

The Glabrous Palmar Flap

The New Free or Reversed Pedicled Palmar Fasciocutaneous Flap for Volar Hand Reconstruction

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Abstract: We devised a new flap using the palmar cutaneous branch of the superficial radial artery proximally and anastomosed with a cutaneous perforator of the superficial palmar arch distally. We named our flap “the volar glabrous palmar flap.” The flap was used both as a free flap and as a reverse-flow island flap. Thirty-six patients with volar hand defects (24 digits, 7 palms, and 5 first web space) were reconstructed with this flap. The flap was used as a proximally based free flap in 15 patients and was used as a reverse-flow island flap based on distal communication in the remaining 21 patients. Free flaps were supplied by the palmar branch of the superficial radial artery and its fasciocutaneous extensions; reverse-flow island flaps were supplied by one of the perforating branches of the superficial palmar arch, which is connected to the proximal fasciocutaneous branches. Flaps extended from the wrist crease to the proximal palmar crease and were designed medially on the thenar crease, extending 2 to 2.5 cm laterally. Flap sizes ranged from 1.5 × 2.2 cm to 2.5 × 10 cm. The palmar cutaneous branch of the median nerve within the flap area was identified and then was sutured to the divided digital nerve in 6 cases of finger pulp defect. The donor sites were closed and repaired primarily in most cases. The postoperative course was uneventful, and all the flaps survived without major complications. Follow-up (minimum 6 mo, mean 24 mo) showed excellent functional and cosmetic results. Satisfactory sensory reinnervation was achieved in patients who underwent sensory flap transfer for pulp defects. At the same time, we studied 6 cadaver hands to understand the vascular anatomy of the thenar area of the hand. We also revised several published anatomic papers to obtain a refined and scrutinized understanding of the palmar anatomy.

Key Words: glabrous skin, palmar flap, superficial radial artery, hand defect

(*Tech Hand Surg* 2009;13: 145–150)

HISTORICAL PERSPECTIVE

Coverage of full-thickness volar hand defects of the palm and the volar digits remain a challenge for hand surgeons. Various procedures are described for reconstruction of defects involving volar soft tissue defect of the palm and digits. Large defects can be reconstructed with many different types of flaps and grafts, but the texture of the skin that the flaps and grafts provide is not glabrous, unlike the palm. Upton et al¹ in 1992 said that the ideal substitute for palmar defects must be sensate, durable, relatively immobile, hairless, and thin. Palmar skin is thick and fixed by fibrous septa, and the shifting of local skin in the palm is only possible to a limited extent. Palmar skin needs to withstand high pressure, so only full-thickness skin grafts or flaps are able to give sufficient cover.

We performed a literature search on the different kinds of flaps used for coverage of glabrous skin. In this paper, we did not include any papers that described flaps that were used to cover skin not having similar characteristics to the donor site. Our literature search revealed that Melone et al² in 1971 was one of the first people to describe a thenar flap that was used for coverage of glabrous skin defects of the fingertips. He tested 150 of the flaps on patients with accidental wounds. Excellent cosmetic results were achieved, but the functional results showed flexion contractures of the proximal interphalangeal joint.² Dellon³ in 1983 also described a thenar flap that was used for volar fingertip reconstruction. Results were similar to the clinical study Melone et al² performed, including excellent functional cosmetic results but flexion contracture of the proximal interphalangeal joint and a need for a second stage. The mini-thenar free flap based on the thumb radial digital artery was presented by Tsai et al⁴ in 1991. The flap was used as a free flap, raised at the level of the metacarpophalangeal joint, and it was used on a woman who sustained a fracture of the middle phalanx and a circumferential laceration of the palmar aspect of the index finger at the same level. The flap included the radial digital artery that was used to revascularize the index finger, and a palmar vein was used to drain the flap. Excellent cosmetic and functional results were achieved, but the procedure resulted in minimal donor site morbidity. Another free thenar flap was described by Kamei et al^{5,6} in 2 cases in 1993. The flap was based on the superficial palmar branch of the radial artery (SPBRA), in connection with the radial flap, and it was used on patients with serious finger injuries. Omokawa et al⁷ described a flap from the radial thenar area based on the SPBRA in 1996. The vascular supply of the flap was based on the radial artery and extending the vascular pedicle to the SPBRA.⁷ Thirty fresh cadaver hands were tested using this flap. Omokawa et al⁸ also presented a transversal distal palmar reverse-flow island flap that was tested on 30 fresh cadaver hands in 2001. The purpose of their study was to explore the vascular and neural anatomy of the midpalmar area of the hand to assess reverse-flow island flaps from this area. Pilz et al⁹ in 1997 described the free or reverse-flow thenar flap based on the SPBRA and the superficial palmar arch in their cadaver study and was used as a free flap to repair the defect after the release of Dupuytren contracture of the fourth finger. Vasconez et al¹⁰ in 1992 presented the use of an arterialized palmar flap to resurface thenar web contractures, and it was based on cutaneous branches of the index digital artery. The first flap based on the reversed flow through the palmar common digital artery was described by Zancolli¹¹ in 1990. The flap was used as a reverse-flow island flap for coverage of fingertip defects, and the donor site was sealed with glabrous skin. The flaps described by Vasconez et al¹⁰ and Zancolli¹¹ resemble our flap the most.

