Section: Plastic Surgery

Original Research Article

AN ANALYSIS OF DIFFERENT FLAPS IN THE TREATMENT OF FOREARM AND HAND DEFECTS

A R Ch. Mohan[1], P Jyotsna[2], Jada Mabu[3], M. Ajay Kumar[4]

[1]*Professor & HOD, Department of Plastic Surgery, Siddartha Medical College, Vijayawada, Andhra Pradesh, India.*
[2]*Associate Professor, Department of Plastic Surgery, Siddartha Medical College, Vijayawada, Andhra Pradesh, India.*
[3,4]*Assistant Professor, Department of Plastic Surgery, Siddartha Medical College, Vijayawada, Andhra Pradesh, India.*

Received *: 07/12/2024*
Received in revised form *: 28/01/2025*
Accepted *: 13/02/2025*

Corresponding Author:
Dr. Jada Mabu,
Assistant Professor, Department of Plastic Surgery, Siddartha Medical College, Vijayawada, Andhra Pradesh.
Email: mabayadav@gmail.com

DOI: 10.70034/ijmedph.2025.1.116

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (1); 619-624

ABSTRACT

Background: There is a growing prevalence of upper extremity defects that require reconstruction, largely due to the increased reliance on machinery, a higher rate of automobile accidents, and conflicts involving more frequent use of firearms and explosives. **Objectives:** 1. To study Aetiology of hand & forearm injuries. 2. To study the role of different flap covers in managing hand & forearm compound defects.
Materials and Methods: Study Design: A prospective hospital-based cross-sectional study. **Study area:** Department of Plastic Surgery, Siddartha Medical College, Vijayawada, Andhra Pradesh. **Study Period:** 1 year. **Study population:** This cross-sectional study will be conducted on 40 patients presenting with hand & forearm compound defects. **Sample size:** The study consisted of 40 subjects. **Sampling method:** Simple random technique.
Results: In our study, most of the defects were on the Dorsum of the Hand. About 50% of the patients underwent Groin Flap cover followed by PIA Flap accounting for 18.75%. The other flap procedures in hand defects were Superiorly & Inferiorly based Abdominal Flaps, and Paraumbilical Flaps. One patient underwent Hypogastric with Paraumbilical Flap.
Conclusion: In this study of 40 patients with hand and forearm injuries, the most affected age group was 21-30 years, with a male predominance (72.5%). Electric burns (47.5%) and road traffic accidents (42.5%) were the leading causes of injury, with the dorsum of the hand (40%) and distal third forearm (30%) being the most common injury sites.
Keywords: upper extremity defects, Paraumbilical Flap, Groin Flap.

INTRODUCTION

There is a growing prevalence of upper extremity defects that require reconstruction, largely due to the increased reliance on machinery, a higher rate of automobile accidents, and conflicts involving more frequent use of firearms and explosives. Injuries to the forearm and hand can expose essential structures like tendons, bones, blood vessels, and nerves, necessitating appropriate coverage. Additionally, conditions such as diabetes, cellulitis, and burns lead to soft tissue defects in the hand and forearm that require sufficient coverage.

The drying out of essential structures can be avoided by using a properly designed flap for coverage (1). The umbilical area (which receives blood from the paraumbilical perforators of the DIEA) and the region below the umbilicus (supplied by the SCIA, SEPA, and SIEA), as well as the lateral part of the torso (which is nourished by perforators from the intercostal vessels and lumbar arteries), are typical sources for pedicled flaps (2).

The Superficial Inferior Epigastric Artery (SIEA) flap can be elevated with either a vertical or horizontal pedicle, provided that the base of the flap includes the superficial inferior epigastric artery (3,4). The Superficial Circumflex Iliac Artery flap (SCIA/GROIN FLAP) marked a significant achievement in the reconstruction of soft tissue defects in the hand (5).

