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CASE REPORT

Incarcerated Coronoid Fracture at the Time of Pediatric Elbow Dislocation

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ABSTRACT

An elbow dislocation with associated incarcerated coronoid fracture in a child is a rare injury. No prior cases of this clinical scenario have been described in the English literature. Radiographs, including a true lateral and contralateral elbow views, are vital to identify the lack of joint congruency. This case underscores the importance of thorough postreduction physical examination, including range of motion and stability, and radiograph interpretation. Suspicion for an entrapped fracture should be high in a patient with a lack of joint congruency, residual joint instability, and limited range of motion following attempted reduction.

Keywords: Case report, Coronoid fracture, Elbow dislocation, Incarcerated fracture, Pediatric elbow.

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INTRODUCTION

Pediatric elbow dislocations are not a common injury pattern. Henrikson described a 3% incidence in a study of 1,579 pediatric patients.[1] Peak incidence occurs in the second decade of life, most commonly between the ages of 13 and 15 years.[2] Elbow dislocations may be associated with concomitant fractures about the elbow, most commonly a medial epicondyle fracture. In 15 to 25% of elbow dislocations, the medial epicondyle is incarcerated in the joint.[3-5] Coronoid fractures are usually associated with elbow dislocations in the setting of terrible triad injuries, which include radial head fracture, coronoid fracture, and elbow dislocation (often posterolateral with lateral collateral ligament injury). While terrible triad injuries are more common in adults, Dailiana et al[6] described two cases in pediatric patients. Several studies have noted associated coronoid avulsion fractures to be present in 4 to 10% of patients (both pediatric and adult) presenting with an elbow dislocation.[7,8] However, no published cases of an incarcerated coronoid fracture associated with an elbow dislocation in a pediatric patient have been published in the English literature.

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CASE REPORT

A 7-year-old right-hand-dominant female presented to our institution for evaluation of left elbow pain 3 days after falling off of a trampoline. On the day of injury, she was taken to an outside hospital where she was diagnosed with a posterior elbow dislocation. According to her mother, the elbow was reduced under sedation in the outside hospital emergency room, and she was placed in a sling. Three days later, due to increasing pain, she was taken to an urgent care facility where radiographs revealed a persistent posterior elbow dislocation, and she was subsequently placed in a posterior slab splint and referred to our institution's emergency department. She denied any numbness, paresthesias, or other locations of pain. The patient was without any contributory past medical history, past surgical history, family history or social history.

On examination, there was moderate swelling and obvious deformity about the left elbow with no open wounds. She demonstrated full passive range of motion (PROM) about the ipsilateral wrist and shoulder. Left elbow PROM was severely limited by pain. Her left hand was warm and well perfused with a 2+ palpable radial pulse. Sensory and motor function of the axillary, median, ulnar, and radial nerves were intact. Initial radiographs demonstrated a posterior elbow dislocation without obvious signs of concomitant fracture (Fig. 1). Left humerus and radius/ulna radiographs did not reveal any proximal or distal injuries.

A closed reduction under intravenous ketamine sedation was carefully attempted in the emergency room. During the procedure, it was noted that the left elbow was extremely unstable when extended greater than 90°. A bivalved long-arm cast was applied, and postreduction

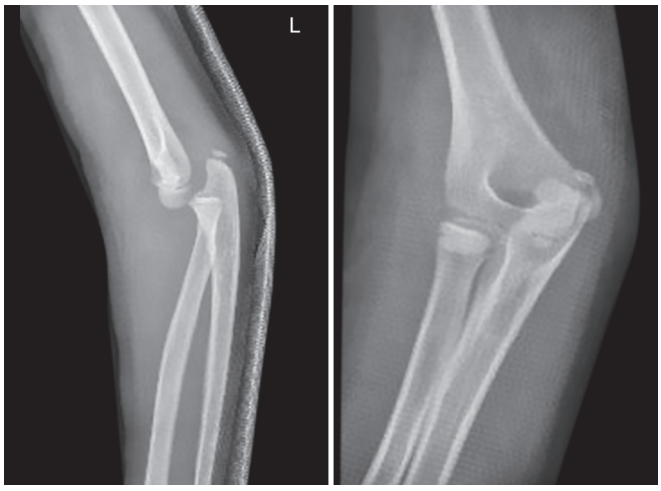

Fig. 1: Initial radiographs demonstrated a left posterior elbow dislocation without clear evidence of associated fracture