Aside from conventional thenar flaps, there are only a few pedicled flaps rising from the palmar and thenar regions. Our

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flap uses the palmar cutaneous branch of the superficial radial artery proximally and is anastomosed with a cutaneous perforator of the superficial palmar arch distally. The glabrous skin of the palm provides the best tissue match for the reconstruction of volar defects, but only a limited amount of tissue is available for this purpose.

Detailed vascular and neural anatomy of the palm was investigated in cadaver studies by some authors,¹²⁻¹⁴ and SPBRA was consistently found in all studies. We could not find any flap based on the proximal cutaneous branch of the superficial palmar radial artery. Taylor and Tempest¹⁵ described the cutaneous arteries of the thenar eminence as long, fine, and minimal, arising from the SPBRA and the lateral digital of the thumb. Omokawa et al¹² in 1997 identified the perforating branches originating from the SPBRA, which lie on the thenar fascia. These branches nourish the thenar cutaneous area. After giving off these branches, the main branch continues within the thenar muscles.¹² We planned our flap to be nourished by the proximal and distal perforator branches. To increase our surgical experience in the dissection of the proximal and distal perforating branches, we performed a cadaver study to present our experience using this new flap for volar hand reconstruction in 36 consecutive patients.

INDICATIONS/CONTRAINDICATIONS

Thirty-six patients with volar hand defects (24 digit, 7 palm, and 5 first web space) were reconstructed with the volar glabrous palmar flap (21 reverse-flows, 15 free). The average patient age was 45 years (range, 8-60 y), and 9 patients were smokers. Etiologic factors were traumatic (21 cases), burn contracture release defects (10 cases), and Dupuytren contracture release defect (5 cases). We used neurovascular flaps in 6 finger pulp amputation cases. Four of them were in the index finger, and the other 2 were in the thumb. The free flap was not used in any patients who were smokers. All surgeries were performed on an outpatient basis, with a follow-up schedule after surgery: every day for the first 5 days, then every week until 2 months, 6 months, 12 months, 24 months, etc. All flaps survived without major complications and showed excellent cosmetic and functional results.

SURGICAL TECHNIQUE

We performed an anatomic dissection on 6 fresh cadaver hands. It was consistently found that the radial artery bifurcated (Fig. 1A) into superficial palmar and dorsal branches 1 to 2 cm (mean 1.2 cm) proximal to the distal wrist crease. In all cadavers, the SPBRA (Fig. 1E) and its venae comitantes run superficial to the flexor carpi radialis tendon, ascend underneath the palmar fascia (Fig. 1D), and give a major branch to the thenar musculature (Fig. 1B), which contributes to the superficial palmar arch (Fig. 1C). At the level of the wrist crease, a cutaneous terminal branch of this superficial palmar artery continues superficially toward the skin, piercing the palmar fascia at a point 0.5 to 1 cm radial to the thenar crease. The average diameter of this branch was 1.2 mm (1-1.4 mm) at this site. These perforating branches formed the proximal pedicle and blood supply of our flap. Our studies showed that the palmar cutaneous branch of the superficial radial artery connects to either the superficial palmar arch or to the deep palmar arch in all cases. Distally, around the junction of the outstretched thumb axis (Kaplan line) and the axis of the third digital ray or the second web, there is a perforator branch that connects the terminal branch