The paraumbilical flap relies on the paraumbilical perforators of the deep inferior epigastric artery, with the largest perforator located about 2 cm from the umbilicus and directed towards the inferior angle of the scapula, where it connects with the posterior

intercostal artery (6). The superficial external pudendal artery (SEPA FLAP) technique is straightforward and uncomplicated (7). For the unilateral SEPA flap, the lateral edge is positioned 2.5 cm from the pubic tubercle, while the medial edge aligns with the midline.

In this research, we aim to outline the function of different flaps in reconstructing defects of the forearm and hand, as well as assess various reconstructive methods in restoring normal limb function. The goals were to analyze the causes of acquired defects in the hand and forearm and to assess the effectiveness of various flaps in providing coverage for these defects.

Aim: To study various compound defects of the hand and forearm and the role of different flaps for those defects.

Objectives

1. To study Aetiology of hand & forearm injuries
2. To study the role of different flap covers in managing hand & forearm compound defects.
3. To study the feasibility of limb salvage through flap cover

MATERIALS AND METHODS

Study Design: A prospective hospital-based cross-sectional study.

Study Area: Department of Plastic Surgery, Siddartha Medical College, Vijayawada, Andhra Pradesh.

Study Period: 1 year.

Study population: This cross-sectional study will be conducted on 40 patients presenting with hand & forearm compound defects.

Sample size: The study consisted of 40 subjects.

Sampling method: Simple random technique.

Inclusion Criteria

- Patients presenting with compound defects of the forearm and hand.
- Both sexes.
- Ages between 5 to 65 years.

Exclusion Criteria

- Patients of <5 years of age and >65 years of age.
- Patients with significant medical disorders and unfit for surgical procedures.
- Mutilating injuries where the hand cannot be salvaged.

Ethical Consideration: Institutional Ethical Committee permission was obtained before the commencement of the study.

Study tools and Data collection procedure

Variables Being Studied

1. Age, Gender distribution and aetiology
2. Side, Site, Size of defect & other structures damaged
3. Timing of the flap cover (Early: <5 Days from the date of injury or Delayed)
4. Type, and dimensions of the flap
5. Complications if any.

PROFORMA

1	NAME	
2	AGE	
3	SEX	
4	DOA	
5	IP.NO	
6	MODE OF INJURY	
7	DIAGNOSIS	
8	OTHER INJURIES	
9	SURGERY: NAME OF FLAP	
10	DIMENSIONS	
11	DONOR SITE	
12	TIMING OF FLAP COVER	
13	DELAY	
14	DIVISION & INSET	
15	COMPLICATIONS	
16	MANAGEMENT OF COMPLICATION	

Statistical Analysis

In the present study, descriptive statistical analysis will be conducted. Results for categorical measurements will be reported in Number (%), whereas results for continuous measurements will be reported as Mean ±SD(Min-Max). Significance is evaluated at a 5% level.

RESULTS

Table 1: Age Distribution

Age Group	Number	Percentage
<10	3	7.50%
11-20	10	25.00%
21-30	13	32.50%
31-40	6	15.00%
41-50	5	12.50%
51-65	3	7.50%

Total	40	100%

Most common age group affected by hand & forearm injuries was 21-30 years (32.50 %) followed by 11-20 years (25%). Only 3 patients were below the age of 10 years. The youngest patient in our study was 5 years old and the oldest patient was 65 years age.

Table 2: Sex Distribution

SEX	Number	Percentage
MALE	29	72.50%
FEMALE	11	27.50%
Total	40	100%

In our study, 72.5 % (29 out of 40) of patients who presented with hand and forearm injuries were male, and only 11 patients were female. This might be because, in our society, males are predominantly the major workforce in industries and other occupations and daily commuters.

The most common cause of hand& forearm injuries in our study was electric burns which were seen in 47.5% of patients. The second most common cause was road traffic accidents which was seen in 42.50 % of patients. And 2 patients had machinery injuries, due to the sugarcane machine. One patient was affected by snake bite cellulitis.