films showed inadequate reduction with lack of congruency compared with the contralateral elbow (Fig. 2). The patient remained neurovascularly intact throughout the reduction attempt. Due to the unsuccessful closed reduction and radiographic findings, there was a high index of suspicion for an interposed fracture fragment. The most probable donor site origin for the suspected fracture fragment was believed to be the medial epicondyle, and thus the patient was taken to the operating room for further evaluation and management of this suspected injury.

Operative Details

The patient was placed supine on a standard operative table with a radiolucent left-hand table extension. The cast was removed and the patient was prepped and draped in standard sterile fashion. A sterile tourniquet was placed and after exsanguination inflated to 200 mm Hg. The left upper extremity was then positioned in 90° of shoulder abduction and 90° of elbow flexion. A 5 cm incision was then made centered over the medial epicondyle in order to facilitate appropriate exposure of suspected fracture fragments, anatomic reduction, and possible open reduction and internal fixation of the medial epicondyle. The underlying subcutaneous tissue and fascia were disrupted as a result of the trauma.

First, the medial epicondyle was evaluated and noted to be intact with all muscle and fascial attachments. Second, the ulnar nerve was carefully exposed. The authors do not routinely mobilize the ulnar nerve in cases of medial epicondyle fractures. However, one centimeter of proximal and distal mobilization was utilized in this case to allow for increased exposure since the donor site of the incarcerated fragment was not yet identified. Next, a freer was used to localize the traumatic arthrotomy, and this was sharply extended to allow for thorough joint evaluation. A large fracture fragment with articular cartilage (1.5 by 0.5 cm) was seen incarcerated between the trochlea and proximal ulna. Further exploration revealed a proximal ulnar donor site with fracture through the base of the coronoid.

The fragment was then mobilized taking care to preserve all soft tissue attachments, and the elbow joint easily reduced (Fig. 3). The joint was ranged under fluoroscopy and was noted to be unstable at 30° of extension with recurrent posterior elbow dislocation. Finally, the fracture fragment with attached anterior capsule was reduced anatomically in the donor site and the ulnohumeral joint reduced. The fragment was fixed with two extra-articular 0.045 inch Kirschner wires; the first directed proximal medial to distal lateral through the incision and the second directed distal anterior to proximal posterior though a percutaneous incision anterior to our exposure (Fig. 4). Inspection was performed to ensure that wire placement

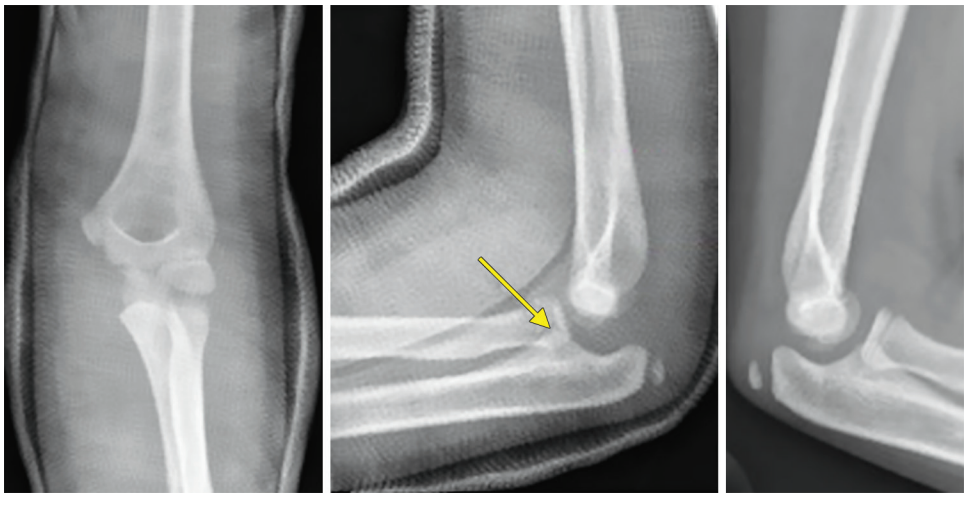

Fig. 2: Postreduction radiographs demonstrating lack of concentricity of the injured elbow (left) relative to the contralateral side (right). The arrow highlights blunting of the coronoid process suggestive of a capsular avulsion fracture

