Concomitant, Distinct Fractures of the Capitellum and Trochlea Separating the Whole Articular Surface of the Distal Humerus in the Coronal Plane

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The medical literature includes few reports on combination fractures involving the trochlea and the capitellum,[1-7] the various fracture patterns of these primarily articular injuries are not adequately described in accepted fracture classifications,[8-10] and treatment modalities vary.

We describe an unusual but clinically important pattern of a coronal shear osteochondral fracture separating the whole articular surface of the distal humerus with a second fracture line in the sagittal plane through the capitellotrochlear sulcus, thus creating concomitant but distinct fractures of the trochlea and the capitellum. We also describe the radiographic findings that should suggest to the orthopedic surgeon the possibility of this fracture pattern, the surgical approach that provides access to this complex articular fracture, and the fixation method.

Case Report

A 47-year-old right-handed woman sustained a closed injury to the right elbow after falling on her outstretched upper extremity. Severe pain was present on palpation over the medial and lateral sides of the joint. The neurovascular status of the upper extremity was unremarkable.

The lateral x-ray showed a coronal shear[4] osteochondral fracture of the articular surface of the distal humerus displaced superiorly (Figure 1). Findings were an unusual double-arc sign and a void at the lower part of the ulnohumeral and radiocapitellar articulations. The original description of the double-arc sign[4] indicates extension of a capitellar coronal fracture line medially to the capitellotrochlear sulcus to include a substantial portion of the trochlea, the subchondral bone of which forms the second arc of the double-arc sign. In that case, the 2 arcs are concentric, and that sign distinguishes the coronal shear fractures from simple fractures of the humeral capitellum, where the fragment has a typical semilunar appearance in the lateral x-ray. In our case, the 2 arcs were not concentric, which indicated concomitant but distinct trochlear and capitellar fractures. In addition, the void at the lower part of the ulnohumeral and radiocapitellar articulations indicated that the whole articular surface of the distal humerus had separated from the anterior aspect of the distal humerus. The anteroposterior x-ray (Figure 1) confirmed the findings of the lateral x-ray. It demonstrated a displaced fracture of the humeral capitellum, which was additionally externally rotated. In the same view, a second fracture line was clearly visible, separating the whole trochlea from the distal articular surface of the humerus. The pathognomonic radiographic finding suggesting this trochlear fracture configuration was the presence of a fracture line medial to the midline of the joint and distal to the medial epicondyle (Figure 1). As adequate information had been obtained from the standard views, additional projections and computed tomography scan were not used.

Under regional anesthesia (axillary block), we used the modified extensile lateral Kocher approach.[11] The origin of the lateral collateral ligamentous complex was identified and subsequently elevated in a subperiosteal fashion from the lateral epicondyle. A varus-supination stress was then applied to the elbow, which opened like a book hinging on the medial collateral ligament. This allowed excellent visualization of capitellar and trochlear fragments (Figure 2).

The capitellar fracture, including a small portion of the anterolateral surface of the lateral humeral condyle, was superiorly displaced and externally rotated. The fracture line separating the trochlear and the capitellar fragments was in the sagittal plane through the capitellotrochlear sulcus. The trochlear fracture was in the coronal plane and slightly displaced. There was no impaction of the subchondral bone behind the trochlear or capitellar fragments, and there was no injury to the radial head. The trochlear fragment was carefully manipulated and completely reduced with a dental pick (Figure 2). It was then provisionally fixed with a smooth Kirschner wire. Two standard noncannulated Herbert screws (Zimmer, Warsaw, Ind) were

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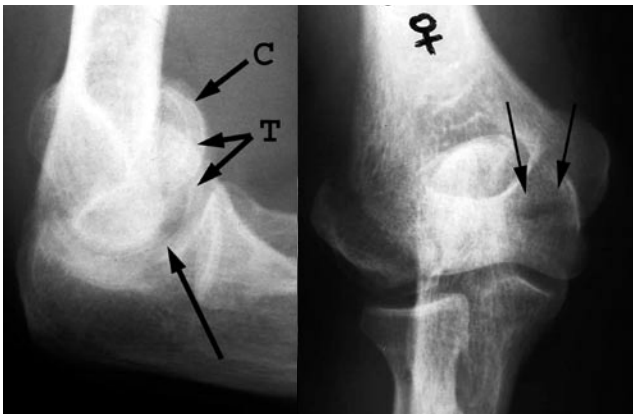

