

Flap Options in Reconstruction of a Burned Hand

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ABSTRACT

Hand burns are commonly seen in large burn injuries. Although the mortality of hand burns is imperceptible, morbidity can be of great importance. The possible disabling outcomes of hand burns necessitate a precise and accurate management, at both early and late stages, to allow optimal functional outcomes. The main goal of management is to maintain a favorable function that also preserves esthetics. Commonly used reconstructive options are skin grafts, skin flaps, and myocutaneous flaps. In this article, we discuss skin flap options in the reconstruction of a burned hand.

KEY WORDS: *Microvascular transplantation, Myocutaneous flaps, Skin flaps*

INTRODUCTION

The hand is important for the tactile sensations for manipulating the surrounding world. The precise movements of the fingers are essential for pinch, grip, and grab functions. Hands are affected in 90% of cases of large burns.¹ For this reason, the American Burn Association has designated hand burns as major burns. Although hands account for less than 9% of total body area, hand burns are highly common. The reason is because the hand is usually the closest body part to the burning agent, and humans usually use their hands to protect themselves.

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Hand burns can be debilitating and disabling for the patient. Functional loss in the hands represents about 57% of loss of function in the individual as a whole.² In addition, esthetic outcomes of burns can be disfiguring. In reconstruction of burned hands, both optimal functional and esthetic outcomes should be considered. However, despite optimal measures taken in the acute management of hand burns, long-term complications are frequently seen, for example, hypertrophic scarring, scar contracture, clawing of fingers, and web space deformities.³ These complications usually necessitate a reconstruction with skin flaps to decrease the rate of recurrence of the deformity. In this article, we have presented detailed options of different types of skin flaps for reconstruction of a burned hand.

Skin Flaps

A skin flap is a skin that is elevated without the interruption of its blood supply. Indications for use of skin flaps in burned hand reconstruction can be categorized according to the timing of the reconstruction. In the early setting, skin flaps are indicated whenever there is a burn wound with exposed underlying structures, such as tendon, nerves, arteries, or bones. Skin flaps are usually used for deep burns on the dorsum of the hand, since the skin is thin and more prone to the development of deep wounds in cases of thermal injuries. The second indication is in delayed reconstruction of a burned hand for the coverage of tissue defects after contracture release. Skin flaps are classified according to the proximity to the wound into local, regional, distant, and free tissue transfer.

Local Skin Flaps

The first choice for tissue defect reconstruction in the hand is a flap from local tissues.⁴ Local skin flaps are indicated for coverage of small to medium size burn wounds. Unfortunately, most of the time, surrounding tissues are also burned, making the use of local flaps limited to certain cases. Advantages of local skin flaps are diminished morbidity, short operating time, and minimal experience needed. Even after successful wound healing and graft

intake, there is always a risk of joint contracture. Local skin flaps are usually the first method of management for contracture release.⁵ Initial treatment is the release of contracture and coverage with skin flaps according to the Z-plasty technique. When the tissue defect that results from contracture release is too large to be covered with the Z-plasty method, local alternatives to skin flaps are used, including V-M plasty and dorsal advancement flap or dorsal metacarpal artery flap.⁶ Dorsal metacarpal artery flaps are usually used after contracture release of web space deformities, especially for contracture of the first digital web space.⁷ Dorsal metacarpal artery flaps are reliable, especially when the dorsum of the hand is not affected.

