



# Ultrasound Evaluation of Radiographically Occult Elbow Injuries in Children and Infants

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Disclosure

None

# Introduction

- Elbow injuries are a common reason for emergency room visits in children
- Elbow fractures account for 15% of all pediatric fractures, with the supracondylar fracture the most common elbow fracture in children
- Radiographs are the preferred imaging modality for evaluating a pediatric elbow injury, however are limited in very small children due to non-ossified epiphyses and difficulty in obtaining 2-plane radiographs of a painful elbow
- Ultrasound may play an important role in suspected elbow injury with an inconclusive or negative radiograph

# Introduction

- Ultrasound has many advantages over other imaging methods:
  - Non-ionizing
  - Portability
  - Rapid acquisition of images
  - Cost-effective
  - Well-tolerated by children



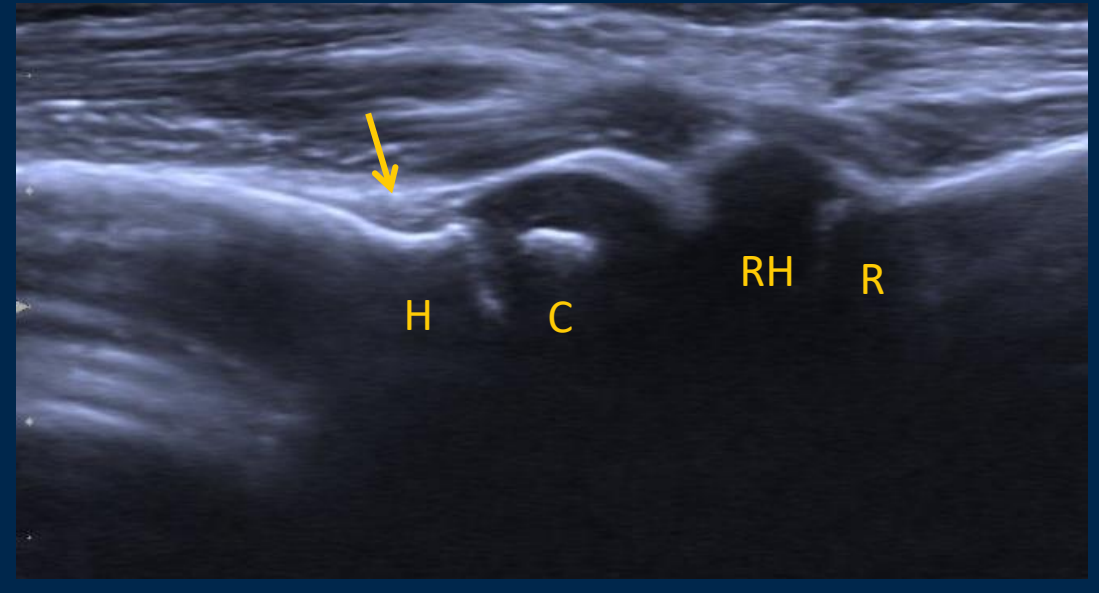
# Educational Objectives

By completion of this exhibit, the learner will be able to:

- Describe a sonographic approach to evaluating the elbow joint
- Understand the indications for elbow sonography in the setting of clinically suspicious elbow injury
- Identify normal appearances of non-ossified epiphyses and the normal anatomic relationships of the elbow joint
- Identify the sonographic appearance of radiographically occult pediatric elbow injuries including: supracondylar fracture, radial neck fracture, lateral condyle fracture, distal humerus epiphysiolysis, medial epicondyle avulsion fracture, elbow dislocation-subluxation, nursemaid's elbow, elbow joint effusion, and clinical fracture mimics such as osteomyelitis and septic arthritis

