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CASE REPORT
Hand/Peripheral Nerve

The Vascularized Medial Femoral Corticoperiosteal Flap for Thumb Reconstruction

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Summary: We present an interesting method of shaping a vascularized medial femoral condyle (MFC) flap into a "neophalanx" for phalangeal reconstruction. Our patient presented with limited strength and function secondary to fracture nonunion of the proximal phalanx of the dominant thumb. Following excision of the pseudarthrosis, an MFC corticoperiosteal flap was harvested, sculpted into a prism shape and inset. The superomedial genicular pedicle was anastomosed to the princeps pollicis artery and a cephalic tributary. On follow-up, new bone growth was seen on radiographs and the patient had substantially improved function, with full metacarpophalangeal extension, a Kapandji score of 9, and a markedly reduced Disabilities of the Arm, Shoulder and Hand score of 2.68. The MFC flap is useful for reconstruction of bony defects, with minimal donor morbidity. This versatile vascularized flap can be crafted to requisite shapes and is useful for small defects in the hand, including phalangeal reconstruction. *(Plast Reconstr Surg Glob Open 2015;3:e492; doi: 10.1097/GOX.0000000000000452; Published online 25 August 2015.)*

Pseudarthrosis refers to fracture nonunion after a significant time, whereby union is unlikely to occur without intervention. This can pose a reconstructive challenge, with difficulties secondary to poor reduction or osteosynthesis, infection, or insufficient vascularity such as following a crush injury.[1] Vascularized bone grafts from the fibula, rib, or iliac crest have been described for upper extremity bony defects. For smaller defects, vascularized periosteal flaps provide a more versatile solution, as they can be more easily shaped.[2] We present a case of phalangeal reconstruction with a free corticoperiosteal medial femoral condyle (MFC) flap in a patient with nonunion of the right thumb proximal phalanx (P1).

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Received for publication September 23, 2014; accepted June 11, 2015.
Presented at British Association of Plastic, Reconstructive and Aesthetic Surgeons Winter Scientific Meeting, Dublin, November 28, 2013 (poster) and Plastic Surgery Section Meeting, Royal Society of Medicine, London, March 11, 2014 (presentation).

DOI: 10.1097/GOX.0000000000000452

CASE DETAILS

A 33-year-old nonsmoking male sustained an industrial crush injury to the right index finger and thumb 8 years before presentation. The patient could oppose the thumb and index finger, but barely achieved a weak pincer grip, compounded by thumb instability. Shortening and ulnar angulation of the index finger proximal phalanx and additional shortening of the thumb were seen (Fig. 1). The patient's priority was to regain function and strength of pinch and tripod grip, to facilitate his writing hobby. He declined toe transfer, and other grafts were thought too bulky. Preoperative radiographs show bone loss and pseudarthrosis of the right thumb and index P1.

Disclosure: *The authors have no financial interest to declare in relation to the content of this article. The Article Processing Charge was paid for by the authors.*

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Fig. 1. Preoperative radiograph showing hypertrophic nonunion of thumb and index finger fractures.

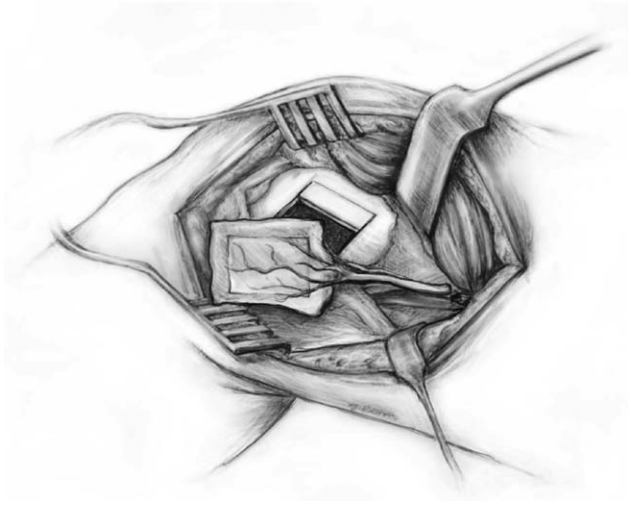

Fig. 2. Intraoperative view of the right knee. Rectangular bone flap raised with overlying periosteum and superomedial genicular pedicle. Free cortical graft marked for harvesting.

Procedure

An S-shaped incision was made along the dorsoradial aspect of the thumb and extensor tendons retracted. The P1 fracture showed evidence of osteophytic growth, and osteotomy of proximal and distal segments of the thumb proximal phalanx was performed. The proximal joint was preserved, leaving a bony defect 25 mm in length. In the extremities, vascularity can be variable, particularly following a previous crush injury, so a vascularized bone graft was chosen to minimize the risk of failure.

A longitudinal incision medial to the patella allowed access to the MFC and its supplying vessels. Superomedial genicular vessels (most prominent in this patient) were isolated giving a pedicle length of 5 cm. A 25-mm-long rectangle was drawn on the MFC (Fig. 2). Cortical and underlying cancellous bones were raised, with a larger surface area of overlying periosteum. The vascularized bone flap was scored longitudinally and folded at an angle of 60 degrees. A rectangular cortical graft was harvested to form the third side of the prism (Fig. 3).