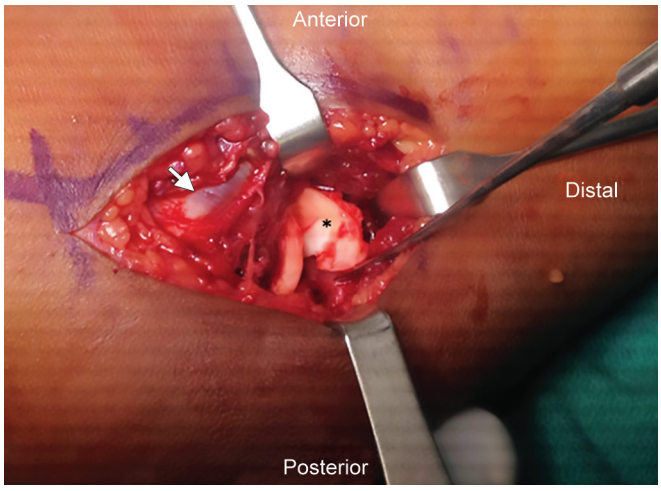

Fig. 3: Operative photograph demonstrating displaced coronoid fragment with articular cartilage (asterisk) in relation to the donor site (freer). This fragment has been removed from incarcerated position. Note the intact flexor/pronator mass (arrow)

was neither intra-articular nor causing tension on the ulnar nerve.

The elbow was again ranged under fluoroscopy and noted to be stable from 0 to 130° of motion to confirm adequate fixation of the fracture fragment. The wound was then closed in layered fashion with absorbable sutures around the two pins. Capsular repair was not achieved due to our pin position. Intraoperatively, it was noted that there was a relatively small target area for fixation and we believed that secure fixation of the fracture fragment took precedent over capsular closure. The pins were bent and cut outside of the skin to facilitate eventual removal in clinic. The arm was then dressed and immobilized in a well-padded, well-molded, long-arm cast with the elbow at 70° of flexion and the forearm in 10° of supination. The cast was bivalved to accommodate swelling. The patient was awoken from anesthesia and transferred to the recovery

