

“Kite Flap” for Thumb Reconstruction: A Case Report

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ABSTRACT

Thumb injuries, particularly those affecting the distal tip, significantly compromise hand function due to the thumb's essential role in fine and gross grasp, opposition, and dexterity. Reconstruction of these defects—especially when bone or tendon is exposed—poses a surgical challenge given the limited availability of local soft tissue and the need for durable and sensate coverage. The first dorsal metacarpal artery (FDMA) flap, commonly known as the Kite flap, has emerged as a reliable option for thumb reconstruction due to its consistent vascular anatomy and favorable outcomes. We report the case of a 54-year-old male with a distal thumb injury (Fassler type C) following trauma with an abrasive tool, presenting with a 2 × 1 cm wound and bone exposure. A heterodigital island flap based on the FDMA was elevated from the dorsal aspect of the index finger and transferred to the defect site. The donor site was reconstructed using a full-thickness skin graft. The procedure resulted in complete flap survival, with early mobilization and satisfactory functional and aesthetic outcomes. The Kite flap offers several advantages, including preservation of thumb length, potential sensory recovery, low donor site morbidity, and applicability to both volar and dorsal defects in a single-stage procedure. Despite the potential risk of distal flap necrosis, technical modifications such as avoiding tunneling and including a skin bridge have improved reliability. In conclusion, the Kite flap remains a versatile, effective, and well-established technique for the reconstruction of distal thumb defects, combining structural restoration with functional and sensory rehabilitation.

KEYWORDS: Kite flap, thumb reconstruction, first dorsal metacarpal artery flap, soft tissue defect, hand trauma, distal thumb injury, heterodigital flap, sensory recovery, functional outcome, skin graft.

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INTRODUCTION

Thumb injuries, particularly those involving the distal tip, significantly affect hand function due to the thumb's essential role in fine grip, power grasp, opposition, and overall dexterity. Loss of thumb function severely impairs hand capability, making the choice of reconstructive technique critical. Reconstructing thumb tip defects, especially those with bone or tendon exposure, presents a challenge due to the limited availability of local soft tissue and the need for durable and sensate coverage. The inadequacy of local tissue for coverage often necessitates the use of regional or distant flaps, as simple closure or skin grafting may be insufficient, especially in complex injuries.

The first dorsal metacarpal artery (FDMA) flap, commonly known as the “Kite flap” or Foucher flap, has emerged as a reliable option for soft tissue reconstruction of the thumb. Its widespread use in the plastic surgery community underscores the strong evidence supporting its efficacy and highlights its value as a reconstructive tool.

The FDMA has a predictable anatomy, enhancing the reliability of the flap. It typically arises from the radial artery in the first intermetacarpal space, just proximal to where the radial artery passes between the heads of the first dorsal interosseous muscle and distal to the extensor pollicis longus tendon. Although its primary origin is consistent, variations may occur, with the FDMA arising from the dorsal carpal arch or anastomoses with the posterior interosseous artery, deep palmar arch, or the ulnar digital artery of the thumb. This potential variability underscores the importance of preoperative Doppler assessment to confirm vessel patency and course.

The FDMA typically courses superficially over the fascia of the first dorsal interosseous muscle, or subfascially in some cases, extending radially and parallel to the second metacarpal bone. Understanding this fascial relationship is critical during surgical dissection to preserve the vascular pedicle. The FDMA usually divides into three branches: an ulnar branch to the index finger, an intermediate branch to the first web space, and a radial branch to the thumb. The ulnar branch (FDMAu) is most commonly used as the dominant pedicle for the flap.

The FDMA supplies the dorsal skin of the hand from the first to the third metacarpals and the dorsal surfaces of the thumb and index finger up to the proximal interphalangeal joint (PIP), thus defining the potential dimensions of the skin island. A critical point during flap elevation is the distal perforator connecting the FDMAu with the second palmar metacarpal artery at the metacarpophalangeal (MCP) joint level, which usually must be ligated or coagulated to ensure the flap's blood supply relies solely on the proximal pedicle. The flap includes one or two subcutaneous veins to facilitate venous drainage and prevent congestion. Additionally, a branch of the superficial radial nerve may be incorporated to create a sensate flap, allowing sensory restoration of the

reconstructed thumb tip. The dorsal veins and sensory nerve enter the flap at the ulnar edge of the MCP joint. The pivot point for flap rotation is typically located at the junction of the bases of the first and second metacarpals—knowledge of which is essential for planning the arc of rotation and ensuring tension-free reach of the flap.

