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CORRECTIVE OSTEOTOMY AND LOCAL BONE GRAFTING FOR EXTRA-ARTICULAR MALUNION OF THE PROXIMAL PHALANX

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ABSTRACT

Corrective osteotomies are often utilised to treat finger deformities that may occur due to a phalangeal malunion. Rotational or angular malalignment, in addition to shortening of the digit may negatively affect hand function and be aesthetically displeasing. Thorough preoperative examination of the malunion and its associated deformities is crucial in determining the type of osteotomy technique to be used. Osteotomies can create bony defects that need to be filled with bone graft or some type of graft substitute. We describe an opening wedge osteotomy with local cancellous bone graft combined with dual plating to treat a dorsal angular deformity in a proximal phalangeal malunion.

Keywords: Osteotomy; Phalangeal Malunion; Bone Graft.

INTRODUCTION

Phalangeal malunions can result in rotational or angular deformities, cause deviation or shortening in the digits, and ultimately lead to a reduction in hand function. Initial treatment of these malunions may include non-operative management such as therapy, but a corrective osteotomy may be warranted if symptoms continue to persist. The existence of these deformities may also be combined with contractures of the tendons and joint capsules. Various corrective osteotomy techniques have been previously described for use in the treatment of rotational or angular deformities associated with malunions of the phalanges.[1] Bone grafting may be necessary if the resulting defect is large. We present a case of a malunion at the base of the proximal phalanx which was corrected using an open wedge osteotomy, dual plating and local bone grafting from the metacarpal head. The authors have obtained the patient's informed written consent for print and electronic publication of the case report.

CASE REPORT

Our patient is a 47-year old right-hand dominant male who presented to us with pain and stiffness in the ring finger of his

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(A) **(B)** **(C)**

Fig. 1 **(A)** AP **(B)** lateral and **(C)** oblique radiographs of ring finger proximal phalanx malunion. Dorsal malunion measures 35° apex anterior with no obvious rotatory deformity.

right hand. He sustained an extra-articular fracture of his ring finger proximal phalanx while playing basketball approximately two months prior to presentation. On physical examination in our clinic, he had tenderness at the proximal phalanx (P1) dorsally and limited flexion at the metacarpal phalangeal (MCP) joint. He had limited active motion at the MCP and proximal interphalangeal (PIP) joints and did not seem to have any pull-through of the flexor digitorum profundus (FDP) at the distal interphalangeal (DIP) joint. His passive range of motion (ROM) was MCP joint 0−25°, PIP joint 0−70°, DIP joint 0−50°. He had no apparent rotational misalignment, but it was difficult to tell secondary to the limited passive flexion. The finger had normal capillary refill and sensation.

Plain radiographs at presentation demonstrated a healed fracture at the base of P1 with extension approaching the MCP joint (Fig. 1). The proximal phalanx had a apex volar, dorsally angulate malunion measuring approximately 35°. A computed tomography (CT) scan was performed to evaluate if the fracture extended into the joint surface. The CT scan showed a healed fracture at the base of the 4th proximal phalanx with volar subluxation of the base of the fourth proximal phalanx on the fourth metacarpal head (Fig. 2). The articular surfaces of the fourth metacarpal head and base of the proximal phalanx were intact with no arthrosis.

Due to the significantly decreased motion and clear extra-articular malunion, it was decided that the patient would undergo a proximal phalanx opening wedge osteotomy with bone grafting and rigid fixation.

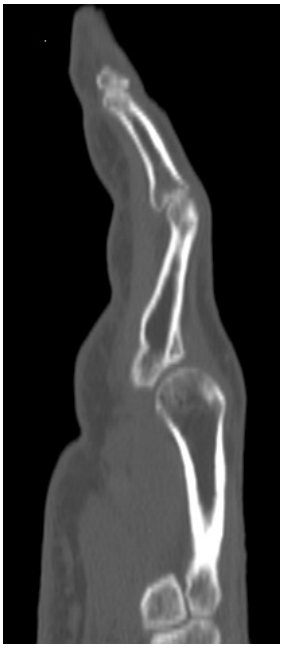


Fig. 2 Computed tomography image of the malunion with dorsal angular deformity.

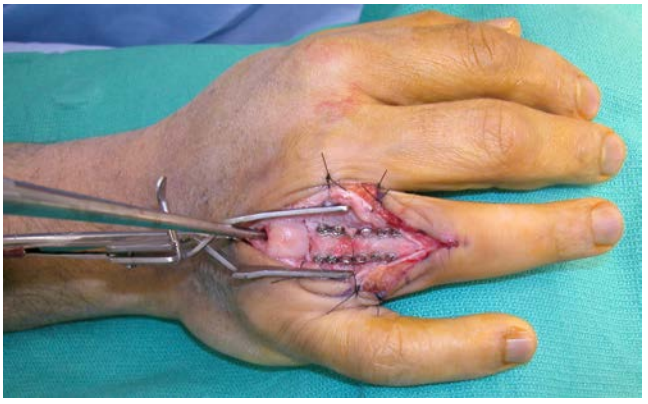


Fig. 3 Intra-operative picture of cancellous bone graft site at the dorsal cortex of the metacarpal head.

