

Reconstruction of Traumatic Dorsal Loss of the Thumb: Four Different Surgical Approaches

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Abstract

Background: This article outlines our methods for thumb reconstruction following dorsal skin loss injury located between the metacarpophalangeal joint (MPj) and the entire nail affecting skin, nail, tendon, and bone in different combinations but with intact sensate palmar skin.

Methods: Between 1990 and 2015, 24 patients were treated for dorsal thumb defects using 4 different surgical techniques. Five cases of dorsal compound traumatic loss were reconstructed by custom-made dorsal great toe transfer. Four patients with dorsal skin and nail loss located at the distal phalanx level were covered with the homodigital flap with reverse flow vascularization. In 9 patients presenting skin defects between the MPj and the nail, reconstruction was achieved by means of the kite flap. Six cases suffered extensive dorsal skin loss, and reconstruction was performed using different types of radial forearm flaps (cutaneous, tendineocutaneous, osteocutaneous, and fascial).

Results: Flap survival was obtained in all cases. No vascular complications occurred with free vascularized compound toe transfer.

Conclusions: Reconstruction of dorsal thumb defects is imperative and its approach is strictly correlated to type of defect, patient's requests, and flap alternatives. For defects with nail involvement, the free osteo-onychocutaneous flap harvested from the great toe provides the best aesthetic result in selected young and well-motivated patients. An alternative is represented by the dorsoulnar flap, when the defect is located distally, or the fascial pedicle radial forearm flap, for major dorsal thumb defects, in patients refusing microsurgical reconstruction. The kite flap still represents a feasible solution for medium-size defects with an intact nail.

Keywords: dorsal thumb, kite flap, homodigital flap, great toe flap, radial forearm flap

Introduction

Traumatic dorsal loss of the thumb represents a difficult reconstructive problem^{10,20} particularly when involving skin, tendon, bone, and nail in different combinations. Many flaps have been described to cover these defects including pedicle and free flaps. This article outlines our current methods for thumb reconstruction following dorsal skin loss injury located between the metacarpophalangeal joint (MPj) and the nail affecting skin, nail, tendon, and bone in different combinations but with intact sensate palmar skin.

Materials and Methods

Twenty-four patients (21 men and 3 women) with a mean age of 36 years (range, 17-61 years) were treated from January 2000 to December 2015 for dorsal thumb defects with

intact palmar skin (Table 1). Local ethics committee approval was obtained. Inclusion criteria were patients who had undergone emergency or elective reconstruction of their dorsal thumb defect with a minimum follow-up of 1 year. Patients were selected from a database containing all the procedures performed and file images (including before and after surgery and follow-up). The mean interval between injury and surgery was 12 days (range, 0-52 days), with the exception of 2 patients who received reconstruction after 102 days and 230 days, respectively (initially dorsal coverage

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Table 1. Clinical Material.

