MRI Features of Posterior Capitellar Impaction Injuries

OBJECTIVE. Posterior capitellar injury is a scantily recognized entity in the literature. Furthermore, irregularity of the posterior capitellum, termed the “pseudodefect” of the capitellum, has been touted as a normal MRI finding, not to be misinterpreted for impaction injury. Our objectives, based on 11 MRI studies, were to report the MRI features of a true posterior capitellar impaction injury and to document associated clinical, osseous, and soft-tissue abnormalities that may shed light on the cause of this injury.

CONCLUSION. Traumatic posterior impaction injuries can occur in the capitellum, albeit infrequently. These lesions often present clinically with elbow instability, have a high incidence of lateral ulnar collateral and radial collateral ligament injuries, and show osseous abnormalities typical of elbow dislocation. Thus, MRI evidence of posterior capitellar impaction injuries, to be distinguished from the pseudodefekt of the capitellum, should raise the possibility of previous elbow dislocation or posterolateral rotatory instability.

the capitellum is susceptible to a number of traumatic abnormalities, including Panner’s disease, osteochondritis dissecans, and acute impaction injuries [1, 2]. These entities usually present with morphologic and signal alterations of the capitellum on MRI [3–5]. Distinction has been made between these lesions, typically found in the anterior capitellum, and a potential interpretive pitfall, coined the “pseudodefekt” of the capitellum, which occurs posteriorly at the junction of the capitellum with the posterior distal humerus [6]. However, we have anecdotally noted, on MRI, true traumatic lesions in the posterior capitellum. The focus of our study was to further examine these lesions and note associated abnormalities that may shed light on their cause.

Materials and Methods

Institutional review board approval was obtained, and informed consent was waived for the retrospective HIPAA-compliant study. A retrospective search of the institutional computer database was obtained, spanning a 42-month period, searching for all cases with marrow edema in the elbow. A total of 781 elbow MRI examinations were performed during that time. Of these, 46 showed marrow edema in one of the bones of the elbow. Eleven of the 46 MR studies depicted posterior capitellar marrow edema and were selected as the study group.

MRI Protocol

The MRI examinations were performed with a 1.5-T unit (Magnetom SP 4000; Siemens Medical Solutions). MRI was performed over 42 months, during which time some changes in the MRI elbow protocol were introduced, resulting in some variability in the protocol. The following sequences were performed in most patients: transverse T1-weighted spin-echo (field of view, 12–14 cm; section thickness, 4 mm; section gap, 1 mm; matrix, 256 × 192; TR range/TE range, 400–800/20); transverse T2-weighted fast spin-echo (echo-train length, 7; field of view, 12–14 cm; section thickness, 4 mm; section gap, 1 mm; matrix, 256 × 192; TR range/TE range, 2,000–6,000/50–90); coronal short inversion time inversion recovery (STIR) (field of view, 12–14 cm; section thickness, 4 mm; section gap, 1 mm; matrix, 256 × 192; 2,000–5,100/30–70; inversion time, 150 milliseconds); and sagittal T2-weighted fast spin-echo with fat saturation (echo-train length, 7; field of view, 12–14 cm; section thickness, 4 mm; section gap, 1 mm; matrix, 256 × 256; TR range/TE range, 2,000–6,000/50–90). Several patients also were imaged with an intermediate-weighted sequence (field of view, 12–14 cm; section thickness, 4 mm; section gap, 1 mm; matrix, 256 × 256; 2,000–6,000/50–90).

MRI Interpretation

The selected MRI studies were reviewed by two musculoskeletal radiologists (one with 15 years of experience and one with 20 years of expe-
Two patients underwent reduction of their nonspecific elbow pain. Further examination included magnetic resonance imaging of the elbow, including the medial collateral ligament (MCL), the lateral collateral ligament (LCL) and the lateral ulnar collateral ligament, and the presence of other osseous and soft-tissue abnormalities such as tendon disorders and joint effusions.

The medical records were reviewed and the following information was documented: clinical indication for the MR study, history of trauma or elbow dislocation, presence of instability on physical examination, and treatment course. Radiographs of the patient’s elbows were also reviewed with special attention to the presence of fracture or dislocation.

