CLINICAL QUIZ

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# Imaging Pitfalls of the Acutely Traumatized Pediatric Elbow

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A four-year-old otherwise healthy girl presented to our outpatient clinic complaining of left elbow pain and swelling. The child's parents reported an indoor trauma the previous day. On clinical examination, the left elbow and forearm exhibited diffuse swelling. The gentle passive range of elbow and forearm motion was normal and mostly pain-free. Nevertheless, the radial head was stable but a palpable click was noted. The neurovascular examination was normal. The patient received radiographs of the traumatized left and normal right elbow [Figures 1 and 2]. Radiographs of her left forearm were unremarkable.

## *Question*

1. What is the most likely diagnosis?
   a. First-degree supracondylar humerus fracture.
   b. Slipped proximal radial epiphysis.
   c. Normal anatomic variant simulating pathology.
   d. Non-displaced lateral condyle fracture.

## *Answer*

c. Normal anatomic variant simulating pathology.

## DISCUSSION

In general, there is a considerable incidence of missed pediatric elbow fractures in the acute setting.

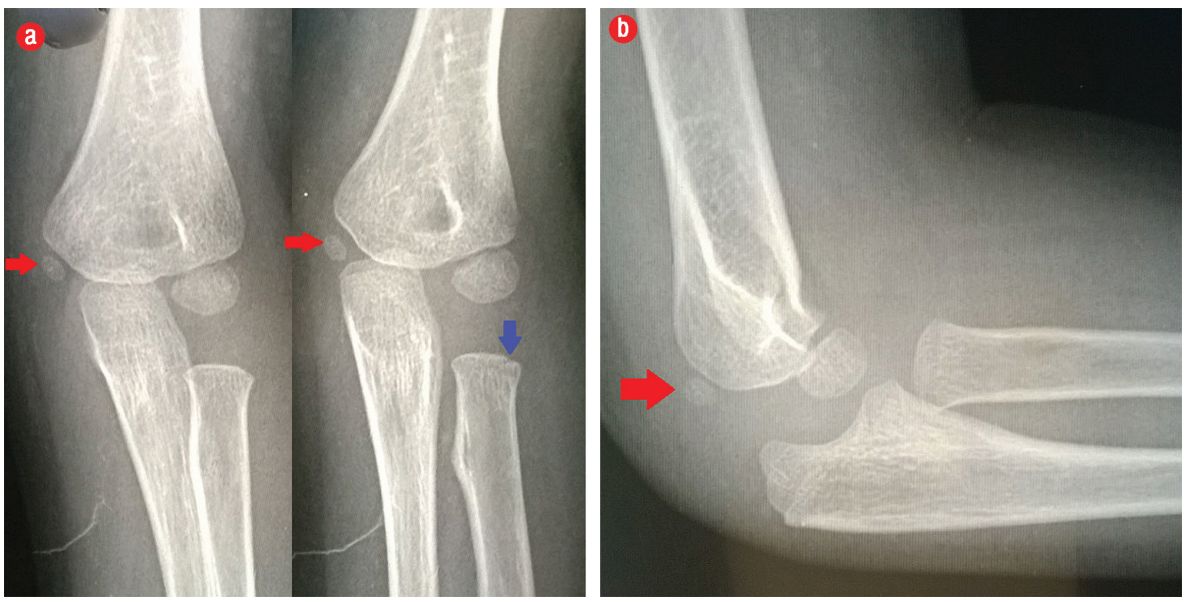


**Figure 1:** Left elbow radiographs. **(a)** Two anterior-posterior projections of the left elbow. Note the presence of a well-ossified medial epicondyle epiphysis (red arrow) and simultaneous absence of the radial head epiphysis. Typically, the center of the radial head should ossify before that of the medial epicondyle. Notice the notched radial metaphysis (blue arrow). This notching is undetected in the other projection because of forearm rotation as indicated by radioulnar overlap. **(b)** Lateral view verifies the presence of well-ossified medial epicondyle epiphysis (red arrow) and simultaneous absence of the radial head epiphysis.

