Pediatrics Tips & Tricks: Management of Pediatric Capitellar Fractures

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Introduction

Isolated fractures of the capitellum humeri are infrequent in pediatric patients, representing less than 1% of elbow fractures in children and adolescents.[1] The management of capitellar fractures in adults has been previously well-described with surgical options for displaced fractures including osteosynthesis, fragment excision, and prosthetic replacement.[2] The evaluation and treatment of capitellar fractures in children, however, has received less attention, resulting in frequently-missed injuries and delays in diagnosis. Even when promptly treated, displaced capitellar fractures often yield poor radiographic and functional outcomes including early arthritis, osteonecrosis, limited range of motion, and mechanical symptoms. These potential complications have therefore prompted recent efforts to better classify pediatric capitellar injuries with an aim towards guiding treatment and optimizing functional outcomes.

Classification

The most widely-used classification system for adult capitellum fractures is attributed to Bryan and Morrey, although it employs prior eponymous descriptions of classic fracture patterns.[3] Type-I fractures (Hahn-Steinthal) involve anterior shear fractures of a large osseous piece of the capitellum.Type-II (Kocher-Lorenz) are shear fractures of the articular cartilage involving minimal to no subchondral bone. Type-III fractures (Broberg-Morrey) are multifragmentary, severely comminuted fractures of the capitellum. In 1996, McKee introduced a fourth classification to include anterior coronal shear fractures involving both the capitellum and trochlea.[4]This system is often criticized for its subjective nature and failure to guide management.

In 2017, Murthy *et al.* introduced a classification scheme unique to pediatric patients based on their observation of 37 children and adolescents with capitellum fractures (Figure 1).[5] Type-I fractures were most

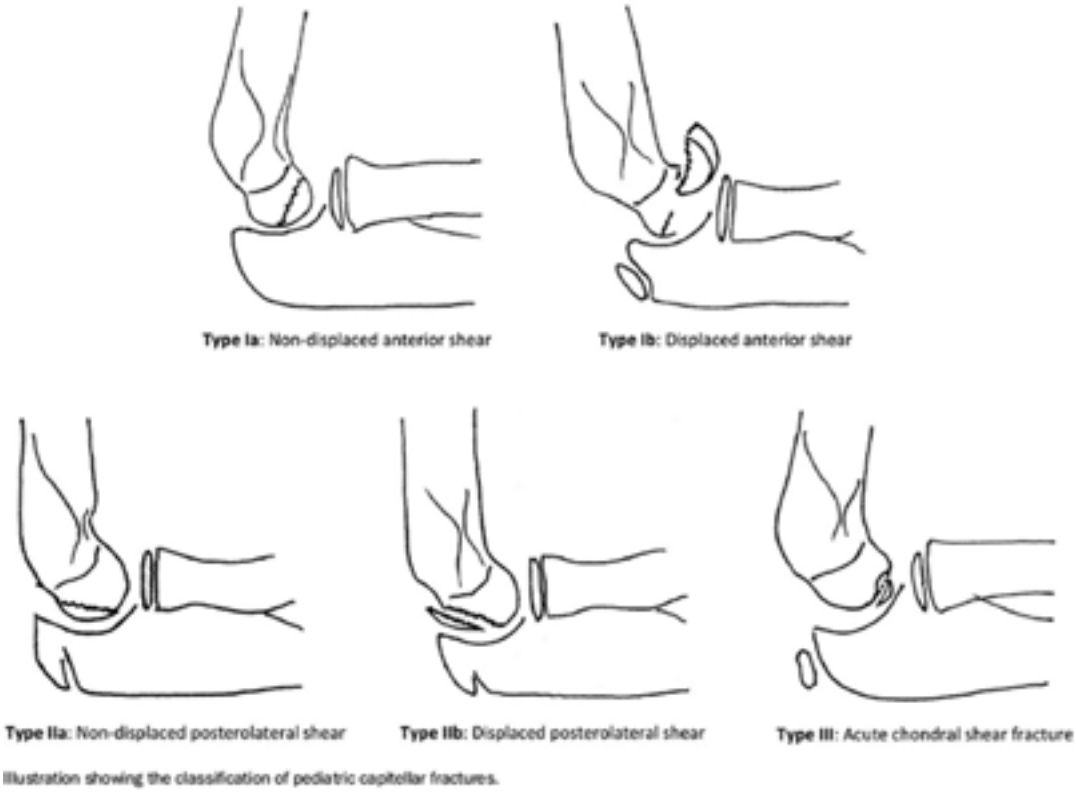

Figure 1. Abstracted from: Murthy, P.G., Vuillermin, C., Naqvi, M.N., Waters, P.M., Bae, D.S., 2017. Capitellar Fractures in Children and Adolescents: Classification and Early Results of Treatment. J Bone Joint Surg Am 99, 1282–1290.

common (incidence = 68%), representing anterior shear injuries of the capitellum, with or without involvement of the lateral crista of the trochlea, similar in description to the adult type-I (Hahn-Steinthal) fracture scheme. Type-II fractures (incidence = 24%) were posterolateral shear injuries. Type-III fractures (incidence = 8%) were acute chondral shear injuries. Each fracture type was further subdivided depending on the degree of displacement (nondisplaced = "a," displaced = "b"). Given its specificity towards the pediatric population, we will reference this classification system in the remainder of this article.