**Results**

**Subjects**

In 46 patients (5.9%), MRI studies depicted elbow marrow edema consisting of low signal on T1-weighted images and high signal on fluid-sensitive images. The marrow abnormalities were located in the posterior capitellum at the junction with the distal humerus in 11 (24%) of these patients (eight men, three women; mean age; 42 years; range, 21–94 years). Five patients described falls as the cause for their injury. In two patients, clinical and radiographic documentation of posterior fracture or dislocation of the elbow was present. Four additional patients had posterolateral rotatory instability on physical examination. Two patients presented with lateral elbow pain consistent with lateral epicondylitis, one patient had recurrent posterolateral elbow pain, and two patients suffered from nonspecific elbow pain.

Follow-up was available in eight patients. Two patients underwent reduction of their elbow dislocation. One of these suffered from residual elbow stiffness. Four were treated with rest and physical therapy and two were treated with arthroscopic débridement and reconstruction of the lateral collateral ligament complex.

**Osseous Abnormalities**

The pattern of signal abnormality in the 11 cases was diffuse, bruiselike changes sometimes extending into the distal humerus (n = 7) (Figs. 1 and 2), a subchondral linear arc of high T2 signal with articular surface discontinuity (n = 2) (Fig. 3), a subarticular cyst (n = 1) (Fig. 4), and a subcortical linear signal (n = 1) (Fig. 5). All marrow signal alterations extended to the posterior capitellar subarticular bone. Flattening of the posterior capitellar articular surface was seen in four patients (Fig. 5). Residual elbow subluxation was noted in one patient (Fig. 2).

Additional osseous abnormalities included a bruiselike pattern of marrow edema in the radial head (n = 4) (Fig. 2), intraarticular radial head fractures (n = 3) (Fig. 4), marrow edema in the coronoid process (n = 4), and marrow edema in the olecranon (n = 1). All cases with coronoid marrow edema had concomitant radial head signal abnormalities. The one patient with the olecranon bruise had concomitant radial head and coronoid abnormalities.

**Collateral Ligamentous Abnormalities**

In two of the 11 cases (18%), no evidence was seen of collateral ligament injury. In the other nine cases (82%), lateral ulnar collateral ligament tears with or without other collateral ligament injury (Figs. 2–4) were seen.

The patterns of injury in the nine cases with lateral ulnar collateral ligament abnormalities included partial tear with thickenings and abnormal signal (n = 5) (Fig. 4) and complete disruption (n = 4) (Figs. 2 and 3). The ligament tears were noted at the proximal humeral origin of the ligament in eight cases. In one case, partial tearing and heterogeneity were noted at both the proximal humeral origin and distal ulnar insertion.

Five (55%) of the nine patients with lateral ulnar collateral ligament tears had either partial (n = 3) or complete (n = 2) tears of the lateral collateral ligament at its humeral origin. In two of the five cases, additional partial medial collateral ligament tears were seen. Only one case had an elbow effusion.

**Other Abnormalities**

Two cases depicted edema and partial tearing of the common extensor tendon origin compatible with lateral epicondylitis (Fig. 6). Both of these cases had concomitant complete lateral ulnar collateral and partial lateral collateral ligament tears.

**Discussion**

The capitellum is a semispheric prominence that arises from the anterolateral aspect of the distal humerus. It is susceptible to lateral elbow compression injuries [1, 2]. The two most well-recognized traumatic capitellar injuries are Panner’s disease, a self-limited osteochondrosis, noted in young children, and osteochondritis dissecans, a more disabling entity, noted in adolescents and young adults [1]. These two entities may reflect a spectrum of disease in which clinical presentation and outcome are related to age at onset of disease. Shearing and impaction fractures of the capitellum can also occur but are less common [2].

Panner’s disease, osteochondritis dissecans, and acute traumatic impaction injuries of the capitellum are well-recognized traumatic capitellar injuries noted in older children and young adults [1, 2]. They occur but are less common. These injuries are characterized by a subchondral linear arc of high T2 signal with articular surface discontinuity. The one patient with a radial head fracture had a concomitant radial head signal abnormality.

