Oblique Capitate Fracture of the Wrist

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Capitate fractures, which usually occur at the head or neck, interrupt the intraosseous circulation to the proximal fragment, creating risks of fracture nonunion and avascular necrosis. Kirschner wire and screw fixation are successful in the treatment of these rare but serious injuries.

Adult capitate fractures are rare but serious injuries. Harrigan reported the first isolated capitate fracture in 1908. The reported incidence of these fractures is 0.42%-4.9% of all adult carpal fractures. Even fewer reports of capitate fractures in children exist.

Capitate fractures occur most frequently in younger, male patients who may be more prone to high-energy trauma than the general population. Coincident polytrauma is frequent. Acute carpal tunnel syndrome has been reported.

Few cases are isolated injuries. They often are associated with other carpal fractures or may herald perilunate injuries involving the greater carpal arc. Proximal capitate fragments may be displaced and rotated as much as 180° in perilunate injuries. Simultaneous trans-scaphoid transcapitate fractures have been termed “scaphocapitate fracture syndrome.”

Blood Supply of the Capitate

The body of the capitate receives its blood supply through its ligamentous and capsular attachments. Smaller dorsal and palmar vessels occasionally enter more proximally near the neck. The head of the capitate has no capsular or ligamentous attachments, deriving its blood supply from retrograde flow through one, and occasionally two, intraosseous arteries arising from the body of the capitate and terminating at the articular surface of the head of the capitate.

Branches from the deep palmar and palmar intercarpal arches penetrate the distal half of the palmar convex side of the capitate through one to three foramina. The substantive portion of the intraosseous circulation of the capitate is derived from its palmar blood supply.

Three patterns of intraosseous capitate circulation have been reported and occur with approximately equal frequency: 1) palmar vessels may supply the entire capitate and form a single intraosseous artery, with little or no contribution from the dorsal blood supply; 2) the palmar vessels may predominate and supply the proximal pole through a single intraosseous artery with both dorsal and palmar branches contributing to the waist and distal pole; or 3) anastomosing dorsal and palmar branches may supply the nonarticular dorsal concave side. The substantive portion of the intraosseous circulation of the capitate is derived from its palmar blood supply.

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Figure: AP (A) and oblique (B) radiographs demonstrate a displaced transverse fracture of the proximal pole of the hamate (arrow 1) and a displaced oblique fracture of the waist of the capitate (arrow 2). The proximal fragment of the capitate is ulnarily angulated and pronated in relation to the distal fragment, which remains fixed to the base of the third metacarpal. CT clearly defines the displaced transverse fracture of the proximal pole of the hamate (arrow 1) and the displaced oblique fracture of the waist of the capitate (arrow 2) (C). The proximal fragment of the capitate is ulnarily angulated and pronated in relation to the distal fragment, which remains fixed to the base of the 3rd metacarpal. Lateral CT reveals a fracture gap, shortening, and palmar displacement of the proximal capitate fragment (D). AP (E) and lateral (F) radiographs show an anatomic fracture reduction and healing via interfragmentary callous formation.
entire capitate, including the proximal pole, with the palmar circulation predominating.\(^9,^{10}\)

**Injury Mechanism**

The capitate is the rigid keystone bridging the intersection of the longitudinal and transverse carpal arches. Ligaments anchor the body of the capitate to the trapezoid, hamate, and base of the third metacarpal, leaving the head and neck vulnerable to fracture from rapid high-energy impact, bending, axial, shear, or torsion loading.\(^2\) Adjacent carpal bones or the borders of the radius may impinge the head or neck, further accentuating these forces. The majority of fractures occur at the neck of the capitate and are transverse in configuration.

**Pathophysiology**

Fractures of the head or neck interrupt the intrasosseous circulation to the proximal fragment. The peripheral blood flow of the proximal fragment is insufficient for reliable fracture healing, thus creating dual risks of fracture nonunion and avascular necrosis of the proximal fragment. The more proximal the fracture, the greater these risks. Consequently, the fate of the fracture may be sealed at the time of injury regardless of the appropriateness and timeliness of management. Fracture comminution and displacement may also confound the outcome.

**Diagnosis**

These injuries usually present with pain, swelling, tenderness, and occasionally crepitus localized dorsally over the capitate. Most fractures are seen on initial standard wrist radiographs or those taken after reduction of wrist dislocation. Undisplaced fractures may occasionally be difficult to confirm on standard radiographs. Special radiographic views taken with the beam directed 30° caudal and cephalad to the vertical axis of the wrist elongate and magnify the capitate, improving capitate visualization and the opportunity to diagnose occult fractures.\(^11\) Bone scans, computed tomography (CT), or magnetic resonance imaging (MRI) may be useful if radiographs are inconclusive. Computed tomography and MRI may also assist in conceptualizing the relationship of the fragments.

