Sensate First Dorsal Metacarpal Artery Flap for Resurfacing Extensive Pulp Defects of the Thumb

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Abstract: Finding an appropriate soft-tissue grafting material to close a wound located over the distal phalanx of the thumb, especially the pulp region, can be a difficult task. A sensate first dorsal metacarpal artery flap, mobilized from the dorsum of the adjacent index finger and used as an island pedicle skin flap, can be useful for this purpose. The pedicle includes the ulnar branch of the first dorsal metacarpal artery, the dorsal veins, and the cutaneous branch of the radial nerve. Although this tiny artery is anatomically variable, safe dissection can be achieved by including the radial shaft peristeum of the secondary metacarpal bone and the ulnar head fascia of the first interosseous muscle.

This approach has been used for 8 individuals with extensive pulp defects of the thumb over the past 3 years. Skin defects in all patients were combined with bone, joint, or tendon exposure. All flaps survived completely. This 1-stage procedure is reliable and technically simple. It provides sensate coverage to the pulp of the thumb but also avoids nerve repair or more complicated microsurgery.

Key Words: first dorsal metacarpal artery flap, pulp defect of thumb

Extensive pulp defects of the thumb, with the exposure of tendon or bone, are challenging reconstructive problems because of the lack of locally available tissue. Surgical treatment includes the use of local, regional, and free flaps. The use of local flaps, including transposition and advancement flaps with random vascularity, is restricted because of the limited range of flap mobility and the limited amount of tissue movable from nearby areas. The use of a skin flap mobilized from an adjacent finger, such as the cross-finger flap, requires a staged approach and has limitations, including a considerable period of immobilization, with the risk of subsequent joint stiffness and a limited arc of transposition.

The heterodigital neurovascular island flap formed from the ulnar pulp of the middle finger or the radial pulp of the ring finger, based on the proper palmar digital artery and nerve, is another option. However, with this flap, 2 major digital arteries are killed and extensive digital and palmar dissection is needed. Microvascular transfer of a free flap, like free partial toe transfer, can be used to remedy these problems, but such a technique requires microsurgical experience and prolonged operation.

Since Foucher and Braun demonstrated that a sensate skin island flap created from the dorsum of the index finger could be raised and based upon the first dorsal metacarpal artery and sensory branch of the radial nerve, similar flaps have been reported subsequently and have been shown to be appropriate for resurfacing the defects of the dorsal thumb or the first web space. Reports seldom comment on its use for pulp loss from the thumb. Here we report 8 cases of extensive pulp loss extending to the tip of the thumb, which were resurfaced with a sensate first dorsal metacarpal artery (FDMA) flap in a single stage procedure.

Vascular Anatomy

The FDMA is a constant vessel arising from the radial artery just distal to the tendon of the extensor pollicis longus and proximal to the point at which the radial artery pierces between the radial and ulnar heads of the first dorsal interosseous muscle. The artery runs over the fascial layer of the first dorsal interosseous muscle and divides into the radial branch to the thumb, the intermediate branch to the web space, and the ulnar branch to the index finger. The ulnar branch usually courses distally within the musculo-osseous groove, between the ulnar head of the first dorsal interosseous muscle and the radial shaft of the second metacarpal bone,
until it reaches the metacarpophalangeal (MP) joint. Here a nutrient branch from the second palmar metacarpal artery joins the artery before it divides into a number of small vessels, which supply a rich subdermal plexus over the dorsum of the proximal phalanx (Fig. 1A).11

**PATIENTS AND METHODS**

The FDMA flap was used to reconstruct the pulp defects of the thumbs in 8 patients over 3 years. The patients included 6 men and 2 women, ranging in age from 20 to 56 years. They all had avulsion injury or painful scar needing reconstruction. Tissue grafting was contraindicated for all patients because of the exposure of tendons or bones at the wound site. The flap was used in the acute stage for wound coverage in 7 patients, and 1 was performed in the late reconstructive stage.

**Operative Technique**

A skin marking, with its size determined by the defect of the thumb, is made over the dorsum of the proximal phalanx of the adjacent index finger. The flap margins are outlined proximally and distally to preserve the dorsal skin of the MP joint and the proximal interphalangeal (PIP) joint respectively. The width of the flap is designed so that it does not extend beyond the radial and ulnar midaxial lines of the proximal phalanx. The estimated pivotal point is then marked on the site of origin of the FDMA.

Operation is performed with the patient under general, axillary block, or regional anesthesia, with the aid of tourniquet control and loupe magnification. The flap is raised from the distal to the proximal side and from the ulnar to the radial side. Care is taken to leave the paratenon undisturbed to

**FIGURE 1.** A, The first dorsal metacarpal artery (FDMA) divides into the FDMAr to the thumb, the FDMAi to the first web space, and the FDMAu to the index finger. The flap territory is limited between the MP joint and the proximal interphalangeal joint. The cutaneous branch of the radial nerve is included in the flap. The dotted line means the radial shaft periosteum of the secondary metacarpal bone will be included in the pedicle. B, FDMAu usually courses within the musculo-osseous groove, between the ulnar head of the first dorsal interosseous muscle and the radial shaft of the secondary metacarpal bone. C, After raising the flap, the FDMAu (arrows) sticks to the fascia of the musculo-osseous groove. The radial shaft periosteum (arrowheads) of the secondary metacarpal bone is included in the pedicle for safe dissection of this tiny artery. FDMAi, intermediate branch of FDMA; FDMAr, radial branch of FDMA; FDMAu, ulnar branch of FDMA; MC I, first metacarpal bone; MC II, second metacarpal bone; RA, radial artery; RN, radial nerve.
ensure the “take” of a skin graft and the free gliding of the tendon. The fascia pedicle will be taken through a zigzag skin incision and subdermal dissection along the radial border of the MP joint toward the pivot point; thus, the maximal potential length of the flap pedicle can be achieved, allowing it to reach the thumb tip without tension. The pedicle includes the fascia of the first dorsal interosseous muscle, the dorsal veins, and the sensory branch of the radial nerve (Fig. 1B).

