Received: 23 February 2023 | Revised: 16 August 2023 | Accepted: 5 September 2023

DOI: 10.1002/micr.31113

CASE REPORT

MICROSURGERY WILEY

Dorso-ulnar reverse flow pedicled osseous flap for reconstruction of the distal phalanx of the thumb: A case report

Daniele Tosi MD | Luca Patanè MD | Pietro Francesco Delle Femmine MD | Matteo Ornelli MD | Giovanni Ruocco MD | Nicola Felici MD

Unit of Reconstructive Surgery of the Limbs, Azienda Ospedaliera San Camillo Forlanini, Rome, Italy

Correspondence
Luca Patanè, Azienda Ospedaliera San Camillo Forlanini, Unit of Reconstructive Surgery of the Limbs, Rome, Italy.
Email: luca.patane2@gmail.com

Abstract

Reconstruction of osseous defects of the distal phalanx of the thumb is usually addressed with free bone grafts or free vascularized bone flaps. Some reports demonstrated the possibility to harvest an osteo-cutaneous flap in the dorso-ulnar side of the first metacarpal bone with success. In the same manner, no reports are present in the literature in which bone deficits were reconstructed with this flap elevated as an exclusively osseous flap. We report our successful experience with one case of distal phalanx reconstruction of the thumb by mean of the dorso-ulnar reverse flow pedicled osseous flap. The patient was a 45-year-old woman with symptoms related to a cystic bone tumor that involved the entirety of the distal phalanx of the thumb. Flap dimensions were calculated based on x-ray gap measures, which resulted in need of 1.5 × 0.8 × 0.5 cm flap dimensions. An osseous flap was harvested and transposed from the ulnar side of the first metacarpal bone. K-wire fixation was utilized for bone flap stabilization. No complications occurred and excellent functional result was evaluated at 6 months follow-up. In our opinion, the flap may be considered as an alternative to free bone grafts in situations in which perilesional tissues may jeopardize the process of free graft taking and in cases in which free vascularized bone flaps are not feasible for patient or surgeon decision.

1 | INTRODUCTION

Reconstruction of osseous defects of the distal phalanx of the thumb remains a challenging procedure in hand surgery. Historically, its reconstruction had been addressed only by mean of bone grafting techniques (Rinaldi & Fiornovelli, 1978), mainly harvested from the radius or the iliac crest (Kurz et al., 1989). Reconstruction with free bone grafts require many factors to prevent graft resorption, such as graft stability and compression or its placement in between well vascularized bone stumps (LaTrenta et al., 1989).

Recently, free vascularized bone flaps, such as the medial femoral condyle free flap (Ruston et al., 2015) or the Great Toe flap (Hamilton & Morrison, 1980), have showed their reliability as useful alternatives to bone grafts in microsurgical reconstruction of bone deficits of the thumb, but the donor site morbidity related to these techniques may not always be accepted by the patient. Pedicled vascularized bone flaps for thumb reconstruction were firstly described by Pellisier et al. (Brunelli et al., 1999; Pellissier et al., 2001; Pistre et al., 2001). They reported three cases of distal phalanx reconstruction of the thumb with an osteo-cutaneous dorso-ulnar flap, which included a bone fragment harvested from the first metacarpal bone. Getting inspiration from those reports and anatomical findings, we revived this reconstructive method using a dorso-ulnar reverse flow pedicled osseous flap. At best of our knowledge, this is one of the few cases reported in the literature.

2 | CASE REPORT

A 45-year-old woman referred to our Reconstructive Unit for symptoms related to a cystic bone tumor that gradually growth over a 10-year period, which caused an almost complete erosion of the distal phalanx of the thumb. She complained about pain in thumb flexion, reduction in pinch grip, hippocratic nail deformity and shape deformity of the distal phalanx of the thumb.