The prism was secured with cerclage wires and encased within the vascularized periosteum. Cancellous bone chips were packed within the prism to form a structurally solid phalanx, tailored to the length of the defect. The "neophalanx" was stabilized and inset with 2 parallel Kirschner (K) wires through the interphalangeal and metacarpophalangeal joints (Fig. 3). The donor vessels were anastomosed to the princeps pollicis artery and a dorsal superficial tributary of the cephalic vein. To avoid undue tension and compression of the anastomoses, a split-thickness skin graft covered the dorsal defect. A scar revision is planned. The index finger nonunion was also addressed with osteotomy and lag screw fixation.

Postoperative Outcome

The patient progressed well postoperatively and was discharged from hand therapy 3 months post surgery. He regained good thumb span of 16.5 cm, at 90 degrees. He had full metacarpophalangeal joint extension but a 15-degree lag from full extension at the interphalangeal joint. Kapandji score on the operated right hand was 9 (left, 10). Right hand grip strength was 58 kg and biometric pinch strength was 7.5 (left, 6.7) (See image, **Supplemental Digital Content 1**, which displays a postoperative hand therapy image demonstrating functional hand grip, ***http://links.lww.com/PRSGO/A118***). Disabilities of the Arm, Shoulder and Hand score improved from 25 to 2.68 after surgery. The knee regained full range of motion by 3 months, although with remaining scar hypersensitivity, and paresthesia over an area of the patella. Radiographs show evidence of new bone formation and flap take (Fig. 4).

DISCUSSION

Fracture pseudarthrosis of the phalanges, particularly the thumb, can cause significant functional impairment. The vascularized MFC corticoperiosteal flap has been described for bony defects of the humerus, clavicle, femur, scaphoid, metacarpal, and distal interphalangeal joints.[3–6] Giessler and Schmidt[1] described the successful use of the flap to reconstruct a wedge-shaped thumb defect, whereas

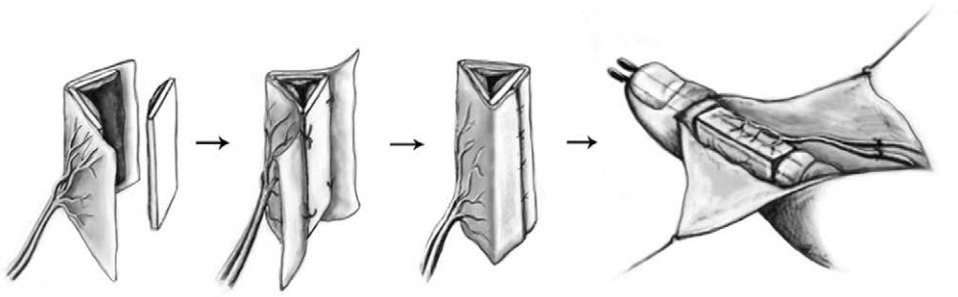

Fig. 3. Creating the neophalanx: scored flap, folded to create a prism and inset as proximal phalanx of thumb.

Fig. 4. Postoperative radiograph at 10 months.

Sammer et al[5] used a plate to fix the MFC flap into a thumb defect. The above case illustrates the technique of sculpting the flexible flap in three dimensions to produce a neophalanx, with cortical bone on each wall of the structure. This has yet to be described in the literature.

The MFC corticoperiosteal flap has reliable anatomy, flexibility, and a satisfactory donor-site profile.[7–9] The MFC has a dual blood supply, from the descending genicular (typically dominant and longer) and the superomedial genicular arteries. The flap can be harvested as periosteum alone or with underlying cortical and cancellous bone. The use of periosteum alone risks disruption of the cambium layer, important for the osteogenic potential of the periosteum.[7] Preservation of the osteocytes enhances graft incorporation and the production of bone mass at the recipient site.[9]

For small defects less than 30 mm, other grafts such as the rib and fibula can be too bulky. As in this defect of 25 mm, the MFC is a suitable choice, with minimal donor morbidity.[9] Following concerns around lower limb strength and knee joint degeneration following this procedure, Rao et al[10] found no radiographic long-term arthritic changes. They report a higher rate of return to sports, with fewer chronic pain issues than after harvest from the iliac crest.

This flap covered with overlying soft tissue can be challenging to monitor. Some authors suggest Doppler monitoring, whereas others suggest that even in the event of anastomotic failure, the nonvascularized bone graft can sometimes prove successful.[8] Iorio et al[8] described the MFC flap with an overlying cutaneous element (based on either the descending genicular artery or the saphenous artery branch). This osteocutaneous flap could be considered in future cases as it facilitates easier flap monitoring and provides tension-free wound closure.

CONCLUSION

This article describes an elegant use of the MFC flap to reconstruct an unstable proximal phalanx and demonstrates how the versatile flap can be sculpted into a required shape, with potential to reconstruct any digit in the hand.

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