Wounds of the hand continue to be a challenge for the hand surgeon. The repair of hand wounds has evolved from the simple, such as allowing primary closure, to the complex, such as free tissue transfer. This evolution has occurred because of better understanding of the vascular supply to the skin of the hand along with the development of improved, more sophisticated surgical technique. Our review of the literature has shown numerous local hand flaps that have stood the test of time. Though lower on the reconstructive ladder, these flaps continue to aid the hand surgeon in dealing with soft tissue losses of the hand. It would be impossible to catalogue all local hand flaps in this article. Thus, we present many of the most useful and historic flaps, which we feel should be a part of every hand surgeon’s armamentarium.

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The practitioner of hand surgery usually has an algorithm for the closure of hand wounds that involve soft tissue losses. That algorithm includes the use of a combination of primary wound healing, grafts, local flaps, distant flaps, and free tissue transfers. Many hand wounds can be closed by simple measures. When more complex wounds present themselves, hand surgeons generally rely on a few favorite local tissue coverage options. The advent of free tissue transfer has made this means an attractive way to close the most complicated wounds. A review of the literature has shown a great number of local hand flaps that have stood the test of time and can be called on as effective tools to aid the hand surgeon in dealing with soft tissue losses of the hand. These flaps can generally be divided into flaps for the fingertips, digits, thumb, palmar hand, and dorsal hand.

RANDOM FLAPS

The principles that govern the use of random flaps can be used throughout the hand and fingers. Generally these flaps are of greater use over the dorsal surfaces, but in the correct circumstances they can be applied to the palmar aspect of the hand as well. A form of transposition flap with which the hand surgeon is familiar is the Z-Plasty (Fig 1). The Z-plasty is of great value when dealing with skin contractures over the volar aspects of the hand, especially contractures that cross the normal volar skin creases. When the Z-plasty technique is used, all the limbs of the Z-plasty should be of equal length. The most common angle Z-plasty is the 60° Z-plasty. Theoretically, there will be a 75% increase in length of the long axis of the Z-plasty. The greatest theoretical gain mathematically comes from a 90° Z-plasty, but this is not clinically feasible.

In the first web space, a 4-flap Z-plasty can be used. Four 60° equilateral triangles are arranged as shown...
(Fig 2) and are transposed as shown to increase length theoretically one and a half times. Another series of transposition flaps of use in the first web space is the so-called jumping-man flap. The flap receives its name based on the pretransposition drawing. The flap is transposed as shown (Fig 3). This flap does more to deepen the web space than it does to increase length.

Another transposition flap often used is the Limberg Flap. This flap is occasionally referred to as the rhomboid flap. In this flap, the defect is turned into a rhomboid. A line is extended that equals the height of the rhomboid. This line is then extended parallel to one of the sides as shown (Fig 4). The flap is elevated and transposed into the defect. The wound can then be primarily closed.

Rotational flaps are used frequently over the dorsum of the hand and fingers (Fig 5). These flaps are designed to allow a defect to be closed by dividing the tension of closure over a much larger surface area. To design this flap the surgeon outlines the defect, decides which adjacent area provides the most tissue, and designs a curved incision, which will allow rotation into the defect when the flap is elevated. The use of a small back cut or creation of a Burow’s triangle can help gain some small extra rotation.

One technique that can help in certain instances when extra tissue is needed and delay of the flap is warranted is the use of tissue expansion. This can be done safely over the dorsum of the hand and can allow the surgeon to gain extra tissue, which has excellent vascularity because of the delay phenomenon.

**LOCAL FLAPS FOR FINGERTIP WOUNDS**

The decision on which method of wound closure should be used depends entirely on the geometry of the wound and on local wound factors. The main factors leading to the use of flaps are (1) exposed vital structures such as bone, tendon, and nerve; (2) a wound not suitable for healing by secondary intention or grafting; or (3) a need for soft tissue padding. The following are many of the options for closure of fingertip wounds.

