

Masquelet Technique for Phalangeal Reconstruction and Osteomyelitis

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Abstract: Osteomyelitis of the finger presents a challenging problem. Although there are multiple treatments described in the literature, the infection often results in eventual amputation. The authors present a case of an open fracture of the index finger complicated by nonunion, infection, and osteomyelitis. This was successfully treated by the placement of an antibiotic cement spacer and subsequent reconstruction with iliac crest bone graft, after the 2-stage Masquelet technique, using intravenous and oral antibiotics. They show that this technique, although infrequently described in the hand and fingers, can be a successful option for the treatment of phalangeal osteomyelitis and phalangeal reconstruction.

Key Words: Masquelet, phalanges, osteomyelitis

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Osteomyelitis of the phalanges requires thorough treatment because of the high risk of finger function and amputation.^{1,2} In one study of patients with metacarpal and phalangeal osteomyelitis, there was an overall incidence of amputation of 39%, and those with a history of trauma and wound contamination, the wound had a 54% chance of undergoing amputation.

Another series indicated that a history of diabetes was associated with a higher amputation rate of 63%.³

We describe a case in which the Masquelet technique was used for nonunion of an open index finger proximal phalanx

fracture complicated by osteomyelitis of both the proximal and middle phalanges. The patient was informed that the details of his case would be submitted for publication and provided written consent.

CASE REPORT

A 50-year-old, right-hand-dominant, male, state trooper presented with a right index finger injury from being caught in the spinning wheel of a car. The injury had been treated at another institution with debridement and placement of an external fixator spanning the proximal and middle phalanges. On the initial presentation, 11 days after his primary surgery, the external fixator was in place with a healing laceration over almost the entire length of the finger on the radial side and a puncture wound on the ulnar side. Radiographs showed a comminuted displaced fracture of the shaft and distal articular surface of the proximal phalanx of the index finger (Fig. 1). The patient's history included poorly controlled insulin-dependent type II diabetes with previous episodes of diabetic ketoacidosis and hemoglobin A1c of > 14 mg/dL.

Without signs of the bony union at 2 months after his initial presentation, he was taken back to the operating room for external fixator modification and bony debridement (Fig. 2). Up to and including this surgery, bone grafting was not planned because of the patient's uncontrolled diabetes, the possibilities of osteomyelitis, and amputation, and the patient's preference to avoid another surgery. Bone grafting would be considered after a tissue diagnosis for infection.

Infection was thought to be probable because of the persistent soft tissue swelling and delayed union. One loose pin was removed and



FIGURE 1. A–C, X-ray of hand on December 18, 2017.

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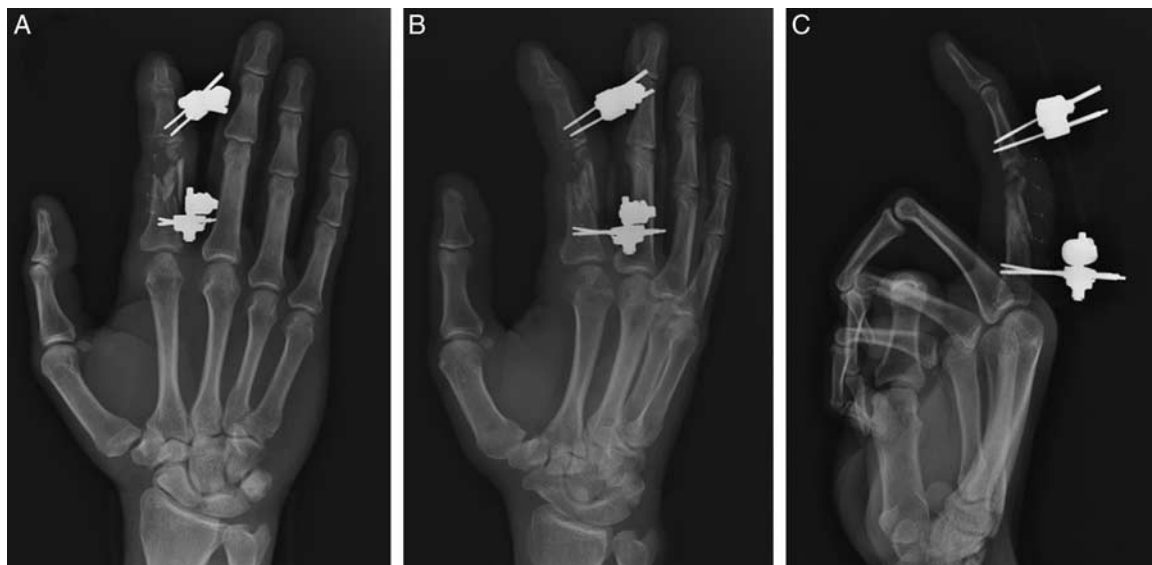