Table 3: Site of Defect

Site of Defect	Number	Percentage
Hand	16	40.00%
Distal 3rd Forearm	12	30.00%
Finger	6	15.00%
Prox 3rd Forearm & Elbow	3	7.50%
Wrist	2	5.00%
Middle 3rd Forearm	1	2.50%
Total	40	100%

In some patients, more than one site was involved and few had injuries at another site of the body also e.g. scalp, legs. The most common site involved in different types of hand & forearm injuries was the dorsum of the hand (40%). Distal 3rd Forearm was the second most commonly affected site seen in 30%. Finger defects were seen in 15% of the patients.

When assessed pre-operatively, out of the 40 patients, 27(67.5%) were associated with functional loss in the form of tendon injury.

Table 4: Type of Flaps for Finger Defects

Name of Flap	Number	Percentage
Cross Finger Flap	**2**	**33.33%**
Fillet Flap	**2**	**33.33%**
Kutler Flap	**1**	**16.67%**
Paraumbilical Flap	**1**	**16.67%**
Total	**6**	**100.00%**

The most common flaps for finger defects in our study were Cross Finger & Fillet flaps accounting for 33.33% each. Followed by Paraumbilical & Kutler flap accounting for 16.67% each. Most cases were done on an outpatient basis.

Table 5: Type of Flaps for Hand Defects

Name of Flap	Number	Percentage
Groin Flap	8	50.00%
PIA Flap	3	18.75%
Sup. Abd Flap	1	6.25%
Inf. Abd Flap	1	6.25%
Hypogastric Flap	1	6.25%
Paraumbilical Flap	1	6.25%
Hypogastric + PUF	1	6.25%
TOTAL	16	100.00%

Note: more than one procedure was performed in some patients.

In our study, most of the defects were on the Dorsum of the Hand. About 50% of the patients underwent Groin Flap cover followed by PIA Flap accounting for 18.75%. The other flap procedures in hand defects were Superiorly & Inferiorly based Abdominal Flaps, and Paraumbilical Flaps. One patient underwent Hypogastric with Paraumbilical Flap.

Table 6: Type of Flaps for Distal Third Forearm Defects

Name of Flap	Number	Percentage
PUF	5	50.00%
Sup Abd Flap	3	30.00%
Hypogastric Flap	1	10.00%
Groin Flap	1	10.00%
Total	10	100.00%

In our study, 50% of patients with Distal Third Forearm defects underwent Paraumbilical Flap, followed by a Superiorly based Abdominal Flap in 30% of patients. Other flap procedure done were Hypogastric flap & Groin flap There were 3 patients who presented with Middle third defects and all of them underwent Paraumbilical Flap Cover. 3 Patients presented with Proximal Forearm & Elbow defects who underwent Inferiorly, and superiorly based abdominal and Paraumbilical Flap cover respectively.

Table 7: Type of Flaps for Proximal Third Forearm & Elbow Defects

Name of Flap	Number	Percentage
Inf. Abd Flap	**1**	**33.33%**
Paraumbilical Flap	**1**	**33.33%**
Sup. Abd Flap	**1**	**33.33%**
Total	**3**	**100%**

In our study, about 72.50% of patients underwent delayed Flap Cover i.e. beyond 5 days from the time of injury and only 27.50% underwent Early Flap Cover.

Table 8: Post-Operative Complications

Complication	Number	Percentage
Partial Flap Necrosis	6	15.00%
Flap Dehiscence	5	12.50%
Hematoma	2	5.00%
Infection	2	5.00%

Figure 1: Preoperative dorsum defect

Figure 3: Immediate postop

Figure 2: Hypogastric flap harvested

Figure 4: After flap division and inset

DISCUSSIONS

Injuries to the upper extremities are the most common following electrical burns, trauma from vehicle accidents, assaults, and infections. Significant harm to deeper tissues, such as muscles, blood vessels, and nerves, occurs with exposure of tendons, vessels, nerves, bones, and joints, necessitating prompt soft tissue coverage with flaps. In certain instances, flap coverage is essential to prevent risks like vascular blowout, which could result in limb amputation or even death if intervention is not timely. Additionally, soft tissue cover is crucial to ensure a stable wound environment for future reconstructive surgeries.