TECHNIQUE

A dorsal incision was made over the MCP joint and the proximal phalanx extending for 4 cm. The extensor tendon was incised longitudinally and tenolysis was performed. The periosteum was elevated as a sleeve for later repair. Upon examination, the MCP joint was found to have significant scarring and was released. A complete dorsal capsulectomy was performed as well as subperiosteal release of the collateral ligaments. This exposure revealed an apex volar deformity of approximately 40°. Even after extensive soft-tissue release, passive flexion into the palm was still limited to MCP joint flexion of 50°. Thus an open wedge osteotomy was performed to improve alignment and range of motion.

A 0.045 K-wire was used to drill the cortex dorsally and volarly. An osteotome was then used to crack the remaining dorsal and volar cortices and allowed us to realign the finger into a neutral position. This created a metaphyseal defect of approximately 7 mm in length and the entire width of the phalanx. To fill the osteotomy site, a bone graft was taken from the metacarpal head. A hole in the dorsal cortex of the metacarpal head was made with a 2.0 mm drill and cancellous graft was taken using a curette (Fig. 3). This graft was combined with Grafton (Osteotech Inc., Eatontown, New Jersey) demineralised bone matrix and impacted into the osteotomy site. The phalanx was then stabilised with two 1.3-mm plates. Dual plating was used to obtain the maximum number of screws into the small proximal fragment. The periosteum was closed over the plate with 3-0 Vicryl, and the extensor tendon was repaired with 3-0 Ethibond suture. The hand was placed into a bulky sterile dressing followed by a volar hand split.

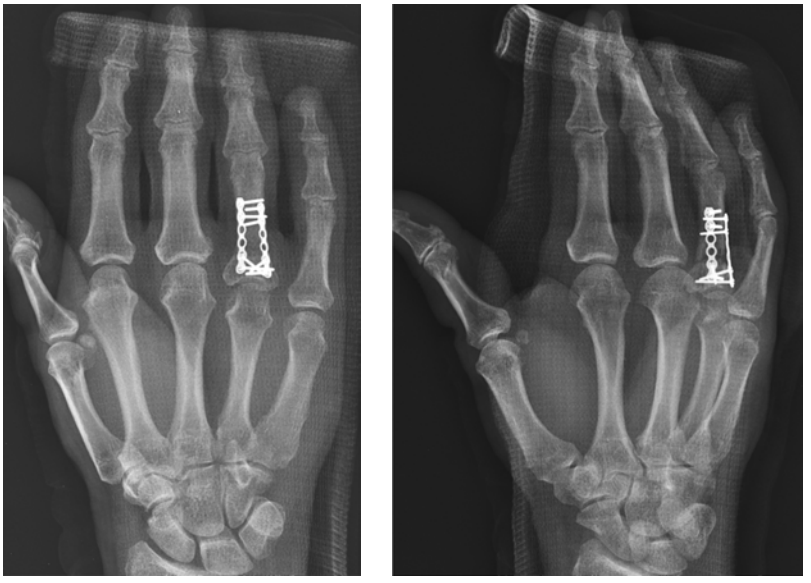
REHABILITATION AND POSTOPERATIVE CARE

The patient was seen in the outpatient office ten days postoperatively. At that time, the wound was healing well and the sutures were removed. Postoperative *x*-rays showed the hardware in place and good alignment of the phalanx (Fig. 4). The patient was placed into a custom-molded splint and a formal therapy program was initiated. Unfortunately, the patient did not adhere to the therapy regiment immediately and started rehabilitation one month later than expected. At 7.5 months following the procedure, physical examination showed that the patient had improved motion and pull-through of his FDP and FDS. His passive motion was MCP joint 20° of hyperextension and flexion of 80°, PIP joint 0—90°, and DIP joint 0—50°. Actively he had full extension of MCP, PIP and DIP joints. He could actively flex his finger into his palm. The patient did not report any pain and radiographs showed complete healing of the osteotomy with good alignment of the digit (Fig. 5).

DISCUSSION

Most closed fractures of the fingers heal uneventfully if treated appropriately. However, non-operative management of fractures may not always result in complete anatomical reduction. Also, necessary early surgical intervention may not be performed due to difficulty with radiographic visualisation from poor hand positioning or cast distortion, and at times from lack of patient compliance.[1] Improper healing may lead to the development of a malunion which may result in rotational or angular deformities. These deformities may diminish the functional capacity of the hand and prevent the patient from performing activities of daily living. Thus, the correction of a malunion and its associated deformities is crucial not only for aesthetic reasons, but functionality as well.