**V-Y Advancement Flap (Atasoy Flap)**

The V-Y advancement flap was first described by Tranquilli-Laeli in 1935 and was reported first in the

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**FIGURE 1. Z-plasty.** A standard Z-plasty with 60° angles. The theoretical gain in length is 75%. (Reprinted with permission.)

**FIGURE 2.** Four-flap Z-plasty. A 4-flap X-plasty in which all measurements are equal. The theoretical gain in length is 150%. (Reprinted with permission.)

**FIGURE 3.** Jumping-man flap. The 5-flap Z-plasty. (Reprinted with permission.)

**FIGURE 4.** Limberg flap. The rhomboid flap of Limberg is shown. (Reprinted with permission.)
United States by Atasoy and colleagues in 1970. The indications for this flap are transverse or dorsal oblique amputations with exposed bone and sufficient nail bed support and length. This flap is contraindicated in volar oblique tip amputations.

This flap is generally described as having the base of the volar triangle as the distal edge of the amputation and the apex occurring at the distal interphalangeal (DIP) crease (Fig 6). It has also been described to extend proximal to the DIP crease without sequelae. Many drawings show the base of the flap to be narrow, but it is helpful and in fact desirable to make the base extend from radial midaxial line to ulnar midaxial line. This will increase the number of vessels flowing into the flap. The flap is mobilized by gently dividing the fibrous septa, which attach the skin to the deeper structures. The deep margin of the flap is cut directly off the periosteum and the flexor sheath. The neurovascular structures should be preserved. With careful and complete mobilization, approximately 1 cm of advancement can be obtained. After advancement the wound is closed as a Y; hence the name V-Y advancement. This flap provides excellent sensation as well as soft tissue coverage.

**Bilateral Triangular Advancement Flap (Kutler Flap)**

Kutler described a double lateral advancement flap in 1947. Shepard has modified this original technique. This flap has been included in most treatises describing fingertip coverage. Although it is probably described far more than it is actually used, there is the occasional patient in whom this flap is useful. The Kutler flap has been condemned primarily because generally the flap does not allow for advancement of more than 3 to 4 mm, and there is a sagittal scar placed on the tip of the finger. Classically, this flap is indicated in patients with transverse or volar oblique amputations. In actuality, the patient in whom this flap is useful generally will have an amputation where there is more tissue on the radial and ulnar margins of an amputation and exposed distal phalanx.

As in the V-Y advancement flap, the bases of the triangles are the cut edges of the wound, this time the radial and ulnar aspects of the wound (Fig 7). The dorsal edges of the 2 flaps begin 1 to 2 mm volar to the edge of the fingernail and extend volarly 7 to 8 mm. The apex of the flap sits just distal to the DIP crease. Soft tissues are mobilized as with the V-Y advancement flap. It is not necessary to close the skin centrally over the fingertip as long as there is good soft tissue closure over the exposed distal phalanx. The wound is then closed as a Y, again as in the V-Y advancement flap.

**Oblique Triangular Flap**

With the description of the volar V-Y advancement flap and the lateral V-Y advancement flap, Ven-
Katawasi and Subramanian described the oblique triangular flap (Fig 8) in 1980. As suggested in its name, establishing an oblique triangle in essence creates this flap. This flap has the advantage in that it can be used for palmar/oblique amputations and it can be converted to a neurovascular island pedicle flap if more advancement is required than can be obtained with a standard elevation of the flap.

The flap is outlined beginning at the midlateral line and is extended proximally 2.5 times the diameter of the wound. The opposite midlateral line is identified, and an oblique incision is made from the distal midlateral wound edge to the proximal margin of the midlateral incision. Care is taken to preserve the neurovascular bundle near the straight midlateral incision. With elevation, the flap is advanced, inset, and then closed in a V-Y fashion. If additional mobilization is necessary, the flap is then converted to a neurovascular island flap (described below) and advanced further into the defect. Closure of the donor site with a full-thickness skin graft may be necessary.
Cross-Finger Flap (Transdigital Flap)

When there is a loss of greater than one third of the volar tissue of the fingertip—especially with exposed flexor tendon, joint, or bone—more tissue is required than with advancement-type flaps. The cross-finger flap is a popular option under these circumstances (Fig 9). This technique was first described by Cronin in 1951 and is still widely used. Multiple fingertips can be covered simultaneously. Diseases that limit joint motion (such as arthritis and Dupuytren’s disease) are contraindications. Patients with impaired digital circulation are also considered contraindications.

