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# Study of Effectiveness in Replacing Damaged Soft Tissue of the Hand and Forearm by Abdominal Flap

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**ABSTRACT**
The pedicled abdominal flap is the fundamental reconstructive principle of restoring both form and function therefore guides the management of patients with defects in upper extremities. Present study was aimed to study of effectiveness in replacing damaged soft tissue of the hand and forearm by abdominal flap. Present study was single-center, prospective, observational study, conducted in patients between 7-50 years of age, with defects over distal forearm, hand and fingers exposing tendons, posted for repair by abdominal flap surgery. A total number of 24 patients with Hand and forearm defects were studied 87.5% (21) patients were males and 12.5% (3) were females. In 12 cases (50%) most common cause was road traffic accidents, followed by electric burns in 8 (33.34%) and work related trauma in 4 (16.66%). Dorsum of hand is the most common site involved in 12 patients, followed by dorsum of distal Forearm in 4.4 patients had palm defects and 4 with wrist defect. Size of the defect ranged from a minimum of 2x1 cm to a maximum of 10x6 cm. Average duration between admission of the patient and flap cover was 2.5 weeks. Superiorly based flaps were placed in 12 (50%), inferiorly based flap in 4(16.66%), Hypogastric flap in 6 (25%) and Louvre flap in 2(8.34%) patients. Average duration between flap cover and flap division was 4.5 weeks. Complications occurred in 25% cases. The shortest hospital stay was 1 week following trauma and >3 weeks following electric burns. The longest stay was 90 days, 75% cases went without any complications. Abdominal flaps has significant role in reconstruction and restoration of hand function and it can be considered the work horse for reconstruction of hand and distal forearm defects.

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**Key Words**
Hand and forearm defects, abdominal flaps, reconstructive surgery, aesthetic appearance

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## INTRODUCTION

Hand is very important and essential part of our body. It has got very important 5 functions in daily life, such as precision, grip, grasp, pinch and stereo-gnosis. Hand injuries can occur unintentionally or due to accident. Victims range from infants to adults. Injury can be a simple cut to a mutilating hand. Hand traumas are caused by machinery/ motor injuries, road traffic accidents, electric burns etc. in our country. Underlying and surrounding tissue, muscles, vessels and nerves may be involved and grossly damaged under extreme conditions. Bone and tendons may be involved and get exposed and lead to their loss of function.

Epidemiologically Post traumatic and post electrical hand and forearm defects always represent a challenging problem in reconstructive surgery. Hand and forearm are frequently prone to different types of injuries (crush, degloving, hot press and friction) resulting in exposed tendons and bone[1]. The reconstruction of cutaneous defects may be achieved with local pedicle flaps, distant pedicle flaps or free flaps. The choice of which technique to employ depends mainly on the size, site, nature and complexity of the defect.

Different reconstructive methods have been used to treat these defects with the aim to restore the function of hand and also the cosmetic aspects[2]. The pedicled abdominal flap is the fundamental reconstructive principle of restoring both form and function therefore guides the management of patients with defects in upper extremities. Abdominal flap is a simple, easy, robust and versatile distant flap that took a great place in the beginning of era of reconstructive surgery. Present study was aimed to study of effectiveness in replacing damaged soft tissue of the hand and forearm by abdominal flap.

## MATERIALS AND METHODS

Present study was single-center, prospective, observational study, conducted in department of Department of Plastic Surgery, Deccan college of medical science(PEH), Hyderabad, Telangana India. Study duration was of 1 years (2022-2023). Study was approved by institutional ethical committee.

**Inclusion Criteria:**

- Patients between 7- 50 years of age, with defects over distal forearm, hand and fingers exposing tendons, posted for repair by abdominal flap surgery, willing to participate in present study.

**Exclusion Criteria:**

- Patients with burn injury or any wounds involving abdomen.
- Patients with co-morbid conditions like uncontrolled epilepsy or associated severe head injury and patients with major fractures of bones of forearm.
- Patients with mental disability.
- Patients who are not willing to give consent to keep the hand attached to abdomen.