Case	Age (y)	Sex	Time elapsed trauma/reconstruction (days)	Site of injury	Type of defect	Size of the defect, length x width (cm)	Method of reconstruction	Additional procedures
1	23	F	7	R P2	Nail, skin	2.5 x 2	Onychocutaneous great toe flap	—
2	28	M	230	L P2	Nail, skin, bone	3 x 2.5	Osteo-onychocutaneous great toe flap	IPj arthrodesis
3	40	M	10	R P2/IPj	Nail, skin, bone (IPj), tendon	3.5 x 2.5	Osteo-onychocutaneous great toe flap	IPj arthrodesis
4	36	M	18	R P2/PI	Nail, skin, bone (IPj), tendon	6 x 3.5	Extended osteo-onychocutaneous great toe flap	IPj arthrodesis
5	30	M	102	R P2/PI	Nail, skin, bone (P2/PI), tendon	6 x 3.5	Extended osteo-onychocutaneous great toe flap	IPj arthrodesis + bone graft
6	54	M	2	L P2	Nail	2 x 2	Dorsolunar flap	Donor site skin graft
7	59	F	6	L P2	Nail	2 x 2	Dorsolunar flap	—
8	17	M	14	R P2	Nail, skin	2.5 x 2	Dorsolunar flap	Donor site skin graft
9	34	M	9	L P2	Nail, skin	2.5 x 2	Dorsolunar flap	Donor site skin graft
10	58	M	8	R P2/IPj	Nail, skin, tendon	3 x 2.5	Kite flap	Kirschner wires P2 fracture + donor site skin graft
11	38	M	0	L IPj/PI	Skin, tendon	3.5 x 3	Kite flap	Tendon graft + donor site skin graft
12	31	M	42	L IPj/PI	Skin, tendon	3.5 x 3	Kite flap	IPj arthrodesis + donor site skin graft
13	40	M	1	R PI	Skin	3 x 3	Kite flap	Donor site skin graft
14	56	M	0	L P1/MPj	Skin, tendon, bone (MPj)	3.5 x 3	Kite flap	MPj arthrodesis + bone graft + donor site skin graft
15	29	M	2	R P1/MPj	Skin, tendon	3.5 x 3	Kite flap	Tendon graft + donor site skin graft
16	61	M	52	L P1/MPj	Skin, tendon	3 x 3	Kite flap	MPj arthrodesis + donor skin graft
17	29	F	0	R P1/MPj	Skin	3 x 3	Kite flap	Donor site skin graft
18	23	M	1	R P1/MPj	Skin	3 x 3.5	Kite flap	Donor site skin graft
19	19	M	0	R P2/PI	Nail, skin, tendon	6 x 3.5	Radial forearm fascial flap	Tendon graft
20	37	M	1	L P2/PI	Nail, skin, tendon, bone (IPj)	6.5 x 3	Radial forearm fascial flap	IPj arthrodesis
21	35	M	47	R P2/PI	Skin, tendon	5.5 x 3	Radial forearm cutaneous flap	IPj arthrodesis
22	32	M	21	L P2/PI	Skin, tendon	5.5 x 3.5	Radial forearm tendineous cutaneous flap	Tendon reconstruction
23	39	M	21	R P2/PI/MPj	Skin, tendon, bone (IPj/PI/MPj)	6 x 3.5	Radial forearm osteocutaneous flap	IPj/MPj arthrodesis
24	28	M	6	L P2/PI/MPj	Skin	6.5 x 4	Radial forearm cutaneous flap	—

Note. R = right; P = phalanx; L = left; IPj = interphalangeal joint; MPj = metacarpophalangeal joint.



Figure 1. Case 4. Compound loss of the thumb and nail following hot press injury. The defect was resurfaced with a compound toe transfer including three-quarters of the distal phalanx bone. (a) Arthrodesis of the interphalangeal joint was made using Kirschner wires. (b) Postoperative view 48 months later. **[AQ: 1]**

was performed elsewhere using a poorly looking groin flap) (Table 1). Microsurgical reconstruction was employed using a composite flap harvested from the dorsal aspect of the great toe in 5 cases (Figure 1a and 1b). The technique is based on the classical partial toe transfer.^{10,25,26} The recipient defect was outlined, and the nail complex, including nail bed, hyponychium, lateral folds, nail matrix, and adjacent skin, was harvested including the dorsal skin. The distal three-quarters of the toe phalanx was harvested in the cases requiring bone reconstruction; osteotomy of the distal phalanx of the donor toe was usually performed to reduce the bone dimension. In such cases, arthrodesis of the interphalangeal joint (IPj) was performed using Kirschner wires (K-wires). The donor site defect was covered with a split-thickness skin graft or by shortening the distal phalanx and then closed with a V-Y plasty using the plantar skin.

In 4 cases characterized by complete nail loss, a dorsolunar rectangular-shaped flap³ was harvested from the medial aspect of the thumb metacarpophalangeal (MCP) region (Figure 2). The donor site was closed directly in 1 case and covered with a split-thickness skin graft in 3 cases.

In 9 cases, dorsal reconstruction was accomplished using the kite flap¹¹ harvested from the dorsum of the proximal phalanx of the index finger. In most of the cases, the defect was localized between the MPj and the IPj; only in 1 case, the kite flap was used to resurface an injury involving the distal part of the thumb and the nail (Figure 3). The donor site was covered in all cases using a split-thickness skin graft. The extensor pollicis longus tendon was reconstructed in 2 cases (cases 11 and 15) using a strip harvested from the palmaris longus tendon. Two cases with severe injury of the IPj (case 12) and MPj (case 14) received arthrodesis during emergency treatment. In case 14, due to bone loss, arthrodesis was accomplished using an iliac bone graft.