Various approaches can be taken to address specific soft tissue defects of the hand and forearm. Often, the most straightforward procedure with the least chance of complications is sufficient. Soft tissue coverage is just one aspect of managing intricate upper limb injuries, which may also require bony stabilization, neurovascular repairs, and tendon reconstruction.

The optimal flap procedure for reconstructing upper limb defects should offer an appropriate tissue match, restore sensibility, minimize donor site complications, reduce scar contracture, allow for unrestricted movement, facilitate easy wound management, be a one-stage outpatient procedure, and utilize a single surgical field. While these criteria represent the ideal for flap procedures, no flap has yet successfully met most of these requirements.[8] The hand's anatomy enables the coverage of minor skin defects through a diverse range of local pedicle and island flaps. However, for more extensive defects, it becomes necessary to utilize flaps from more remote donor sites, whether as free or pedicle flaps.

In our study, we included a total of 40 patients with hand& forearm injuries. Most of the patients in our study were male (72.5%) with the male: female ratio being 2.6:1. Male predominance (Male: Female 1.9: 1) was also seen in the study by Jalal Fattah.[9] Similarly, in the study by A M Hashem, all 6 patients were males.[10] Ahmed Ali et al also showed male predominance (26 out of 30 male patients) in their study.[11] Male predominance in upper limb injuries may be due to increased exposure to electricity, machines at work, as occupational hazards and common victims of motor vehicle accidents.

The most common cause of hand injury in our study was electric burns (47.50 %) followed by Road Traffic accidents (42. 50%). Machinery injury was seen in 2 patients. In one case, a hand injury was due to a snake bite. However, road traffic accidents were the most common cause of upper limb injury in the study by Muhammad Shahzad et al3. In the study by Wael Ayad, crush injury (57.14%) was found to be the most common cause of hand injury. [12] Haitham Mohammed.[13] (39.7%) and Jimmy Chow et al,[14] (37.5%) also reported crush injury as the most common cause. Ghosh et al,[15] found Machinery injury (58.82%) to be the commonest cause of hand injury.

In the present study, the most common site of injury was the dorsum of the hand in 16 cases (40 %) followed by distal third forearm (seen in 30 %) and finger injuries (15 %). Similarly, the dorsum of the hand was affected in 66.66% of the patients in the study by Dietmar et al.[16] In the study by Saeed Cheema,[17] the most common soft tissue defects were in the area of the palm (50%). Sanjay Saraf,[18] and Ahmed Ali et al reported around 23 % of patients with distal third forearm defects. In the study by Muhammad Shahzad et al,[19] the volar aspect of the wrist was the most common site of soft tissue defect seen in 39.62% of cases.

In our study, the right upper limb was seen as involved in 23 patients (57.5%) and the left hand was affected in 17 patients (42.5%). In the study by Haitham Mohammed et al,[13] the right hand was involved in 64.1% while the left hand accounted for 34%, with both hands equal to 1.9% of cases. Most of the patients (24 out of 40) in our study presented on the same day of injury. This might be because the majority of patients in our study were affected by electric burns and road traffic accidents. A total of 5 out of 40 patients presented in the first week of injury. 4 patients presented in 2nd and 3rd week after injury. 5 patients presented one month after injury.