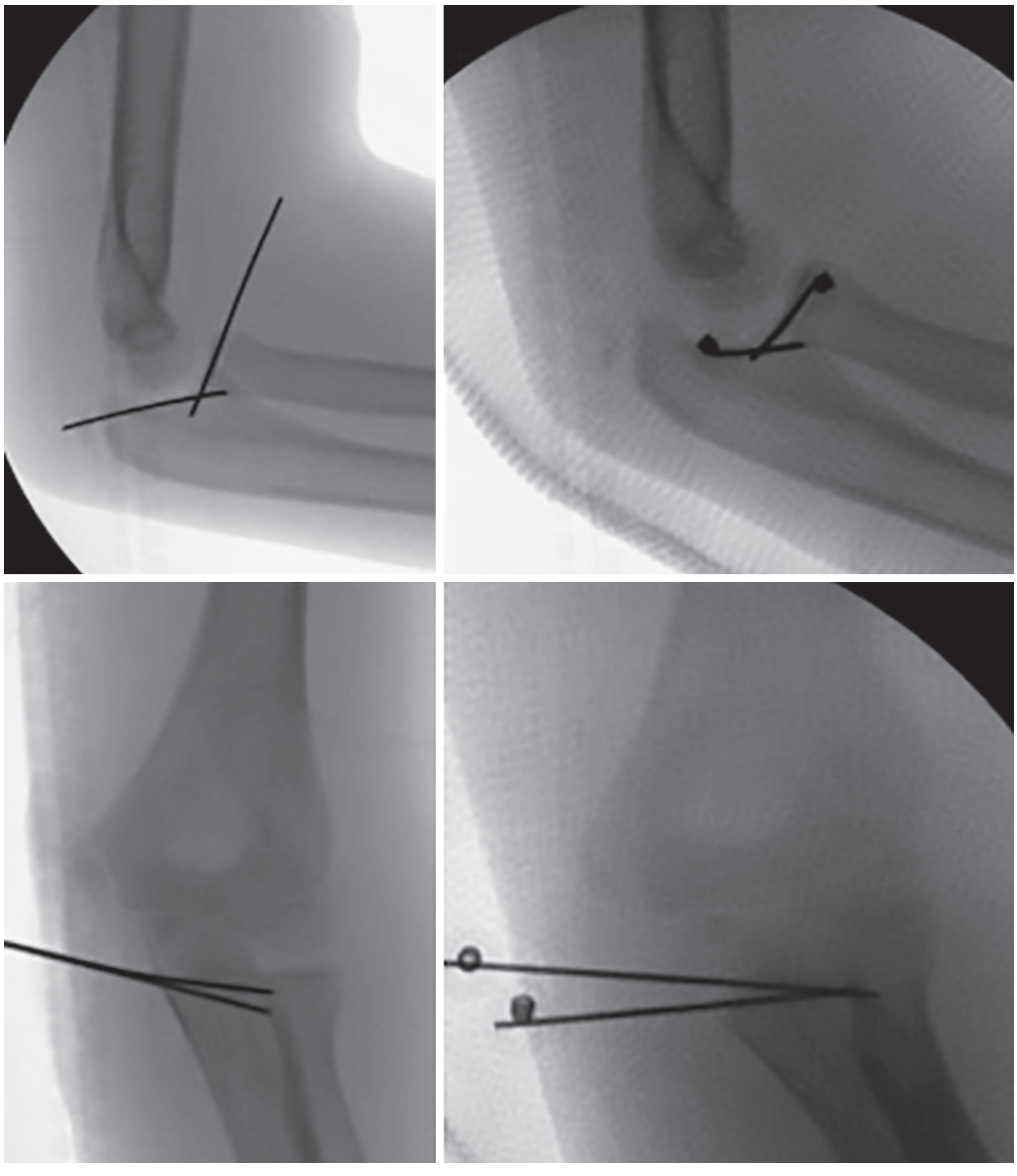

Fig. 4: Intraoperative fluoroscopy. The coronoid process was anatomically reduced and fixed using two 0.045 inch Kirschner wires. Note the interval change in joint congruency

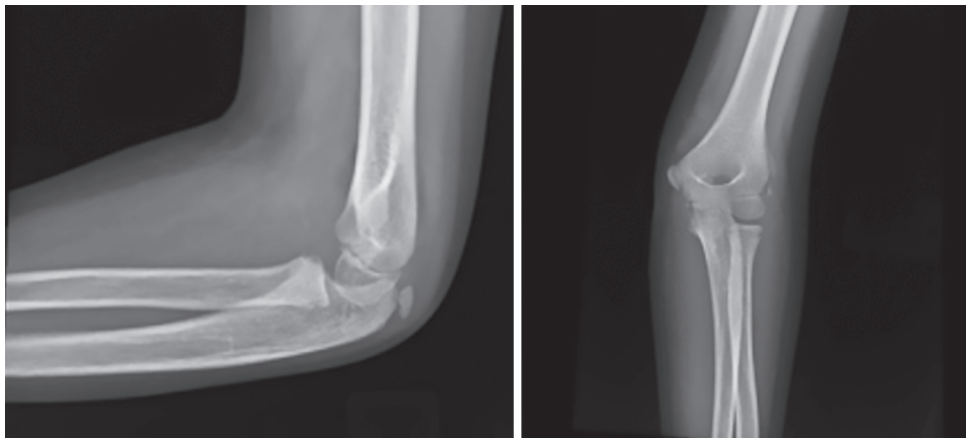

Fig. 5: Four-week postoperative radiographs demonstrating removal of Kirschner wires with interval bony healing of the previously observed coronoid fracture

room. Orthopedic postoperative neurovascular examination was intact and unchanged from preoperative exam.

