Vascularized Pedicled Proximal Phalanx Flap for Spare Part for Reconstruction of Metacarpal Avulsion Injury

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Summary: Traumatic injuries to the hand with significant loss of bone or soft tissue can be quite difficult to reconstruct and often require an innovative and flexible surgical plan for reconstruction. We present a case of a young manual laborer with a significant crush avulsion injury involving his third and fourth metacarpals. We were able to preserve his fourth metacarpophalangeal joint by utilizing a pedicled vascularized proximal phalanx flap from the nonsalvageable third digit to reconstruct and provide osseous stability to the fourth metacarpal. The patient had excellent functional and aesthetic outcomes with full return to work at his farm by less than 12 months postoperatively. (Plast Reconstr Surg Glob Open 2019;7:e2570; doi: 10.1097/GOX.0000000000002570; Published online 28 November 2019.)

Surgeons have been able to use spare parts from non-salvageable tissue to reconstruct salvageable portions of the traumatized extremity. This has been documented in the joints of the hand.12 We present a case of a crush avulsion injury of the third and fourth metacarpals with preservation of the fourth metacarpophalangeal (MCP) joint. Salvage of the partially preserved MCP was obtained with a pedicled vascularized reversed proximal phalanx bone flap from the third digit.

METHODS

A healthy 20-year-old male smoker presented with a mangled left hand following an auger accident while ice fishing. He had open fractures involving his second through fourth metacarpals with partial avulsion of the third and fourth metacarpals with injuries to the overlying extensor tendons. His initial operative exploration revealed complete loss of the third metacarpal including the MCP joint and loss of the majority of the fourth metacarpal with preservation of the MCP joint. The second metacarpal had a comminuted fracture with laceration of the extensor tendons of the involved digits (Fig. 1A). Initial management included irrigation and debridement with K-wire fixation to hold the third and fourth fingers out to length. The neurovascular supply to all digits remained intact.

Postoperatively, a computed tomography (CT) scan of both hands was obtained to plan definitive reconstruction. The patient was a young manual laborer and desired an efficient reconstruction to optimize function and return to work. Given the lack of an MCP joint of the third digit in association with severe soft tissue and tendon trauma, it was determined that sacrifice of this digit with use of spare part principles would give him the best overall result in terms of final hand function. At 72 hours from the initial event, the patient returned to the operating room and a vascularized bone flap using the third proximal phalanx was used for reconstruction of the fourth metacarpal allowing preservation of a functional fourth finger MCP joint. The preoperative CT scan was used for measurement of the bony defect and to obtain an ideal match the third proximal phalanx was oriented in reverse, meaning the proximal portion of the proximal phalanx was fixated to the distal portion of the fourth metacarpal to reconstruct a 4.5-cm bone defect. The proximal phalanx was harvested using midaxial incisions preserving the ulnar digital vessel back to its origin (Fig. 1B). The skin, subcutaneous tissue, and extensor tendon of the third proximal phalanx were removed, maintaining a cuff of subcutaneous tissue and periosteum around the bone and neurovascular bundle. Following elevation of this pedicled bone flap, arterial bleeding was visible at the osteotomy sites and Doppler signals present going into the bone flap. Bony fixation was achieved using 0.35 K-wires after ensuring appropriate reduction (Fig. 1C). The transverse metacarpal ligament was reconstructed with the third digit flexor digitorum profundus tendon by suturing it to periosteum of the reconstructed fourth metacarpal and the periosteum of...
the second metacarpal under appropriate tension. There was minimal soft tissue defect due to the avulsive nature of the injury, and the wound was closed primarily, similar to a ray amputation of the third metacarpal.

RESULTS

The patient was followed postoperatively by occupational and physiotherapy. Radiographic and clinical union was evident by 4 weeks postoperatively, and his K-wires were removed. He then began range of motion exercises. The patient required an extensor tendon tenolysis and capsumotomies of his second and fourth digits MCP joint at 4 months postoperatively, which resulted in significant improvement in range of motion ROM (ROM). At 12 months postoperatively, the patient had no pain, was not using analgesic medications, and was able to return to his job as a farmer. He had good ROM of his second and fifth digit proximal and distal interphalangeal joints. The ROM of his MCP joints was restricted to 65, 40, and 25 degrees of flexion at his fifth, fourth, and second digits, respectively. His ROM of his fourth digit’s distal and proximal interphalangeal joints was 55 and 60 degrees of flexion. All measurements were performed with a goniometer, and he had excellent extension of all of his digits with minimal extensor lag. The patient was offered a second tenolysis with capsulotomy as he had interval improvement of the suppleness of his soft tissue envelope since the initial procedure, but as he was pain free and working, he did not desire to undergo further surgical intervention.

DISCUSSION

Salvage of a digit after traumatic injury can often be a difficult decision for hand surgeons. When reconstruction

Fig. 1. A, Preoperative imaging of the left hand showing traumatic loss of the majority of third and fourth metacarpals and comminuted fracture of the second metacarpal. B, Intraoperative photograph showing dissection of the vascularized pedicled proximal phalanx of the third digit with preservation of the ulnar neurovascular. C, Intraoperative imaging showing K-wire fixation of the pedicled proximal phalanx with preservation of the MCP joint. D, Dorsum of the patient’s hand demonstrating an aesthetic outcome at 12 months postoperatively.
will result in a stiff and painful finger, amputation may be the favored treatment. If reconstruction is pursued, function must be at the forefront of the surgical plan. By using a pedicled vascular bone flap from a nonsalvageable digit, we avoided any further donor site morbidity and kept all trauma to the injured hand, preserved a joint, and provided a functional outcome. We used spare parts to reconstruct the transverse metacarpal ligament improving lateral stability of the reconstructed digit and provided an aesthetic outcome by performing a ray amputation of the nonsalvageable digit (Fig. 1D).

Alternatively, we could have used nonvascularized corticocancellous bone graft or a methylmethacrylate spacer followed by bone grafting in a delayed fashion; however, these options would have required another donor site and had higher risk of nonunion or potentially degenerative change from avascular necrosis to the metacarpal portion of the MCP joint. With the patient’s smoking history, he would have been at higher risk for these complications. These options would prolong the patient’s recovery likely leading to increased stiffness, increased time away from work, and the associated psychosocial and financial implications. By using the proximal phalanx, we were also able to get a much better and more stable construct for tendon reconstruction reducing the risk of tendon adhesions and getting the patient to earlier tendon rehabilitation, minimizing time of immobilization.

The use of pedicled vascular bone grafts in hand reconstruction is a rare entity. Patrick and Payatakes described a case report using the middle phalanx and a fillet flap off the same digit to reconstruct a gunshot injury to the base of the fourth and fifth metacarpal. Coban et al also used a pedicled middle phalanx to reconstruct a bony defect of the first metacarpal. Kessler described a pedicled transfer of a middle finger remnant amputation stump to improve the functional length of an amputated thumb. Billig et al recently utilized a vascularized pedicled proximal interphalangeal joint from the fourth digit for reconstruction of the third digit MCP joint.

**CONCLUSIONS**

We were able to provide an excellent aesthetic and functional outcome while avoiding donor site morbidity by utilizing parts from a spare digit, that if salvaged would have had poor aesthetics and function. To our knowledge, a pedicled proximal phalanx flap has not been used to reconstruct a metacarpal defect in this fashion.

**ACKNOWLEDGMENT**

Informed consent was obtained from the patient involved in this case report, and the University of Manitoba Health Research Ethics Board approval was also obtained.

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