In this study, 11 (27.50%) patients were given early flap cover i.e. within 5 days of injury and 29 patients (72.50 %) were given delayed flap cover. In the study by Mohammad Shahzad et al,[13] most of the patients were operated between the third and fourth week of the injury. The earliest operation was done after the second week and the maximum delay was 4.5 weeks. In the study by M Meky,[20] 2 out of 6 patients with complex hand injuries were treated primarily during the first 24 hours after trauma, 3 patients presented 3 weeks after trauma so they were treated in a delayed primary manner, while one case presented with severe contracture 5 months after trauma. In Jimmy Chow et al,[14] performed delayed primary flap coverage in 25 patients within 1 month.

In our study, nine types of flap procedures were performed in these 40 patients. The type of flap procedure was decided depending on the patient's comfort, site and size of the defect. More than one procedure was performed in a few patients, because of multiple site injuries. Groin flap is a workhorse of hand injuries and was the most common procedure performed in 8 out of 16 hand defect patients (50%). The second most common procedure performed is Posterior Interosseous Artery Flap in 3 patients (18.75%). The most common flap used for finger defects were cross-finger & Fillet flaps done in 2 cases each of the 6 cases presented with a finger injury. The most common flap used for Distal third forearm defects was Superiorly based Abdominal flap in 4 cases, followed by PUF in 3 cases. For the

Middle third defects, PUF was the most commonly used flap in 3 cases and defects of the proximal third & Elbow, the flaps used were inferiorly based abdominal flap, PUF and superiorly based abdominal flap done in one case each.

In our study, 6 patients (15%) had partial flap necrosis which was managed by debridement and flap readjustment. Dehiscence was seen in 5 patients (12.5%) and was treated with an inset of the flap. Infection & Hematoma were noted in 5% each. In the study by Muhammad Shahzad et al,[19] marginal loss over the distal edge of the flap was noted in one (2%) patient which was managed with flap advancement and suturing. Wael M,[12] noted partial flap necrosis in the distal part of the 2 groin flap managed conservatively in one case and excision with the advancement of the flap surgically in another case. Infection of the donor wound was seen in 2 cases which were managed by frequent cleaning and dressing and antibiotics. While in the study by Jalal Fattah et al,[9] marginal flap necrosis was noted in 6 (4.6%), partial loss of skin graft in 3 (2.3%), wound infection in 2 (1.53%), and joint stiffness in 2 (1.53%) cases.

In the study by Ahmed Ali et al,[19] one out of 30 flaps had distal flap necrosis involving 2cm that needed debridement and resuture to the edge of the defect and one flap had disruption that needed secondary sutures. Ghosh et al,[15] in their study found marginal distal flap loss in 3 (10.71%) cases and distal flap loss of up to 5% in one (3.57%) patient. While in the study by Saeed Cheema et al,[17] partial flap loss was noted in one patient and contracture formation at the suture lines was found to be the most common problem. Out of 150 patients studied, Sanjay Saraf,[18] found marginal necrosis of the flap in 10 patients, partial wound dehiscence in 3 cases, partial wound detachment in 3 patients and wound infection in 2 patients.

CONCLUSION

In this study of 40 patients with hand and forearm injuries, the most affected age group was 21-30 years, with a male predominance (72.5%). Electric burns (47.5%) and road traffic accidents (42.5%) were the leading causes of injury, with the dorsum of the hand (40%) and distal third forearm (30%) being the most common injury sites. The right upper limb was more frequently involved (57.5%). Early flap coverage (<5 days) was performed in 27.5% of cases, with the paraumbilical flap (30%) and groin flap (22.5%) being the most commonly used. Complications included partial flap necrosis (15%) and flap dehiscence (12.5%), but all defects were successfully managed with stable flap coverage. Debridement, disarticulation, SSG, and K-wire fixation were common additional procedures. Overall, effective flap coverage ensured defect salvage in all cases.

