

Distally-Based Forearm Flow-Through Flaps for Emergency Finger Revascularization

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ABSTRACT

This paper reports the authors' experience with the use of distally-based forearm flaps as flow-through flaps for revascularization of distal parts of the hand, by simultaneous coverage of traumatic soft-tissue defects. Two clinical cases are presented and the pertinent literature is reviewed.

KEYWORDS: Flaps, emergency, revascularization

Several authors have used flow-through flaps for immediate closure of soft-tissue defects and blood-flow restoration to distally devascularized parts. The rectus abdominis flow-through flap was used by Nakatsuka et al.,¹ the temporal fascia flap by Upton and colleagues,² and the dorsalis pedis flap by Brandt and coworkers.³ Both "traditional" flaps and venous skin flaps⁴⁻⁷ may be used for simultaneous reconstruction of soft tissue and blood vessels. The possibility of using the *antegrade* radial forearm flap as a flow-through flap was first described by Yang and colleagues,⁸ and later repeatedly used to revascularize the fingers, hand,^{9,10} limbs,¹¹ or tongue.¹²

In the cases presented here, we performed soft-tissue defect coverage of the hand with simultaneous revascularization of the fingers, using *retrograde* forearm flaps. After coverage of soft-tissue defects with the distally-based forearm flap, the free end of the artery included in the flap was anastomosed to the digital arteries of the fingers, to restore the arterial blood supply.

CASE REPORTS

Case 1 A 42-year-old carpenter was seen on the 12th day after a woodcutter injured his right (dominant)

hand. During the accident, the thumb was amputated at the base of the metacarpal and was not replanted. The MP joints of the index and long fingers, and the base of the proximal phalanx of the ring finger were crushed. The blood supply of the index finger was compromised. At the initial surgery performed elsewhere, arthrodesis of the MP joint of the long finger and osteosynthesis of the proximal phalanx of the ring finger were performed, and both flexor and extensor tendons of the long finger were sutured. The index finger was attached to the first metacarpal. The palmar common digital artery and one dorsal vein of the index finger were repaired. The web space between the index and long fingers was not formatted at the time of emergency surgery.

On admission, skin necrosis was noted on the palmar side of the hand. Seven days later, the necrotic tissues were excised, resulting in a 4- x 1.5-cm soft-tissue defect, with an exposed FDP tendon of the long finger (Fig. 1). Closure of the soft-tissue defect over the exposed tendon, with simultaneous formatting of the first web space, were planned.

On the 21st post-injury day, a distally-based radial forearm flap was harvested from the right forearm. The 5- x 7-cm dermal component of the flap was elongated proximally by a 5- x 3-cm fascial component. Since injury of the palmar arterial arches was suspected,

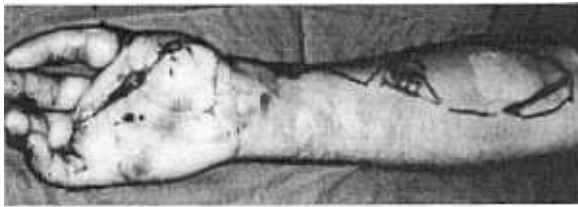


Figure 1 Case 1. After debridement, a 4- x 1.5-cm soft-tissue defect with exposed FDP tendon of the middle finger was evident.

the pivot point of the flap was located 4 cm proximally from the radial styloid. The web space between the index and the long finger was deepened, dividing the skin, soft tissue, and the deep transverse metacarpal ligament. To complete the deepening of the web space, the branch of the common palmar digital artery to the long finger was divided. The previously reconstructed palmar digital artery was damaged during surgery. The newly formatted thumb was placed in opposition, and the radial forearm flap was transposed to the hand, filling the first web space and the defect over the exposed FDP tendon (Fig. 2). The tendon was wrapped in the fascial part of the flap and covered with a split-thickness skin graft. To restore the arterial blood supply to the newly formatted thumb, the common palmar digital artery was anastomosed end-to-side to the radial artery included in the flap (Fig. 3).

No postoperative complications were noted. The patient was discharged on the 11th postoperative day. Two years after surgery, the hand is functional and the newly formed thumb participates in the grip (Fig. 4). The patient continued his previous job as a carpenter and is carrying out his favorite woodcutting jobs, drawing, and painting.