There are multiple donor choices for this flap. The middle finger can be used to cover the thumb, index, or ring fingers. The ring finger can be used to cover the long or small fingers. Once the donor digit has been selected, the recipient finger is debrided. The flap from the donor digit should be designed slightly larger than the recipient defect. The flap is rectangular and is based on the midlateral line closest to the recipient digit. The plane of dissection is just dorsal to the paratenon. Care must be taken not to injure the paratenon during elevation. The donor site is covered with a full-thickness skin graft, and the flap is sutured to the recipient site. The digit is held together either with a splint or with Kirschner wires. At 10 days to 3 weeks, the flap is separated from the donor site and the remainder of the flap is inset.

Variations of the cross-finger flap have been described in which dorsal nerves have been included and anastomosed to the digital nerve stump with reported improvement in sensation. A reverse cross-finger flap has also been described by Atasoy in which the epidermis and papillary dermis are divided and the reticular dermis and subcutaneous tissue have been used to cover the dorsum of an adjacent digit (Fig 10). The skin flap is laid back into place over the donor site. A full-thickness graft is then placed on the reverse flap.

Hueston Flap

Hueston described a lateral palmar advancement flap to cover the tip of the amputated finger (Fig 11). Souquet described a similar flap (Fig 12). The difference between the 2 flaps is that the Hueston flap includes only the neurovascular bundle at the base of the flap, whereas Souquet’s flap includes both neurovascular bundles. Both flaps are technically rotation advancement flaps. In the Hueston flap the longitu-
dinal incision is made volar to the neurovascular bundle, and in the Souquet flap the incision is made dorsal to the bundle. The incision is generally 2 to 3 cm long. A transverse back cut is made across the volar aspect of the finger, and the flap is elevated off the flexor tendon sheath. Next, the flap is elevated and rotated into the defect. There will generally be a triangular defect proximally, and this must be closed with a skin graft.

**Thenar Flap (Thenar H-Flap)**

The thenar flap is used to cover defects and preserve length in tip injuries to the index and long fingers (Fig 13). This flap is not used to cover defects in the ring and small fingers. Contraindications to this flap are similar to that for the cross-finger flaps.

The donor site is found by taking the tip of the injured index or ring finger and placing it against the thenar eminence. It is helpful to draw a circle around...
the area of contact. An H is drawn that is slightly larger than the outlined circle. The transverse portion of the H is made at the distal-most portion of the circle. The H is incised, and flaps in the subcutaneous plane are elevated. The ends of the flaps are sutured to the respective dorsal and volar fingertips and to each other along the lateral margins. This method effectively advances the edges of the donor defects to one another. The digit is left attached to the donor site for approximately 2 weeks, and the flap is then divided by using the proximal flap to cover the fingertip and the distal flap to fill in the donor site.

**Dorsal Middle Phalangeal Finger Flap**

Hirase and colleagues described a potentially sensitive flap to cover the fingertip from the dorsum of the long finger (Fig 14). The dorsal middle phalangeal finger flap has been described to be used for the tips of any finger except the thumb. This flap requires that digital Allen’s test be normal in the donor digit.

The flap is outlined exactly as would be a cross-finger flap. However, the flap is incised as an island, and the base is taken volar enough to include a vascular bundle. The dorsal sensory branch of the long finger is taken with enough length proximally to perform an anastomosis with the recipient digital nerve. The vascular pedicle is dissected proximally either to the level of the common digital artery or even to the superficial arch if needed. Once the dissection is complete, the island flap is transferred to the recipient site by means of an incision from the origin of the pedicle to the recipient defect. The wound is closed after the neural anastomosis is carried out. Finally, a full-thickness skin graft is used to close the donor defect. Joshi describes a similar flap but uses it exclusively on the donor digit.