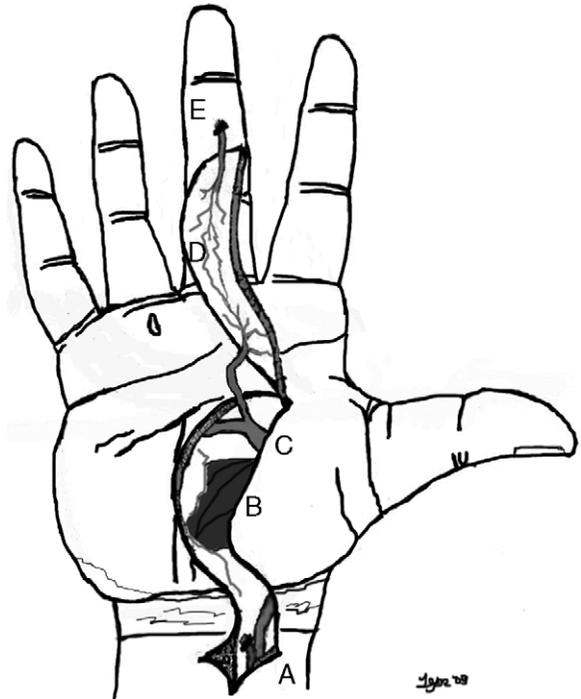


FIGURE 1. A, The radial artery bifurcated into superficial palmar and dorsal branches 1 to 2 cm (mean 1.2 cm) proximal to the distal wrist crease. B, Major artery radial branch to the thenar musculature. C, SPBRA contributes to the superficial palmar arch. D and E, SPBRA run superficial to the flexor carpi radialis tendon, ascend underneath the palmar fascia. At the level of the wrist crease, a cutaneous terminal branch of this superficial palmar artery continues superficially toward the skin. SPBRA indicates superficial palmar branch of the radial artery.

of the superficial palmar artery with the superficial palmar arch. This is the distal blood supply of our flap.

A palmar skin flap perfused by the proximal pedicle can be raised as a free flap, and the same cutaneous territory can be raised as a reverse-island pedicled flap perfused by the distal perforator. This cutaneous island flap extends from the wrist crease to the transverse palmar crease, is bordered ulnarly by the thenar crease, and can be made 2 to 2.5 cm wide while closing the donor defect. If the patient's defect is too long, and a classically designed flap is not enough to repair the defect, the distal pedicle (which contains the common digital artery or perforator from the common digital artery) of the second web or proximal pedicle may be extended to the origin of the SPBRA. Sensory nerve branches originating from the median nerve were found inside the flap in all cadavers.

