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Editorial

Misdiagnoses Related to Pediatric Coronoid Process Fractures

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This editorial aims to highlight the wide range of misdiagnoses detected in publications reporting children with elbow injuries diagnosed with coronoid process fractures. It also presents illustrative cases from our common pediatric orthopaedic trauma practice.

Coronoid fractures are rare in children, and the number of documented cases is limited. The radiographic appearance of the distal edge of the trochlear (semilunar) notch, formed from the coronoid process, may be erroneously indicative of a fracture in children with elbow injuries (Fig. 1). The diagnosis of coronoid fractures may escape on the anteroposterior and lateral elbow radiographs. The oblique radiographic view may identify subtle coronoid fractures by removing the overlap of the radial head and coronoid process, which is usually evident on the lateral radiograph [1].

The mechanism of injury may include two options. In the former, the coronoid articular slope is totally or partially detached due to a shearing force of either the anterior (dislocation-type injury) (Fig. 2, 3) or posterior (reduction-type injury) aspect of the trochlea. In the latter, a traction force through the strong anterior bundle of the medial (ulnar) collateral ligament avulses the sublime tubercle on the medial side of the coronoid [2].

Any restriction in the elbow flexion-extension range of motion following manual reduction of the pediatric elbow dislocation is usually diagnostic of an incarcerated intraarticular fragment and rarely may be due to a missed congenital anomaly [3]. Post-reduction radiographic control is crucial. Additionally, computed tomography may indicate fractures beyond those diagnosed on the radiographs. Furthermore, magnetic resonance imaging may help to identify an intraarticular cartilaginous fragment and prove associated bone bruising and soft-tissue injury. However, the latter may have little bearing on treatment or clinical prognosis [4]. It may be prudent to conclude that imaging documentation of a pediatric coronoid fracture is an absolute prerequisite in a scientific publication.

Diagnosing pediatric coronoid process fractures, with no additional radiographic findings, as brachialis muscle avulsion injury is controversial. In such cases, the clinical findings may significantly guide the diagnostic evaluation. The identification of diffuse, tense, and painful soft tissue swelling and bruising, particularly on the medial aspect of the elbow, occasionally misinterpreted as a potential avulsion fracture of the medial epicondyle, should never be underestimated. Furthermore, it seems unjustified how median nerve palsy could complicate a solitary nondisplaced fracture of the coronoid process. It may be prudent to accept that these lesions are secondary to a spontaneously reduced elbow dislocation. Therefore, when encountered on the radiographs as an isolated pediatric traumatic lesion, the coronoid fracture should always be considered secondary to a spontaneously reduced elbow dislocation or subluxation until otherwise proven.

Pediatric displaced or nondisplaced lateral humeral condyle fractures may occur with elbow dislocations. Rarely, they may be associated with subclinical posterior elbow dislocation, indicated by additional traumatic lesions, such as a coronoid fracture (Fig. 4). The latter may be misinterpreted as an olecranon avulsion fracture when entrapped in the articular space [5].

Figure 1. *The notch-shaped defect proximal to the coronoid tip is not a fracture.*

Figure 2. *Radiograph of a 9-year-old girl with posterior elbow dislocation before (left view) and after reduction (right view). The coronoid fracture reduced acceptably and healed uneventfully.*

Figure 3. *Proximal partial detachment of the coronoid indicating a dislocation-type injury. Healing was evident on the radiograph after a 5-week immobilization.*

Figure 4. *Radiograph of a non-displaced lateral humeral condyle fracture associated with a large avulsed coronoid fragment.*

A 12-year-old boy presented to our service due to a fall on his outstretched hand. There was painful diffuse elbow swelling. The anteroposterior and lateral plain radiographs were normal (Fig. 5a). The pronounced clinical findings necessitated his admission. Further radiographic examination with an oblique view diagnosed lateral humeral condyle and coronoid process fractures (Fig. 5b). The potential intraepiphyseal localization of the lateral condyle fracture was considered atypical, with no similar reports in the literature. Subsequently, we asked for a computed tomography. It revealed that the capitellum fracture involved the posterolateral meta-epiphyseal region (Fig. 5c). The final diagnosis changed to coronoid fracture and avulsion injury of the capsuloligamentous lateral-sided elbow stabilizers from the capitellum in the context of a spontaneously reduced posterior elbow dislocation. In a similar adult injury, instead of an avulsion fracture, all or a part of the lateral collateral ligament complex would be disrupted, potentially leading to posterolateral rotatory elbow instability.

The 'unhappy' triad injury in children is equivalent to the adult terrible elbow triad. It involves three critical traumatic elbow entities: posterior dislocation or subluxation, radial head or neck fracture, and another bone injury. The latter may present as a soft tissue injury of the anterior, medial, or lateral capsuloligamentous structures in older children and adolescents.

The bone injury may be an avulsion of the medial epicondyle or a coronoid fracture [6]. In the literature, papers are misinterpreting this complex injury as a dislocation-type fracture of the radial head. The latter may be evident in either an unreduced or spontaneously reduced (Fig. 6) pediatric posterior elbow dislocation [7]. The 'unhappy' triad may also be due to spontaneously reduced posterior elbow dislocations. It would be prudent to accept the diagnosis of a pediatric 'unhappy' triad in complex elbow injuries with no radiographic evidence of elbow dislocation, provided that clinical findings and associated fractures support the diagnosis (Fig. 7).

