



Case Series

A CASE SERIES OF VARIOUS FLAPS USED IN HAND AND FOREARM RECONSTRUCTION: EXPERIENCE FROM A TERTIARY CARE CENTER AND REVIEW OF LITERATURE

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ABSTRACT

Background: Soft-tissue defects of the hand and distal forearm are challenging because exposed tendons, joints, bone, nerves, or vessels require durable vascularized coverage while preserving function, sensation, and aesthetic. Although free tissue transfer expands reconstructive options for large or complex defects, local and regional flaps remain important because they can provide reliable coverage with relatively shorter procedures and without microsurgical anastomosis.

Materials and Methods: A descriptive case series was conducted in the Department of Plastic and Reconstructive Surgery, Pt. B.D. Sharma PGIMS, Rohtak, in the month of February 2024. Eleven out of consecutive cases of hand and forearm injuries operated during this month are being represented in this series. Flap selection was individualized according to defect location, size, depth and exposed structures. Clinical flap survival and postoperative complications were recorded.

Results: The 11 patients ranged from 5 to 60 years (mean 28.1 years; median 25 years); 10 were male and 1 was female. Eight patients had traumatic injuries and three had electrical burns. The reconstructive options included Interpolation flap, first dorsal metacarpal artery, posterior interosseous artery, groin, cross-finger, reverse cross-finger, dorso-ulnar (Brunelli), Atasoy V-Y, reverse radial artery, and reverse ulnar artery perforator flaps. Complete flap survival was observed in all cases. One child who underwent reverse cross-finger flap reconstruction developed a fixed distal interphalangeal joint extension deformity that improved with physiotherapy. Pedicled groin and cross-finger flaps required secondary division at approximately 3 weeks.

Conclusion: This series illustrates the continuing utility of local and regional flaps across a broad range of hand defects. Flap selection should be driven by defect anatomy and reconstructive goals rather than by a single preferred technique. In appropriately selected small-to-large defects, these flaps can provide durable coverage while preserving major vessels in selected designs and avoiding the resources required for free tissue transfer. Larger consecutive studies with standardized functional and patient-reported outcomes are needed to for more defined effectiveness.

Keywords: hand reconstruction; soft-tissue defect; local flap; regional flap; cross-finger flap; posterior interosseous artery flap; thumb reconstruction; groin flap.

INTRODUCTION

Soft-tissue loss of the hand and distal forearm remains a demanding reconstructive problem because the hand is a specialized organ in which even a small area of tissue loss may expose structures essential for movement, sensation, tendon excursion and skeletal stability. Durable coverage is especially important when tendons, joints, bone, nerves, or vessels are exposed. Early coverage protects these structures from desiccation and infection and improves the overall outcome.^[1,2]

Skin grafting remains appropriate for superficial wounds with a vascularized wound bed, but grafting cannot be done over bare tendon without an intact paratenon, exposed bone without periosteum, or exposed joint and neurovascular structures. In such settings, vascularized tissue is required.^[2] The reconstructive choice depends on defect location and size, tissue pliability, availability of recipient vessels, donor-site morbidity, and patient age and comorbidities.

Local and regional flaps hold an important position in the reconstructive spectrum. Cross-finger and V–Y advancement flaps are established options for selected digital and fingertip defects; first dorsal metacarpal artery and dorso-ulnar flaps provide tissue suitable for thumb reconstruction; posterior interosseous artery, reverse radial artery, and ulnar artery perforator flaps extend coverage to the dorsum of the hand and wrist; and the pedicled groin flap remains useful for larger defects when microsurgical reconstruction is undesirable or unavailable.^[4–14]

Rather than presenting a single flap as universally preferable, the present series demonstrates how

different local and regional options can be matched to different anatomical problems in routine tertiary-care practice. The series also highlights practical considerations in resource-limited setting.

MATERIALS AND METHODS

Study design: This descriptive case series was conducted in the Department of Plastic and Reconstructive Surgery, Pt. B.D. Sharma PGIMS, Rohtak, in the month of February 2024.. Eleven representative cases involving different anatomical regions and reconstructive strategies were selected for this report.