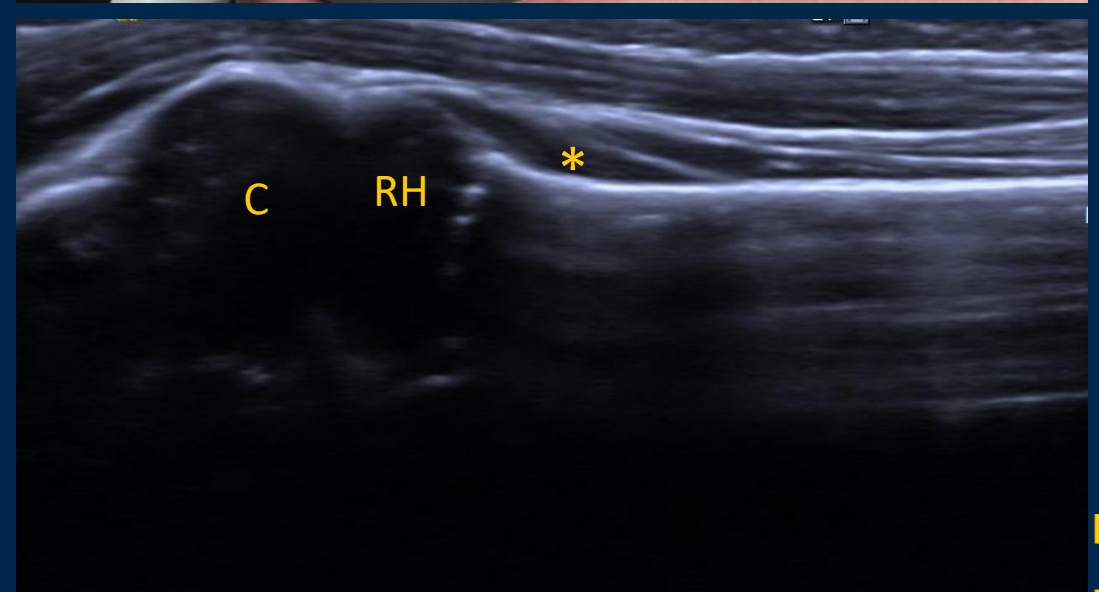
# Technique for Elbow Ultrasound, Anterior Approach

- Sonographic technique for longitudinal anterior evaluation of the elbow joint using an 18 Mhz linear transducer (Acuson S3000, Siemens Medical Solutions USA, Malvern, PA)
- Normal sonographic anatomy of the elbow from an anterior approach in a 15-month-old child. Normal radiocapitellar alignment is easily appreciated. Notice the partially ossified capitellum (C) and cartilaginous (non-ossified) radial head (RH). Normal anterior fat pad (arrow), distal humerus (H), radial metaphysis (R)



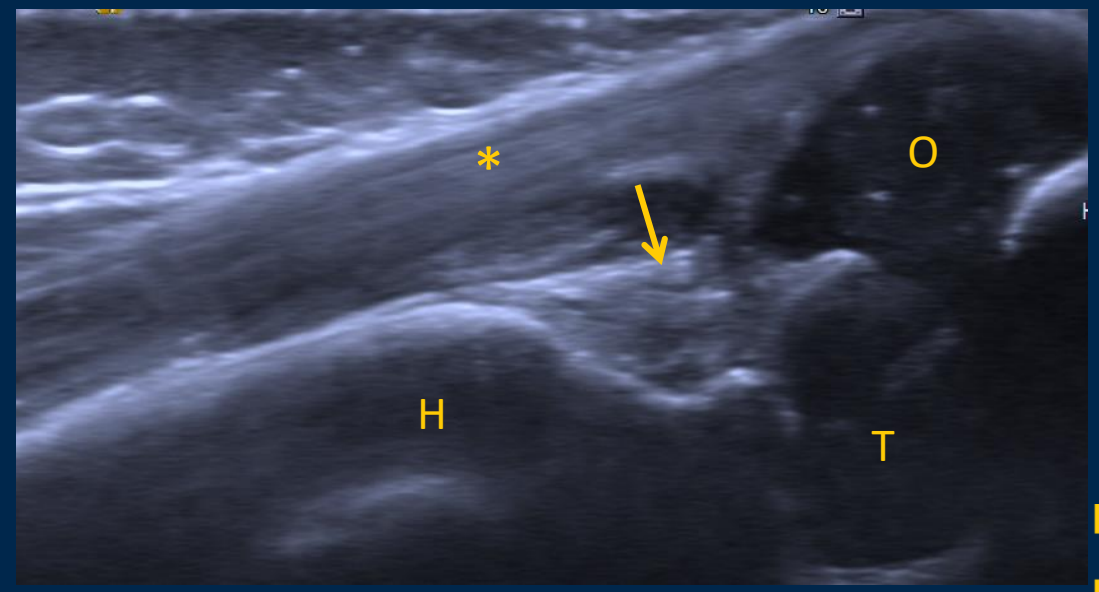
# Technique for Elbow Ultrasound, Lateral Approach