The x-ray showed a complete absence of volar and dorsal cortical bone and a cystic dilatation of the central portion of the phalanx. The distal inter phalangeal (DIP) joint was slightly deformed but still preserved (Figure 1a). The MRI confirmed these findings and suggested a diagnosis of enchondroma or aneurismatic cyst of the distal phalanx.

Many different techniques were proposed to the patient for excising the bone tumor, restoring thumb functionality and aesthetic appearance of the thumb (Figure 1b,c). A Trimmed Toe to thumb reconstruction was firstly proposed for restoring thumb functionality and aesthetic appearance. Reconstruction with a trimmed toe to thumb could have ameliorated both aspects complained by the patient, but it was rejected by the patient for its high donor site morbidity. To overcome patient's apprehension on the donor site area, we proposed a dorso-ulnar reverse flow osseous flap harvested from the ulnar side of the first metacarpal bone.

Skin markings were performed preoperatively, with a "lazy S" shaped line representing the skin incision (Figure 2a). The pivot point of the pedicle was marked 2 cm proximal to the nail fold; the dorso-ulnar artery was identified 1 cm lateral to the median axis of the proximal phalanx. In Figure 2, the dotted line represented the width of the harvested pedicle including artery and veins. The location of bone harvesting was determined by measuring, along the finger axis, the distance between the pivot point and the distal extension of the bone defect. Flap dimensions were calculated based on x-ray an intraoperative gap measures and resulted in $1.5 \times 0.8 \times 0.5$ cm in flap dimensions.

The surgical procedure was performed under loco-regional anesthesia, using an arm tourniquet and under loupe magnification. The skin was incised at the level of the "lazy S" marking in a subdermal plane in order to expose the subcutaneous pedicle of the flap. At the level of the first metacarpal bone, the incision was prolonged on the radial edge deep to the paratenon of the extensor pollicis longus (EPL) tendon and on the ulnar edge deep to the fascia of the first dorsal interosseous muscle (Figure 2b). The EPL tendon was then retracted radially, allowing the incision of the periosteum and the osteotomy at the level of the first metacarpal shaft on the radial side. On the ulnar side, a sling of the first interosseous aponeurosis was included in the flap preserving its continuity with the periosteum elevated by the ulnar osteotomy. To obtain a rectangular shaped bone segment, longitudinal radial and ulnar sided osteotomies were performed first, while proximal and distal transverse osteotomies were executed conserving distally the continuity between the adipose pedicle and the periosteum of the flap. The flap was then elevated in a proximal to distal direction till the pivot point was reached (Figure 2c). The tourniquet was released confirming flap vascularization by evaluating bone edges bleeding. Once performed this assessment, the flap was rotated to fill the bone defect and fixed under fluoroscopy with K-wires temporarily blocking the IPj (Figure 2d,e). At the pivot point level, a small area of pedicle was left healed by secondary intention to avoid compression on the pedicle (Figure 2f). Skin was sutured avoiding excessive tension of the skin flaps. A volar thumb split was positioned to immobilize the IPj.

The final pathology report stated the diagnosis of enchondroma. The patient was discharged the first postoperative day. X-rays evaluations were performed at two (Figure 3a), four, eight (Figure 3b,c) and 16 weeks (Figure 3d) postoperatively. Mobilization started 2 weeks after surgery with thumb opposition exercises; K-wires were removed at 8 weeks when the x-ray evaluation demonstrated complete bone consolidation and healing of the donor site area at the first metacarpal bone with restoration of bone radiopacity. The patient returned to heavy manual work 12 weeks after surgery with a ROM of 0-0-70°