FIGURE 2. A–C, X-ray of hand on February 27, 2018.

replaced nearby. Debridement of sequestra and obviously infected soft tissues, and cultures, were performed. The soft tissues demonstrated a serous exudate. The major bone fragments removed was about 12 mm×8 mm×4 mm. Pathologic analysis showed acute inflammation and necrosis within the bony specimen submitted. The soft tissues between the bony fragments showed acute and chronic inflammation. The pathology showed osteomyelitis although cultures were negative, as may occur even without antibiotics present. Intravenous cefadroxil was initiated for a 6-week course, followed by cephalexin, under the supervision of his Infectious Disease Consultant.

There continued to be an absence of bony healing on radiographs at 5 months postinjury. The patient strongly preferred to avoid amputation. Because of uncontrolled diabetes, prior surgery and ischemic bone, severe trauma to the soft tissues, difficulties maintaining the rigidity of the 1-stage external fixator pins, and osteomyelitis, it was thought that radical debridement with bone grafting of this magnitude had little chance of success. After receiving informed consent, he elected to attempt the Masquelet technique in this unique setting. First, the external fixator was removed and the previous incision was opened over the middle phalanx and proximal phalanx. The infected bone of the

proximal and middle phalanges was excised. The bone appeared to be avascular and infected without signs of callus. The bone was essentially cortical in an environment of fibrinous and serous connective tissue. An external fixator was reapplied outside the zone of debridement, which included the infected appearing bone spanning most of the proximal and middle phalanges, including 3 mm of additional normal-appearing bone at each end. One 40-g pouch of Palacos bone cement was prepared with a mixture of 2 g of tobramycin and 4 g of vancomycin. The cement was cylindrically shaped around a premeasured 0.045 K-wire and inserted into small drill holes in the medullary canals of the proximal and middle phalanges, recreating the appropriate length.

The external fixator pins were then reconnected with a bar to maintain the proper alignment and length (Fig. 3). The pathologic analysis demonstrated osteomyelitis. Cultures taken at this time grew *Staphylococcus haemolyticus* and he was placed on augmentin 875 mg 2 times per day under the Infectious Disease Consultant's supervision, being aware that the organism may be a skin contaminant.

Six weeks later, the bioactive membrane was incised and the cement spacer removed. There was no gross evidence of infection. As a departure from the original Masquelet technique, a solid corticocancellous graft was

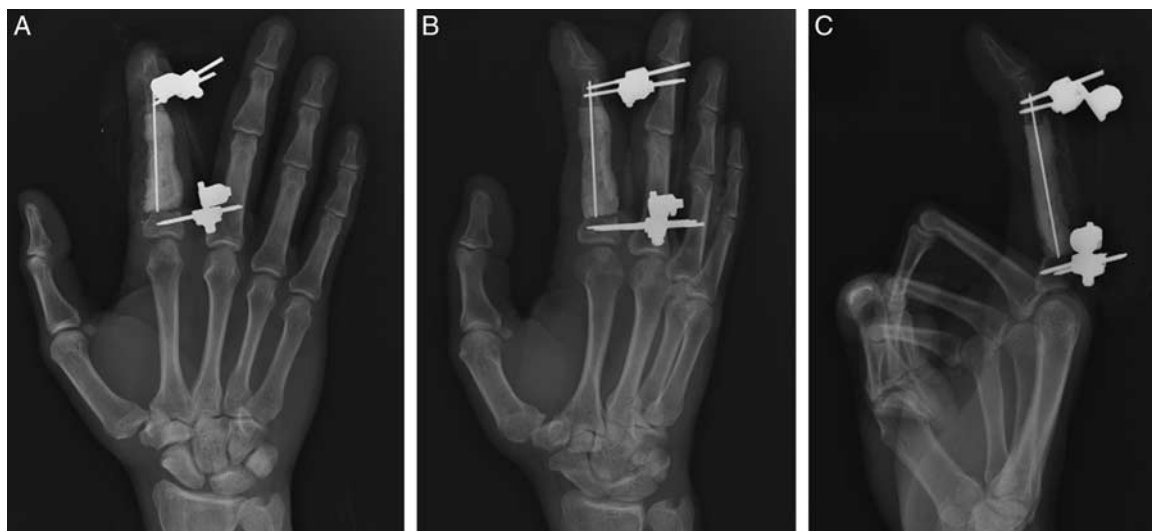


FIGURE 3. A–C, X-ray of hand on April 30, 2018.