The pattern of signal abnormality in the 11 cases was diffuse, bruiselike changes sometimes extending into the distal humerus (n = 7). In two of the five cases, additional partial medial collateral ligament tears were seen. Only one case had an elbow effusion. Additional osseous abnormalities included a bruiselike pattern of marrow edema in the radial head (n = 4), intraarticular radial head fractures (n = 3), marrow edema in the coronoid process (n = 4), and marrow edema in the olecranon (n = 1). All cases with coronoid marrow edema had concomitant radial head signal abnormalities. The one patient with the olecranon bruise had concomitant radial head and coronoid abnormalities.

Collateral ligamentous injuries were noted in two of the 11 cases (18%). In the other nine cases (82%), lateral ulnar collateral ligament tears were noted. In one case, partial tearing and heterogeneity were noted at both the proximal humeral origin and distal ulnar insertion. Five (55%) of the nine patients with lateral ulnar collateral ligament tears had either partial (n = 3) or complete (n = 2) tears of the lateral collateral ligament at its humeral origin. In two of the five cases, additional partial medial collateral ligament tears were seen. Only one case had an elbow effusion.

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**Fig. 1**—31-year-old man with history of posterolateral elbow pain. A and B, Diffuse edema (*asterisk*) is seen in posterior capitellum and distal humerus on sagittal T1-weighted MR image (TR/TE, 500/14) (A) and sagittal T2-weighted fat-suppressed image (4,000/50) (B).
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Fig. 2—91-year-old man after elbow dislocation and collateral ligamentous injuries.
A, Lateral radiograph shows residual elbow subluxation. Crescentic defect in posterior capitellum (arrow) and intraarticular fragments are seen.
B, Sagittal T1-weighted MR image (TR/TE, 500/14) shows low-signal posterior marrow edema in capitellar–distal humerus junction (arrow). Contralateral low-signal impaction fracture in radial head (arrowhead) is also noted.
C, Coronal STIR image (TR/TE, 6,000/30; inversion time, 150 milliseconds) depicts complete tear at humeral insertion (arrow) of lateral ulnar collateral ligament. Capitellar marrow edema (asterisk) is also noted.

Fig. 3—39-year-old woman with elbow pain after fall off bike and clinical evidence of posterolateral elbow instability.
A and B, Coronal STIR (TR/TE, 6,000/30; inversion time, 150 milliseconds) (A) and sagittal T2-weighted fat-suppressed (4,000/50) (B) images depict cortical discontinuity, edema, and subchondral arclike increased signal (solid arrow) in posterior capitellum. Disruption of lateral ulnar collateral ligament (open arrow, A) is noted.
capitellum are related to either acute or chronic lateral compression forces and direct impact of the radial head against the opposing capitellum. Subsequent imaging findings are located in the anterior capitellum. Both Panner’s disease and osteochondritis dissecans can be detected on radiography but are better assessed on MRI. Panner’s disease is depicted on MRI as diffuse capitellar abnormal signal, typically without morphologic changes [3]. A more severe constellation of capitellar abnormalities, including abnormal marrow signal, bone fragmentation, cystic changes, cartilaginous defects, and intraarticular bodies, may be noted in osteochondritis dissecans [4, 5]. The MRI depiction of capitellar fractures, as elsewhere in the body, varies with the severity and type of injury, but may include fracture lines, marrow edema, and impact deformities of the articular surface and subchondral bone.

In distinction to these anterior capitellar disorders, we describe impact injuries of the posterior capitellum, at the junction of the capitellum with the distal humerus. The MRI features of these posterior capitellar lesions include bone bruises, subchondral arclike linear or cystic marrow signal abnormalities, and posterior capitellar subchondral flattening and discontinuity. In our study, the lesions were commonly associated with fractures or contusions in the radial head and coronoid process. A high prevalence (82%) of lateral ulnar collateral ligament injuries was also noted, suggesting the posterior capitellar impactation injuries are associated with elbow instability. We speculate that avulsion of the lateral ulnar collateral ligament with or without an avulsion fragment may, occasionally, also contribute to the posterior marrow edema.

