out the reliability and dimensions of the pedicled paraumbilical perforator flaps to cover the compound defects of the forearm and hand.

**Methods:** Twelve (12) patients with defects of hand, wrist, forearm and elbow are included in this study. The study period extends from August 2012 to February 2015. Patients were aged between 12-45 years. The detailed systemic examination of the patient and the local examination of the wound was carried out in all the patients. For the patients with burns, hemodynamic stabilization was done with appropriate fluid management and blood transfusions. The routine laboratory investigations were done.

**Results:** It was a prospective study of twelve (12) cases was carried out in this study. Six men (50%) aged between 25-45 years were the commonly affected group, followed by three women (25%) aged between 35 - 40 years and three children (25%), two males and one female aged between 12-17 years. Most common cause of the defect was electrical burns in seven cases (58.33%) due to accidental contact with high tension live electrical wire while at work in adults. In children it was due to accidental contact with live electric wire while they were playing. Most common site of injury was found on forearm in seven cases (58.33%), out of which left forearm was injured in five cases (41.66%) and right forearm in two cases (16.66%), followed by wrist in 2 cases (16.66%), dorsum of hand in one case (8.33%) and elbow in two cases (16.66%). All the defects were compound in nature with exposure of the tendons and bones and they were devoid of paratenon and periosteum.

**Conclusions:** This study conclude that the paraumbilical flap is useful flap for coverage of the upper limb defects involving the hand, wrist, forearm and elbow. A fairly large flap with dimensions as large as 18 x 13 cm can be harvested. The flap is reliable with flap survival rate of 91.66%, (11 cases). There is no need to isolate the vascular pedicle, and the dissection is quick and easy. The flap and the limb remain in an elevated position and there is minimal edema and congestion postoperatively. Although the donor site scar is not concealed, as in groin flap, majority of the patients accepted the donor scar as it got concealed under the traditional dress. Thus, this flap can become workhorse for the defects of hand, wrist, proximal forearm and defects around the elbow.

**Keywords:** Forearm and hand, Paraumbilical flap, Vascular pedicle

## INTRODUCTION

The compound defects of the hand and forearm from electrical burns, trauma and infections are common. The

reconstruction of complex wounds of hand, wrist and proximal and mid-forearm is challenging as the vital structures such as bones, tendons and joints are exposed.<sup>1</sup> Traditional pedicled flaps are either insufficient in length

to reach more proximal forearm defects or are used sparingly due to donor site complications and extremity stiffness. The description of the axial groin flap has revolutionized the management of hand injuries.<sup>2</sup> But this flap has some limitations, it is insufficient for the large defects of the hand, adjacent forearm, and the defects around elbow.

The limb edema is constantly noticed due to the dependent position of the limb. Single large raw area in the hand and forearm are difficult to cover with conventional groin or hypogastric flap.<sup>3</sup> Though abdomen is a favourable donor site for a pedicled distant flap for soft tissue coverage of the hand and forearm, pedicle flaps based on paraumbilical perforators are not commonly used. Free tissue transfer might not be feasible in certain patients or at institutions lacking microsurgical expertise and equipment.

To address these issues, the pedicled paraumbilical flap based on perforators from deep inferior epigastric artery has come in to clinical practice, which can cover the hand, adjacent forearm and elbow defects effectively. This flap has consistent anatomy, is simple and easy to harvest, has low donor site morbidity, and is positioned higher up in the trunk so that the postoperative edema is lessened.<sup>4,5</sup> It allows elbow and shoulder range of motion during the interval between flap transfer and pedicle division. This study is carried out to find out the reliability and dimensions of the pedicled paraumbilical perforator flaps to cover the compound defects of the forearm and hand.

## METHODS

Twelve (12) patients with defects of hand, wrist, forearm and elbow are included in this study. The study period extends from August 2012 to February 2015.

### ***Inclusion criteria***

Both male and female patients between 12-45 years of age with compound defects of hand, wrist, forearm and elbow on both the extensor and volar aspects were selected for the study. All the patients who presented to us with defects from electrical burns, trauma from motor vehicular accidents, human bites and infections were included in this study.

### ***Exclusion criteria***

The patients with superficial defects which did not involve deeper vital structures such as tendons and bones were excluded from the study as they had adequate soft tissue cover. These raw areas were covered with skin graft.

The detailed systemic examination of the patient and the local examination of the wound was carried out in all the patients. For the patients with burns, hemodynamic

stabilization was done with appropriate fluid management and blood transfusions. The routine laboratory investigations were done. The blood was reserved for the indicated patients for post-operative transfusions. Then once the patients were found to be fit for surgery, they were taken up for serial debridement to prepare the wounds for flap cover.