Case 1

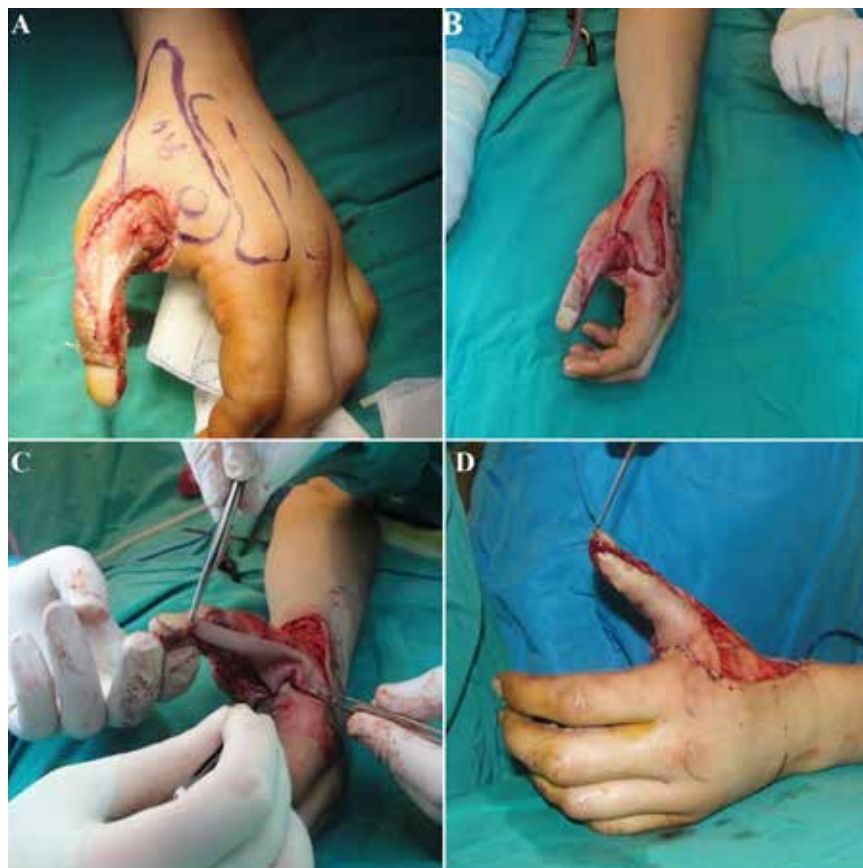
A 24-year-old male patient presented to the burn care unit of Baskent University Hospital with an electrical burn that caused a third-degree burn of his left thumb. On physical examination, there was a deep burn (6 × 4 cm) on the dorsal and ulnar sides of the left thumb, associated with exposed extensor tendons (Figure 1A). After tissue debridement, coverage with a dorsal metacarpal

artery flap was planned. The site of the perforator artery was defined preoperatively with the use of a hand-held Doppler. A skin flap of 9 × 4 cm was elevated on a plane above the paratenon of extensor tendons (Figure 1B). A cuff of tissue of (1 cm²) was left intact around the area where the perforating vessel was piercing the flap. The flap was rotated 180 degrees to cover the defect (Figure 1, C and D). The donor site of the flap was covered with a split thickness skin graft. No complications were seen apart from minimal retraction of the distal end of the flap in the early postoperative period. At the patient's 3-month postoperative follow-up, the wound had totally healed with good thumb opposition (Figure 2).

Case 2

A 37-year-old male patient presented to the department of Plastic, Reconstructive, and Aesthetic Surgery with clawing of the fifth finger after a third-degree thermal injury due to a home fire disaster. On physical examination, there were flexion deformities of both the proximal and distal interphalangeal joints of the fifth finger of the left hand. In addition, the thumb had been amputated at the level of the middle of the proximal phalanx with

FIGURE 1. Reconstruction With First Dorsal Metacarpal Artery Flap



(A) The tissue defect. **(B)** Flap incision and elevation. **(C)** Adaptation of the flap on the tissue defect. **(D)** Immediate postoperative view of the flap.

contracture of the first digital web space (Figure 3A). Contracture release of the fifth finger with deepening of the first digital web space was planned. Flexion contracture of the fifth finger was released, and simultaneous reconstruction was done with the Z-plasty technique. A Kirschner wire was inserted to stabilize the finger for

4 weeks (Figure 3B). Concurrently, a perforator-based skin flap was designed in the first interdigital web space (Figure 3C). A skin flap measuring 6×3 cm was raised in a dorsopalmar alignment. The flap was then rotated 90 degrees so that the long axis of the flap was adjusted to become parallel to the axis of the thumb (Figure 3D).