Fig. 4—31-year-old man after fall from scooter and instability on clinical examination. A, Sagittal T2-weighted fat-suppressed image (TR/TE, 4,000/50) depicts deformity and edema (asterisk) in radial head consistent with fracture (fracture line visualized on other images). Marrow edema at posterior capitellar–distal humeral junction (arrow) is noted. B, Coronal STIR image (6,000/30; inversion time, 150 milliseconds) depicts increased signal (arrows) at humeral origin and distal ulnar insertion of lateral ulnar collateral ligament, consistent with partial tear.

Fig. 5—Linear capitellar impaction injury in 21-year-old man with history of tripping while playing basketball. T2-weighted fat-suppressed image (TR/TE, 4,000/50) depicts posterior capitellar edema (solid arrow) and flattening of subcortical surface (open arrow).
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Fig. 6—44-year-old man with lateral elbow pain and MRI evidence of lateral epicondylitis. 
A, Coronal T1-weighted MR image (TR/TE, 500/14) depicts partial tears at origins of common extensor tendon (solid arrow) and lateral ulnar collateral ligament (open arrow). 
B, Posterior capitellar marrow edema (arrow) is noted on more posterior coronal STIR image.

To our knowledge, only two previous cases of posterior capitellar impaction injuries and their imaging characteristics are reported in the literature [7, 8]. Faber and King [8] noted a posterior capitellar injury on radiographs in a 27-year-old woman with posterolateral rotatory elbow instability, which they coined a “posterior capitellum impression” injury. The impaction injury was best visualized on an oblique lateral radiograph. Feldman et al. [7] described a 25-year-old woman who suffered an acute elbow dislocation. A posterior capitellar impaction injury, with an opposing radial head contusion, was noted on the pre-reduction lateral radiograph and on post-reduction MR images. A few MR images consistent with posterior capitellar impaction injuries were also depicted, without discussion of the phenomena, in an MRI study of patients with posterolateral rotatory instability [9].

The capitellar abnormalities described in these publications are similar to the lesions we noted in our study. In all previous articles they occurred in the setting of either an acute elbow dislocation or with posterolateral rotatory elbow instability. Similarly, the capitellar lesions noted in our study were associated with either an acute or a transient elbow instability. Six of our 11 patients (55%) had a history of either previous elbow dislocation or posterolateral rotatory elbow instability. In addition, nine of our 11 cases (82%) showed MRI evidence of either partial or complete tears of the lateral ulnar collateral ligament. Finally, other osseous MRI findings in our study, such as contusions and fractures of the...
radial head and coronoid process, provided further MRI support for elbow instability.

Complete elbow dislocations are acute traumatic events, typically caused by a fall on an outstretched hand [10]. They can be classified as simple, with isolated tearing of all the supporting collateral ligaments, or complex, in which additional fractures of the coronoid process and radial head or avulsion fractures at the origins of the collateral ligaments are seen. A small subset of patients with acute traumatic elbow dislocation can develop recurrent elbow instability. Elbow instability and incomplete elbow dislocation can also occur after acute or repetitive axial loading, external rotation, and valgus or varus stress on the elbow. Initially, this occurs in the setting of a functionally intact medial collateral ligament and insufficiency or tearing of the lateral ulnar collateral ligament [11]. Disruption of the lateral ulnar collateral ligament allows the ulna to sublux laterally. Because the annular ligament is intact, the radial head and ulna move as a unit, and the radial head dislocates posterior to the distal humerus. In stage I elbow instability, also termed “posterolateral rotatory instability,” there is disruption of the lateral ulnar collateral ligament and possibly of the radial collateral ligament and the posterolateral capsule. In stage II instability, evidenced by a perched incomplete elbow dislocation, the anterior and posterior capsules are also torn. Progressive tearing of the medial collateral ligament occurs in stage III instability or complete elbow dislocation.

