Use of a Subcutaneous Pedicle Ulnar Flap to Cover Skin Defects Around the Wrist

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A subcutaneous pedicle ulnar flap used to cover a skin defect around the wrist is reported. Unlike the standard ulnar flap, which is isolated around the dorsal branch of the ulnar artery and its associated veins, this flap is based on the ascending branch of the dorsal branch of the ulnar artery more proximally to obtain a longer vascular pedicle. A subcutaneous pedicle flap that contained the ascending branch, its associated veins, and a superficial vein was obtained. The disadvantages of the standard ulnar flap can be overcome by this design, which provides greater mobility, preserves the healthy skin between the rotation point and the defect, and eliminates contour abnormalities. (J Hand Surg 1998;23A:551-555. Copyright © 1998 by the American Society for Surgery of the Hand.)

A flap based on the dorsal branch of the ulnar artery was originally described by Becker and Gilbert. This standard flap, which is supplied by the dorsal branch of the ulnar artery and its associated veins appears to be a simple and reliable means of providing good-quality coverage for medium-sized skin defects of the hand. This flap, however, does not have the ease of transfer and the mobility of a genuine island flap because the pedicle is short. Although intervening skin is not required for reconstruction, a large cutaneous area is harvested to obtain a long pedicle. The standard flap sacrifices the healthy skin between the donor defect and the pivot point of the flap. In addition, it causes contour abnormalities at the base of the flap, which will later require adjustment.

To overcome these disadvantages, we studied a modified technique in which the flap was planned on the ascending branch of the dorsal branch of the ulnar artery. It was raised with a subcutaneous pedicle centered around the ascending branch, its associated veins, and a superficial vein and dissected up to the dorsal branch of the ulnar artery (Fig. 1).

The subcutaneous pedicle design offers several advantages. First, the pedicle is soft and pliable, and can be transferred smoothly without kinking. Second, the pedicle, which is approximately 5 cm long, provides a greater rotation arc than a wide skin pedicle. Third, this flap is tunneled subcutaneously under the intervening skin bridge and inset into the distant defect. Use of a subcutaneous tunnel obviates the need to sacrifice a bridge of normal skin. Fourth, no contour abnormality is created by flap rotation because no skin is placed in the area adjacent to the rotation point or between the rotation point and the defect. Finally, using our modified technique, the ulnar side of the distal forearm is preserved. This
permits primary, tension-free closure. Closure of the preserved skin over the rotated subcutaneous pedicle has the added benefit of eliminating contour irregularity and improves the aesthetic result (Fig. 2). We report a case of the subcutaneous pedicle ulnar flap for resurfacing a soft tissue defect on the dorsal surface of the hand.

**Surgical Anatomy**

The dorsal branch of the ulnar artery originates between 2 and 4 cm proximal to the pisiform. This constant artery, with a diameter of 1 to 1.3 mm, passes medially beneath the flexor carpi ulnaris tendon. This artery runs an oblique line from the volar surface of the distal forearm to the dorsoulnar surface. Three collateral branches appear 3 to 6 cm down a common trunk. The proximal branch enters the flexor carpi ulnaris muscle 4 to 6 cm from its pisiform insertion. The distal branch is the pisiform artery. The medial branch is a fasciocutaneous branch, which divides into ascending and descending branches behind or on the inferior surface of the flexor carpi ulnaris. The ascending branch passes between the ulnar crest and the posterior border of the flexor carpi ulnaris and then divides into multiple ramifications. It provides the vascularization of a large area of skin on the ulnar side of the forearm (9-20 cm long × 5-10 cm wide). The ascending branch runs along the ulnar border of the forearm for 9 to 20 cm, and the descending branch connects with the dorsal carpal arch. The ulnar artery is accompanied by 2 venae comitantes, as is the dorsal ulnar artery. Anastomotic veins connect the very rich superficial venous network to one of the vena comitantes. The dorsal branch of the ulnar nerve must be protected while identifying the dorsal branch of the ulnar artery. The nerve emerges from the medial border of the flexor carpi ulnaris at a point approximately 5 cm proximal to the pisiform. This nerve follows the descending cutaneous branch and reaches the dorsal side of the hand. Proximal to the wrist, 2 to 3 branches are given off, 1 branch to the ulnocarpal joint and the other 2 branches to the dorsum of the hand and fingers.²