Study was explained to participants in local language and written informed consent was taken. Once the patient was found fit for surgery, He/she was taken up for initial wound cleansing and debridement followed by primary flap cover. Patients admitted with electric burns were initially resuscitated from shock and after the patients general condition is stabilized, swabs were collected for culture and sensitivity. After serial debridement when the wound is ready patient was taken up for secondary flap cover.

Various abdominal flaps used in this study:

- Superiorly based abdominal flap.
- Inferiorly based abdominal flap.
- Hypogastric Flap.
- Louvre flap.

The flap was inspected frequently in the early postoperative period. About three weeks later patients were taken up for delay procedure. Division and inset of the pedicle flap were safely be done 5-7 days after the delay procedure. The donor site was completely closed., the previously placed split thickness skin graft was removed and replaced with tissue remaining from the pedicle. Early hand physiotherapy was undertaken to facilitate early functional recovery. Data was collected and compiled using Microsoft Excel, analysed using SPSS 23.0 version. Statistical analysis was done using descriptive statistics.

## RESULTS AND DISCUSSIONS

In present study, 24 patients were included. The patients were in the age group between 7-50 years. Most common age group was 31-40 years (37.5%). 87.5% (21) patients were males and 12.5% (3) were females. In this series, 12 (50%) patients presented with history of road traffic accidents, 8 (33.34%) with history of electric burns and 4 (16.66%) patients presented with work related trauma.

In this series, 14 patients presented with history of road traffic accidents and work-related trauma, 8 patients who had wounds due to post electric burns, underwent serial debridement and 2 patients presented late with contractures due to post infective cellulitis caused by snake bite.

**Table 1: General characteristics**

| Characteristics | No. of subjects | Percentage |
|---|---|---|
| Age group (in years) | | |
| ≤10 | 3 | 12.5% |
| 11-20 | 1 | 4.16% |
| 21-30 | 8 | 33.34% |
| 31-40 | 9 | 37.5% |
| 41-50 | 3 | 12.5% |
| Gender | | |
| Male | 21 | 87.5 % |
| Female | 3 | 12.5 % |
| CAUSE | | |
| Work related trauma | 4 | 16.66% |
| Road Traffic Accident | 12 | 50% |
| Electric burns | 8 | 33.34% |
| TIME OF PRESENTATION | | |
| Acute | 14 | 58.34% |
| Chronic | 10 | 41.66% |

In this series, 12 patients had defects over dorsum of hand, 4 patients had defects over dorsum of distal Forearm, 4 patients had palm defects and 4 patients had hand wrist defects.

Size of the defect in our study ranged from 3-10 cm. Out of 24 patients only 3 patients had defects <3cm, 13 patients had a defect of size 3-5 cm. And 8 patients had a size defect between 5-10 cm.

In this series, 75% of patients had dominant limb affected by injury. 18 patients had right sided involvement., 6 patients had left sided involvement.

**Table 2: Defect characteristics**

| Characteristics | No. of subjects | Percentage |
|---|---|---|
| SITE OF DEFECT | | |
| Dorsum of Hand | 12 | 50% |
| Dorsum of Distal Forearm | 4 | 16.6% |
| Palm | 4 | 16.6% |
| Wrist | 4 | 16.6% |
| SIZE OF DEFECT | | |
| <3 cm | 3 | 12.50% |
| 3 -5cm | 13 | 54.17% |
| 6 -10 cm | 8 | 33.33% |
| SIDE OF INVOLVEMENT | | |
| Right sided involvement | 18 | 75% |
| Left sided involvement | 6 | 25% |

The earliest primary flap cover could be given was within 24 hrs. of trauma (when there was no associated injury). Secondary flap cover was given 1 week after electrical burns and in patients who presented late with contractures due to post infective cellulitis caused by snake bite.

**Table 3: Timing of flap cover**

| Timing of flap cover | No. Of cases | % of cases |
|---|---|---|
| Primary Flap Cover | 14 | 58.3% |
| Secondary Flap Cover | 10 | 41.7% |

In this series, superiorly based flaps were placed in 12 patients (50%), inferiorly based flap is placed in 4 patients (16.66%), hypogastric flaps in 6 patients (25%) and Louvre flap in 2 (8.34%) patients.