All the patients were treated with administration of antibiotics, analgesics and other supportive treatments. After serial debridement, once the wound was ready, patient was taken up for flap cover. The paraumbilical perforators were identified by the hand held doppler and marked in the wards preoperatively. The dimensions, planning and marking of the flap was carried out preoperatively, depending upon the site and size of the defect. The paraumbilical perforators were again identified on the operation table by hand held doppler and flap harvested based on the perforators. The flap cover was achieved in staged manner, preoperative flap delay (in some cases), flap harvest and inset, postoperative delay (in some cases) and then division and inset over a period of 3 to 6 weeks.

The donor area was minimized by advancing the wound margins and suturing. The left-over donor area was covered with split thickness skin graft in majority of the patients. The skin graft was harvested from the thighs. In few patients primary closure was possible. Post-operative flap monitoring was done by observing the flap clinically for any evidence of any flap infection, flap necrosis, and inset dehiscence. All the postoperative complications were of minor nature except in one case where total flap dehiscence occurred. This was managed with return of the flap to the donor area. The other postoperative complications were treated accordingly with antibiotics, debridement of Necrosed margins, flap advancement and reinsert.

The postoperative stiffness of elbow and shoulder joints was observed. The postoperative limb edema was also observed and it was found to be less when compared to the groin or hypogastric flaps, as the limb is at higher position than in the groin or hypogastric flap. Donor area of the flap was managed with regular dressings. The donor area of skin graft was left to heal without disturbing the dressing. The donor area dressing was changed only when it was soaked or when patient complained of pain at the site. The division and inset was carried out between 3-6 weeks. The flap inset sutures were removed after 10-14 days.

## **RESULTS**

In present study smallest defect size was 5x4 Cm and the largest size was 16x11 Cm. The largest dimension of the flap was 18x13 cm and smallest dimension was 6x5 Cm. Average duration between flap cover and flap division and inset was 3-6 weeks.

Table 1 shows total number of cases studied in this study were twelve (12). Out of twelve patients eight (66.66%) patients were males and four (33.33) were females. The patients were aged between 12 - 45 years. The youngest patient was 12 years old and oldest was 45 years old. There were nine (75%) adult patients and three (25%) children.

**Table 1: Demographic distribution of the cases.**

Gender	No. of patients	%
Male	8	66.66%
Female	4	33.33
<b>Age group</b>		
<10 years	---	---
11-20 years	3	25%
21-30 years	3	25%
31-40 years	5	41.66%
41-50 years	1	8.33%

Table 2 shows that Majority of defects were from electrical burn injury in seven patients (58.33%). Average duration between the injury and the flap cover was 5 - 6 weeks. Majority of defects were found on the forearm in seven patients (58.33%).

**Table 2: Causes of defects and sites of defects in study.**

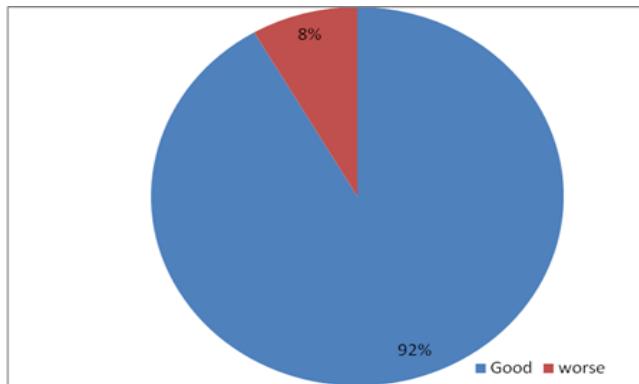
Causes	No. of patients	%
Electrical burns	8	66.66%
Trauma (motor vehicle accidents)	3	25%
Human bite/infective	1	8.33%
<b>Site of the defect</b>		
Hand	1	8.33%
Wrist	2	16.66%
Forearm	7	58.33%
Elbow	2	16.66%

Table 3 shows that complications occurred in five cases (41.66%). Marginal necrosis occurred in two cases (40%), flap infection in two cases (40%) and total flap dehiscence in one case (20%). Cases without any complications were Seven (58.33%).

**Table 3: Incidence of complications of flaps.**

Complications	No. of cases	%
No complication	7	58.33%
Complications	5	41.66%
Wound infection and partial flap dehiscence	2	40%
Marginal flap necrosis and partial flap dehiscence	2	40%
Total flap dehiscence	1	20 %

The eleven cases had good flap survival with good outcome (91.66%).



**Figure 1: Outcome in patients in study.**

## DISCUSSION

The upper extremities are the most frequently involved sites of injuries following electrical burns, trauma from motor vehicular accidents and assaults and infections. Extensive damage to the deeper tissues such as muscles, blood vessels and nerves, etc takes place with exposure of tendons, vessels, nerves, bones and joints, which requires early soft tissue cover by flaps.