FIGURE 2. Three-Month Postoperative Results of Figure 1 Patient

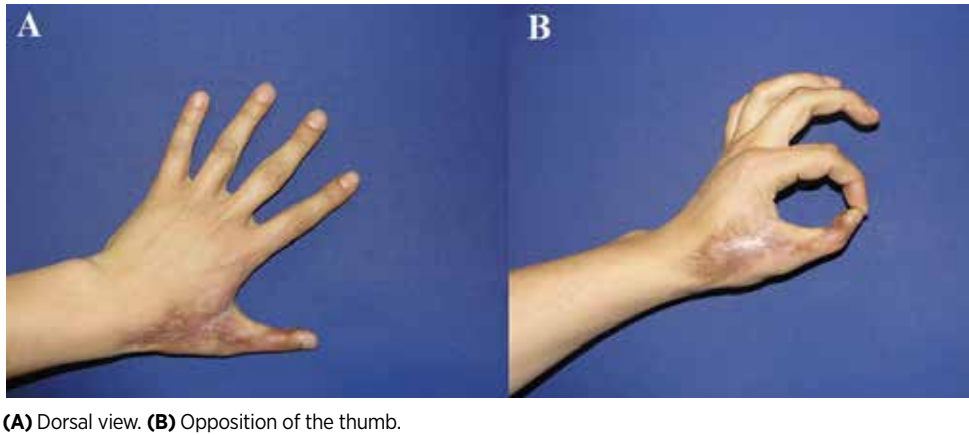


FIGURE 3. Reconstruction With Z-Plasty and Perforator-Based Skin Flap



(A) Preoperative view showing flexion contracture of fifth finger and shallowing of the first digital web space. (B) Contracture release and fixation with Kirschner wire. (C) Planning of perforator-based skin flap. (D) Immediate postoperative view showing deepening of the first web space.

Both the flap and donor site of the flap were sutured primarily with no need for skin graft. After 3 months of hand rehabilitation, there was total release of both contractures with unlimited flexion of the fifth finger and good deepening and release of the first digital web space (Figure 4, A and B).

Regional Skin Flaps

Regional flaps are derived from tissues not immediately adjacent to the primary defect but from its vicinity. When the surrounding tissues are not sufficient for coverage of a tissue defect or when the defect is too large for local skin flaps to cover, regional skin flaps can be used. Some of the regional skin flaps require only 1 operation, but other flaps require 2 operations, depending on their blood supply (that is, whether it is random or axial pattern). Regional flaps can be taken from within the hand or from the forearm according to the size and site of the wound and the extent of the burn within the extremity. Examples are pedicled regional hand flaps, reverse radial forearm flaps, and posterior interosseous artery flaps.⁸ Regional flaps taken from the hand itself have better color match than regional flaps from the forearm.

Case 1

A 41-year-old female patient presented to the burn care unit of Baskent University Hospital with a third-degree burn on the fourth finger of the right hand. The patient was a smoker and had a medical history relevant for hypertension. On physical examination, there was a deep necrotic wound measuring 6×3 cm on the ulnar aspect of the whole length of the fourth finger of the right hand (Figure 5A). After tissue debridement, the middle phalanx

and proximal interphalangeal joint were exposed (Figure 5, B and C). A plan was made to reconstruct the tissue defect with pedicled thenar flap (Figure 5D). A skin flap measuring 5×2.5 cm was raised above the level of palmar aponeurosis of the hand. The flap was adapted and sutured to the recipient site (Figure 5E). The donor site of the flap was left open to be covered later after flap division. After 4 weeks of flap delay, the flap was separated from the palm and transferred to the finger with closure of the tissue defect totally. The donor site of the flap was covered with a full thickness skin graft (Figure 5F). Long-term follow-up showed an acceptable flexion of the finger with no joint or scar contracture.