RESULTS

At 4-week postoperative follow-up, the child's cast and coronoid pins were removed in the orthopedic clinic. Radiographs at that time were notable for interval bony healing of the previously observed coronoid fracture (Fig. 5). The child was noted to have intact median, ulnar, and radial motor and sensory function, with no pain about the elbow. The patient was able to exhibit painless sagittal plane motion about the elbow from 20 to 90° of flexion.

DISCUSSION

Elbow dislocations in children are relatively rare injuries, accounting for approximately 3% of injuries to the elbow.[1] These injuries typically occur in children older than this patient, usually in the second decade of life.[9] In a case series of 58 posterior elbow dislocations in pediatric patients by Carlioz and Abols,[9] 64% were associated with fractures or avulsions. Another case series of 33 children with elbow dislocations by Rasool revealed that 75% had associated fractures about the elbow, with 24% of patients in this series not receiving an accurate diagnosis following their initial radiographs.[10] The most commonly associated fracture in those case series was a medial epicondyle avulsion fracture in 41 to 45% of patients.[9,10] Lateral condyle fractures were the next most common, constituting 10 to 18% of associated fractures.[9,10] Carlioz and Abols[9] also reported associated isolated coronoid process fractures in 3% (2 patients), but this study did not specify if the fragments hindered reduction or stability. Both studies had 2 patients (3–6%) with incarcerated medial epicondyle fragments that required open reduction and internal fixation. Quick reported on a case of an osteochondral flap injury of the coronoid in the setting of an isolated elbow injury in a child; however, in contrast to the case presented here, their patient did not exhibit a mechanical block to reduction.[11] To our knowledge, this is the first documented case of an incarcerated coronoid process fracture posing a mechanical block to reduction in the setting of a pediatric elbow dislocation.

Fractures about the elbow in children, while relatively common, pose numerous diagnostic and management challenges stemming from the unique developmental anatomy of the elbow.[12,13] The progression of ossification of the six primary centers about the elbow has been well described in the literature.[14] Cheng et al[15] reviewed the radiographs of 1,577 children, noting the relative conservation of the sequence of ossification in males and females, with all centers exhibiting delayed ossification in males except the capitellum. Elbow fractures in children are at particularly high risk for misinterpretation, given the ossification process of the skeletally immature elbow. Up to 6% of fractures are not recognized on initial radiographs.[16,17] Injuries at particularly high risk for being missed on initial radiographs include the "TRASH" lesions previously described by Waters et al[18]: Transphyseal distal humerus fractures, displaced medial humeral condyle fractures before ossification of the trochlea, capitellar shear fractures, radial head fracture with subsequent radiocapitellar subluxation, and intra-articular osteochondral fractures.[18]

Radiographic assessment of coronoid injuries is made particularly difficult by the superimposition of the radial head on the coronoid on lateral radiographs, occasionally necessitating dedicated oblique views of the elbow for appropriate assessment of the coronoid. A review of radiographs of 510 pediatric elbow fractures in 462 children examined at a children's hospital over a 10-month period noted the presence of only 12 coronoid fractures (2.4% of all observed fractures), with one-third

of these being missed on initial radiographs.[16] Given the potentially occult nature and relative difficulty of identifying these injuries in the skeletally immature patient, oblique radiographs of the elbow and proximal radioulnar joint may be beneficial in evaluating for injuries not well appreciated on standard anteroposterior or lateral radiographs.[19] The use of elbow arthrography has also been described as a highly sensitive adjunct in identifying intra-articular pathology and capsular disruption in skeletally immature patients prior to operative management of suspected elbow pathology.[20] Yates and Sullivan[21] noted in their series of 36 children who underwent arthrography for radiographic evidence or clinical concern for elbow trauma that 19% (7/39) were found to have an injury differing from that which was suspected. All seven of these patients' treatments were altered by the results of their arthrogram, further highlighting the utility of this study not only in establishing a diagnosis but also in developing a proposed treatment plan for patients. The use of MRI in evaluation of suspected elbow trauma in the pediatric patient has recently gained increased favor based on its observed sensitivity of up to 89% in detecting otherwise radiographically occult fractures about the elbow.[22,23] However, the frequent need for conscious sedation, associated cost, and the timeliness with which a desired study may be obtained must be considered when determining whether or not an MRI is indicated for patients with suspect elbow trauma.[24,25]