**Homodigital Bipedicle Island Advancement Flap**

The homodigital bipedicle island advancement flap is useful for defects over the volar aspect of the finger in the area of the middle phalanx. O’Brien and Snow originally described an advancement flap for injuries to the tip of the thumb. This flap was also applied to the other digits. After a wave of initial enthusiasm, the use of the flap decreased because of problems with flexion contractures of the digits and the risk of dorsal skin loss. Whereas the thumb has relatively independent volar and dorsal circulation, the dorsum of the fingers have circulation more dependent on the volar blood supply. That said, there is
still some value for the neurovascular island flap in the digits. Although the flap is generally described to cover fingertip injuries, it can also be used to cover defects of the volar middle phalanx. Damage to the digital arteries is a contraindication to the use of this flap. Advancement of 10 to 15 mm can usually be achieved.

A rectangular incision is made from midlateral line to midlateral line (Fig 15). The flap is elevated, and the radial and ulnar neurovascular bundles in the flap are preserved. The flap is elevated off the flexor sheath with care not to expose the flexor tendons. By using gentle traction, the neurovascular bundles are preserved, and the flap is advanced with the aid of gentle

**FIGURE 13.** Thenar flaps can be based (A) proximally, (B) distally, or (C) both. The donor site is closed primarily. (D) A Thenar flap. (Parts A, B, and C reprinted with permission.32)

**FIGURE 14.** Dorsal middle phalangeal finger flap. Illustration of the steps for elevation. (Reprinted with permission.35)
dissection of the neurovascular bundles. The flap is then inset, and the donor defect is covered with a full-thickness skin graft.

**Turkisk Flap (C-Ring Cross-Finger Flap)**

The Turkisk flap can be used to cover relatively large defects of the volar and dorsal skin of the fingers (Fig 16). It is sometimes used to cover degloved finger stumps. An abnormal digital Allen’s test is a contraindication for the use of this flap.

The flap is based on one of the digital vascular bundles and can be based distally or proximally. The digital nerve is not included in the flap. Although the flap is based on the dorsum of the finger, it can include volar skin of the area of the middle phalanx. As with many of these flaps, the plane of dissection is just superficial to the paratenon, with care taken to leave the paratenon intact. Although a small skin bridge is left intact to protect the digital artery, the flap can be made into an island flap to allow for more flap mo-
bility. The flap is then inset into the recipient defect. For a degloving injury the flap can be sewn to itself to create a cap over the degloved segment defect. A full-thickness skin graft is used to cover the donor site. Flap division is carried out at 10 to 14 days.

**Reverse Vascular Pedicle Digital Island Flap**

The reverse vascular pedicle digital island flap was described in 1989 by Lai et al.\(^\text{15}\) and then in 1990 by Kojima et al.\(^\text{16}\) Although most local coverage of the finger relies on antegrade arterial flow, this flap functions on the digit much as the reverse radial forearm flap does on the hand and arm. A positive digital Allen’s test is a contraindication to the use of this flap.

An island of skin is outlined at the base of the affected finger (Fig 17). The flap is centered on one of the digital arteries. The flap is elevated from a proximal to distal direction and the digital vessel is ligated proximally. Elevation of the flap continues in a distal direction. Digital vessels are kept in the soft tissues of the flap. Once the island has been elevated, the digital vessel along with a cuff of perivascular fat is taken to include the venae commitantes. The vessels are dissected distally to the level of the mid–middle phalanx. The flap is then rotated into the recipient site and sutured in place. The donor site is skin grafted.

**FLAPS FOR COVERAGE OF THE VOLAR THUMB**

Many of the flaps that have been described for use in covering the thumb were originally described to aid in thumb reconstruction. With the advent of microvascular toe-to-thumb transfer, some of these flaps are used with less frequency. There still are specific indications, however, for which knowledge of these flaps is of value.