**Case Report**

A 65-year-old man presented with a 2 × 2 cm squamous cell carcinoma on the dorsum of the wrist. There was no adenopathy. Surgical excision with a 1.5-cm margin was performed (Fig. 3A). The excision specimen included skin and paratenon. In view of the depth and localization of the defect, a flap coverage was required. A flap measuring 5 × 4 cm was designed on the skin territory of the ascending branch approximately 9 cm proximal to the pisiform (Fig. 3B). The dorsal branch of the ulnar artery was localized as it emerged under the flexor carpi ulnaris tendon, 4 cm proximally to the pisiform. Care was paid to the dorsal branch of the ulnar nerve while identifying the dorsal branch of the ulnar artery. The flap was incised through skin and subcutaneous tissue down the deep fascia along its proximal and ulnar margins and through skin only along its distal margin. The flap was raised from proximal to distal without including the deep fascia. The subcutaneous pedicle was then liberated in the subdermal plane by preserving the ascending branch,
Figure 2. (A) The postoperative appearance of the standard ulnar flap. I: Closure of the ulnar side of the distal forearm under tension. This area is included in the flap to obtain a long pedicle, although it is not required for reconstruction. II: Contour abnormalities in the ulnar side of the distal forearm. III: Intact skin is sacrificed for flap insetting. (B) Postoperative appearance of the subcutaneous pedicle ulnar flap.

Figure 3. (A) Skin defect after tumor excision. (B) A 5 × 4 cm flap was plotted on the ascending branch of the ulnar artery. X, Pisiform. (C) A subcutaneous pedicle flap was dissected up to the dorsal branch distally. (D) The intact skin between the rotation point and the defect was preserved. (E) Postoperative view 2 years after surgery. (F) The donor scar was almost invisible, with no contour abnormalities.

Discussion

In the original technique described by Becker and Gilbert, the flap is isolated on the dorsal branch and transferred to the defect by being rotated around this pivot point. Holevich-Madjarova et al. included 1 to 2 superficial veins in the vascular pedicle to improve the venous drainage and also suggested a racquet-shaped design to prevent the tiny subdermal veins from tension during closure. We had no problem with inadequate venous drainage of the flap, possibly because of the dual drainage. The primary venous drainage is through the deep venous system, which accompanies the dorsal branch and the descending branch. The superficial vein served as a second drainage system. Use of the ulnar flap to cover suitable defects has well-known advantages over the use of distally based island flaps: the surgical technique is quick and easy, no major hand vessel is sacrificed and the donor scar is more ulnar and less obvious. Our modification has several added advantages: the subcutaneous pedicle of the flap permits an easier flap transfer without any noticeable contour abnormalities at the base of the flap, the flap is transferred to the wrist defect...
See p. 553 for legend to Figure 3.
THE DORSOULNAR FLAP BASED ON DISTAL BRANCHES OF THE ULNAR ARTERY

Unlike the ulnar artery forearm flap, the dorsoulnar flap does not interrupt the ulnar vascular axis. First described by Becker and Gilbert, it is perfused by the ascending branch of the dorsal ulnar artery, one of the major branches of the ulnar artery in the distal forearm.

Flap Elevation

The dorsal ulnar flap can be raised either with a cutaneous bridge as a hinge (peninsular design), or as a true island flap. To cover the hand, contrary to the previously described flaps, it is not a reverse flow flap, but a distally based island flap.

The flap is outlined over the ulnar aspect of the forearm according to the defect size. The anterior limit can be safely placed up to the palmaris longus tendon, and posteriorly the flap may be extended to the extensor digitorum communis tendon of the fourth finger. The length of the flap is determined by the major axis of the tissue loss but can extend up to 20 cm. The effective pivot point is 2 to 4 cm more proximal to the cutaneous hinge of the flap. This is the point where the dorsoulnar vascular pedicle enters the skin.

The operative procedure is performed under pneumatic tourniquet without exanguinating the limb for better identification of the pedicle. When raising a peninsular flap, the dissection is carried out from proximal to distal in a subfascial plane. The pedicle emerges from the ulnar artery 2 to 5 cm proximal to the pisiform (Fig. 9). It is exposed by retracting radially the flexor carpi ulnaris. Once the pedicle is visualized, the dissection stops and the flap is rotated to cover the defect. With a cutaneous hinge, the flap does not freely rotate and the effective pivot point is actually 2 to 4 cm more proximal.

When a true island flap is planned, the dissection is slightly more difficult. The dorsoulnar artery has to be dissected first at its origin from the ulnar artery before the distal border of the flap can be determined and the distal incision which permits the 180° free pivot performed.