Although the ulnar branch of the FDMA is tiny and courses deeply within the musculo-osseous groove, no attempt is made to visualize the artery. Instead, safe dissection can be achieved by including the radial shaft periosteum of the second metacarpal bone, continued by the ulnar head fascia of the first dorsal interosseous muscle (Fig. 1C). Another key point for successful flap dissection is near the MP joint, where the nutrient branch needs to be carefully identified and divided. Also, distal to this critical area, the FDMA starts to ramify into small vessels. If the fascia overlying the first dorsal interosseous muscle is not included, dissection will be difficult. After raising the flap, the tourniquet is released and vascular flow to the flap is ascertained. A subcutaneous tunnel is made, and the flap is transferred by gentle traction into the pulp defect of the thumb. The donor site is grafted with either a split-thickness or full-thickness skin graft, depending on convenience during surgery.

RESULTS
Clinical data were summarized in Table 1. The flap sizes ranged from 3 × 1.5 cm to 5 × 3 cm, and all survived completely. The eventual static 2-point discrimination of the flap ranged from 6 to 14 mm, and the patients needed 4 to 8 months to reorient the flap in the new location. The skin grafts applied to the donor area were satisfactory, and full recovery of flexion and extension of the index finger was also obtained. The only complaint from the patients was graft discoloration.

CASE REPORTS
Case 2
A 28-year-old man experienced a crushing injury with soft tissue loss and joint exposure over the pulp of his left thumb. A sensate FDMA flap, 3 × 1.5 cm in size, was raised to cover the defect. The flap was completely viable following surgery, and its static 2-point discrimination was 8 mm, as for the contralateral side of the dorsal index finger (Fig. 2A-D).

Case 7
A 37-year-old man sustained an electric saw injury with extensive pulp loss and bone exposure to his right thumb. A sensate FDMA flap, 5 × 3 cm in size, was raised to restore the pulp defect. The vascular pedicle, including the radial shaft periosteum of the second metacarpal bone, was dissected to the origin of the FDMA. The flap survived well and the contour of the thumb appeared to be nicely restored. The static 2-point discrimination of the flap was 9 mm (Fig. 3A-D).

DISCUSSION
As an island sensory flap, the FDMA flap has a pedicle length up to 7 cm, allowing a wide arc of rotation, and has proved to be very useful in resurfacing pulp defects of the thumb. Although there are some variations of the FDMA and its ulnar branch is tiny and fragile, the vascularity of the FDMA flap can be maintained if the fascia overlying the musculo-osseous groove is included in the pedicle. Because the ulnar branch of the FDMA usually sticks to the fascia within the groove, this modified method avoids the need for meticulous dissection of the artery or raising the flap on a nondominant arterial branch.

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F, female; M, male; 2-PD, 2-point discrimination.
The dorsal cutaneous branch from the radial nerve is included in the flap for obtaining sensory restoration. The nerve enters the flap lateral to the MP joint and superficial to the extensor apparatus. It is easily identified. All cases in our series recovered good or excellent tactile gnosis, while the eventual static 2-point discrimination was in the order of 6 to 14 mm. Although the sensation pattern of this flap in the new location of thumb pulp was still felt as if it was at the donor site—the dorsum of the proximal index finger—most patients adapted it to well within 4 to 8 months.

Size limitation is a restricting factor for the FDMA flap, which can extend distally to the PIP joint and proximally to the MP joint. There is no single artery that traverses the dorsal skin of the proximal phalanx after the ulnar branch of the dorsal cutaneous branch from the radial nerve. The dorsal cutaneous branch from the radial nerve is included in the flap for obtaining sensory restoration. The nerve enters the flap lateral to the MP joint and superficial to the extensor apparatus. It is easily identified. All cases in our series recovered good or excellent tactile gnosis, while the eventual static 2-point discrimination was in the order of 6 to 14 mm. Although the sensation pattern of this flap in the new location of thumb pulp was still felt as if it was at the donor site—the dorsum of the proximal index finger—most patients adapted it to well within 4 to 8 months.

FIGURE 2. A, A pulp defect of the left thumb with joint exposure. B, A sensate FDMA flap, 3 × 1.5 cm in size, was designed on the dorsum of the proximal index finger. C, Immediately after the operation, the pulp has been nicely restored. D, View at 2-year follow-up. The static 2-point discrimination was 8 mm, as on the contralateral side of the index finger.
the FDMA ramifies into small branches distal to the MP joint, so the flap is a random flap, and its length should be confined within the dorsum of the proximal phalanx. If the flap extends beyond the PIP joint, the viability of its distal part and scar contracture of the donor region will be the major concerns. In our series, there was no morbidity related to the donor area on the dorsum of the index finger. Good take of the skin graft on preserved paratenon and maintaining the specialized skin over the MP and PIP joints intact were factors contributing to this.

The main goal of the plastic surgeon facing a complex soft-tissue defect is to replace “like with like” tissue at minimal donor site cost and with maximal efficacy. The FDMA flap, which allows the surgeon to accomplish the goal better, should serve as a valuable alternative for sensory resurfacing in the thumb.
REFERENCES