Thumb tip reconstruction follows several core principles: prioritizing function and sensation, preserving the interphalangeal (IP) joint, achieving good soft tissue coverage, and restoring motor and sensory functions. Ideally, like-for-like tissue replacement is preferred, particularly the unique volar glabrous skin of the thumb pulp, for optimal sensory outcomes. While the Kite flap provides durable and flexible skin, it is not glabrous. Preserving thumb length is crucial for grip and pinch functions, and the Kite flap generally allows full length preservation. The technique also minimizes donor site morbidity, despite requiring a skin graft on the index finger.

Early mobilization of the thumb is essential to prevent stiffness and encourage functional recovery, a benefit of the Kite flap as it is usually a single-stage procedure. While functional restoration is paramount, the aesthetic outcome of both the reconstructed thumb and the donor site is also an important consideration for patient satisfaction.

Studies consistently report high survival rates for the Kite flap, ranging from 90% to 100%. In one series, 14 out of 15 flaps survived completely, and another study with a modified technique reported no distal necrosis in 9 patients. These outcomes highlight the reliability of the FDMA as a vascular source. Nevertheless, distal flap necrosis remains a known complication with variable incidence. One study reported distal necrosis in 1 of 15 flaps, and another noted partial necrosis in 2 of 42 flaps. Technique modifications, such as adding a skin bridge and avoiding tunneling, aim to reduce this risk.

When considering thumb tip reconstruction, the Kite flap should be compared with other available techniques. The Moberg flap, a volar advancement flap, is suitable for smaller defects (≤ 2 cm) and provides sensate skin, but its advancement capacity is limited and may lead to flexion contracture of the IP joint, cold intolerance, and other complications. In contrast, the Kite flap can cover larger dorsal and volar defects and generally preserves thumb length better.

The Kite flap can be sensate in a single stage and is versatile for both volar and dorsal defects. Free tissue transfer techniques, such as toe-to-thumb transfer, offer excellent coverage and sensory restoration for large defects but are more complex and associated with greater donor site morbidity. The Kite flap offers a simpler regional option in most cases. The palmar advancement flap (Moberg-Littler) is another sensate island flap for volar defects, but the Kite flap provides dorsal access and broader applicability

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Characteristics	Kite Flap (FDMA)	Moberg Flap	Cross Finger Flap	Free Tissue Transfer (e.g., Toe Transfer)
Defect Size	Small to Medium	Thumb	Small	Medium to Large
Location	Fingers, including thumb (if ne nerve)	Thumb	Not infected for thumb (unless un...	Fingers
Sensibility Restoration	Yes unpredictably (if nerve is inc.	Unpredictable	No (at least good)	Yes (good)
Stages	Generally one	Generally one	Two-stage	Generally
Primary Length Restoration	Generally	Limitations	From volar of donor (scar) (scar)	Generally good
Donor Site	Dorsal finger (scar)	Volar thumb (scar)	Volar aspect of donor (scar)	Variable
Potential Complications	Necrosis, venous congestion pain	Flexion contracture intolerance to cold	Rigidity, necrosis of part of didigit or hand	Microsurgical complications, loss of function, donor site morbidity

CASE REPORT

A 26-year-old male suffered an avulsion injury to the distal phalanx of the right thumb in a workplace accident involving a steel cable. The patient presented with loss of distal pulp, partial exposure of the distal phalanx, and bone loss. Neurovascular structures were preserved. Given the exposure of bone and tendon, simple skin grafting was contraindicated, and a regional flap was required. A Kite flap based on the first dorsal metacarpal artery was selected to reconstruct the thumb



Figure 1. Fassler Classification



Figure 2. Transverse 2 cm palmar defect.