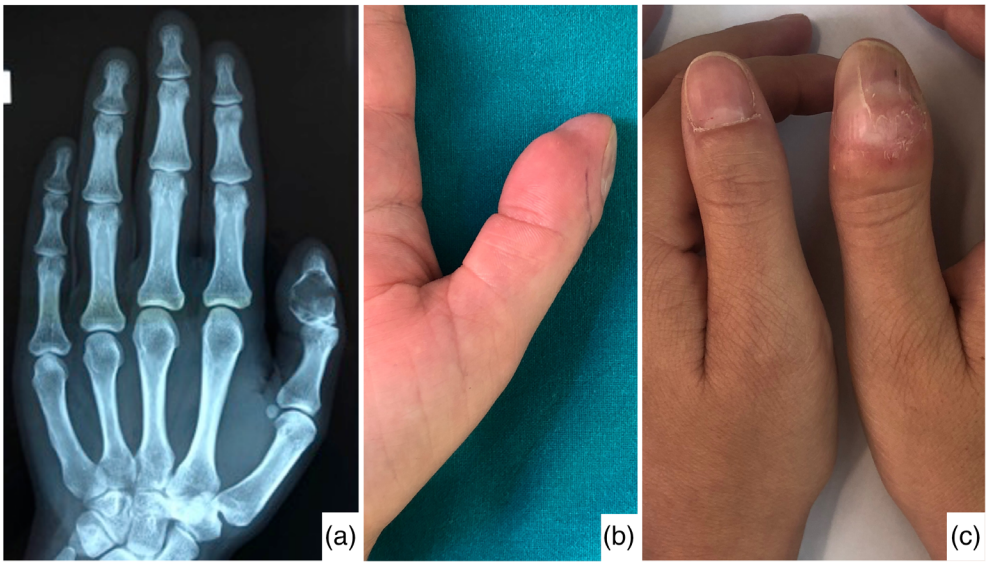

FIGURE 1 X-ray documenting erosion of the cortical bone and deformity of the distal inter phalangeal (DIP) joint. The low radiopacity of the lesion of the distal phalanx of the thumb was consistent with the diagnosis of enchondroma or bone cyst (a). Hippocratic nail and shape deformity of the distal phalanx of the right thumb (b,c).