The diagnosis of early elbow instability is clinically challenging. Patients may present with nonspecific elbow pain, recurrent snapping, and a feeling of the elbow giving way [12, 13]. A lateral pivot–shift test involving application of axial force, external rotation, and valgus stress can be difficult to perform, and without general anesthesia may elicit only apprehension rather than elbow dislocation [12]. Accurate performance of the test is also difficult and requires significant clinical experience [12]. Because the subluxation is often transient, radiographs are usually normal, although during subluxation there is widening of the ulnohumeral joint or posterolateral dislocation of the radiohumeral joint.

MRI findings of posterolateral elbow instability include abnormalities such as increased signal, partial or complete tearing, and absence of the lateral ulnar collateral ligament [9, 13]. Chondral injury of the capitellum has been described in two patients [9]. We believe that the focal posterior capitellar impaction injuries noted in our study are additional osseous MRI findings that may indicate elbow instability. These impaction injuries are analogous to the Hill-Sachs deformity of the humeral head and osseous Bankart injury of the glenoid noted in shoulder dislocation and to the lateral femoral condyle and posterior tibial impaction injuries after anterior cruciate ligament tears in the knee. In all these processes, either acute or chronic traumatic injury with secondary ligamentous disruption produces displacement of one bone against another and a resultant impaction injury. We believe that the reason posterior capitellar lesions have received scant recognition until now is the difficulty of detecting them on radiographs.

Elbow instability, typically secondary to trauma, can also be associated with lateral epicondylitis, surgical release of lateral epicondylitis, and radial head resection [12, 13]. It is believed that the same repetitive microtrauma and overload mechanisms that produce lateral epicondylitis also cause injury to the lateral ulnar collateral ligament. Corticosteroid injections in the course of treatment of lateral epicondylitis may also play a role in the development of lateral ulnar collateral ligament degeneration [13]. On MRI the lateral ulnar collateral ligament was noted to be abnormal in 63% of patients with lateral epicondylitis [14]. Similarly, two of our patients had MRI evidence of lateral epicondylitis with concomitant lateral ulnar collateral and lateral collateral ligamentous injuries.

The posterior capitellar traumatic injuries we describe should be distinguished from a well-recognized MRI pitfall inherent to the normal lateral anatomy of the distal humerus, termed the “pseudodefect” of the capitellum [6]. The normal capitellum tapers in size as it descends downward. Posterolaterally, its articular surface overhangs a troughlike indentation of the distal humerus at the junction with the lateral epicondyle. The overhanging edge of the capitellum, together with the adjacent trough, results in a notchlike appearance on sagittal and posterior coronal MR images, simulating an osteochondral defect (Fig. 7). The pseudodefect of the capitellum has been reported to be easily distinguished from common osteochondral injuries of the capitellum, such as Panner’s disease and osteochondritis dissecans, by its posterior location and by the lack of marrow edema [6]. However, our study indicates that true posterior capitellar lesions exist, and distinction between them and the pseudodefect of the capitellum may be more difficult than previously believed.

We adhere to the presence of marrow edema as the major distinguishing feature between the two processes. Flattening of the posterior capitellar articular surface; cortical discontinuity; and linear, cystic, or arclike marrow signal changes in the capitellar subchondral bone are other imaging features that may aid in separating a true posterior capitellar lesion from the pseudodefect of the capitellum.

This study is limited by its retrospective nature and the small number of cases. In addition, we lack surgical proof. Another limitation is problems in syntax-generated searches. Therefore, not all cases of posterior capitellar injury may have been identified from the computer database review. Future prospective studies may be useful in detecting the prevalence of posterior capitellar impaction injuries in patients with recurrent elbow dislocation and posterolateral rotatory elbow instability.

In summary, we describe the MRI features of posterior capitellar impaction injuries. The prevalent clinical history of elbow instability and the high incidence of lateral ulnar collateral ligament tears and contusions or fractures of the radial head and corono- noid process in our patients indicate that the posterior capitellar impaction injuries are the osseous sequelae of either complete elbow dislocation or posterolateral elbow instability. These injuries should be distinguished from the pseudodefect of the capitellum by the presence of marrow edema and the presence of articular and subchondral abnormalities of the posterior capitellum.

References

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