Patient assessment and reconstruction: Patients presented with traumatic injuries or electrical burns. Each wound underwent thorough debridement and assessment of the depth of tissue loss, exposed structures, skeletal stability, neurovascular status, contamination, and availability of adjacent tissue. Where required, skeletal stabilization was performed before definitive soft-tissue coverage. The flap was selected according to defect location, size, tissue requirements, arc of rotation and donor-site.

Outcome assessment: The primary clinical outcome was flap survival. Secondary observations included postoperative vascular compromise, necrosis, infection, need for additional flap surgery, donor-site management, need for staged flap division, and clinically documented functional or aesthetic concerns. Follow-up period was approximately 2 months.

Ethical considerations: Written informed consent for surgery and use of clinical photographs for academic publication was obtained.

Case Series

Case	Age/Sex	Etiology	Side	Defect	Flap	Complication	Additional details
1	54/M	Trauma	Right	Dorsal index finger	Interpolation flap	None	Complete survival; primary donor closure
2	46/M	Trauma	Left	Dorso-lateral thumb	FDMA flap	None	K-wire removal on day 21; uneventful healing
3	22/M	Trauma	Right	Dorsum of hand	Posterior interosseous artery flap	None	K-wire stabilization; STSG to donor site
4	60/M	Electrical burn	Right	Dorsum of hand	Pedicled groin flap	None	Staged division at 21 days
5	5/F	Trauma	Right	Index and middle fingers	Cross-finger flaps	None	STSG to donor sites; separation at 3 weeks
6	7/M	Electrical burn	Right	Index finger	Reverse cross-finger flap	Fixed DIP extension deformity	Improved with physiotherapy
7	25/M	Trauma	Right	Thumb tip	Dorso-ulnar (Brunelli) flap	None	Primary donor closure; viable flap
8	5/M	Trauma	Right	Index fingertip	Atasoy volar V–Y advancement flap	None	Good pulp contour and preserved sensibility
9	33/M	Electrical burn	Left	Middle/ring fingers and wrist	Cross-finger flaps + groin flap	None	Residual raw areas managed with STSG
10	32/M	Trauma	Left	Thumb	Reverse radial artery flap	None	Good contour; thumb-tip sensation preserved
11	20/M	Trauma	Right	Wrist	Reverse ulnar artery perforator flap	None	Coverage after ulnar nerve cable grafting; no congestion/necrosis

Case 1: A 54-year-old man presented with a post-traumatic defect over the dorsum of right index finger

with exposure of the proximal phalanx and metacarpal head. An interpolation flap from the

dorsal wrist-crease region was done and the donor site was closed primarily. The flap survived completely and maintained acceptable contour at 2-month follow-up.

Case 2: A 46-year-old man sustained a dorsolateral left thumb injury with exposed and subluxated phalanges. After K-wire stabilization, coverage was achieved with a first dorsal metacarpal artery (FDMA) flap. The donor site was closed partially primarily and with STSG. The flap healed uneventfully and K-wires were removed on postoperative day 21.

Case 3: A 22-year-old man had a traumatic dorsal hand defect with exposed extensor tendons and subluxated carpal bones. Carpal stabilization was achieved with K-wires, followed by coverage using a posterior interosseous artery (PIA) flap. The donor site was resurfaced with a split-thickness skin graft (STSG). Both flap and graft healed satisfactorily.

Case 4: A 60-year-old man sustained an electrical burn to the dorsum of the right hand. Following debridement, the defect exposed metacarpals and extensor tendons. A pedicled groin flap was used for durable coverage, with primary closure of the donor site. Healing was uneventful and flap division was performed after approximately 21 days.

Case 5: A 5-year-old girl sustained machine amputations of the index and middle fingers at the proximal interphalangeal joint level. The index defect was reconstructed with a cross-finger flap from the middle finger, while the middle-finger defect was reconstructed using tissue from the ring finger. Donor sites were covered with STSG. Both flaps survived and were separated after approximately 3 weeks.

Case 6: A 7-year-old boy presented with an electrical burn of the dorsum of the right index finger with exposed middle phalanx. Following debridement and K-wire stabilization, a reverse cross-finger flap from the adjacent middle finger was used. The flap healed well; however, a fixed distal interphalangeal joint extension deformity developed and subsequently improved with physiotherapy.