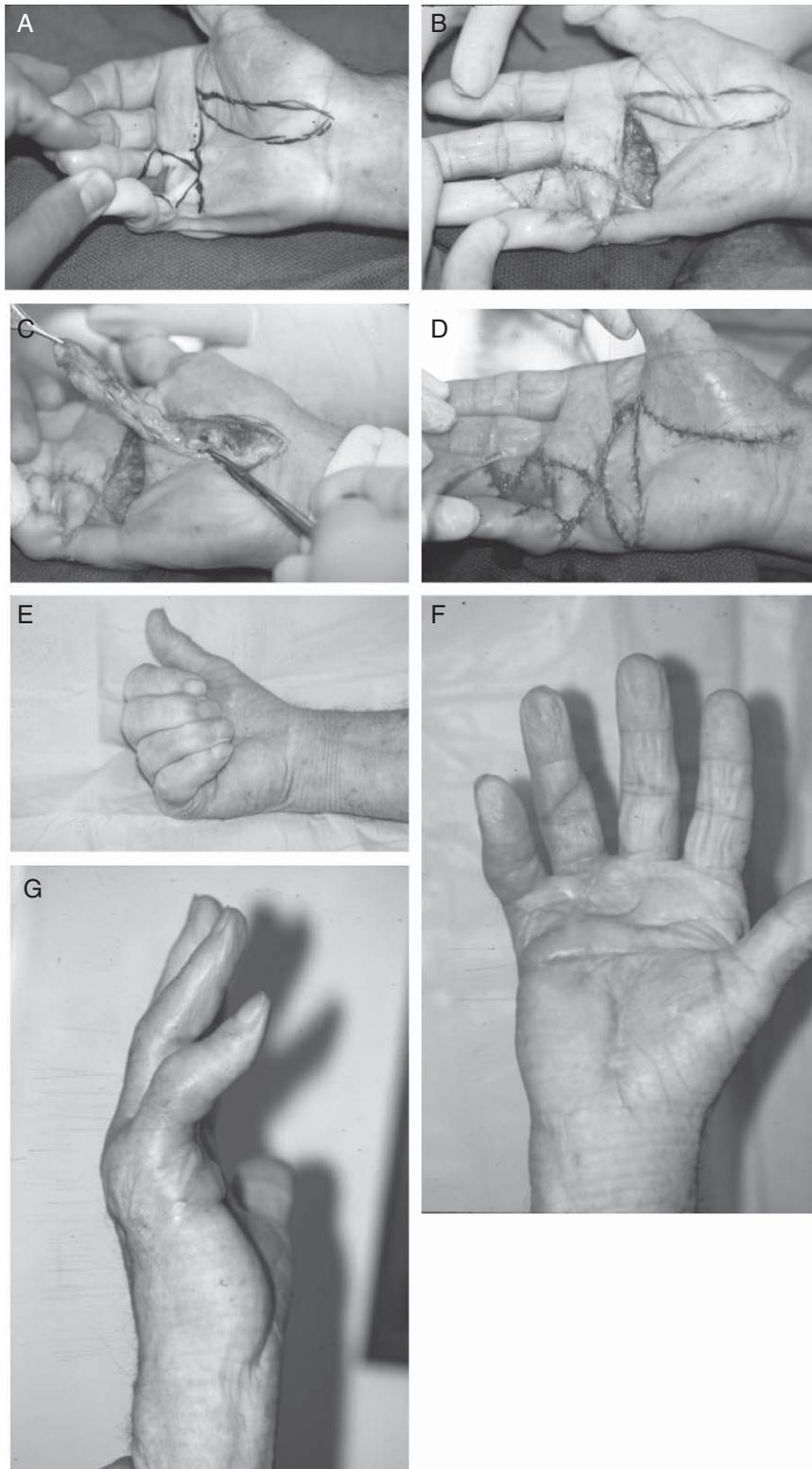
On all of our patients, SPBRA was identified with vascular Doppler before surgery in all cases to facilitate identified superficial cutaneous branches, and a free or a reverse-flow island flap was planned. The flap extended from the wrist crease to the proximal palmar crease, and it was designed medially on the thenar crease and extended 2 to 2.5 cm laterally. If the classically designed flap length was insufficient, extra pedicle length was provided by further dissection to the level of the common digital artery of the second web. Likewise, the proximal pedicle could be extended to the origin of the SPBRA. All of the flap dissections were performed proximal to the distal palmar crease, and the thenar



CASE 1. Neurovascular flap for index finger pulp reconstruction. Thirty-nine year old male that had a 1.6 × 5 cm right index finger pulp defect caused by incidentally injecting paint into his index finger. After this injection, ul thickness pulp skin necrosis has occurred (A,B). In order to cover the defect, a neurovascular free palmar flap based on proximal pedicle was designed. The cutaneous branch of the palmar radial artery and accompanied vein were anastomosed to the right digital artery (C). The palmar cutaneous nerve was dissected and was included in the flap, and the palmar cutaneous nerve was anastomosed to the right digital nerve (D,E). The flap survived without complications (F). Two points discrimination was recorded at 6 mm in the patient 16 months after surgery.

fascia was included in the flaps to enhance vascularization. A small cutaneous nerve originating from the palmar cutaneous branch of the median nerve was identified inside the flap in 6 cases. One of these nerves was sutured to the divided digital nerve ends. Flap sizes ranged from 1.5 × 2.2 cm to 2.5 × 10 cm. The smallest flap (1.5 × 2.2 cm) was used as a

free flap in a 21-year-old patient to cover a ring finger pulp defect. The largest flap (2.5 × 10 cm) was used as a reverse-flow island flap in another patient with first web contracture. In the free transfer cases, flap dissection and the microvascular anastomoses were usually performed during the same tourniquet run (<2 h).



CASE 2. Reverse-Flow Island Flap for Palmar Reconstruction. Sixty-three year old male that had Dupuytren's disease in both hands with severe 90 degree flexion contractures in the right ring finger and small finger (A). The palmar fascia causing the contracture was excised, and the ring and small finger contractures were released (B). The palmar defect was reconstructed using a 2.2 x 7.3 cm reverse-flow island flap (C,D). The postoperative course was uneventful. Full range of motion and full release of the contracture were achieved (E,F,G).