**Table 4: Types of flaps**

| Type of flap | No of cases | % of cases |
|---|---|---|
| Superiorly based flaps | 12 | 50% |
| Inferiorly based flaps | 4 | 16.66% |
| Hypogastric flaps | 6 | 25% |
| Louvre | 2 | 8.34% |

The shortest hospital stay was 1 week following trauma and >3 weeks following electric burns. The longest stay was 90 days.

**Table 5: Duration of hospital stay**

| Duration of hospital stay | No. Of cases | % of cases |
|---|---|---|
| <1 week | 16 | 66.67% |
| >3 weeks | 8 | 33.33% |

Only 2 patients had wound dehiscence and 4 patients had partial flap necrosis.

**Table 6: Complications**

| Complications | No. Of cases | % of cases |
|---|---|---|
| No complication | 18 | 75% |
| Partial flap necrosis | 4 | 16.66% |
| Flap dehiscence | 2 | 8.34% |

**Fig. 1:** 7 Year Male with Defect of 6x4cm Over Left Distal Forearm Post Electric Burn with Involvement of Skin, Flexors and Bone. Inferiorly Based Abdominal Flat was Used to Cover the Defect

**Fig. 2:** 22 Year Male with Post Traumatic Degloving Injury with a Defect of 2x1cm Involving the Dorsal Aspect of Right Index, Middle and Right Fingers Involving Skin and Extensor. Louvre Flap was Used to Cover the Defect

**Fig. 3:** 40 Years Male with 6x4cm Post Electric Burn Defect Over Right Wrist Involving Skin, Flexor Tendons was Covered by Superiorly Based Abdominal Flap After Debridement and Division Inset was Done at the End of 4 Weeks and Flap Donor Site was Closed Primarily

The aim of treatment is to achieve good final function with good cosmetic appearance along with early return to normal productive life. In literature post traumatic road traffic accidents, crush injuries, machine related injuries and electrical injuries usually affect young age group, the incidence is high amongst males as compared to females because of work related nature of injury. The age group involved in various studies ranged from 10-50 years.

In this study, causes of injury were road traffic accidents (50%), electrical burn injury (33.34%) and work-related injury (16.66 %). The causes of Electrical burn injuries were work related, domestic accidents and in children while playing kites. It was also observed a clear relationship between hand dominance and limb involvement as 75% of the patients had dominant limb affected by injury. The upper limb can tolerate delayed reconstruction but the hand will not endure due the consequential joint stiffness and tendon adhesions.

Derderian[4] found that in 133 patients flap failure and infection was lowered when performed between the days 6 and 21. Godina[5] advocated that within 72 hours wound coverage should be provided to prevent infection and edema. Shahram[6] in a study on early coverage of upper extremity electrical Injury wounds, abdominal flap was the flap of choice for most of the patients who had either a forearm fasciotomy or forearm injury.

In this study 58.34% patients were presented in acute phase and were given early flap cover and 41.66% patients presented later and they were treated by secondary flap cover. Liu[7] used lower abdominal skin flaps in 6 cases for the ulcer resulting from snake-bite injury which was characterized by deep and wide tissue necrosis and secondary infection. 3 of the 6 flaps had mild signs of inflammation which disappeared after administration of antibiotics. One had necrosis of the distal part of the flap and was healed with split skin graft. This type of skin flap was an ideal method for the treatment of snake-bite injury of the upper extremity. Yongwei[8] conducted a study on random-pattern abdominal flap to cover the defect of the scar-released hand., all patients were evaluated for 0.5-4 years after surgery. The range of motion of the metacarpophalangeal joints and the space capacity of the thumb web were improved greatly.

Ahmed[2] suggested a role of abdominal thin skin flaps for 30 patients who had 23 post traumatic hand defects and 7 forearm defects which were reconstructed by abdominal thin skin flaps. With a maximum of 9x16 cm flap dimension, all flaps survived. Furthermore, the flaps were thin that did not require revision.