Case 2 A 41-year-old carpenter sustained trauma to his right (dominant) hand in a circular saw, resulting in a

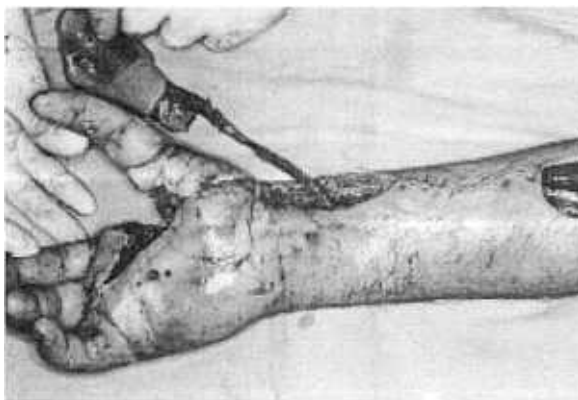


Figure 2 Case 1. The newly formatted thumb was placed in opposition, and the radial forearm flap was transposed to the hand.

skin and soft-tissue defect on the palmar side, with segmental loss of the flexor tendons, metacarpal bones, and palmar digital arteries and nerves of the ring and small finger (Fig. 5). The two ulnar fingers were pale, with no capillary refill. The patient required salvage of the fingers. An 8- x 5-cm skin and soft-tissue defect remained after debridement. There was a 4-cm-long gap in the FDP tendons of the ring and small fingers, and 3- and 4-cm bone defects of the corresponding metacarpals proximally to the MP joints.

Conventional bone grafts from the iliac crest were used to fill the defects in the metacarpal bones; the soft-tissue defect was closed with an 8- x 5-cm large distally-based ulnar forearm flap, containing one-half of the longitudinally split FCU tendon and the palmaris longus tendon (Fig. 6). Vascularized tendon grafts were used as bridge grafts to the FDP tendons of the ring and small fingers. The free end of the ulnar artery was anastomosed to the common palmar digital artery in the fourth web space (Fig. 7). After removal of the tourniquet, color, temperature, and capillary refill of the two ulnar fingers appeared normal. The donor site of the flap was covered with a split-thickness skin graft. Both fingers survived,

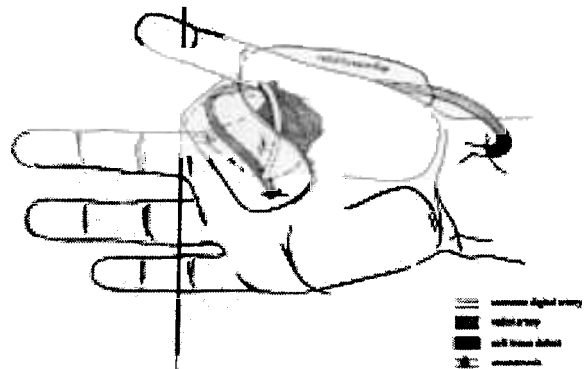


Figure 3 Case 1. The common palmar digital artery was anastomosed end-to-side to the radial artery.

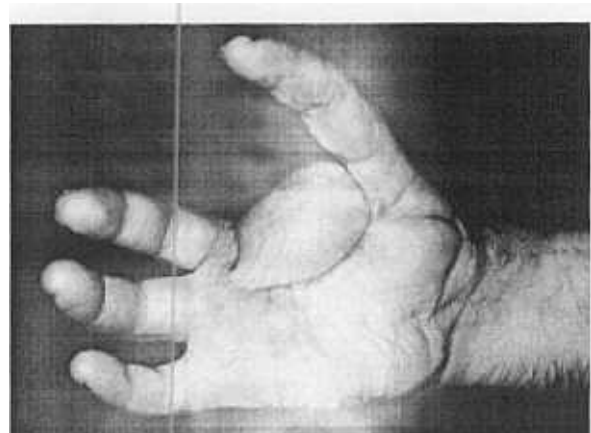


Figure 4 Case 1. Appearance of the reconstructed hand 2 years after surgery.

and the patient was discharged on the 8th postoperative day (Fig. 8). Two months after surgery, he began a hand therapy program in the outpatient department.

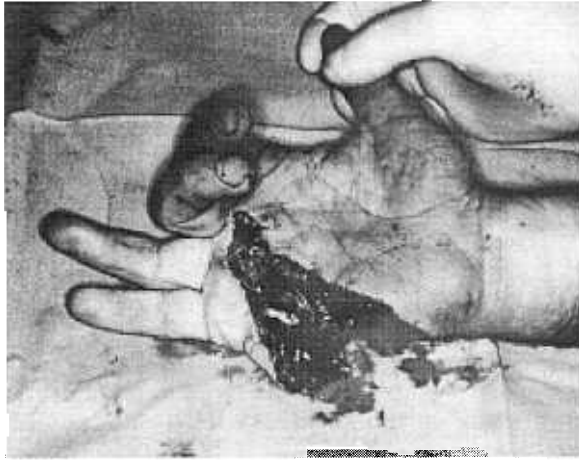


Figure 5 Case 2. Skin and soft-tissue defect with segmental loss of the flexor tendons, metacarpal bones, palmar digital arteries and nerves.