Discussion

Especially with the peninsular variant, this flap has the main advantage of being very simple and rapid to dissect. It is also very reliable and can allow the transfer of a very large amount of well-perfused tissue (Fig. 10). Because it is not a reverse flow flap, the danger of venous congestion is minimized. Like the posterior interosseous flap, this flap can cover the hand without the sacrifice of one of the major perfusion axes.

The main disadvantage of this flap is its short pedicle and its relatively limited arc of rotation. The flap can reach only the proximal palm and the ulnar dorsum of the hand. The peninsular design leaves an unsightly standing cone at the ulnar border of the wrist.
The dorsal flap is its duality, and the distal hand. The wrist.

**Figure 10. Dorsoulnar flap: clinical case.** A. Outline of the dorsoulnar flap to be used to reconstruct a major crush injury involving both palmar and dorsal surfaces. B. The dorsoulnar flap is dissected, and the complex hand defect is evident. C. The dorsoulnar flap is folded over and de-epitelized as a vascular bed for tendon grafting. D. A contralateral radial forearm free flap is added for final skin cover. View in flexion. E. View in extension.
The island design avoids this problem but increases the complexity of the operation and puts flap at greater risk of failure.

THE ANTERIOR INTEROSSEOUS FLAP

Until 1989, the only axes used for pedicle flap transfer to the hand were the radial, the ulnar, and posterior interosseous arteries. The authors then developed the idea of studying the fourth available well-known axis, the anterior interosseous artery (AIA).

Over its proximal course, the vessel lies deep in the anterior compartment over the interosseous membrane. In the distal forearm, most of its cutaneous branches perfuse the dorsal and not the volar skin. The AIA has two large distal branches that pierce the interosseous membrane to emerge in the posterior compartment between the extensor pollicis longus (EPL) and the extensor pollicis brevis (EPB). Contrary to what the name may suggest, the cutaneous paddle is harvested from the dorsal radial part of the distal forearm. To reach the hand as a pedicle flap, the authors' recently described principle of Y-to-V lengthening of the pedicle is needed. A brief description of the Y-to-V principle is needed (Fig. 11).

There are many situations in which the vascular pedicle of a flap branches in a Y before reaching the flap. After the branch, one limb of the Y continues to become the pedicle proper and the second perfuses another territory or becomes part of a vascular arcade. In such a situation, dividing the pedicle proxi-

Figure 11. The Y-to-V principle. A, Normal flow. B, Reverse flow after dividing the proximal stem of the Y. C, The length of the pedicle becomes equal to combined length of both limbs of the original Y: a-b and b-c.
Indications

As a vascularized epiphysial flap, it is an excellent choice for revascularization of the carpal bones, notably scaphoid nonunions and Kienbock's disease, and for isolated osseous defects and osteocutaneous reconstruction of the phalanges; however, for isolated skin coverage, the posterior interosseous flap remains the authors' preference.

SUMMARY

From all of the flaps reviewed, it is important to know how to select the most suitable choice in each case. Aside from the technical expertise of the surgeon, the indication depends on the size and the location of the substance loss.

For large defects in any location, the radial forearm flap remains the most reliable and safest choice. For children and women, the authors prefer distant pedicled transfers or free flaps to minimize cosmetic donor site morbidity.

For small or medium defects that cannot be managed by a local transposition flap, the indication is based on the location of the wound.

Palmar defects, if proximal and ulnar, may be covered using the dorsal ulnar flap, with little morbidity in the donor area. The anterior interosseous flap is a better choice whenever vascularized tendon, nerve, or bone are needed also. For the first web space and neighboring radial defects, the posterior interosseous flap provides a reasonable alternative.

Dorsal defects of the hand can be reconstructed with a posterior interosseous flap, provided there is no suspicion of injury to the anastomotic dorsal system of the wrist. The anterior interosseous flap is a good choice for composite osteocutaneous transfers.

For complex composite defects, the ulnar artery forearm flap distally based may be indicated for reconstructive problems requiring vascularized flexor tendons. The anterior interosseous flap is able to provide excellent quality vascularized bone.

Indications depend above all on the surgeon's experience and on the different schools. As always, the better flap is that which is performed by the surgeon who has mastered the particular surgical technique.

In conclusion, this article is devoted to an update on forearm flaps and illustrates the innovative strength of this specialty. It also points out that, through in depth knowledge of the anatomy, flaps may be raised from many anatomic regions of a limb without disturbing the main vascular axis of that extremity.

Minimizing the donor site morbidity while maximizing the quality of the reconstruction is the primary concern when indications are established for reconstructive hand surgery, which is where one of the authors' main research efforts resides.

References