Li QS[9] in a study of 19 cases with degloving injury of hand who were treated with two flaps, one flap with the inferior epigastric artery as pedicle and another with superficial epigastric artery. The two skin flaps were designed oppositely to cover the injured hands. All the flaps survived, followed up for 1-3 years. The contour of hands was fine. Extension of fingers was normal and opposition of thumb was good.

Nasr[10] used a thin SIEA free flap for resurfacing areas of tissue loss on the hands. They removed the deep subcutaneous fat totally while superficial subcutaneous tissue was thinned and a fat tissue layer was left under the skin to protect the sub dermal network.

In this study such free flaps could not be done due to lack of feasibility of set up and patient's refusal for the free flaps for its known morbidity. Ya -Dong[11] used random-pattern abdominal flap which was constructed based on the shapes and sizes of the wounds. The length-to-width ratio of the flap was maintained at 2:1 or lower to ensure flap revascularization the patient was positioned in a manner that prevented the torsion of the skin flap pedicle. All flaps survived. The postoperative follow-up period ranged from 2 weeks to 6 months. The appearances in the color, flexibility, texture and sensory recovery were satisfactory in both flap and hand. Random-pattern abdominal skin flap therefore repairs fingertip skin defects achieving sensory recovery.

In comparison with above Literature, in this study the types of Abdominal flaps which are being frequently used are completely based on its feasibility according to the types of defects and were so designed in order to have maximum inset in the first surgery, with the position aiding in achieving the maximum inset without leading to much discomfort to the patient and joint stiffness. Superiorly based flaps were placed in 12 (50%), inferiorly based flap in 4(16.66%), Hypogastric flap in 6 (25%) and Louvre flap in 2(8.34%) patients.

Superiorly based abdominal flaps and hypogastric flaps were the major flaps done to cover the dorsal defects of hand as well as palmar defects of wrist and distal forearm and inferiorly based abdominal flaps for defects of dorsum of hand and louvre flaps for defects of fingers.

A. j. j. Emmett[12] in his studies used multiple subcutaneous pedicle or louvre flaps on resurfacing of multiple, adjacent finger defects. These are broad thin flaps mainly based on subcutaneous tissue pedicles. Skin bridges were preserved as much as possible. The flaps were divided at 20 days, taking the remaining skin left on the abdomen with each flap and setting this in to each finger.

G. Karthikeyan[13] in his studies used step ladder abdominal flaps in hand reconstruction for defect on the dorsal aspect of the multiple fingers and thumb. The flaps were divided at the end of the second week.

Most of the flaps healed well giving good contour and range of motion to the hand with satisfactory results. The reconstructed hands and fingers were aesthetically pleasing with no complication in 75% and complications such as partial flap necrosis occurred in 16.66% and flap dehiscence occurred in 8.33%. This study was not focused on further reconstructive surgery for rehabilitation., however, the patients were advised physiotherapy initially.

The result of this study is encouraging in terms of covering the defect and range of motion to the hand which was satisfactory and is reasonably good when compared to the study carried out by Ahmed[2] in 30 patients where all flaps had complete survival at the time of division and all flaps gave a satisfactory coverage with excellent contouring.

There is no flap loss in this series. Good result was obtained in 75% patients with excellent flap adhesion. Complications such as Partial flap necrosis (16.66%) and Flap dehiscence (8.33%) occurred which were subsequently managed by flap debridement, advancement and rein set.

## CONCLUSION

This study concludes that hand and forearm defects due to post trauma and post electric burns are more common in male population. In this study major reconstructions were done as primary procedure whereas Secondary reconstruction was chosen for electrical injuries and snake bite cellulitis cases after serial debridement. Complication rate was relatively less and very minimal in this study. Functional restoration is achieved to the maximum and its aesthetic appearance was good. We conclude that abdominal flaps has significant role in reconstruction and restoration of hand function and it can be considered the work horse for reconstruction of hand and distal forearm defects.

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