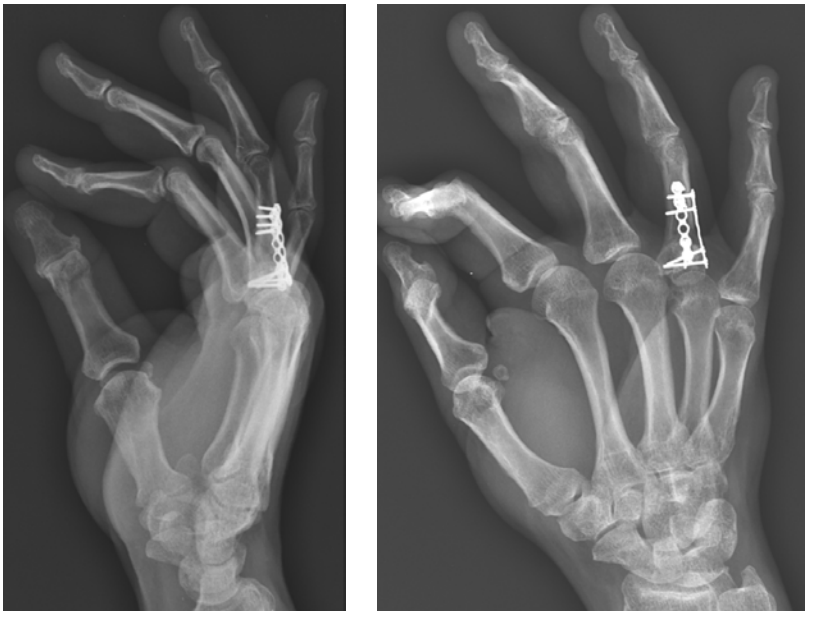
Up to approximately ten weeks after injury, an early osteotomy can be performed on malunions to remove the soft immature callus and stabilize the original fracture site before the establishment of severe tendon adhesions.[1,2] However, even in cases where early correction might be indicated, the surgeon may be reluctant to intervene due to digital stiffness and the fear of causing additional soft tissue damage.[1] Some authors have recommended that a corrective osteotomy should be delayed until at least three months after injury to allow the establishment of the malunion and maximal recovery of digital motion.[2]



(A) **(B)**

Fig. 4 Post-operative **(A)** AP and **(B)** oblique radiographs of ring finger with hardware in place and showing good alignment.

According to Buchler *et al.*,[1] one should evaluate the malunion by determining its site, the type and extent of bone deformity, skeletal maturity of the malunion, time elapsed since development, and mechanism of injury. The treatment of angulatory phalangeal malunions by corrective osteotomies at the metacarpal level has limited utility and can result in a zigzag deformity.[1,3] Studies have demonstrated that osteotomies at the malunion site in the proximal phalanx resulted in effective deformity correction and recovery of finger motion.[1,4,5] Extra-articular osteotomies phalanges have been shown to be



(A) **(B)**

Fig. 5 **(A)** Lateral and **(B)** oblique radiographs of the healed proximal phalanx with maintenance of good alignment.

successful when used to correct rotational, angular, or combined deformities.[2,6–8]

Depending on the type of deformity present due to the malunion, correction can be accomplished with a complete transverse, close-wedge or open-wedge osteotomy. For malunions with only a rotational deformity, a complete transverse osteotomy at right angles to the bone is effective.[1] A purely angular deformity can be corrected with either a transverse closing — or opening — wedge osteotomy. Although a closing-wedge is easier to perform, it will result in some shortening of the digit.[1] When doing an open-wedge osteotomy, some type of bone graft is needed to fill the resulting metaphyseal gap in the phalanx.[1,3] It is useful if a local bone graft can be taken from the same operative site. In addition to the osteotomy, a capsulectomy and tenolysis are often beneficial in restoring functional digital range of motion.[1]

The ability to harvest autograft from the same operative site limits donor site morbidity and lowers total operative cost. Other sources of local non-vascularised bone grafts from the distal radius for fixation of scaphoid non-unions have been described.[9] However, if this bone grafting technique is used for phalangeal non-unions then a separate incision is required. Report on vascularised metacarpal grafts for scaphoid non-unions and distant non-vascularised osteochondral grafts from the foot for joint defects in the hand has also been published.[10] Complex vascularised bone grafting from the metacarpal head has been previously described for non-unions in the carpus. In a study by Bertelli *et al.*[11] scaphoid nonunion was repaired using a bone graft raised from the thumb metacarpal and based on the first dorsal metacarpal artery. The simplicity of the technique described here is that a non-vasularised graft is used from the same surgical incision.

In summary, we present the case of a post-traumatic malunion that resulted in an angular deformity in the fourth proximal phalanx of an adult male. An open-wedge osteotomy with local cancellous bone graft from the metacarpal head and rigid stabilisation with dual plating was performed. Early follow-up showed correction of alignment of the proximal phalanx and restoration of functional range of motion. This technique is straightforward and eliminates the need for bone graft substitute or graft harvesting from a distant site.

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