Evaluation

The evaluation of capitellum fractures is prompted in a child or adolescent with acute traumatic elbow symptoms. These injuries are frequently difficult to visualize on plan radiographs, particularly type-II and type-III fracture patterns. A large fracture fragment may be apparent on a lateral radiographic, however on the anteroposterior (AP) view it may be obscured by the underlying distal humeral metaphysis. The inclusion of oblique views is therefore recommended in the initial evaluation of traumatic elbow pain without clear evidence of an injury on the standard AP-lateral radiographs. In capitellar fractures, the postulated mechanism of injury is compression or shear by the radial head. Associated injuries to the radial head or neck are therefore common, estimated to be as high as 31%.[6] Patients with confirmed fractures of the capitellum may benefit from evaluation with magnetic resonance imaging (MRI) or computed tomography (CT) to better define the fracture pattern and plan surgical treatment. Given the high rates of radiographically-occult capitellar fractures and the potentially devastating outcomes resulting from missed injuries, we recommend advanced imaging with MRI or CT in patients with severe, persistent elbow pain, stiffness, swelling, or mechanical symptoms.

Case Report

A 12 year-old otherwise-healthy male presented to the Emergency Department with a one-day history of left elbow pain. The pain began after a fall from bicycle in which he landed onto his outstretched left arm. He endorsed severe pain with lateral elbow palpation and joint passive range of motion. There was a clinically-apparent effusion. The patient demonstrated intact radial and ulnar pulses and no neurologic deficits. There were no associated injuries to the remainder of his extremities noted by exam.

Initial radiographs and CT imaging with three-dimensional reconstruction demonstrated a large fractured osseous fragment of capitellum overlying the anterior distal humerus (Figure 2). Additionally noted was a minimally displaced

Figure 2. AP, lateral radiographs and three-dimensional computed tomography reconstruction demonstrating a large displaced capitellum fracture with associated minimally displaced medial epicondyle fracture.

avulsion fracture of the medial epicondyle. The extremity was immobilized, and the following day the patient underwent open reduction, internal fixation utilizing an anterolateral (Kocher) approach to the elbow (Figure 3). The fixation of choice was a single 3.5 mm fully-threaded cannulated screw with washer (inserted through the posterolateral aspect of the capitellum) as well as two 3.0 mm headless compression screws (inserted anteriorly to posteriorly).

At three-week follow-up, the cast was removed and converted to a hinged elbow brace; the patient was advised to begin range of motion exercises as tolerated. His post-operative course was subsequently complicated by elbow stiffness—at 6-month follow-up, he demonstrated an ulnohumeral arc of 45 degrees extension to 110 degrees of flexion. The decision was therefore made to proceed with manipulation under anesthesia with arthrography of the elbow joint demonstrating a congruent joint with no evidence of hardware penetration of the joint. During exam under anesthesia, the range of motion of the elbow was 10-135 degrees. At the time of this writing, he is awaiting clinical follow-up for this procedure.

Treatment Options

Capitellum fractures in pediatric patients are rare and challenging to diagnose, and treatment outcomes are variable depending on the timeliness of diagnosis and the treatment modality selected. Further, only a limited number of studies have been published on the treatment of capitellum fractures, of which most are limited to case reports or case series.[7-13] Despite these limitations, a general review of the available literature yields several guidelines related to the management of pediatric capitellum fractures. First, nondisplaced fractures of the capitellum, particularly types-Ia and IIa are generally amenable to non-operative treatment with cast immobilization. Although the exact frequency of missed injuries is unknown due to the paucity of published data, these fractures are likely more common than cited owing to the poor sensitivity of standard radiographs in the identification of these injuries.[5] It stands to reason that in patients for whom the diagnosis of nondisplaced capitellar fracture is missed, non-surgical treatment is generally successful with limited immobilization.

The treatment of displaced anterior and posterolateral shear injuries (type-Ib and type-IIb, respectively) centers on surgical fixation. Various modalities, including suture repair, Kirschner wire fixation, bioabsorbable pin fixation, and fixation with cortical, cannulated, or variable-pitch headless compression screws, have been described. To our knowledge, there are as yet no studies directly comparing the outcomes of different fixation strategies. The choice of fixation is therefore left to the discretion of the surgeon, guided by surgeon comfort and fracture characteristics. Additionally, surgical excision of

Figure 3. AP, lateral radiographs demonstrating reduction and internal fixation of capitellum fracture.

late-presenting small fracture and osteochondritis dissecans lesions has demonstrated successful outcomes in very young patients.[1,12] In particular, excision of small type-III chondral shear injuries has been shown to yield excellent restoration of motion and alleviation of pain. Fixation techniques for type-III lesions have also been wide-ranging but typically include Kirschner wire fixation and suture repair.[4,8]

Conclusions

The timely diagnosis and management of capitellar fractures are essential to ensuring restoration of articular congruity, range of motion, and joint stability in children and adolescents. Capitellum fractures in pediatric patients demonstrate unique patterns and characteristics when compared to adult fractures. Therefore, advanced imaging with MRI or CT is recommended for better characterization of the fracture pattern and to plan fixation strategies. Of the various fracture patterns, type-II posterior shear and type-III chondral injuries are most easily missed on routine screening radiographs. A high index of suspicion for these injury types is therefore imperative in patients who have a consistent history, persistent pain and swelling, and mechanical blocks to motion of the elbow. Whereas nondisplaced fractures are generally treated well without surgery, fixation and fragment excision represent the mainstays of surgical treatment for displaced fractures. Successful outcomes may be expected when the injury has been promptly diagnosed and appropriately treated.

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