**Case Report**

A 15-year-old right-handed skeletally mature girl sustained a displaced oblique capitate waist fracture, displaced transverse fracture of the adjacent proximal pole of the hamate, right pubic ramus fracture, and first lumbar vertebral burst fracture in an automobile accident (Figures A and B). Computed tomography further defined the capitate injury (Figures C and D).

Five days after injury, the capitate was reduced operatively through a dorsal incision and stabilized with a small retrograde, headless, canulated bone screw that compressed the fracture. The hamate fracture was reduced and stable following capitate fixation. Because of this and the fact that the fracture was so small, no hamate fixation was used. The repaired fracture was protected with an orthoplast fracture brace for 6 weeks while the incision healed, swelling and tenderness resolved, and the patient regained full digital motion.

Four months postoperatively, radiographs revealed callus crossing both fractures. The radiographic appearance of the proximal fragment was normal (Figures E and F). After further rehabilitation and recovery, full wrist motion and grip strength were regained. No residual pain was present. The remaining injuries were treated nonoperatively and healed uneventfully. She returned to full unrestricted activity.

**Discussion**

The management of capitate fractures is challenging. \(^2\) Rand et al\(^2\) reported the largest series of capitate fractures (13 patients) with average 6-year follow-up. Eleven patients had acute fractures and 2 were referred with nonunions. Three capitate fractures were isolated, 3 patients had multiple carpal fractures without perilunate dislocation, 6 had associated “scaphocapitate fracture syndrome,” and 1 fracture occurred in conjunction with a perilunate dislocation. Two patients presented with acute carpal tunnel syndrome. Six were polytrauma victims. Treatment varied from simple splinting to open reduction and K-wire fixation.

Four patients developed a nonunion, including the two who had been referred. Three of the four nonunions were successfully salvaged with bone grafting procedures. The remaining patient elected to do nothing because of their degree of disability.

### Stable fracture reduction restores wrist alignment, stability, and the most favorable prognosis for recovering normal wrist kinematics.

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\(^1\) Kirschner wires have been used successfully to achieve fracture stability and subsequent healing. Stable fracture reduction also restores wrist
alignment, stability, and the most favorable prognosis for recovering normal wrist kinematics.

A headless cannulated compression screw was selected for our patient. Kirschner wires splint the reduced fracture, but do not provide compression. Screws that provide the additional dimension of compression may even further improve apposition and stability and facilitate healing and the re-establishment of circulation to the proximal fragment. If the fracture is displaced and requires open reduction, it would seem prudent to provide the most secure fixation available. Our patient exhibited expeditious fracture healing and full functional recovery with no radiographic suggestion of transient avascular necrosis of the proximal fragment.

Screw canulation allows accurate antegrade or retrograde placement over a well-positioned K-wire. A second peripherally placed temporary parallel K-wire may prevent distraction and rotation during screw application. Conventional screws have uniform pitch and compress the fracture by the buttress effect of the screw head. Headless screws provide compression via differential pitch design. They are less likely to cause articular injury to the capitare and adjacent joint than screws with conventional heads. The surgeon must be careful not to excessively recess the proximal portion of the screw into poorly mineralized bone. We use the smallest diameter screw that will provide sufficient stability until fracture healing. This preserves a larger surface area of bone for healing at the fracture site while allowing salvage of an insecure fixation with the next larger diameter screw if necessary. Kirschner wire fixation or limited intercarpal arthrodesis may ultimately be necessary to salvage insecure screw fixation.

Even undisplaced capitare fractures are at risk for nonunion and avascular necrosis owing to small amounts of motion or separation at the fracture site. Although undisplaced capitare fractures have been successfully treated with protective splinting or casting alone, they must be monitored until healing is assured. Initial K-wire fixation may increase the probability of healing. Compression screw fixation may be even more reliable and may be used as primary treatment or to salvage delayed union.

Complications tend to relate to injury severity and fracture proximity. Common complications include stiffness, weakness, nonunion, avascular necrosis, wrist instability, and arthrosis. Nonunion and avascular necrosis may be coincident. Complications, arthrodesis in particular, may only be recognized in patients with longer follow-up.

Bone grafting and stabilization has been successful in the management of most but not all established nonunions. Capitate length should be restored, if necessary, to prevent wrist collapse. Establish ed avascular necrosis without collapse may be similarly managed. A proximal fragment that is unjured or excised because it is too small to repair or one that develops avascular necrosis with collapse may lead to wrist instability and arthrosis. These patients may be treated effectively by intercarpal arthrodesis (capitulate or four-corner ulnocarpal arthrodesis). Anterior and posterior interosseous neurotomy may adjunctively improve or resolve related chronic pain. A successful diagnostic local anesthetic nerve block is a good discriminator for these neurotomy.

References