CASE 3. Reverse-Flow Island Flap for First Web Space Contracture Release. Thirty-five-year-old woman with a 30-degree first web adduction contracture of the left hand caused by a burn scar (A). A 2 x 6 cm flap was designed based on the distal perforator to resurface the first web (B). After adequate release of the first web (C), the reverse-flow island flap with 2 triangular extensions was transposed to the first web (D-F). The donor site was closed primarily, and the postoperative course was uneventful. Excellent functional and cosmetic results were obtained (G-I).

COMPLICATIONS

Only 1 patient (aged 76 y), on whom Dupuytren release was performed, suffered from a distal necrosis due to venous congestion. This resolved spontaneously.

SUMMARY

A new fasciocutaneous flap from the palmar region was proposed along with our clinical results. Conventional flaps for reconstruction of volar hand defects have some disadvantages. Donor site morbidity, loss of sensation in the finger, insensitivity of the flap, possible injury to other fingers, and poor tissue match are some disadvantages of these methods. The ideal flap procedure to reconstruct the hand defects must provide same tissue match, sensibility, low donor site morbidity, minimal scar contracture, unrestricted mobilization, easy wound care, a 1-stage outpatient operation, and 1

operative field.¹ Although this is the ideal for flaps, there is yet to be a flap that provides most of these terms. Our flap, nonetheless, provides most of these terms in all cases. Sensibility was only necessary in 6 cases, which allowed for the palmar cutaneous branch of the median nerve to be used. Although Omokawa et al¹² described the detailed neural anatomy of this area, there is not a consistent and a long neural pedicle in this region. In our cadaver study, we consistently found a long neural pedicle in all the specimens.

Although a lot of vascular variations of the superficial vascular arch were described by different authors, the superficial cutaneous branch of the radial artery was consistently found in all specimens.^{13,14} Omokawa et al¹² found that the constant area of skin supplied by the superficial palmar branch was an area approximately 4 x 3 cm, located over the proximal parts of the abductor pollicis brevis and opponens muscles. However, if the flap is to be longer than 2.5 cm, the donor site

cannot be closed primarily. There is little sacrifice of the donor sites in our new flap procedure because primary closure of the donor defect is possible. We found that the thenar flap described by Kamei et al⁵ can be bigger than the flap size he describes (2.5 × 1.5 cm). We also found that Zancolli¹¹ in 1990 described that it was possible to use different flaps from the skin of the central portion of the palm for coverage of finger defects, but in his paper, he did not comment on the size of the flap and its sensation. Our flap design generally does not need to divide the SPBRA. Most of the cases only need the sacrifice of the cutaneous terminal branch. We advocate that it is unnecessary to divide the SPBRA during flap construction, as we found that the proximal perforating branches alone were capable of nourishing the flap. The diameter of this branch is comparable to the digital arteries. If the caliber of the perforating branch from the SPBRA was not suitable for anastomosis, we preferred to use the SPBRA as a pedicle.

CASES

In case 1, a free neurovascular was used for index finger pulp reconstruction on a patient with full-thickness pulp skin necrosis. Normally, a volar defect of the finger was formerly treated with a cross-finger flap, later with advancement flaps, and recently with neurovascular island flaps from the finger or dorsal metacarpal area.¹⁶ There are a lot of problems with these flaps. For example, staged flaps need prolonged immobilization and a second stage. Reverse digital artery flaps from the palm and the digits need the sacrifice of one of the main supplies of the digit. Preoperative Allen test or Doppler examination is mandatory in all cases.¹⁶ We propose the use of our flap as a neurovascular free flap in all finger cases.

In case 2, a reverse-flow island flap was used for palmar reconstruction on a patient that had Dupuytren disease. There is no literature about the use of reverse-flow flaps for reconstruction of Dupuytren contractures. Only Pilz et al⁹ used a free thenar flap to repair a defect caused by the release of a Dupuytren contracture on the fourth finger. Due to the fact that this flap provides same tissue match and appropriate thickness, it is the most suitable reverse-flow island flap in cases of Dupuytren release defect, but distal flap necrosis may occur, especially in elder and smoking patients (Fig. 2).

In case 3, a reverse-flow island flap was used for first web space contracture release caused by a burn scar. Volar defects of the palm and the first web space were formerly treated with local flaps, grafts, island flaps from the forearm, and distant flaps from the abdomen and the groin.^{17,18} All these flaps have some disadvantages, especially in the donor sites, including wrong tissue match because of the color, type of skin, and elasticity, morbidity, and insensitivity. Consequently, our flap, either as a free flap or as a reverse-flow

island flap, is an excellent alternative for palm and volar digital reconstruction.

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