Case 7: A 25-year-old man presented with traumatic amputation of the right thumb tip with loss of part of the distal phalanx. A dorso-ulnar (Brunelli) flap was elevated to reconstruct the defect. The flap remained viable throughout follow-up and the donor site was closed primarily.

Case 8: A 5-year-old boy sustained a window-glass injury with distal amputation of the right index fingertip including part of the distal phalanx. An Atasoy volar V-Y advancement flap was performed. The flap healed with satisfactory pulp contour and preserved sensation.

Case 9: A 33-year-old man presented with multiple post-electrical-burn defects involving the left wrist, middle finger, and ring finger with exposed tendons. Cross-finger flaps were used for the digital defects and a pedicled groin flap for the wrist. Residual raw areas were covered with STSG. All flaps and grafts healed without any complications.

Case 10: A 32-year-old man sustained a traumatic left-thumb soft-tissue defect. A reverse radial artery flap was performed, with STSG used for the forearm donor site. The flap demonstrated good contour and thumb-tip sensation was preserved.

Case 11: A 20-year-old man presented 1.5 months after a neglected wrist injury that had previously been sutured outside. He had scar contracture, partial clawing, and clinical features of untreated ulnar nerve injury. Ulnar nerve reconstruction with sural nerve cable grafts was performed, followed by coverage with a reverse ulnar artery perforator flap. The flap healed without congestion or necrosis.

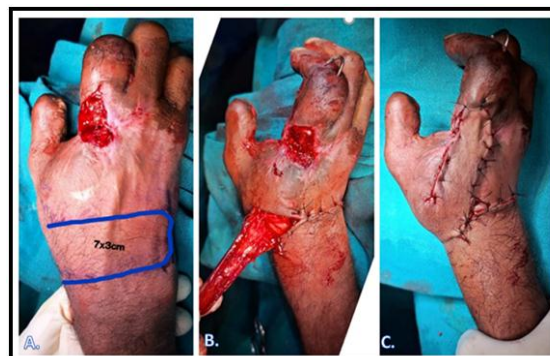


Figure 1: Case 1: Dorsal index-finger defect and local interpolation flap. (A) Defect and flap marking. (B) Flap elevation with preservation of the paratenon. (C) Inset and primary closure of the donor site.

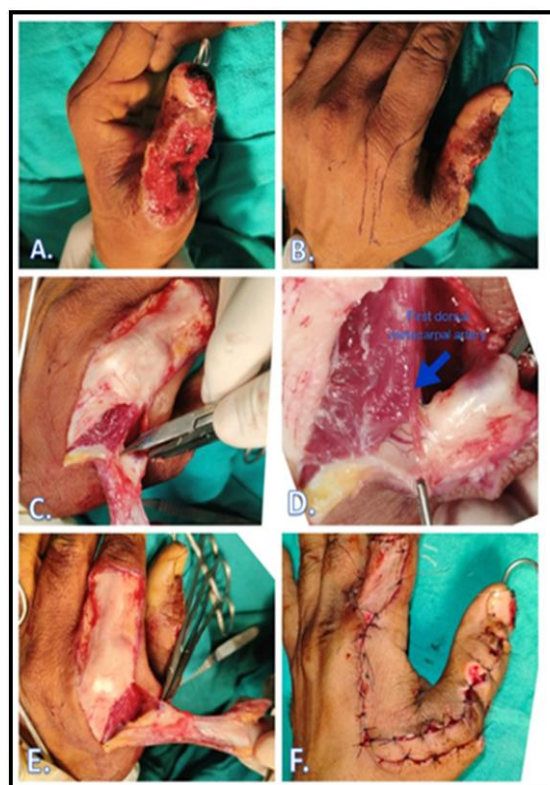


Figure 2: Case 2: FDMA flap for a dorsolateral thumb defect. (A) Thumb defect. (B) Flap marking. (C) Elevation of the flap while preserving the paratenon. (D) Identification of the first dorsal metacarpal artery. (E-F) Flap elevation and inset.



Figure 3: Cases 3 and 4. (I) Posterior interosseous artery flap for dorsal hand reconstruction: defect, flap marking, vascular pedicle identification, flap elevation/inset, and postoperative result. (II) Pedicled groin flap for an electrical-burn defect of the dorsum of the hand.