FIGURE 4. A–C, X-ray of hand on June 12, 2018.

used instead of cancellous or reamer/aspirator bone to impart rigidity and reduce dead space and fixation requirements. The area was measured and an appropriately sized portion of the top of the iliac crest was harvested to fill the void. Carpentry to add curvature would have required more crest exposure and created tension in the traumatized dorsal skin of the finger. The patient wanted the appearance of maximum length to match the contralateral extended digit. The 65-mm bone graft was shaped with additional dowels at each end and press-fit into the middle and proximal phalanges. The 40-degree flexion contracture at the distal interphalangeal joint was released and reduced to 20 degrees. A 0.062 K-wire was passed retrograde from the tip of the finger through the phalanges and graft into the head of the metacarpal. Oblique 0.045 K-wires were placed from the radial side of the middle and proximal phalanges into the graft to add additional stability. The wires were cut and buried under the skin. The middle phalanx angulation was accepted to accomplish the in-line pinning of all bony segments (Fig. 4). Osteomyelitis was absent from the pathologic analysis. Cultures continued to yield no growth, but he was continued

empirically for broad-spectrum coverage using levaquin 500 mg daily for a total of 8 weeks, under the supervision of the Infectious Disease Consultant. The use of an external bone stimulator began. After radiographic evidence of integration of the bone graft, 5 months later, the 3 pins were removed (Fig. 5). Intraoperative pathology and cultures were negative. At his most recent follow-up, 14 months after the second stage of the Masquelet technique, he seemed free of infection. His index finger metacarpophalangeal joint motion was 0 to 35 degrees and without interphalangeal joint motion. He reported being exceedingly gratified with his finger function and appearance. He was determined and able to return to work as a state trooper with re-education (Fig. 6). The QuickDASH score was 0 at 14 months after the first operation.

DISCUSSION

The Masquelet 2-stage technique has been used for the reconstruction of metacarpals.^{4,5}



FIGURE 5. A–C, X-ray of hand in November 2018.

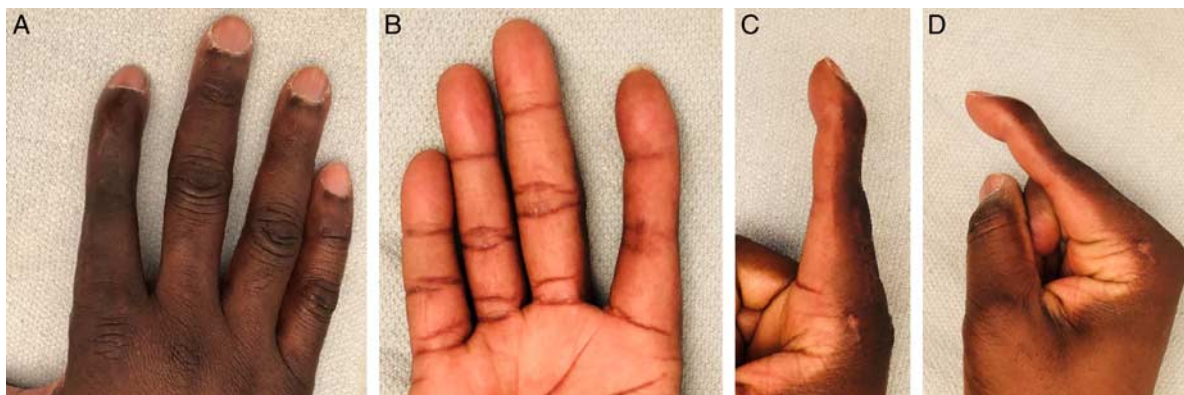


FIGURE 6. A–D, Photographs.

This technique was first described for long-bone defects in the leg and was found to be successful in both aseptic and septic conditions.^{6,7} These injuries often require both complex bony and soft tissue reconstruction.^{8,9} Moris et al⁸ reported a series of 18 patients with open complex fractures of the phalanx or metacarpal treated by cement spacers without antibiotics and showed that the 2-stage technique can be used for traumatic bone with soft tissue loss. Lum et al⁹ also described a case report of first metacarpal reconstruction after close-range shotgun injury. Tabib and Haddad¹⁰ described the successful use of the technique for second metacarpal chronic osteomyelitis because of pin infection. Our patient's infected nonunion of his phalangeal fracture and uncontrolled diabetes made amputation seem inevitable. By following the Masquelet 2-stage technique, we salvaged the use of the patient's index finger with bony reconstruction and eradication of infection. The induced membrane has growth factors and increases the osteoinductive activity of the graft.

When planning to use the technique, potential considerations include the extent of the injury, the need for soft tissue coverage, appropriate bone graft, cement use, antibiotic treatment, and timing regarding the staged surgeries. Our case study shows that the Masquelet 2-stage technique is a versatile tool that can also be applied in the treatment of nonunion complicated by osteomyelitis of the phalanges.

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