In 6 cases, dorsal thumb reconstruction was made using the radial forearm flap used in different forms (Table 1). The



Figure 2. Case 6. Posttraumatic avulsion of the nail complex with bone exposure. The patient refused microsurgical toenail transfer, and coverage of the distal dorsal thumb defect was obtained using the dorsolunar artery flap. The donor site was covered with a split-thickness skin graft with a satisfactory result at 24-months of follow-up.

standard radial forearm pedicle flap¹⁶ was used in 2 cases, the tendineocutaneous flap including a strip of palmaris longus tendon¹ and the osteocutaneous flap¹⁸ in 1 case each. The radial forearm fascial flap^{4,23} was used in 2 patients (Figure 4a and 4b). Donor site was always closed primarily. Arthrodesis of the IPj was performed in 2 cases due to the severity of the fracture of the articular surface (case 20) and to the time of joint exposure (case 21). In case 23, bone loss involved the entire proximal phalanx that was replaced using



Figure 3. Case 10. Dorsal skin loss with nail involvement. The defect was repaired by transferring a pedicle kite flap. Result at 12-months of follow-up.

a vascularized bone graft interposed between the IPj and MPj. In Figure 5, the surgical purpose of treatment for dorsal thumb reconstruction used by the authors is reported.

Results

All flaps survived. No flap congestion was reported with dorsolunar, kite, or radial flaps. No vascular complications occurred with free vascularized compound toe transfer. One patient developed wound dehiscence at the donor site after harvesting a radial cutaneous forearm flap; 1 case suffered partial skin graft loss after raising the kite flap (no further surgery required).

At follow-up, no patients complained of cold intolerance following the harvesting of a pedicle radial forearm flap.

Case Reports

Case 4

A 36-year-old man sustained an isolated hot press injury affecting the nail, the distal phalanx bone, and the dorsal skin of the right thumb. Eighteen days later, the defect was resurfaced with a compound toe transfer including three-quarters of the distal phalanx bone. Arthrodesis of the IPj was performed using K-wires (Figure 1a). At a 4-year follow-up, the reconstructed thumb appeared normal with complete integration between the palmar and the dorsal skin; the appearance of the thumb closely mirrored that of the opposite thumb (Figure 1b).

Case 6

A 54-year-old man reported a traumatic avulsion of the distal phalanx of the left thumb including the nail matrix with

exposure of the periosteum. The patient refused microsurgical toenail transfer, and coverage of the distal dorsal thumb defect was obtained using the dorsolunar artery flap. The donor site was covered with a split-thickness skin graft with a satisfactory result at 2-year follow-up (Figure 2).

Case 10

A 58-year-old man had a crush injury to the right thumb while working. The skin of the dorsal side was injured together with the nail and tendon; a fracture of the distal phalanx was also present. The defect was repaired by transferring a pedicle kite flap. The flap was designed over the dorsum of the index finger extending from the MP level to the proximal IPj. The pedicle was dissected up to the origin of the first metacarpal artery allowing an arc of rotation that enabled the coverage of the dorsal thumb defect. The flap was transferred through a skin tunnel. At 1-year follow-up, the residual nail was unaesthetic and therefore removed a few months later after the surgical procedure (Figure 3).

Case 20

A 37-year-old man reported an electrical saw injury to the right thumb, including loss of nail, skin, and tendon with bone exposure and severe articular IPj fracture. A microsurgical extended osteo-onychocutaneous free flap was suggested, but the patient refused any surgical procedure involving the foot as a donor tissue. Arthrodesis of the IPj was performed, and a pedicle reverse radial forearm fascial flap was planned for coverage. The entire flap along with the radial vessel were tunneled under the skin and inserted into the defect using absorbable sutures. A split-thickness skin graft was placed over the flap (Figure 4a). Result at 15-month follow-up showed an acceptable aesthetic appearance of the reconstructed thumb with minimal donor site scar (Figure 4b).