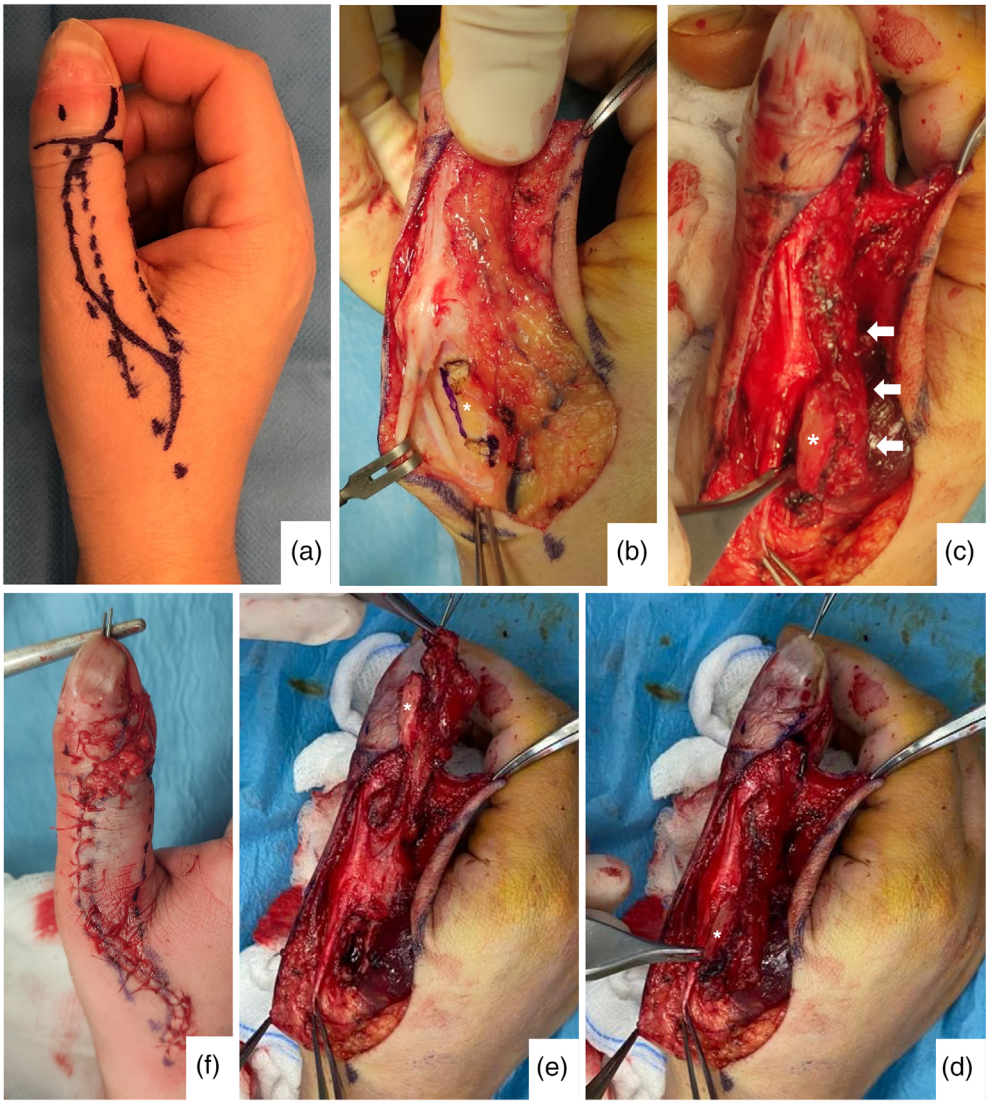

FIGURE 2 Preoperative markings. The dotted line represented the width of the harvested pedicle including artery and veins (a). Bone gap dimensions were taken intraoperatively and marked on the donor site area (b). Asterisks indicate the bone flap and the arrows mark the vascular pedicle. Intraoperative view of the flap transposition (c–e). Immediate postoperative result. A small part of the pedicle was left healed by secondary intention (f).

FIGURE 3 X-ray evaluation at 2 weeks (a), 2 months (b,c) and 6 months (d) follow-up. The increase of radiopacity of the bone flap was sign of flap vitality and determined by the periosteal reaction of the flap with its surrounding tissues. Optimal union between the flap and the dital bone stump of the distal phalanx was obtained (d). X-rays showed progressive healing of the donor site area at the first metacarpal bone with restoration of bone radiopacity.