**Moberg Volar Advancement Flap**

Moberg\(^\text{17}\) first described the thumb advancement flap in 1964 as a means to preserve length in the distally amputated thumb. There are certain reasons why this flap is an attractive option for the closure of wounds for the tip of the thumb. First, the flap vascular supply is easily identified at the end of the wound. Second, the blood supply to the dorsal aspect of the thumb is quite independent of the volar blood supply. Third, as opposed to the fingers, a resultant flexion contracture of the thumb generally leaves the thumb in a functional position.

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*FIGURE 16. Steps for elevation and inset of C-ring cross-finger flap (Turkish flap.) (Reprinted with permission from the Christine M. Kleinert Institute for Hand and Microsurgery, Inc.\(^\text{32}\)*
Moberg’s thumb advancement flap is used when there are amputations through the distal phalanx. The neurovascular bundles are identified and incisions are made on either side of the thumb, dorsal to the bundles (Fig 18). Dissection is carried down to the flexor sheath, and the flap is elevated off the flexor sheath. Usually the proximal metacarpal phalangeal crease of the thumb is the proximal margin of the dissection. The flap is then advanced to cover the defect. If necessary, the interphalangeal joint of the thumb can be flexed. This flap can be converted into a bipedicle island flap to gain greater length if necessary. The resulting defect can be skin grafted with a full-thickness skin graft.

**Neurovascular Island Pedicle Flap**

Before free tissue transfer for thumb reconstruction, the neurovascular island pedicle flap was used to attempt to provide sensation to an insensate thumb reconstruction. There were those surgeons who were very enthusiastic about the flap, but there was difficulty in that the brain would still interpret sensory information as coming from the donor digit. A potential solution was to suture the digital nerve from the proximal thumb to the divided distal nerve in the flap. The problems with this, however, are incomplete sensory recovery and possible damage to the vascular structures in the pedicle. Currently, the only indication for the use of this flap is the scarred and sensitive thumb with ischemic pain.

The donor site is usually the ulnar aspect of the long or ring finger. Most surgeons prefer the long finger, because the pedicle is longer. It is essential to perform a digital Allen’s test to the donor finger as well as to the adjacent finger before considering this flap. Attention is first turned to the recipient site. The scarred and sensitive area of the thumb tip is excised, and the defect is created and measured. The ulnar digital nerve is found and is prepared for anastomosis. The flap is then outlined on the donor digit and is incised, preserving the neurovascular bundle (Fig 19). The bundle is traced proximally as far as the superficial arch. As much perivascular fat as possible is kept with the bundle. The common digital vessel with the adjacent
finger is divided, and the vessel is taken back to the superficial arch. A subcutaneous tunnel is created to the recipient site, and the island flap is passed into the recipient site. The flap should not be twisted or be tight in any way. The nerve transposition is then performed. A full-thickness graft is used to cover the donor site.

Holevich Racquet Flap

Holevich described the racquet flap in 1963 as a means of restoring sensibility to the thumb by using tissue from the dorsum of the hand, especially for chronic median nerve lesions. His flap used portions of the superficial branch of the radial nerve to substitute for the lost sensation over the volar thumb. This flap can be used to add soft pliable tissue to contractures or defects of the first web space.

A proximally based flap is created over the base of the second metacarpal (Fig 20). The flap includes 2 to 3 branches of the dorsal sensory branch of the radial nerve. The flap is extended distally to the level of the metacarpal head. Because the second dorsal intermetacarpal artery is included in the flap, the flap can be made quite narrow (2 to 3 cm) relative to its length. The flap can be easily elevated from the extensor tendons. An incision is made from the donor site to the defect on the thumb. The flap is then inset into
the recipient site. The donor defect can sometimes be closed primarily, but if tension of the closure is too great, a full-thickness graft can be used to close the donor site.

**Foucher Kite Flap**

As a logical extension of the previous flap, Foucher and Braun in 1979 improved on the Holevich flap by undertaking a detailed description of the anatomy of the first dorsal metacarpal artery. By defining the anatomy so precisely, they were able to devise an island flap from the dorsum of the index finger to the thumb. This flap is an excellent choice when there is a need for soft tissue coverage on the thumb. The flap has also been used when there is trophic scarring of the thumb or a sensory deficit of the thumb that cannot be managed in other ways. The flap is contraindicated when the soft tissue tunnel is so scarred that the resulting tight tunnel would jeopardize circulation of the flap.