Discussion

Covering dorsal thumb defects can be a challenging problem particularly when multiple tissues are involved simultaneously. Free composite transfer from the dorsum of the foot represents the best technique in terms of cosmetic appearance with a result similar to a normal thumb; in fact, this 1-stage procedure maintains the thumb length, provides vascularized bone, and the quality of the skin is very similar to the original one^{6,10,24} (Figure 1a and 1b). This method is generally indicated in selected patients, and the choice of this surgical approach is influenced by important factors such as age, sex, job, and other activities. Furthermore, many patients are reluctant to donate tissues from the great toe. If the patient refuses this procedure or is not a suitable



Figure 4. Case 20. Loss of nail, skin, and tendon with bone exposure and severe articular interphalangeal joint fracture. (a) Pedicle radial forearm fascial flap covered with a split-thickness skin graft. (b) Postoperative result after 15 months.

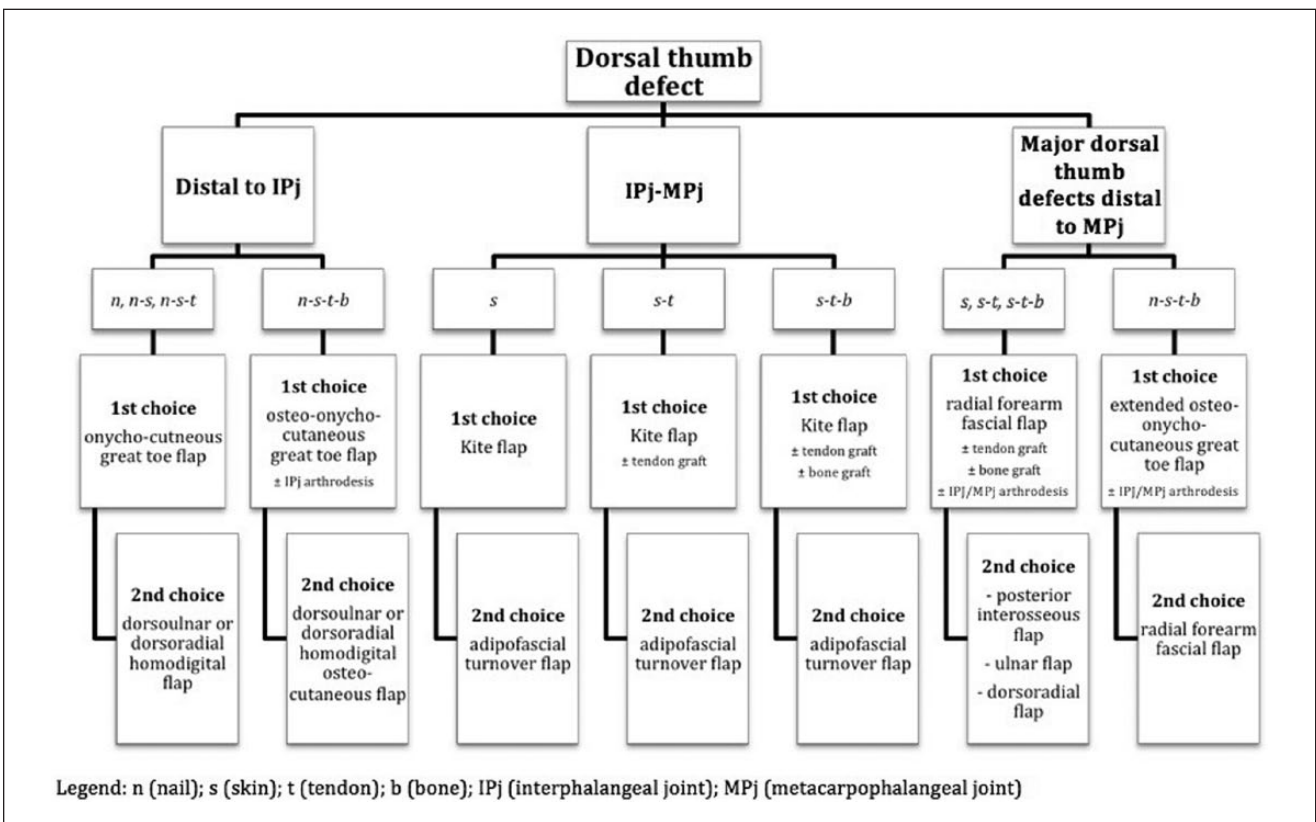


Figure 5. Surgical purpose of treatment for dorsal thumb reconstruction.