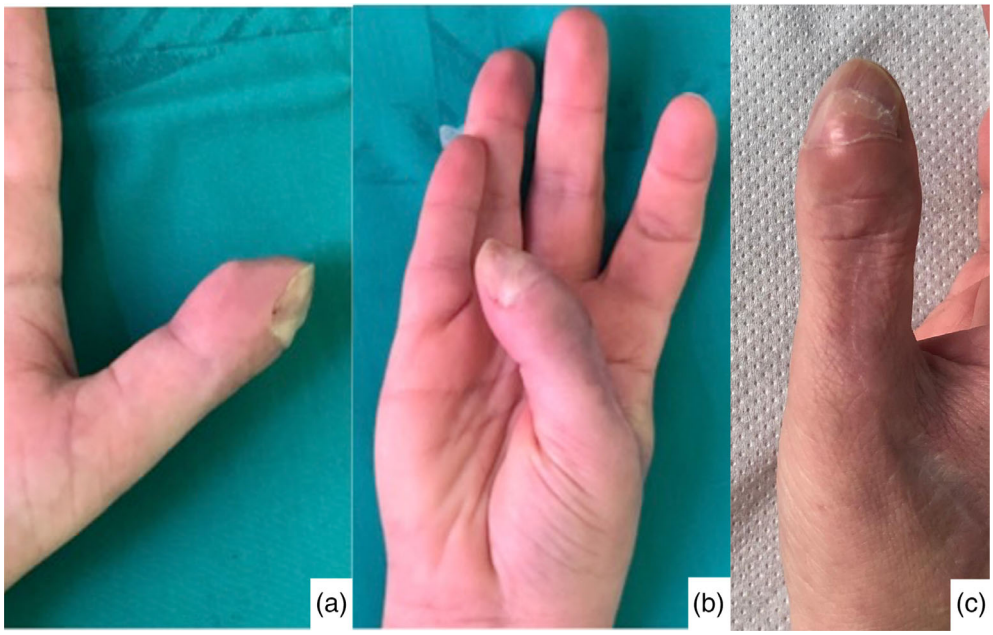

FIGURE 4 Postoperative result at 2 (a,b) and 6 (c) months with good flexion of the DIP.

and a restored pinch force, confirmed by Jamar pinch test without pain. At 2- (Figure 4a,b) and 6 months (Figure 4c) follow-up the thumb presented full stability of the distal phalanx and an adequate pinch movement, with complete restoration of thumb function. At 6 months, postoperatively no signs of recurrence were noted.

3 | DISCUSSION

It is widely recognized that bone gap reconstruction requires a vascularized bone graft if the deficit is interposed between two bone segments not optimally vascularized (Arai et al., 1999; Cutting & McCarthy, 1983). This is why it is highly probable that free bone grafts could be resorbed without an adequate environment. Reconstruction by mean of free vascularized bone flaps could be considered an excessive option in some cases in terms of time consume and costs or refused by the patient due to donor site morbidity. In this case, a bone graft reconstruction was considered at high risk of failure. In fact, the proximal and distal portions of the distal phalanx of the patient's thumb were not considered adequate for allowing a sufficient compression and stability of the whole reconstruction, leading to bone resorption, chronic instability and inability to perform pinch movements, finally requiring surgical revision. On the other hand, a well vascularized bone flap was deemed to overcome this situation, stimulating bone union even with moderate stability and compression between the bone stumps.

Despite various osteo-cutaneous flaps are described in the literature, such as composite radial or posterior interosseous bone flaps, in some cases these flaps may be considered excessive for the type of defect or still not feasible. A reverse radiodorsal artery-pedicled thumb metacarpal vascularized bone graft was described for the treatment of an osteochondral fracture of the thumb interphalangeal joint (Hirose et al., 2021). Even if it could be considered a good alternative to the ulnar sided flap, We believe that the pedicle is too short and it is not adequate to allow reconstruction of bone defects distal to the DIP. Basing on the anatomical and case series studies published by Brunelli et al. (1996) and (Pellissier et al., 2001), the dorsal ulnar vascular supply of the first metacarpal bone is guaranteed by the dorso-ulnar artery. This artery shows a constant distal anastomosis with the volar proper digital artery at the level of the neck of the thumb's proximal phalanx. Basing on these anatomical findings, a case series of three distal phalanx reconstruction using osteocutaneous reverse flow flaps was reported (Pellissier et al., 2001).

We report a case of extended bone defect of the distal phalanx of the thumb reconstructed with a dorso-ulnar reverse flow pedicled osseous flap. In this case, a skin deficit was not present but a well vascularized pedicled bone flap was necessary. At 2- and 6-months follow-up, the radiographs showed that size and density of the bone flap was greater than the donor site area. According to the authors, this fact was due to the strong periostal reaction of the bone flap. The periosteal reaction of the flap was quite evident and noticeable with a high radiopacity of the bone flap and with calcification of the subcutaneous tissue around the flap. We believe that this reaction allowed to connect the bone flap with the bone stumps of the distal phalanx. In case of reconstruction after malignant tumor resection, a longer follow-up is strongly suggested. In this case, clinical examination confirmed optimal bone healing with normal pinch movement and complete restoration of thumb function.

As the anatomy of the flap is well established and documented in the literature, we believe that this flap is a solution that may overcome donor site related concerns in distal phalanx bone reconstruction.

CONFLICT OF INTEREST STATEMENT

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

DATA AVAILABILITY STATEMENT

Research data are not shared.