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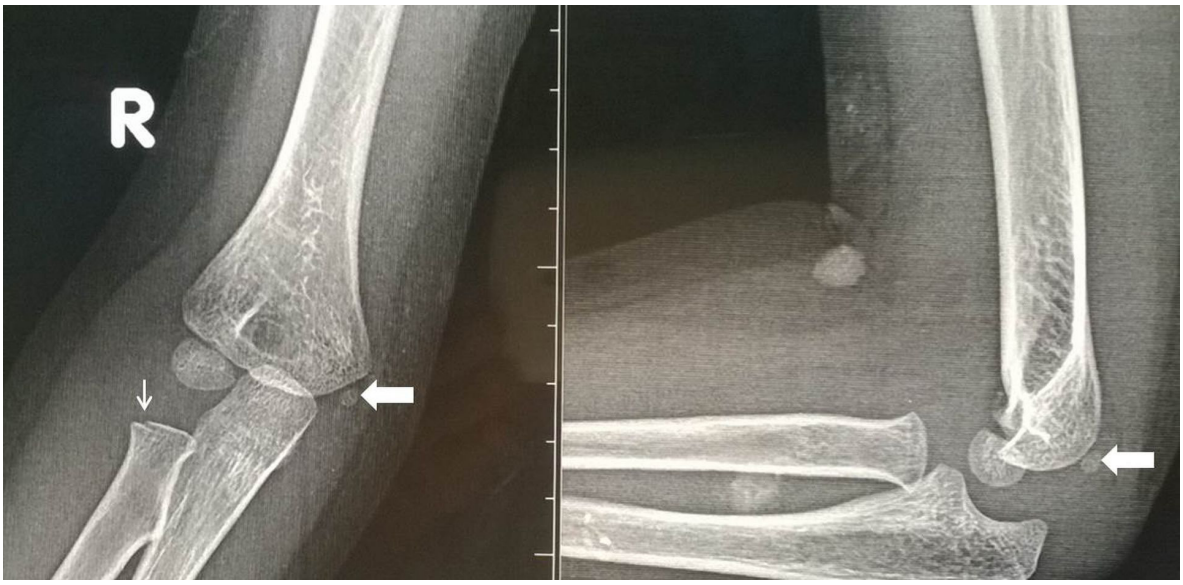


**Figure 2:** Anterior-posterior and lateral radiographs of the normal right elbow. The radiographic appearance is identical to the left elbow regarding the reversal of the chronological order of ossification and notching of the radial metaphysis.

This is primarily attributed to the indistinct nature of some fractures and the failure to promptly perform targeted radiographs in a timely fashion.[1] Anatomical variants that resemble pathology present an additional challenge. Such normally existing anatomic variants should not be confused with pathologic conditions.[2,3] This underscores the importance of prompt and accurate radiologic diagnosis of the acutely traumatized elbow in children. Misdiagnosis can result in longstanding functional impairment and complicate management strategies.[4–6] The radiologic anatomy of the growing child is complex. The timing of appearance of elbow secondary ossification centers shows considerable diversity regarding age, gender, and race.[2,7,8] Additionally, the anatomic pattern of radiographic eruption of an individual epiphysis and symmetrical eruption of both elbows can exhibit variability.[2,3] Nonetheless, the chronological order of appearance of the ossification centers is extremely constant.[2,3] This chronological order serves as a useful guide for interpretation of pediatric elbow radiographs, especially for emergency department physicians in the acute setting. The chronological order of appearance of the elbow ossification centers follows this rule: capitellum, radial head, medial epicondyle, trochlea, olecranon, and lateral epicondyle. They ossify at 1, 5, 7, 10, 10, and 11 years, respectively.[2,3]

Interestingly, our patient showed a disturbed sequence of ossification. Her radiographs demonstrated a well-ossified medial epicondyle, while the epiphysis of radial head was completely non-ossified in orthogonal views. This 'reversal' of the chronological order of appearance of the elbow ossification centers represents a rare but normal anatomic variant simulating pathology. Plain radiographs of the contralateral elbow revealed identical findings, thus confirming our diagnosis. Furthermore, our patient's elbow showed another anatomic variant simulating pathology, namely the notched proximal radial metaphysis. This notch or discontinuation is suggestive of a fracture. Likewise, the trochlea and olecranon can have two or more ossification centers, which can give them a fragmented appearance. These normal anatomic variants conditions are more commonly encountered compared to pathologies such as fractures or avascular necrosis. However, the presence of an ossified trochlea epiphysis without an ossified medial epicondyle epiphysis usually indicates an avulsed medial epicondyle and subsequent intra-articular entrapment. Such scenario can lead to potentially serious consequences if it is not detected.[9] First-degree supracondylar humerus fracture and non-displaced lateral condyle fracture are unlikely diagnoses because neither a fracture line nor an abnormal fat pad sign is detectable. Additionally, the presence of a relatively smooth but full range of motion at the elbow and forearm precludes the diagnosis of slipped proximal radial epiphysis.

The present case spreads awareness amongst the radiologists and orthopedic surgeons on the importance of differentiating normal from abnormal findings in acute pediatric elbow injuries. Such knowledge will definitely help physicians to make better clinical judgment and avoid unnecessary investigations and interventions.

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