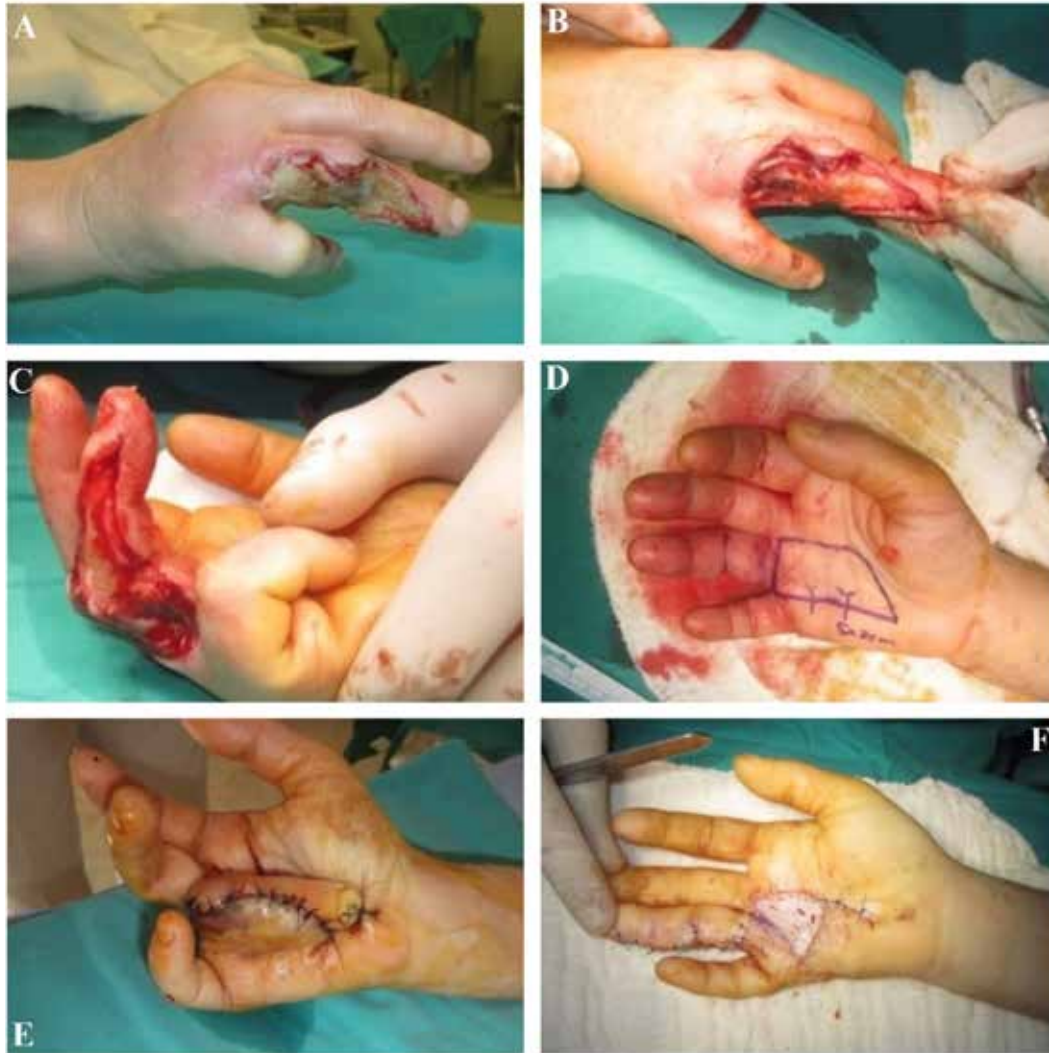
Distant Pedicled Skin Flaps (Interpolation Flaps)

Hand burns often lead to extensive damage with open wounds that might involve the wrist and regional tissues that may be insufficient for coverage. Therefore, larger flaps from distant regions are needed for reconstruction. Apart from damage to the soft tissues, thermal injury causes intimal damage of blood vessels with profound vasospasm. This sequel is more pronounced in electrical burns. The intimal damage impedes a successful anastomosis of recipient and donor vessels in free tissue transfers. Thus, a pedicled distant skin flap is indicated in patients with large tissue defects with unreliable vascular status or in cases of electrical burns. Large tissue defects of the hand or the wrist in children are also an indication for this type of skin flap since the diameter of vessels in pediatric patients is small, rendering microvascular tissue transfer difficult. Disadvantages of this method include the need for a second operation to divide the pedicle (usually after 3 to 4 weeks), thereby resulting in a longer duration of immobilization

FIGURE 4. Three-Month Postoperative Results of Figure 3 Patient Showing Excellent Contracture Release and Deepening of Web Space



(A) Fifth finger contracture release. **(B)** Acceptable deepening of the first interdigital web space.

FIGURE 5. Reconstruction With Thenar Flap

(A) Third-degree burn on the fourth finger. **(B)** and **(C)** Tissue defect after debridement. **(D)** Planning of thenar flap. **(E)** Flap inset on defect and fixation of the finger to the palm. **(F)** Immediate postoperative view.

and hospitalization. Chest, abdomen, and groin are the most commonly used donor areas for pedicled skin flaps.