Figure 4: Case 5: Cross-finger flap reconstruction for index- and middle-finger defects, with flap inset and postoperative appearance after separation.



Figure 5: Cases 7 and 8. (I) Dorso-ulnar (Brunelli) flap for thumb-tip reconstruction. (II) Atasoy volar V-Y advancement flap for index-fingertip amputation.

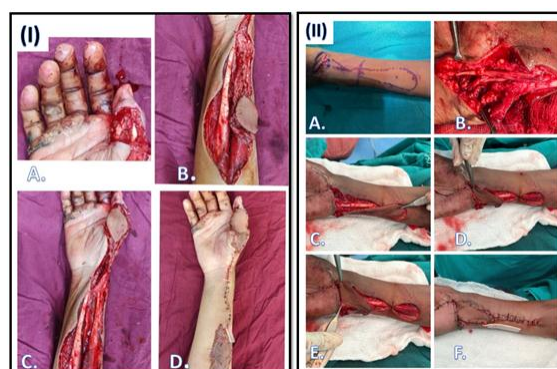


Figure 6: Cases 10 and 11. (I) Reverse radial artery flap for thumb reconstruction and donor-site closure with STSG. (II) Reverse ulnar artery perforator flap for wrist coverage following ulnar nerve reconstruction.

RESULTS

The 11 patients ranged from 5 to 60 years of age (mean 28.1 years; median 25 years). Ten patients were male and one was female. Eight patients (72.7%) sustained traumatic injuries and three (27.3%) sustained electrical burns. Defects involved the thumb, index, middle and ring fingers, dorsal hand, and wrist.

Ten reconstructive strategies were represented, with cross-finger and groin flaps each used in more than one patient and additional cases demonstrating FDMA, PIA, dorso-ulnar, Atasoy V-Y, reverse radial artery, reverse ulnar artery perforator, and local interpolation flaps. Several patients required concomitant skeletal stabilization, and case 11 required nerve reconstruction in addition to soft-tissue coverage.

All 11 flaps demonstrated complete clinical survival. No flap congestion, partial or total necrosis, or postoperative infection was reported, and no patient required a secondary flap procedure. One patient developed a fixed DIP extension deformity following reverse cross-finger flap reconstruction and splintage; which later improved with physiotherapy. Pedicled cross-finger and groin flaps required staged division at approximately 3 weeks. The mean follow-up was approximately 2 months.

Because the series contains only 11 selected cases and did not use standardized functional outcome instruments, the findings should be interpreted only as an illustration of flap selection and technical feasibility rather than as evidence of comparative superiority among flap types.

Table 1

Outcome	N(11)	Percentage
Complete flap survival	11	100%
Flap congestion/necrosis	0	0%
Postoperative infection reported	0	0%
Secondary flap procedure	0	0%
Documented DIP extension deformity	1	9.1%
Traumatic etiology	8	72.7%
Electrical burn etiology	3	27.3%

DISCUSSION

Soft-tissue reconstruction of the hand is very demanding and requires a carefully thought reconstruction. Before deciding which flap to do we must ask ourselves four questions: what structures are exposed; what tissue characteristics are required; which local vascular territories remain available; and what donor-site outcome is acceptable. Our series demonstrates this principle across 11 anatomically different defects.

An important strength of local and regional flaps is the ability to provide tissue with similar thickness and texture while avoiding microsurgical anastomosis. This can be particularly relevant in emergency or resource-limited settings, in patients who are poor candidates for long procedures, or when recipient vessels are limited. However, the choice should not be interpreted as a general alternative to free tissue transfer. Large, composite, and complex defects may be better served by free flaps, especially when a thin, pliable, sensate, or muscle-containing tissue requirement cannot be met by a regional option.

Cross-finger flaps remain useful for selected volar or dorsal digital defects in which adjacent-finger tissue can provide a vascularized bed. Their major limitations are temporary immobilization, a second-stage division procedure, donor-site grafting, and the risk of stiffness. In our series, the only reported postoperative deformity occurred after a reverse cross-finger flap in a child. The improvement with physiotherapy emphasizes that flap survival alone does not define success; joint positioning, skeletal stability, early rehabilitation, and timely flap division are also important. Published long-term experience with cross-finger flaps supports their continued role in selected fingertip amputations.^[4]

Thumb reconstruction has particularly high functional demands because the thumb contributes to opposition, pinch, and grasp. The FDMA flap provides thin, reliable tissue for thumb defects and is based on a well-described dorsal arterial system.^[5]

The dorso-ulnar (Brunelli) flap provides tissue from the thumb itself and can offer favorable tissue match while avoiding sacrifice of a major forearm artery.^[6,7]

In our series, both techniques produced viable coverage, showing that thumb reconstruction should be individualized according to the tissue loss and the desired preservation of length and sensation.