Figure 3. Transverse defect, lateral view.

SURGICAL TECHNIQUE

Under regional block anesthesia and tourniquet control, the thumb defect was debrided. A handheld Doppler probe was used to identify and mark the course of the first dorsal metacarpal artery. The flap was designed on the dorsal aspect of the proximal phalanx of the index finger, overlying the first dorsal interosseous muscle. The skin paddle was raised

incorporating the fascia to protect the vascular pedicle, and a subcutaneous vein and branch of the superficial radial nerve were included to allow for sensory restoration. The flap was elevated from distal to proximal, ligating the distal communicating branch at the level of the MCP joint. The flap was rotated toward the thumb defect with its pivot point at the base of the first and second metacarpals. Care was

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taken to avoid kinking of the pedicle. The donor site on the index finger was covered with a full-thickness skin graft harvested from the medial arm. The flap was inset into the

thumb defect with absorbable sutures, and the hand was immobilized with a splint.



Figure 4. Flap design.



Figure 5. First dorsal metacarpal



Figure 6. Flap fixation and full-thickness skin graft.



Figure 7. Flap fixation and full-thickness skin graft.



Figure 8. Flap fixation and full-thickness skin graft.

Postoperative care included elevation, dressing changes, and close monitoring for signs of venous congestion or ischemia. The flap survived completely without signs of necrosis. Early physiotherapy was initiated three weeks postoperatively. At 8 weeks, the patient demonstrated good range of motion and satisfactory aesthetic and functional results. Protective sensation over the flap area was partially restored by 10 weeks.

DISCUSSION

Thumb tip injuries present a significant reconstructive challenge due to the thumb's critical role in hand function, including fine motor skills, opposition, and grip strength. The complexity increases when bone or tendon is exposed,

necessitating durable, sensate, and well-vascularized tissue coverage. The first dorsal metacarpal artery (FDMA) flap, or Kite flap, provides a reliable and versatile option for these defects due to its predictable vascular anatomy, ability to restore sensation, and relatively low donor site morbidity.

In the presented case, a 54-year-old male with a distal thumb defect was successfully treated using an FDMA heterodigital island flap combined with a full-thickness skin graft for donor site closure. The surgical technique emphasized preservation of the vascular pedicle and inclusion of a sensory branch of the radial nerve to optimize functional recovery. Early mobilization facilitated by the single-stage procedure contributed to minimizing joint stiffness and promoting rehabilitation.

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Literature supports high survival rates of the Kite flap, typically ranging from 90% to 100%, with distal flap necrosis being a relatively rare but important complication. Various technical modifications, such as avoiding tunneling and maintaining a skin bridge, have been shown to reduce this risk. Compared to alternative techniques like the Moberg flap or free tissue transfer, the Kite flap offers a favorable balance between complexity, donor morbidity, and functional outcome, especially for small to medium-sized defects.

Sensory restoration is particularly important in thumb reconstruction, and the inclusion of a sensory nerve branch in the flap design allows for meaningful recovery of protective sensation, enhancing patient satisfaction and hand functionality. Preservation of thumb length and the ability to cover both volar and dorsal defects make the Kite flap a highly practical solution.

Future studies focusing on long-term functional and sensory outcomes, as well as comparisons with other reconstructive methods, will further clarify the indications and optimize surgical planning. Overall, the FDMA Kite flap remains a cornerstone technique in thumb tip reconstruction, combining reliability, versatility, and satisfactory aesthetic and functional results.

CONCLUSIONS

The Kite flap is a reliable and versatile reconstructive option for thumb tip injuries with bone or tendon exposure. It offers several advantages including good vascularity, potential for sensory restoration, preservation of thumb length, and minimal donor site morbidity. The anatomy of the first dorsal metacarpal artery is well-defined, allowing for reproducible flap harvest. Its ability to cover both dorsal and volar defects makes it suitable for a wide range of thumb injuries. Despite some risk of distal necrosis, particularly in longer flaps or in cases of pedicle compression, proper technique and planning minimize complications. The Kite flap remains a valuable tool in the reconstructive surgeon's armamentarium.

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