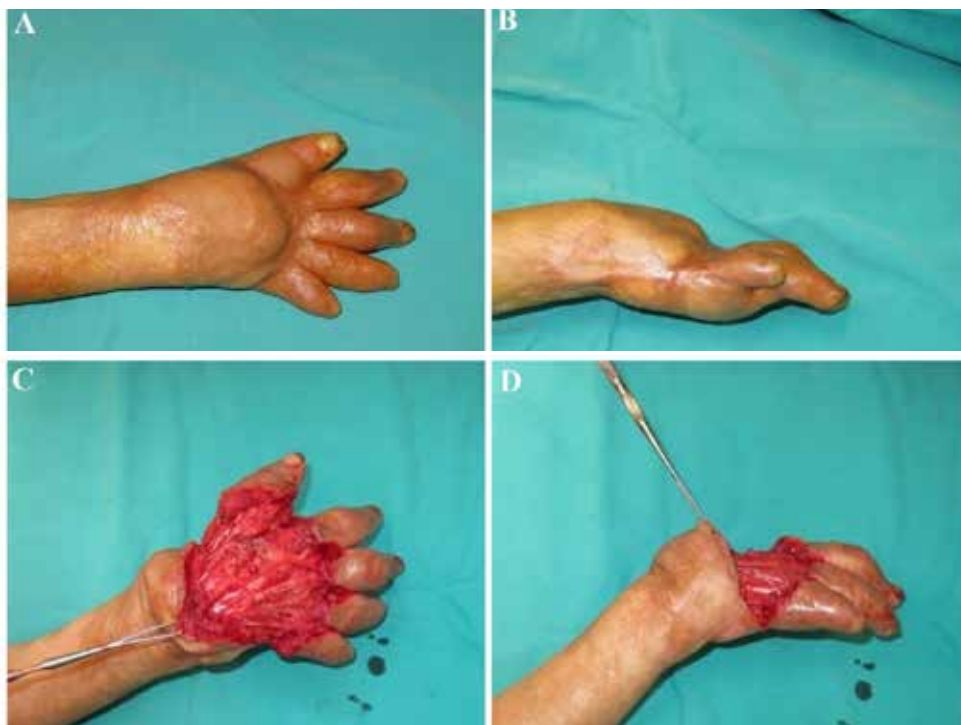
Case 1

A 7-year old child was consulted to our clinic with severe burn contracture of the right hand, which had developed after third-degree burn injury from aerosol spray. On physical examination, there was severe extension contracture with webbing of all fingers (Figure 6, A and B). The status of the regional vessels was unreliable for free flap reconstruction due to the extent of the burn. Thus, a pedicled distant abdominal flap was planned. Initially, a contracture release of the dorsum of the hand and the interdigital web spaces was performed in which underlying extensor tendons of the fingers were exposed (Figure 6, C and D). Later, a bipedicle (superior and inferior) abdominal skin

flap was designed to cover the tissue defect on the dorsum of the hand. Concurrently, small skin flaps were prepared medially to sit on the defects in between the fingers (Figure 7A). The flaps were inset and sutured as shown in Figure 7B. After 4 weeks of follow-up with daily dressing and immobilization, the flaps were divided and transferred to the hand. Early (month 1) postoperative follow-up showed a good contour and release of the contracture (Figure 7, C and D).

Case 2

A 45-year-old female patient presented to the burn care unit of Baskent University Hospital with a third-degree hand burn due to contact injury with a hot solid object. On examination, there was burn eschar on the distal part of the palm volar surface of the ulnar 4 fingers of the left hand

FIGURE 6. Severe Hand Contracture From Third-Degree Burn Injury in Pediatric Patient**(A)** Dorsal and **(B)** lateral preoperative views of the hand. **(C)** Dorsal and **(D)** lateral views after tissue debridement.**FIGURE 7.** Pedicled Distant Abdominal Flap for Figure 6 Pediatric Patient**(A)** Abdominal flap design. **(B)** Immediate postoperative view. **(C)** Dorsal and **(D)** lateral views showing the early postoperative results.