candidate for microsurgical reconstruction, it is mandatory to offer other types of surgery. If the area of the skin loss is limited to the distal phalanx, the dorsoulnar flap³ may represent a suitable alternative to a toenail transfer¹⁴ or to more complex free flaps.¹⁷

The Brunelli flap is a reverse homodigital pedicle flap based on the dorsoulnar artery of the thumb; it can be used for covering both distal dorsal and volar thumb defects. It is harvested from the medial side of the MCP region and can

easily reach the distal areas of the thumb because of its distally based pedicle. The donor site is usually covered with a split-thickness skin graft and closed primarily with loss of substance up to a maximum area of 2 × 2 cm. The good aesthetic and functional results obtained and the low morbidity rate at the donor site make this flap, or the similar dorsoradial flap,¹⁹ the first choice for covering distal thumb defects with nail avulsion, when a microsurgical toenail transfer is refused or not indicated (Figure 2).

For more proximally defects, especially between the MPJ and the distal phalanx, the kite flap still represents a fast and effective procedure. The first dorsal metacarpal artery flap is mostly used to resurface thumb pulp defects,⁵ although it represents a reliable technique for skin reconstruction of the dorsum of the thumb. It can be easily passed through a subcutaneous tunnel to reach the dorsum of the thumb; it also provides skin of a similar quality, obtaining superior cosmetic results when compared with other local techniques.²² The kite flap allows treatment of skin defects considerably larger than those covered with the Brunelli flap: the size of the kite flap can reach up to 5 to 6 cm in length and 4 cm in width.⁹ However, we prefer to limit the size of the flap to a maximum of 3 × 3.5 cm (Figure 3) to avoid the risk of an unacceptable donor site defect at the second MCP joint level determining a poor scar.²¹

Current literature reports a variety of pedicle fasciocutaneous flaps^{7,8,13,16} harvested from the upper limb for reconstructing dorsal soft tissue defects of the thumb. Most of these flaps provide a bulky skin paddle, which does not correspond to the contour of the thumb. This was directly observed in the study patients when the pedicle radial flap was harvested as a pure fasciocutaneous flap or including the palmaris longus tendon¹ or a vascularized radial bone graft.¹⁸ We do not believe that other fasciocutaneous flaps, such as the posterior interosseous⁷ or the ulnar flap,¹³ may improve the final cosmetic result. The recently described dorsoradial flap^{2,8} provides pliable and thin skin, but its major disadvantage is represented by the donor site scar which is located in a very visible area as the dorsoradial aspect of the wrist cannot be closed directly and requires a skin graft.

For these reasons, the thickness of the flap can be reduced by harvesting a pure fascial flap covered by a split-thickness skin graft.^{4,23} This flap is particularly well suited for dorsal hand wounds including the thumb; it provides thin, pliable, and well-vascularized coverage avoiding donor site problems. This flap was used with satisfactory result in 2 cases, both characterized by a major injury of the dorsal aspect of the thumb. The major drawback is the sacrifice of the radial artery, although no patient complained of cold intolerance. A possible alternative may be represented by free flaps¹² or by perforator flaps harvested from the forearm (the radial or ulnar artery perforator flap) used as either fasciocutaneous or adipofascial flaps. Their pivot point is located more proximally than in traditional pedicle flaps; therefore, it is difficult to extend them to cover the distal dorsal aspect of the thumb.¹⁵

Reconstruction of dorsal thumb defects is imperative and its approach is correlated to patient selection and flap alternatives. For defects with nail involvement, the free osteo-onychocutaneous flap harvested from the great toe provides the best aesthetic result, with an alternative represented by the dorsoulnar flap, when the defect is located

distally, or the fascial pedicle radial forearm flap, for major dorsal thumb defects. The kite flap still represents a feasible solution for medium-size defects with an intact nail.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008. Informed consent was obtained from all patients for being included in the study.

Statement of Informed Consent

Informed consent was obtained from all individual participants included in the study.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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