For distal fingertip amputations, the Atasoy volar V-Y advancement flap can preserve length and provide sensate volar tissue when the defect and remaining tissue allow advancement.^[8] Its main advantages are single-stage reconstruction and avoidance of a separate donor site. The technique is less suitable for extensive oblique tissue loss or defects in which adequate advancement would compromise perfusion or cause excessive tension. The satisfactory contour and preserved sensibility documented in case 8 are consistent with the intended advantages of this technique.

The posterior interosseous artery flap is valuable for dorsal hand and wrist defects. It provides tissue from a regional vascular territory while preserving the major radial and ulnar arteries. Cheema et al. reported a 68-case experience with reverse-flow posterior interosseous flaps, providing a substantially larger clinical experience with this flap than the single case in the present series.^[10] Our case similarly demonstrates its usefulness for a dorsal hand defect with exposed extensor tendons and unstable carpal structures, where vascularized coverage was combined with skeletal stabilization.

The groin flap remains an easy and practical option for larger hand and wrist defects, particularly when the recipient bed is unfavorable or microsurgical reconstruction is not available. Its principal disadvantages are prolonged attachment to the groin, the need for staged division, potential discomfort and limitations in mobilization, and the possibility of a relatively bulky flap. In the present series, groin flaps were used for electrical-burn defects with exposed tendons and metacarpals and survived without reported complications. Previous reports have also described the pedicled groin flap for resurfacing deep upper-extremity wounds and hand burn reconstruction.^[11,12]

Reverse radial artery flaps offer a good extent of reach and are useful for selected thumb and hand defects. Their major limitation is the traditional sacrifice of the radial artery, which makes preoperative assessment of hand perfusion extremely important. Artery-preserving modifications and perforator-based approaches have been described.^[2,13] In the present series, a reverse radial artery flap provided satisfactory thumb coverage with preserved thumb-tip sensation. The case illustrates the value of considering vascular consequences alongside coverage requirements rather than evaluating flap viability alone.

The reverse ulnar artery perforator flap represents another artery-sparing regional option. It is a useful option when the defect is on the ulnar side of the wrist or hand and a suitable perforator is available. In case 11, the flap was used after delayed presentation with scarred tissue and concomitant ulnar nerve reconstruction. The ability to address nerve and soft-tissue problems in the same reconstructive episode illustrates the importance of planning the hand as a functional unit rather than treating skin coverage in isolation. Perforator-based ulnar artery flaps have been described as a means of providing fasciocutaneous tissue while preserving the main ulnar artery.^[14]

From a reconstructive-ladder perspective, the practical sequence is not necessarily 'simple first' in every patient. Instead, the reconstructive method should be escalated according to the tissue requirements of the defect.

Limitations: This is a small, single-center case series comprising 11 selected representative cases operated consecutively in one month in our trauma centre.

The flap types, defect locations, mechanisms of injury, and patient ages were heterogeneous. Consequently, meaningful statistical comparison between flap techniques is not possible. Functional outcomes were not measured with validated scores. Future studies should include objective range of motion, grip/pinch strength, sensation testing and patient-reported satisfaction.

CONCLUSION

Local and regional flaps remain important components of the reconstructive armamentarium for hand and distal-forearm soft-tissue defects. In our 11-case experience, a broad range of flap designs provided complete clinical flap survival across traumatic and electrical-burn defects, with one reported postoperative joint deformity that improved with physiotherapy. The principal lesson is not that one flap is universally superior, but that successful reconstruction depends on matching flap characteristics to defect anatomy, exposed structures, vascular status, functional requirements, and donor-site cost. Larger studies with standardized functional and patient-reported outcomes are required to establish comparative effectiveness and propose an anatomy guided algorithm for reconstruction.

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