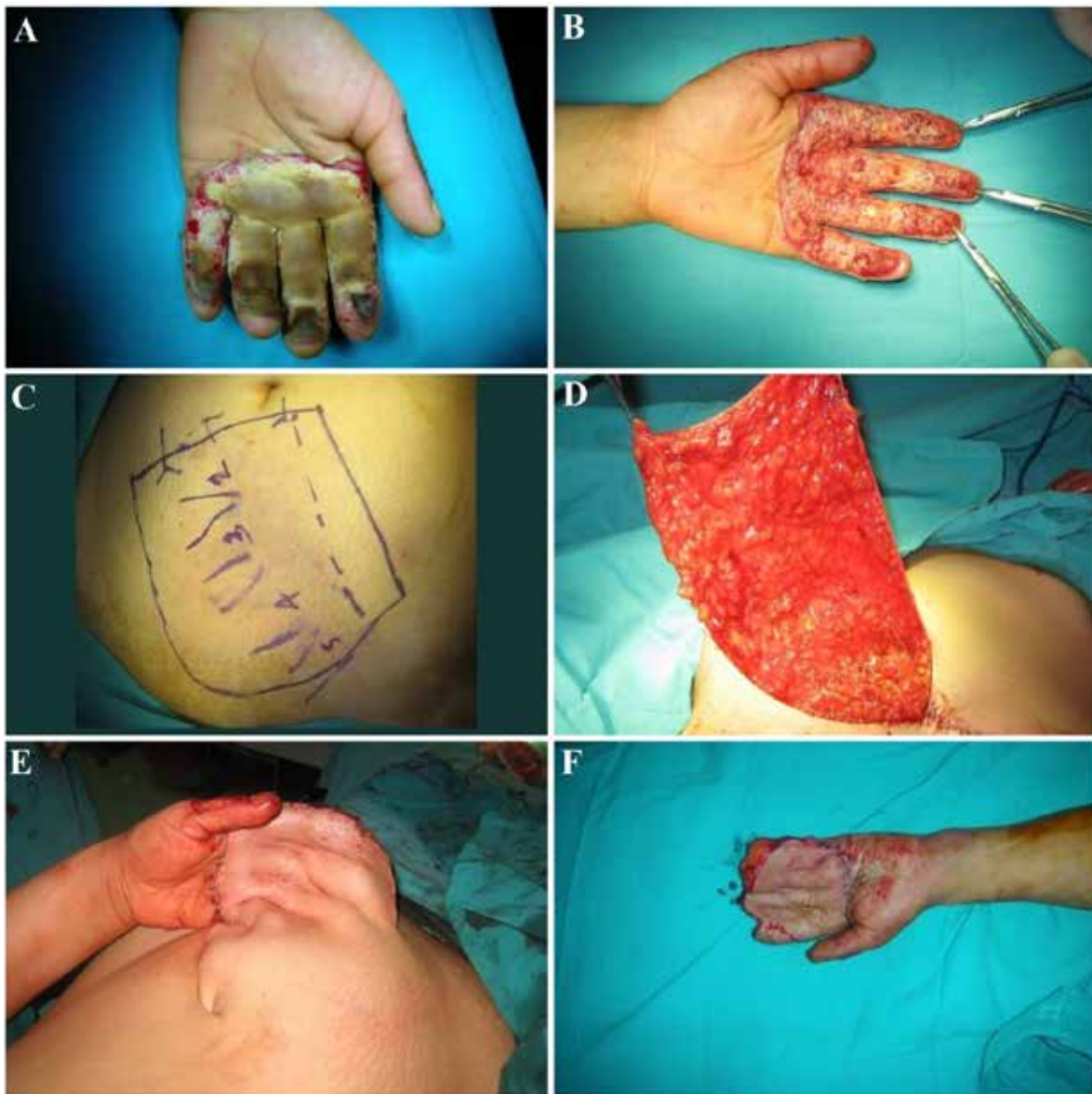
(Figure 8A). After eschar debridement, an extensive tissue defect came into view with exposure of flexor tendon of the third finger (Figure 8B). A supra-thin abdominal flap was planned for coverage of the tissue defect (Figure 8C). A superiorly based skin flap measuring 15×13 cm was raised above the Camper's fascia (Figure 8D). The flap was inset on the tissue defect as a whole (Figure 8E). Immobilization and flap delaying were done for 4 weeks to ensure blood supply to the skin flap. After flap division, the flap was transferred to the hand and the donor site was closed primarily (Figure 8F). After 2 months of follow-up, fingers

were separated and the flaps were contoured to each finger individually. A 3-month postoperative follow-up showed an acceptable contour of fingers with good grip and grasp function of the hand (Figure 9).

Free Tissue Transfer

Microvascular transplantation is presently the reconstructive method of choice for large burns of the hand.⁹ This field is maturing, with a wealth of well-understood methods and algorithms. Microsurgical tissue transfer is being done today with high success rates and good outcomes.