Figure 1. Preoperative lateral (left) and anteroposterior (AP; right) x-rays of the patient's right elbow. Note in the lateral view the nonconcentric arcs of the capitellum (C) and the trochlea (T) and the void at the inferior aspect of the ulnohumeral and the radiocapitellar joints (arrow). In the AP view, the capitellum is markedly displaced and externally rotated. Also note the pathognomonic radiographic finding suggesting the trochlear fracture on the AP view—presence of a fracture line medial to the midline of the joint and distal to the medial epicondyle (arrows).

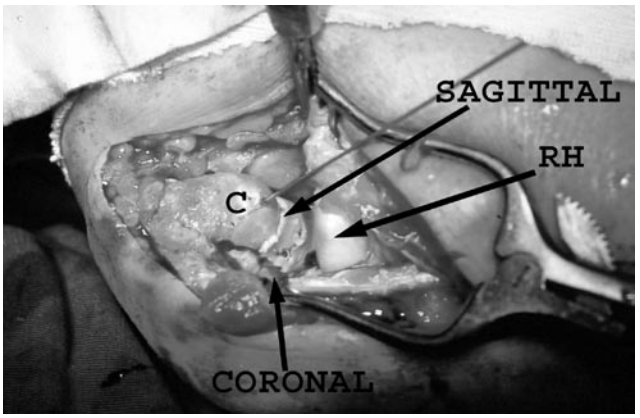

Figure 3. Elbow after completion of the fixation and before removal of the smooth Kirschner wire used for provisional fixation of the capitellum (C). The forearm is on the right. The Herbert screws are buried underneath the articular cartilage. Note the signs of the fracture lines in the sagittal plane through the capitellotrochlear sulcus (arrow) and in the coronal plane separating the trochlear (arrow) from the anterior aspect of the distal humerus. The radial head is also marked (RH).

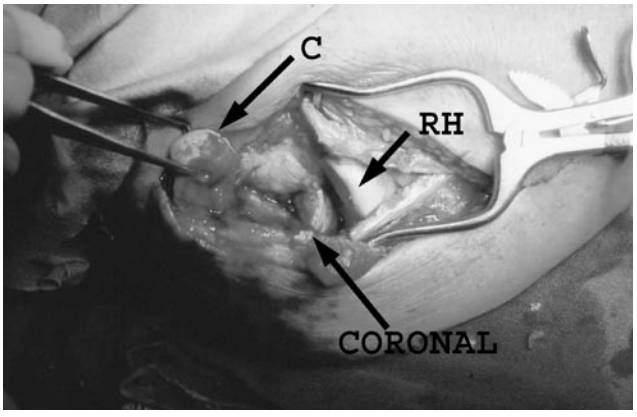

Figure 2. Elbow after reduction of the trochlear fragment. The forearm is on the right side. The capitellar fragment is carefully rotated with a forceps (C). Note the visible fracture line in the coronal plane separating the trochlea from the anterior surface of the distal humerus (arrow). The radial head is marked (RH).

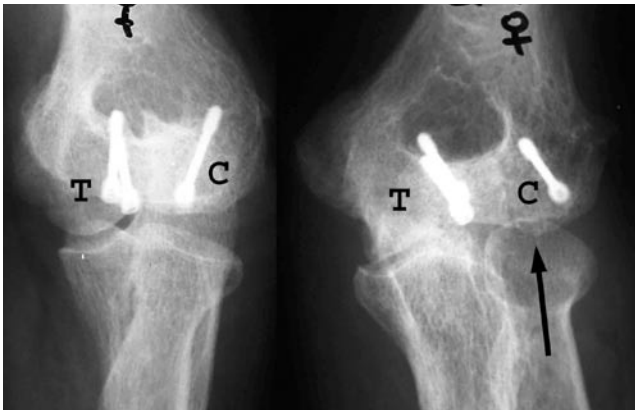

Figure 4. Latest (4-year) follow-up x-rays, oblique (left) and anteroposterior (right), were selected to show the excellent reduction of both the capitellar (C) and the trochlear (T) fragments, the absence of signs of osteonecrosis, and the presence of mild articular distortion in the radiocapitellar joint (arrow).

inserted freehand from the dense subchondral bone of the lateral trochlear ridge anterolaterally to the subchondral bone of the medial column posteromedially. The capitellar fragment was subsequently reduced and fixed with a single Herbert screw through the articular surface (Figure 3). Drill holes in the lateral epicondyle and transosseous sutures were used to secure the origin of the lateral ligamentous complex. Standard closure of the capsule and skin was then performed over a suction drain. There were no intraoperative complications.