ETHICS STATEMENT

Institutional review board approval is not applicable for case reports.

ORCID

Daniele Tosi https://orcid.org/0000-0002-4894-206X
Luca Patanè https://orcid.org/0000-0003-4811-5248

REFERENCES

Arai, K., Toh, S., & Harata, S. (1999). Experimental study on vascularized Island pedicle bone graft: Bony fusion between the graft and the recipient floor. *Microsurgery*, *19*, 239–246.

Brunelli, F., Brunelli, G., & Vigasio, A. (1996). Le Lambeau dorso-cubital du pouce. Etude anatomique et applications cliniques. A propos de vingt-deux cas (Dorso-cubital flap of the thumb. An anatomical study with clinical applications. Apropos of 22 cases). *Annales de Chirurgie Plastique et Esthétique*, *41*(3), 259–268.

Brunelli, F., Vigasio, A., Valenti, P., & Brunelli, G. R. (1999). Arterial anatomy and clinical application of the dorso-ulnar flap of the thumb. *The Journal of Hand Surgery*, *24A*, 803–811.

Cutting, C. B., & McCarthy, J. G. (1983). Comparison of residual osseous mass between vascularized and nonvascularized onlay bone transfers. *Plastic and Reconstructive Surgery*, *72*, 672–675.

Hamilton, R. B., & Morrison, W. A. (1980). Microvascular segmental thumb reconstruction: A case report. *British Journal of Plastic Surgery*, *33*(1), 64–67. https://doi.org/10.1016/0007-1226(80)90056-9

Hirose, H., Komura, S., Hirakawa, A., Okuda, R., Kato, K., Kanamori, S., Masuda, T., Ito, Y., & Akiyama, H. (2021). Reverse radiodorsal artery-pedicled thumb metacarpal vascularized bone graft for osteochondral fracture of the thumb interphalangeal joint with a bone defect: A case report. *Microsurgery*, *41*(2), 170–174. https://doi.org/10.1002/micr.30663

Kurz, L. T., Garfin, S. R., & Booth, R. E., Jr. (1989). Harvesting autogenous iliac bone grafts. A review of complications and techniques. *Spine*, *14*, 1324–1331.

LaTrenta, G. S., McCarthy, J. G., Breitbart, A. S., May, M., & Sissons, H. A. (1989). The role of rigid skeletal fixation in bone-graft augmentation of the craniofacial skeleton. *Plastic and Reconstructive Surgery*, *84*, 578–588.

Pellissier, P., Pistre, V., Casoli, A., Lim, A., Martin, D., & Baudet, J. (2001). Dorso-ulnar osteocutaneous reverse flow flap of the thumb. *The Journal of Hand Surgery*, *26B*, 207–211.

Pistre, V., Pellissier, P., Martin, D., & Baudet, J. (2001). Vascular blood supply of the dorsal side of the thumb, first web and index finger: Anatomical study. *The Journal of Hand Surgery*, *26B*, 98–104.

Rinaldi, E., & Fiornovelli, P. (1978). Bone grafting in the reconstruction of the phalanges of the hand. *Italian Journal of Orthopaedics and Traumatology*, *4*(2), 143–147.

Ruston, J. C., Amin, K., Darhouse, N., Sivakumar, B., & Floyd, D. (2015). The vascularized medial femoral Corticoperiosteal flap for thumb reconstruction. *Plastic and Reconstructive Surgery. Global Open*, *3*(8), e492. https://doi.org/10.1097/GOX.0000000000000452

How to cite this article: Tosi, D., Patanè, L., Delle Femmine, P. F., Ornelli, M., Ruocco, G., & Felici, N. (2023). Dorso-ulnar reverse flow pedicled osseous flap for reconstruction of the distal phalanx of the thumb: A case report. *Microsurgery*, *43*(8), 837–841. https://doi.org/10.1002/micr.31113