FIGURE 8. Reconstruction With Pedicled Abdominal Flap



(A) Third-degree contact burn on left hand. **(B)** Immediately after tissue debridement. **(C)** Abdominal flap planning. **(D)** Elevation of supra-thin skin flap. **(E)** Coverage of the tissue defects of the palm and the fingers with the flap. **(F)** Flap division.

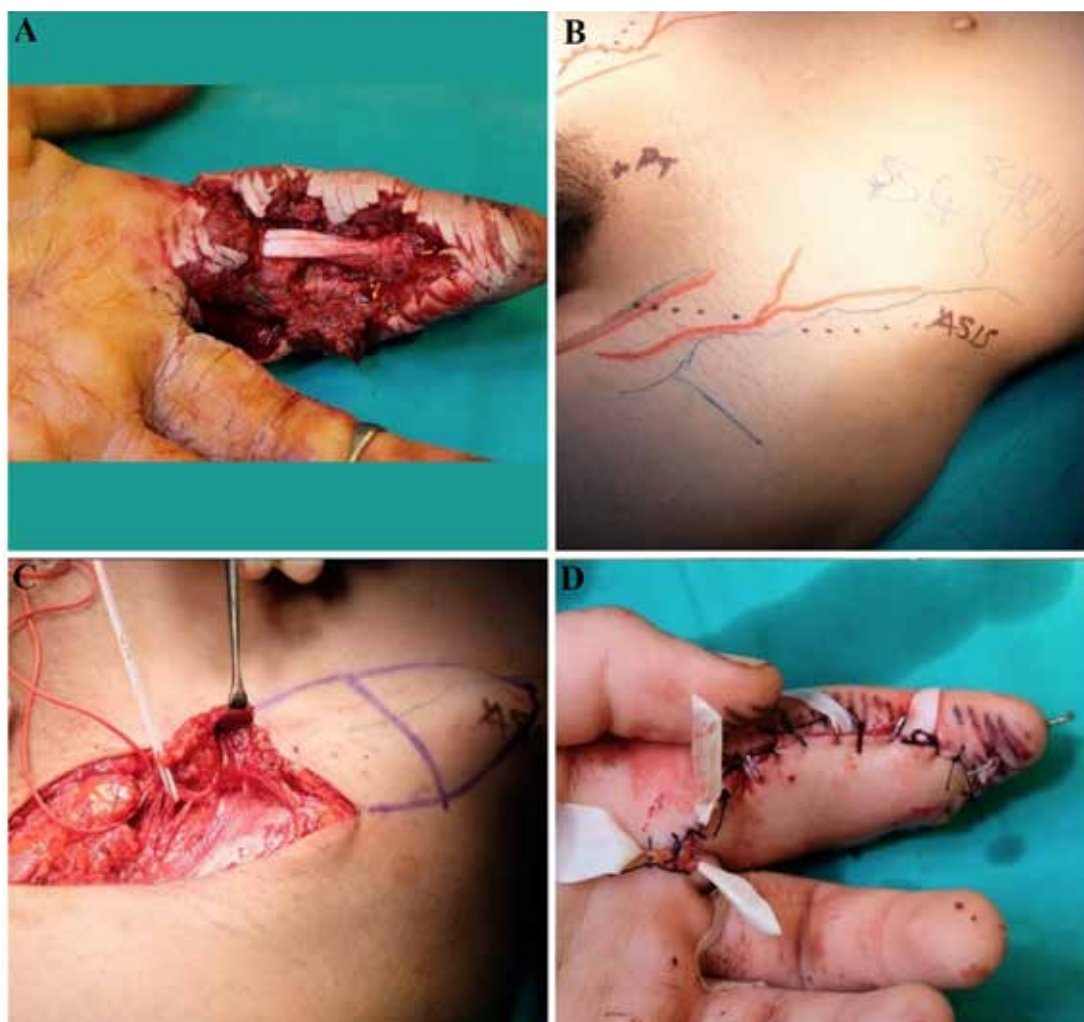
FIGURE 9. Three-Month Postoperative Results of Figure 8 Patient

Apart from their frequent use in the acute management of burn wounds with exposed structures, free flaps play an important role in delayed reconstruction after contracture release to prevent the recurrence of the contracture.¹⁰