The flap is outlined over the dorsum of the proximal phalanx of the index finger (Fig 21). The flap can include the skin overlying the metacarpophalangeal joint if necessary. An incision is then made in the dorsal first web space, and dissection is carried down to the first dorsal metacarpal artery, which arises from the radial artery. With a very complete dissection, a pedicle of 7 to 8 cm can be created. The flap is then incised and elevated at the level of the paratenon from a distal to proximal direction. Fascia adjacent to the second metacarpal along with adjacent fat are kept intact along the course of the vessels. A subcutaneous tunnel is created from the donor site to the recipient site, and the flap is brought through, with care taken not to kink or twist the pedicle. The dorsal proximal phalanx is covered with a full-thickness skin graft.

**Annular Flap**

Goumain et al described the tetrapedicled homodigital island flap in 1972 (Fig 22). This flap is used especially when sensory tissue is required to cover defects of the thumb, particularly at the level of the proximal phalanx, but occasionally it has been used also for the ring finger. The flap is contraindicated when there has been disruption of one or both neurovascular bundles.

A circular area is outlined approximately 2 cm proximal to the edge of the soft tissue defect. Only the skin and subcutaneous tissue are dissected. The neurovascular bundles are freed proximally to allow the
annular flap to advance distally 10 to 12 mm. The distal wound can thus be closed, and the proximal wound is either grafted or allowed to heal by secondary intention.

**Coverage of Defects of the Hand and Proximal Fingers**

With defects of the hand, often the tissues immediately adjacent to the wound are of insufficient quantity to close the wound. In some instances recruitment of the local tissues of the forearm are necessary to gain adequate coverage of the wound. The skin and subcutaneous tissues of the forearm are an excellent match in quality and depth to cover wounds of the hand.

**Dorsal Island Digital Flap (Axial Flap)**

Lister has advocated and described a flap from the dorsal proximal phalanx of a digit that can be used to cover adjacent defects of the finger and hand. This flap usually covers defects of the ipsilateral or adjacent digit to the level of the proximal interphalangeal joint. This flap is based on the dorsal digital artery of the adjacent finger.

The flap is outlined over the dorsum of the proximal phalanx of the donor digits (Fig 23). Flaps up to 3 × 3 cm can easily be raised. The dorsal digital artery is identified. It generally arises as a branch of the proper digital artery but may also arise from the dorsal metacarpal artery. When the vessel is identified, it is preserved with the dorsal regional venous drainage. The flap is then elevated as an island from distal to proximal, preserving the extensor paratenon. With full elevation of the flap, the flap is rotated into position, with care taken to avoid kinking of the pedicle. The donor defect is closed with a full-thickness skin graft.

**Fillet Flap**

The fillet flap should always be considered when one is dealing with injuries requiring amputation of a digit. The soft tissues of a digit can sometimes be salvaged by fillet of the bony structures from the soft tissue and skin. The flap is useful for covering palmar or dorsal hand wounds. In designing the fillet flap, the pulp tissue is usually discarded (Fig 24). A longitudinal incision is made according to the location of the defect to be closed. An incision is made approximately 0.5 cm proximal to the nail fold. The phalanges and tendons are excised. The flap is placed into the defect with the base of the flap as a hinge point.

**Radial Forearm Flap/Radial Forearm Fascial Flap**

Chang and Wang published their results with a retrograde flap based on the radial artery in 1980. This flap has proven to have wide use in the hand and even fingers to cover relatively large defects. The flap has also been popular as a free tissue transfer. Occasionally, the flap can be used as a fascial flap as well if skin and subcutaneous tissue are not needed at the recipient site. The flap is contraindicated in instances where, either congenitally or because of trauma, the palmar arch is incomplete. There is discussion as to whether or not to reconstruct the radial artery after flap transfer, but this does not appear to be necessary most of the time.