Figure 5. *A 12-year-old boy with a severely injured elbow. The initial plain radiographs were negative. A fracture-like olecranon ossification center was evident* ***(a)****. The oblique view showed lateral humeral condyle and coronoid fractures* ***(b)****. Axial and three-dimensional computed tomography localized the avulsion injury on the posterolateral aspect of the lateral humeral condyle* ***(c)****.*

Figure 6*. The two types of radial head fractures associated with posterior elbow dislocation: the dislocation type (left) and the reduction type (right) (Reference No 7).*

Figure 7. *A 10-year-old boy with an 'unhappy' triad injury. The diffuse, tense, and painful soft tissue swelling and bruising, more pronounced on the medial side of the elbow, indicated the diagnosis of a spontaneously reduced elbow dislocation. We treated him with closed reduction and 5-week immobilization.*

A diagnostic debate is evident in children with olecranon fracture-dislocation. The literature indicates that children with posterior elbow dislocation and fractures of the radial head, coronoid process, and olecranon are not 'unhappy' triad injuries. It is also evident that the most commonly documented variant of the elbow terrible triad in adults includes an olecranon fracture and, less commonly, Essex-Lopresti injury, triceps tendon avulsion, and carpal fracture-dislocation [8]. Therefore, a pediatric 'unhappy' triad injury associated with a fractured olecranon is an 'unhappy' triad variant.

In addition, the inaccurate diagnosis of pediatric trans-olecranon fracture-dislocation is evident in the literature. Trans-olecranon fracture dislocations are injuries in which the stability of the ulnohumeral joint is lost due to the intraarticular fracture of the olecranon without disruption of the proximal radioulnar joint, while the coronoid remains attached to the ulnar metaphysis, not to the olecranon. They result in radial head anterior displacement relative to the capitellum and always present as an anterior elbow dislocation or subluxation. The lesion should not be confused with anterior Monteggia injuries. The fourth type of pediatric trans-olecranon fracture-dislocation, according to the Tiemdjo classification, is the only one associated with a coronoid fracture. Pediatric variants usually include trans-olecranon fracture-dislocation combined with medial epicondyle and radial neck fractures [9].

It is evident from the literature review that pediatric 'unhappy' triad variants are olecranon fracture-posterior dislocations, while trans-olecranon fracture-dislocations are olecranon fracture-anterior dislocations. Significant divergence in the definition of olecranon fracture-posterior dislocations in adults and children is evident in the literature since the publication of trans-olecranon fracture-posterior dislocations. The author would recommend the diagnosis of olecranon fracture-dislocation for a posterior dislocation or subluxation associated with an olecranon fracture (Fig. 8). Injuries with additional fractures, such as coronoid osteochondral flaps, would be complex olecranon fracture-dislocation. The latter could occasionally be equivalent to an 'unhappy' triad variant. In addition, the author would consider the Mayo classification of proximal trans-ulnar fracture-dislocations in adults, based on whether the coronoid remains attached to the olecranon, ulnar metaphysis, or neither, unsuitable for the classification of young pediatric patients.

There is a debate on treatment options in pediatric complex elbow fracture-dislocations, and many publications suggest operative treatment similar to adults. However, it may be prudent to agree that the treating surgeon should never consider the immature skeleton as a small adult, always attempt a closed reduction under anesthesia (Fig. 7), and never consider surgical excision of the coronoid fragment. We use open reduction and internal fixation for large coronoid fragments or marked displacement. After manual stabilization, percutaneous pinning follows through the anterior surface of the elbow under direct vision of the reduced fragment. We usually use 1-2 smooth Kirschner pins (0.8-1.2 mm diameter), not screws. The pins are driven posteriorly through the olecranon to stick out of the posterior elbow skin. They are left protruding about 1-2 mm from the coronoid process. Then, their opposite end is bent (Fig. 9). The long arm plaster and pins are removed at five weeks postoperatively.

Figure 8. *Slight anterior and superior translation of the capitellum in the trochlear notch, olecranon fracture, and positive anterior and posterior fat pad sign were evident on the lateral radiograph.*

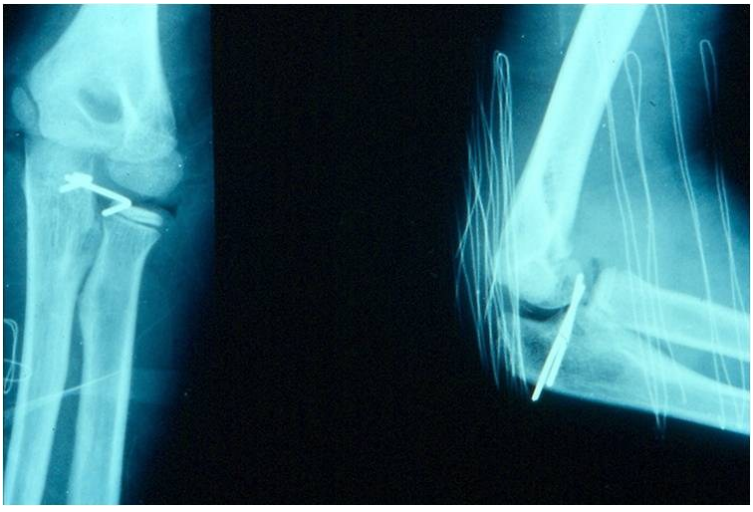

Figure 9. *Postoperative radiograph of a coronoid fracture-elbow dislocation.*

Conflicts of Interest

The author certifies that he has no commercial associations (such as consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article. The author received no financial support for this study.

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