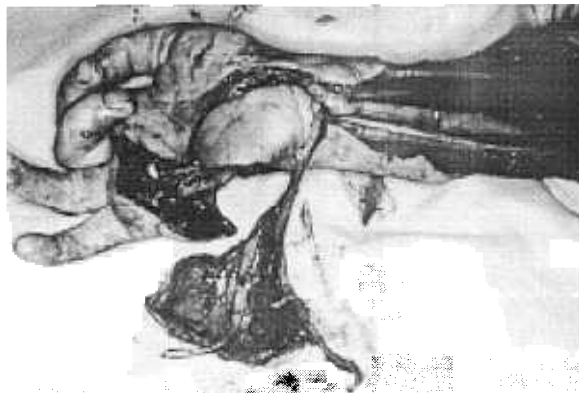


Figure 6 Case 2. The soft-tissue defect was closed by an 8-x-5-cm distally-based ulnar forearm flap.

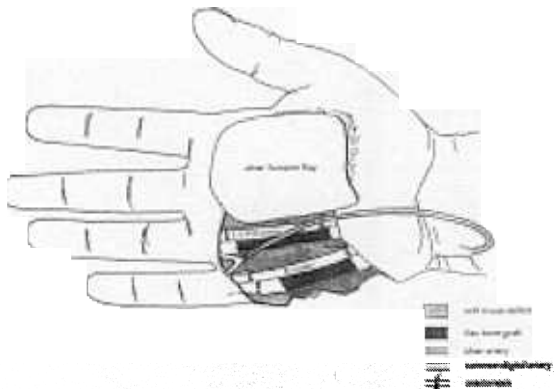


Figure 7 Case 2. The free end of the ulnar artery was anastomosed to the common palmar digital artery.



Figure 8 Case 2. Appearance of the reconstructed hand on the day of discharge.

DISCUSSION

Flow-through flaps are useful for the treatment of complex soft-tissue and vascular defects, since the nutrient artery of the flap also provides blood flow to the distal devascularized part. Although, traditionally, flow-through flaps are antegrade flaps, Mahoney and Naiberg¹³ and later Gucer and Coskunfirat¹⁴ described two cases, in which the radial artery, included in a retrograde radial forearm flap, was used as a feeding artery for the toe, transplanted to the hand. Karacalar and coworkers¹⁵ used the radial forearm flap for reconstruction of missing soft tissue and an artery of the thumb. We performed simultaneous reconstruction of soft-tissue defects and arteries in two cases, using both radial and ulnar retrograde forearm flaps. In one case presented, a complex wound on the palmar aspect of the hand was closed by a retrograde teno-cutaneous forearm flow-through flap.

In our first case, the clinical situation afforded the use of a flap to cover exposed flexor tendon. Possibly, tendon alone could be covered by a local flap but, to minimize the number of reconstructive procedures, we decided to perform the formatting of the first web space at the same stage, and to solve all soft-tissue problems with a larger regional flap. The blood supply to the pollicized index finger was restored by anastomosing of the common digital artery to the radial artery, considering this method to be safer than the use of an autovenous graft.

In the second case, we tried to perform a one-stage reconstruction of two rays with a soft-tissue defect and associated segmental defects of the metacarpals and flexor tendons, nerves and arteries. The fingers were arterially compromised, and anastomosing the end of the ulnar artery, included in the flap, to the common digital artery, seemed to be the easiest way to restore the blood supply.

Retrograde forearm flaps are frequently criticized because of the donor-site defect and influence on the circulation of the hand.¹⁶⁻¹⁸ However, when large, complex soft-tissue defects of the hand are present, the choices for the reconstructive options are a pedicled flap or a free flap. The use of a pedicled flap requires the placement of the hand in a non-physiological

position, and therefore may provoke swelling. The transfer of the free flap is expensive, needs an additional surgical team and, in hospitals with limited capabilities, usually could not be performed as an emergency procedure. Therefore, application of a retrograde forearm flap could be a unique opportunity to save and reconstruct even a heavily injured extremity. The use of the main artery of the flap as a vascular conduit may provide additional options in the treatment of complex soft-tissue defects of the hand.

CONCLUSION

The artery included in a retrograde radial or ulnar forearm flap can be utilized for acute revascularization of the distal parts of the hand.

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