REFERENCES

1. Shamsuzzaman M, Uddin SKB, Masoom M, Islam MA, Haque A. Groin flap: a good converge for hand injury. JMed 2006;7(1):15-19.
2. Hester TR Jr, Nahai F, Beegle PE, Bostwick J 3rd. The blood supply of the abdomen was revisited, with emphasis on the superficial inferior epigastric artery. Plast Reconstr Surg1984;74(5):657-70.
3. Wood J. Case of extreme deformity of the neck and forearm, from the cicatrices of a burn, cured by extension, excision, and transplantation of skin, adjacent and remote. Med ChirTrans 1863; 46:149-59.
4. Shaw DT, Payne RL Jr. One stage tubed abdominal flaps; single pedicle tubes. Surg Gynecol Obstet 1946; 83:205-09.
5. McGregor IA. Flap reconstruction in hand surgery: the evolution of presently used methods. J Hand Surg Am1979;4(1):1-10.
6. Taylor GI, Daniel RK. The anatomy of several free flap donor sites. Plast Reconstr Surg 1975;56(3):243-53.
7. Dias AD, Thatte RL, Patil UA, Dhami LD, Prasad S. Theuses of the SEPA flap in the repair of defects in the hands and fingers. Br J Plast Surg 1987;40(4):348-59.
8. Jorge L. Orbay, Joseph Gregory Rosen, Roger K Khouri, Igor Indriago. The glabrous palmar flap- The new free or reversed pedicled palmar fasciocutaneous flap for volar hand reconstruction. Techniques in hand and upper extremity surgery 2009;13 (3) 145-150
9. Jalal Hamasalih Fattah, Rasul Hamed Awia. Management of fingertip injury in Ebril, an evaluation study. Zanco J. Med Sci., 2013; 17(3): 518-525
10. A M Hashem. The interdigital neurovascular island flap: a sensible solution for difficult digital defects. Kasr El Aini Journal of Surgery 2006; 7 (2): 55-62.
11. Ahmed Ali, Mahammed Farag, Khalid Safe. Reconstruction of hand and forearm defects by abdominal thin skin flaps. Egypt J. Plast. Reconstr. Surg 2007; 31 (2): 181-185
12. Wael M, Ayad. The outcome of local and distant fasciocutaneous flaps for soft tissue reconstruction of complex hand defects. Egypt J. Plast. Reconstr. Surg 2007; 31 (1): 37-43.
13. Haitham Yousif Elhaj Mohammed, Osama Murtada Ahmed. Hand machinery injuries presentation and management. Global J of Medical Research Surgeries and Cardiovascular system 2013; 13(4): 31-36.
14. Jimmy A, Chow, Z. John Bilos, Peter Hui, Robert F. Hall, Alan E. Seyfer, Allan C. Smith. The groin flap in reparative surgery of the hand. Plastic and reconstructive surgery 1986; 77 (3): 421-425.
15. Ghosh JC, Hazra SC, Singha SK, Aolad FR. Resurfacing of hand injury with groin flap: an analysis of thirty-four cases. Bangladesh Med J 2014; 43(1): 21-25.
16. Dietmar Ulrich, Paul Fuchs, Ahmed Bozkurt. Free serratus anterior fascia flap for reconstruction of hand and finger defects. Arch Orthop Trauma Surg 2010; 130: 217-222
17. Saeed Ashraf Cheema, Nabeela Talaat. Reverse radial artery flap for soft tissue defects of hand in pediatric age group. J. Ayub Med Coll Abbottabad 2009; 21 (1): 35-38.
18. Sanjay Saraf, VK Tiwari. Fingertip injuries. I. J. O. 2007; 41 (2): 163-168.
19. Muhammad Naveed Shahzad, Naheed Ahmed, Khalid Hussain Qureshi. Reverse flow posterior interosseous flap: Experience with 53 flaps at Nishtar Hospital, Multan. J. Pak Med Assoc 2012; 62 (9): 950-954.
20. M. Meky, Y. Safoury. Composite anterolateral thigh perforator flaps in the management of complex hand injuries. Journal of hand Surg Eur vol 2011; 1-5.