The flap is designed along the longitudinal axis of the radial artery (Fig 25). There is some variation in designing the flap to allow for varying lengths of the

**FIGURE 22.** Annular flap. (A) Amputation with protruding bone. (B) Dissection and advancement. (C) Distal closure. (Reprinted with permission.34)

**FIGURE 23.** Dorsal island digital flap (axial). The dorsal digital artery may arise either from the proximal digital artery or from the dorsal interosseous metacarpal artery. (Reprinted with permission.38)
pedicle. Thus, the flap can be designed to cover either proximal or distal hand wounds. More distal defects will require more proximal skin paddles. Dissection is first carried out through the distal forearm to expose the radial artery and the venae comitantes. When the distal border of the flap is encountered, the flap is dissected first from its ulnar border. The dissection continues to the pedicle. The plane of dissection is superficial to the palmaris longus and flexor carpi radialis. Just radial to the flexor carpi radialis, the pedicle will be found lying within a septum. The pedicle and the perforators, which supply the flap, are...
kept contiguous with the flap. Dissection is then begun over the radial aspect of the flap, and the dissection continues radially until the septum is reached. The dissection then proceeds under the radial vascular bundle, and muscular branches are ligated and divided. The radial artery is divided at the level of the proximal margin of the flap, and the dissection continues distally. When the flap and pedicle are adequately dissected distally, the flap is rotated, with care taken not to kink the radial artery. The flap and pedicle can be brought into a defect either by generous tunneling or by using an incision to connect the distal pedicle incision to the recipient site. A tunnel is generally preferred over the radial wrist because of the superficial radial nerve. Care should be taken over the ulnar wrist in the area of the dorsal sensory branch of the ulnar nerve. The donor site is then covered with a split-thickness skin graft.

When a radial forearm fascial flap is to be used, a longitudinal or zigzag incision is used throughout the forearm. The skin and subcutaneous tissue are elevated, leaving the antebrachial fascia intact. The flap is designed on the fascia, and the dissection proceeds as with the standard reverse radial forearm flap. The donor site is closed primarily, and the fascia is covered with a split-thickness skin graft at the recipient site.

**FIGURE 25.** Radial forearm flap. (A) Flap outlined. (B) Dissection. (C) Inset. (D) Flap covering traumatic amputations with loss of soft tissue, syndactylizing the long and ring fingers. (E) After maturation of graft and division of long and ring fingers. (F) The key point in raising a radial forearm flap is recognizing the level of the septum containing the radial artery and its septocutaneous perforators. BR, brachioradialis; FCR, flexor carpi radialis; FDS, flexor digitorum superficialis; PL, palmaris longus; R, radius; RA, radial artery; U, ulna. (Reprinted with permission.)

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**FIGURE 25.** Radial forearm flap. (A) Flap outlined. (B) Dissection. (C) Inset. (D) Flap covering traumatic amputations with loss of soft tissue, syndactylizing the long and ring fingers. (E) After maturation of graft and division of long and ring fingers. (F) The key point in raising a radial forearm flap is recognizing the level of the septum containing the radial artery and its septocutaneous perforators. BR, brachioradialis; FCR, flexor carpi radialis; FDS, flexor digitorum superficialis; PL, palmaris longus; R, radius; RA, radial artery; U, ulna. (Reprinted with permission.)
Posterior Interosseous Forearm Flap

The posterior interosseous forearm flap was described by Penteado, Masquelet and Chevrel as well as by Zancolli and Angrigiani. This flap is another retrograde flap that is based on the posterior interosseous artery (PIA). Defects of the first web space, thumb, dorsal hand to the level of the proximal interphalangeal joints, palm, and anterior wrist are potentially covered by this flap. Significant injuries to the wrist are contraindications to this flap as is any other condition that may cause PIA thrombosis.

Flap design is carried out by drawing a line from the lateral epicondyle to the ulnar styloid with the elbow held at 90° of flexion (Fig 26). This line approximates the septocutaneous axis of the flap. The PIA arises at the junction of the proximal to middle thirds of this line. Along the course of the PIA there are 7 to 14 cutaneous perforators, which supply the skin and fascia. The most proximal perforator arises close to the proximal/middle third junction. The center of the flap should be located distal to this perforator. The PIA anastomoses with the dorsal wrist arcade 2 cm proximal to the end of the drawn axis line. Dissection is begun at this point to ascertain integrity of the PIA. Technically, a flap 6 to 7 cm wide can be raised, but defects greater than 4 cm in width are difficult to close primarily.