In some cases, flap cover is required to avoid potential hazards such as vascular blow out which may lead to amputation of the limb or even death if timely intervention is delayed. The soft tissue cover is also required to provide stable wound cover for the future reconstructive surgery and for correct fitting of limb prosthesis over an amputation stump and soft tissue padding for the prosthesis. Twelve (12) Patients were studied during the time span of August 2012 to February 2015. Out of the 12 patients, six were working men (50%), three were working women (25%) and three were children (25%), two males and one female, who accidentally got injured. Most commonly the defects were found on the forearm in seven cases (58.33%). The other defects were found on the wrist in two cases (16.66%), on elbow in two cases (16.66 %) and on dorsum of hand in one case (8.33%).

Most commonly affected side was left side in 7 cases (58.33%) and right side in five cases (41.66 %). Out of the 12 cases, four patients (33.33 %) presented in acute phase and other eight cases (66.66%) presented in chronic phase of the injury. But in both categories patients required 4- 6 weeks of time to stabilize the patients and to prepare the wound for flap cover. The timing of flap cover varied and ranged from as early as 3 weeks to as late as 18 weeks with a mean timing of 3-6 weeks. We were unable to give flap cover earlier than 3 weeks, mainly because of the late presentation of the patient to us and because of the time taken to prepare the patient and wound for the flap cover. The flap used to cover the defect was pedicled paraumbilical flap based on the perforators from the deep inferior epigastric artery. The perforators were identified by the hand-held Doppler.

The flap dimensions were planned according to the demand of the defect to be covered effectively. After harvesting the flap great care was taken to inset the flap to the maximum extent possible.

The distance of the perforators from the umbilicus was 1.5-2.5Cm. The distance of base of the flap from umbilicus was 2.5-3Cm. Out of the 12 flaps, seven flaps (58.33%) were harvested within the limits of anterior axillary line where as five flaps (41.66%) of larger dimensions, required to be extended up to the mid axillary line. Average width of the flap at base ranged from 4-7 Cm. The donor area was managed by reducing the raw area by advancing and suturing the margins of the donor defect. The remaining area was then covered with split thickness skin graft in 10 cases (83.33%). In two cases (16.66%) we could close the donor area by primary closure. All the donor areas healed without any complications with minimal scarring. The division and inset was done between 3<sup>rd</sup> and 4<sup>th</sup> week in 7 patients (58.33%), between 5<sup>th</sup> and 6<sup>th</sup> week in four patients (33.33%).

In one patient flap had to be returned at 3 weeks postoperatively (8.33%) as there was total flap dehiscence. The common complications were distal marginal flap necrosis in 2 cases (16.66%) and flap infection in 2 cases (16.66%). In one case there was total flap dehiscence (8.33%). All these complications occurred before the flap division and inset. No complications occurred after flap division and inset. The flap which developed post-operative dehiscence was due to the presence of unstable fibroses wound adjacent to the inset of the flap.

Complications were managed by debridement and advancement of the flap margins and re-inset in case of marginal necrosis and dehiscence. The infected flaps were managed by appropriate antibiotics. The donor areas were managed with regular dressings postoperatively. At the time of division and inset the raw area was covered by returning the remaining flap after division and with supplementary split thickness skin graft. Most of the donor areas healed very well without any complications with minimal scarring. The postoperative upper limb edema was found to be less, when compared to the edema observed in groin and hypogastric flaps. This could be because of the immobilization of upper limb at a higher and in an elevated position.

The shoulder, elbow and wrist stiffness observed during the postoperative period before the division and inset of the flap decreased after the division and inset and range of motion of the joints improved. The patients were advised to come for follow-up for flap debulking and reconstructive procedures especially for tendon reconstruction and repair at a later date. This study was not focused on further reconstructive surgery and rehabilitation; however, the patients were advised physiotherapy postoperatively.

The local flaps were not feasible due to non-availability of the local tissues for required dimensions and due to rotation limitations of the flap. Blood supply which may be compromised by the original or progressive thrombosis of the vessels in electrical burns at the recipient site makes use of free flaps an unwise option in centers where microsurgical facilities are limited.

Therefore, the pedicled paraumbilical perforator flaps were selected for the cover of the defects, because of ample of tissue availability, robust blood supply and uninvolved area in the electrical burn injury. The limitation of the pedicled paraumbilical perforator flap was that there was a need for immobilisation of the limb for 3-4 weeks or more, which causes lot of inconvenience to the patient, making them dependent on their relatives for daily activities. The elbow and shoulder joint stiffness and scar on the anterior abdominal wall were the other limiting factors. In study done in 11 patients by Sarper Yilmer studied for extensive soft tissue defects of forearm and hand showed that a relatively narrow pedicle, large flap up to 5x14 cm can be raised.<sup>6</sup> Comfortable position of the hand and forearm was also observed.