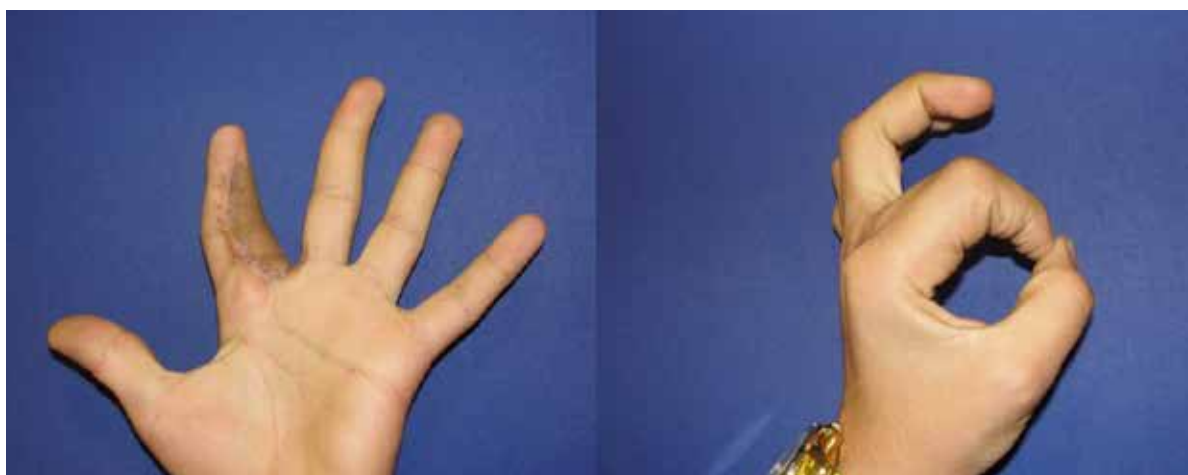
A wide variety of free skin flaps can be used in acute and delayed burn reconstruction. The superficial circumflex iliac perforator (SCIP) flap, the anterolateral thigh flap, the radial forearm flap, and the free medial pedis perforator flap are the most widely used free skin flaps.¹¹ Free flap selection is based on the site and the size of the tissue defect, tissue characteristics, donor site availability, length of the pedicle that is required, and preferences of the surgeon. Thin skin flaps can be procured to match the thickness of hand skin for better contouring and to avoid the functional limitations of thick flaps. This method of reconstruction has disadvantages for electrical burns and in pediatric patients and requires surgeon experience with microsurgery of hand burns.¹² Usually, there is also a need for additional skin grafts to cover the donor site of the flap. Preoperative angiography is recommended to ensure the patency of the recipient vessels.

Case 1

A 17-year-old healthy male patient was referred to our burn care unit with an open wound on his left hand as a result of contact burn injury. Wound debridement was performed in another hospital. On physical examination, there was a deep wound measuring 5×3 cm on the volar surface of the proximal and middle phalanx of the second finger of his left hand (Figure 10A). Reconstruction with a free SCIP flap was planned. A skin flap of 7×4 cm was designed in the left groin based on the territory of the perforating vessel (Figure 10B). After skin incision and flap elevation, the superficial circumflex iliac vessels were reached and dissection was carried out until a pedicle length of 3 cm was provided (Figure 10C). After pedicle transaction, the flap was transferred and adapted on the tissue defect on the finger (Figure 10D). The artery of the flap was anastomosed to the stump of the ulnar digital artery while the vein was anastomosed to a dorsal vein. No complications were seen postoperatively. A 3-month follow-up showed an excellent contour with no limitation of finger movements (Figure 11).

FIGURE 10. Reconstruction With Free Superficial Circumflex Artery Flap

(A) Deep tissue defect on the second finger with exposed flexor tendon of the finger. **(B)** Flap planning. **(C)** Intraoperative view showing the pedicle of the flap. **(D)** Immediate postoperative view of the flap.

FIGURE 11. Three-Month Postoperative Results of Figure 10 Patient

SUMMARY

Skin flaps are commonly used in reconstruction of hand burns. Skin flaps provide reconstruction with vascularized tissues that are thin enough to allow for unrestricted movements and are bulky enough to prevent scar contracture. Greater functional and esthetic improvements can be provided by the use of different types of skin flaps, each designed according to the patient's individual characteristics.

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