The radial incision is created first, and a subfascial dissection is carried ulnarly. By retracting the extensor digiti quinti proprius, extensor indicis proprius, and extensor digitorum communis radially, as well as the extensor carpi ulnaris ulnarly, the septum containing the PIA and venae comitantes can be identified. Muscular branches of the PIA are ligated and divided. Care must be taken to avoid injury to the posterior interosseous nerve, which lies radial to the vessels. Dissection continues proximally to the main septal perforator (most proximal perforator). The artery is separated from the posterior interosseous nerve. The vessels are ligated proximal to the main perforator to the flap. Next, the ulnar border of the flap is elevated, and the pedicle including the septum is released from the ulnar shaft. The flap and pedicle are dissected proximally until enough length of the pedicle is obtained to rotate into the defect. The vessels cannot be kinked at the rotation point, and the most distal

FIGURE 26. (A) Posterior interosseous forearm flap. Landmarks: the epicondyle, the distal radioulnar articulation, and the straight line that joins them. The origin of the posterior interosseous artery is located at the junction of the proximal and middle third of this line. The center of the flap should be based distal to this point. (B) Loss of small finger and ulnar side of hand because of injury. (C) Flap inset into defect. (Part A reprinted with permission.)
vessels can be rotated 2 cm proximal to the distal end of the initial axis line.

**Dorsal Ulnar Artery Flap**

Becker and Gilbert\(^\text{25}\) described a flap based on the dorsal ulnar artery in 1992 (Fig 27). This flap can be used to cover defects of the dorsal or palmar hand.

To construct this flap, an incision is made 2 cm proximal to the pisiform. The flexor carpi ulnaris is retracted to reveal the origin of the dorsal branch of the ulnar artery, which arises 2 to 5 cm proximal to the pisiform. The flap is then centered along the axis of the ulna with the palmaris longus as the volar limit and the extensor digitorum communis to the ring finger as the dorsal limit of the dissection. The length of the flap is variable and designed to fit the defect. The rotation point of the flap is 2 to 4 cm from the pisiform, depending on the origin of the dorsal branch of the ulnar artery. The flap is elevated from proximal to distal. When the dorsal branch of the ulnar artery is reached, the flap can be rotated and inset. The donor site is covered with a split-thickness skin graft.

**Retrograde Radial Forearm Fascial Flap**

Weinzweig et al\(^\text{26}\) described the retrograde radial forearm fascial flap in 1994 (Fig 28). Some additional clinical applications were discussed by Braun et al\(^\text{27}\) in 1995. This flap is unlike the other radial forearm flap in that the radial artery is left in situ. Essentially, this flap is a distally based turnover flap of the volar forearm fascia. Vascularity of the flap comes from distal perforating vessels of the radial artery. This flap can be used to cover defects of the volar and dorsal hand.

The design of the flap is such that the flap should minimally be 2 to 3 cm wide. The pivot point is generally 5 to 8 cm proximal to the radial styloid. In addition, the flap needs to be designed to be larger than the defect it is to fill. A gentle S-shaped incision is made over the volar forearm. Skin flaps are elevated just deep to the hair follicles. Branches of the radial and lateral antebrachial cutaneous nerve are identified and freed from the subcutaneous tissue. Once the skin flaps are elevated to expose the area of flap desired, the subcutaneous tissue and fascia are incised and elevated in a proximal to distal direction. Dissection ends at the pivot point, and the flap is turned over or rotated into position. Care needs to be taken to avoid undue tension on the flap.

There are many different problems in wound coverage because of the many different wounds that
the hand surgeon will encounter. Working knowledge of a number of local coverage options will aid the hand surgeon in dealing with these sometimes vexing wounds.

REFERENCES

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