The main disadvantage was the abdominal scar like other pedicled abdominal flaps. In this study all the flaps survived pointing out the reliability of the flap. Primary donor site closure was done in 10 cases, in one patient small split thickness skin graft was applied Sharad Mishra et al conducted a study in which injuries to upper limb has been on the increase and is invariably associated with significant soft tissue loss requiring a flap cover.<sup>7</sup> Local tissue may not be available for cover in a majority of situations, necessitating import of tissue from a distant source. We have utilized the thoraco-umbilical flap taken from the trunk for this purpose. This flap is based on the perforators of the deep inferior epigastric artery that are maximally centred on the periumbilical region. This flap was used in 83 patients. The patients were observed for at least 3 weeks and any flap or donor site complications were recorded. The patients were again followed up at 3 months interval and the donor site scar was assessed. The flaps survived in 81 patients; there was marginal flap necrosis in five patients and partial flap necrosis in two patients.

None of these patients required any additional procedure for coverage. The flap is technically easy to plan, almost effortless to drape around upper limb defects, with no significant donor site morbidity and also the post-operative immobilization was fairly comfortable. The thoraco-umbilical flap thus is a very useful technique for coverage of the upper limb and is recommended as a first line flap for this purpose. Nguyen T Hoang et al conducted a study in which flap prefabrication represents a new trend in microsurgical tissue transfer.<sup>8</sup> Based on the concept of neovascularisation, in Chinchilla Bastard rabbits (n=40), an isolated venous pedicle dissected from the femoral and saphena magna vein was arterialised by

end-to-end anastomosis to the femoral artery at the inguinal ligament. This arterialised venous loop was implanted beneath a random-pattern vascularised abdominal fasciocutaneous flap as large as  $8 \times 15 \text{ cm}^2$  to investigate the development of neovascularisation at various evaluating times of 4, 8, 12, 16 and 20 days. To prevent neoangiogenesis from occurring between the underlying vascular bed and abdominal flap, a silicone sheet with the corresponding dimension of  $8 \text{ cm} \times 15 \text{ cm} \times 0.25 \text{ mm}$  was placed and fixed on the abdominal wall. The flap viability and the neovascularisation process in the prefabricated abdominal skin flaps were evaluated by macroscopic observation, blood analysis, selective microangiography and histology.

The experimental results showed that newly formed vessels originating from the implanted isolated venous pedicle were evident on the angiograms 4 days after pedicle implantation. In the 8- and 12-day groups, newly formed vessels became larger and some were connected to the originally available vasculature in the abdominal fasciocutaneous flaps. In the 20-day group, entire flaps were perfused by the blood flow supplied from the newly implanted venous pedicles through newly formed vessels and their vascular connections. This study indicated that large flap prefabrication can be created by implantation of an isolated arterialised venous pedicle into a random-pattern vascularised fasciocutaneous flap. Twenty days appears to be the minimal length of time required after arterialised venous pedicle implantation for the maturation of neovascularisation in the prefabricated flap. Hosny H et al, conducted a study to discuss the applications of distal ulnar artery perforator flaps in the coverage of hand and wrist defects.<sup>9</sup> This study included 10 patients presenting with various defects.

Seven patients had defects over wrist and distal forearm, while 3 patients had defects over the hand. Distal ulnar artery perforators were used to design flaps to cover these defects. Successful stable coverage was achieved in all 10 cases. Seven cases healed uneventfully while minor complications were encountered in the form of partial loss in one case and infection in 2 cases. Five cases were designed as propeller flaps and rotated 180° while 5 cases had a skin pedicle and were rotated 90°. Distal ulnar artery perforator flaps offer a reliable method for reconstruction of defects in the wrist and proximal hand. They are suitable in the treatment of complex cases with extensive soft tissue loss and associated injuries. The flaps are thin, pliable, and robust. The skin is not hirsute. The scar is relatively inconspicuous. It is also a one stage procedure and does not require the sacrifice of a main vessel.

## CONCLUSION

This study concludes that the paraumbilical flap is useful flap for coverage of the upper limb defects involving the hand, wrist, forearm and elbow. A fairly large flap with dimensions as large as  $18 \times 13 \text{ cm}$  can be harvested. The flap is reliable with flap survival rate of 91.66%, (11 cases). There is no need to isolate the vascular pedicle, and the dissection is quick and easy. The flap and the limb remain in an elevated position and there is minimal edema and congestion postoperatively. Although the donor site scar is not concealed, as in groin flap, majority of the patients accepted the donor scar as it got concealed under the traditional dress. Thus, this flap can become workhorse for the defects of hand, wrist, proximal forearm and defects around the elbow.

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