An understanding of the osteologic development and anatomic relationships of the coronoid process provides a framework for discussing the observed patterns of injury in both pediatric and adult patients. Until approximately age 6, the coronoid process is made up predominately of epiphyseal and physeal cartilage extending volarly and distally from the apophysis of the olecranon. Unlike other bony prominences of the elbow, the coronoid process does not arise from its own ossification center, instead ossifying in conjunction with the advancing edge of the ulnar metaphysis.[26] Ossification of the coronoid process is generally complete at the time of the appearance of the olecranon ossific nucleus, although some authors note that the cartilaginous nature of the coronoid may persist late into childhood.[27] Following ossification, the coronoid acts in conjunction with the radial head as an anterior buttress relative to the articular surface of the distal humerus, bearing up to 40% of the load distributed across the ulnohumeral joint during axial loading in extension.[28,29] Biomechanical studies in the adult population suggest that the relative percentage of intact coronoid articular surface is significant in predicting the ability to resist posterior and proximal linear translations of the ulna.[30] The incidence of coronoid fractures in the pediatric population is relatively low, representing between 1 and 2% of pediatric elbow fractures.[31] A review of 23 pediatric coronoid fractures by Bracq[32] suggests a likely bimodal distribution of these injuries with most occurring between ages 8 and 9 or between 12 and 14 years.

Outcomes after pediatric elbow dislocation have been reported as favorable. Ninety-seven patients obtained a good (30%) or excellent (67%) result at a mean of 10 months in Rasool's study of 33 pediatric elbow dislocations.[10] Better outcomes were seen in patients with simple dislocations, as 88% of those patients recovered full range of motion. Worse outcomes were seen in patients with lateral compartment injuries (radial head, lateral condyle) or complex elbow fracture dislocations. Carlioz and Abols[9] found in their series of 39 patients with both simple and complex elbow dislocations that at minimum 4-month follow-up, 54% exhibited excellent results, 36% good results, and 10% poor results. An excellent outcome was defined as no symptoms with less than 10° loss of motion. Good outcomes were defined as mild symptoms and less than 30° of motion loss. Poor outcomes included those with severe symptoms or more than 30° of motion loss, as described by Roberts.[33] Bilgili et al[34] examined the effect of time to surgical intervention on outcomes in a retrospective study of 26 patients with acute elbow fracture dislocations. In their series, these authors found no statistically significant difference in outcomes of those treated surgically within 24 hours of injury and those who received operative treatment more than 24 hours after injury.

Complications after elbow dislocation and fracture dislocations include neurovascular injuries, reduced range of motion, heterotrophic ossification, synostosis, recurrent dislocation, and pseudarthrosis. In cases of elbow trauma, an accurate neurovascular examination is extremely important and must be performed carefully prior to and after treatment. Most commonly, prolonged immobilization may lead to reduced range of motion.[9] There are numerous case reports in the literature of median nerve injuries after elbow dislocations or entrapment blocking reduction.[35-37] Moreover, the ulnar nerve can be affected after elbow dislocations with associated medial epicondyle fractures, and radial nerve injury has been reported with divergent elbow dislocation.[10,35]

CLINICAL SIGNIFICANCE

This case report describes a pediatric posterior elbow dislocation complicated by an incarcerated coronoid fracture preventing joint reduction. This case underscores the importance of thorough postreduction physical examination, including range of motion and stability, and radiographic interpretation. Suspicion for an entrapped fracture should be high in a patient with a lack of joint

congruency, residual joint instability, and limited range of motion following attempted reduction. After unsuccessful reduction, further intervention is warranted with axial imaging or surgical intervention with a goal of concentric reduction and stable range of motion through discovery and resolution of the block to reduction.

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