The patient's postoperative recovery was unremarkable. The elbow was immobilized in a cast in 90° of flexion and moderate pronation for 2 weeks. After that time, the patient was instructed to remove the protective splint 3 to 4 times daily to perform active flexion-extension and pronation exercises. Strengthening exercises were delayed until 6 weeks after surgery. By 8 weeks after surgery, the fractures had healed. At that time, the patient was referred to a supervised rehabilitation program to further enhance the range of motion (ROM) and strength of the elbow.

The 4-year follow-up, performed by Dr. Stamatis, included x-rays, physical examination, and assessment of elbow function. The patient had painless full ROM and no clinical findings or subjective complaints consistent with instability of the elbow joint. She reported no activity limitations and said she was completely satisfied with her outcome. Radiographic evaluation at that time revealed complete fracture healing with excellent restoration of the distal humeral anatomy, with no signs of osteonecrosis, and with only mild evidence of articular distortion in the radiocapitellar joint (Figure 4).

Discussion

After Mouchet's (1898) and Kocher's (1904) original descriptions,[12] a few authors reported a coronal shear fracture of the capitellum with the fracture line extending medially to include the lateral trochlear ridge and a portion of the trochlea.[2-4,7,13] Robertson and Bogart[6] in 1933 described a similar fracture, with the fracture line extending obliquely through the lateral humeral condyle. These descriptions, especially that provided by McKee and colleagues,[4] demonstrated the clinical significance of these osteochondral fractures—the potential instability of the elbow joint given the involvement of the lateral trochlear ridge and the difficulty in accurately visualizing and reducing the medial extent of the fracture. Failure to reduce this fracture anatomically may adversely affect not only the intrinsic stability of the elbow provided by the trochlea-olecranon articulation but also the ROM of the elbow joint. However, these were reports of an "en masse" fracture pattern involving part of the articular surface of the distal humerus.

Darrach[1] in 1916 and Oppenheim and colleagues[5] in 1989 described concomitant but distinct fractures of the capitellum and trochlea fitting the description of the AO/ASIF (Arbeitsgemeinschaft für Osteosynthesefragen/Association for the Study of Internal Fixation) B3.3 fracture pattern.[9] However, in their cases (unlike ours), the distinct capitellar and trochlear fragments involved only a part of the articular surface of the distal humerus. In addition, Darrach's patient was treated with excision of the trochlear fragment, and Oppenheim and colleagues used both lateral and medial arthrotomies to approach the trochlear fragment, which was fixed, as the capitellar fragment was, with K-wires.

To our knowledge, the present report is the first of concomitant but distinct osteochondral fractures of the capitellum and the trochlea involving the whole articular surface of the distal humerus in the coronal plane, not in conjunction with complex elbow fracture pattern or dislocation, and treated with open reduction and internal fixation through a single lateral exposure.

Trochlear fractures not in association with elbow dislocation[13] or complex distal humeral fracture[10] are extremely rare because the forces producing them tend to be tangential rather than shear, and the trochlea is located deep in the elbow and is therefore less vulnerable to injury.[5] Given that coronal shear fractures of the capitellum are encountered with a shearing-type mechanism, we are not certain of the mechanism that can produce coronal separation of both trochlea and capitellum with concomitant separation in the sagittal plane and not associated with elbow dislocation or complex fracture pattern.

Careful evaluation of preoperative x-rays in 2 planes will reveal, in the majority of cases, the pathognomonic radiographic signs of these rather rare fracture patterns. Independent of the fracture extension to involve a large portion or the whole distal humeral articular surface, these injuries should be treated with open anatomic reduction and stable internal fixation to enhance an excellent functional outcome. A modified extensile lateral Kocher approach offers excellent visualization of the fracture and adequate working space for fracture fixation through the joint.

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The authors report no actual or potential conflict of interest in relation to this article.

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