- Technique for longitudinal lateral evaluation of the elbow
- Longitudinal sonographic image of the lateral elbow demonstrates normal radiocapitellar alignment. Capitellum (C) and radial head (RH). Supinator muscle (\*)  
**(Important view for evaluating for nursemaid elbow!)**



# Technique for Elbow Ultrasound, Posterior Approach

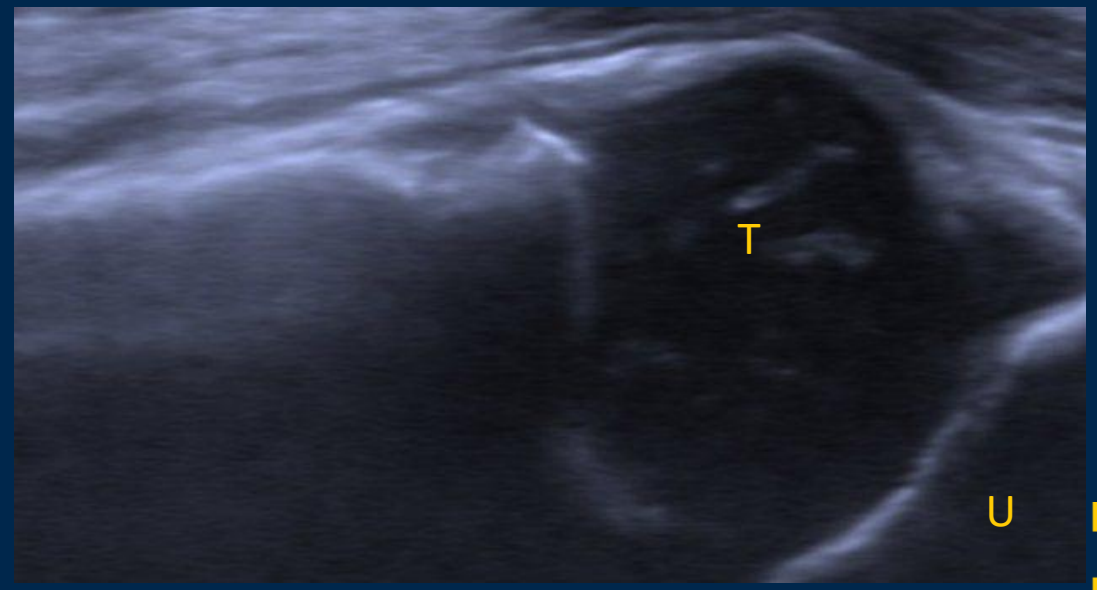
- Technique for longitudinal posterior evaluation of the elbow with arm fully extended
- Longitudinal sonographic image of the posterior elbow demonstrates the normal posterior fat pad (**arrow**) flush against the humerus (H), the non-ossified olecranon (O) and trochlea (T). Triceps tendon (\*)



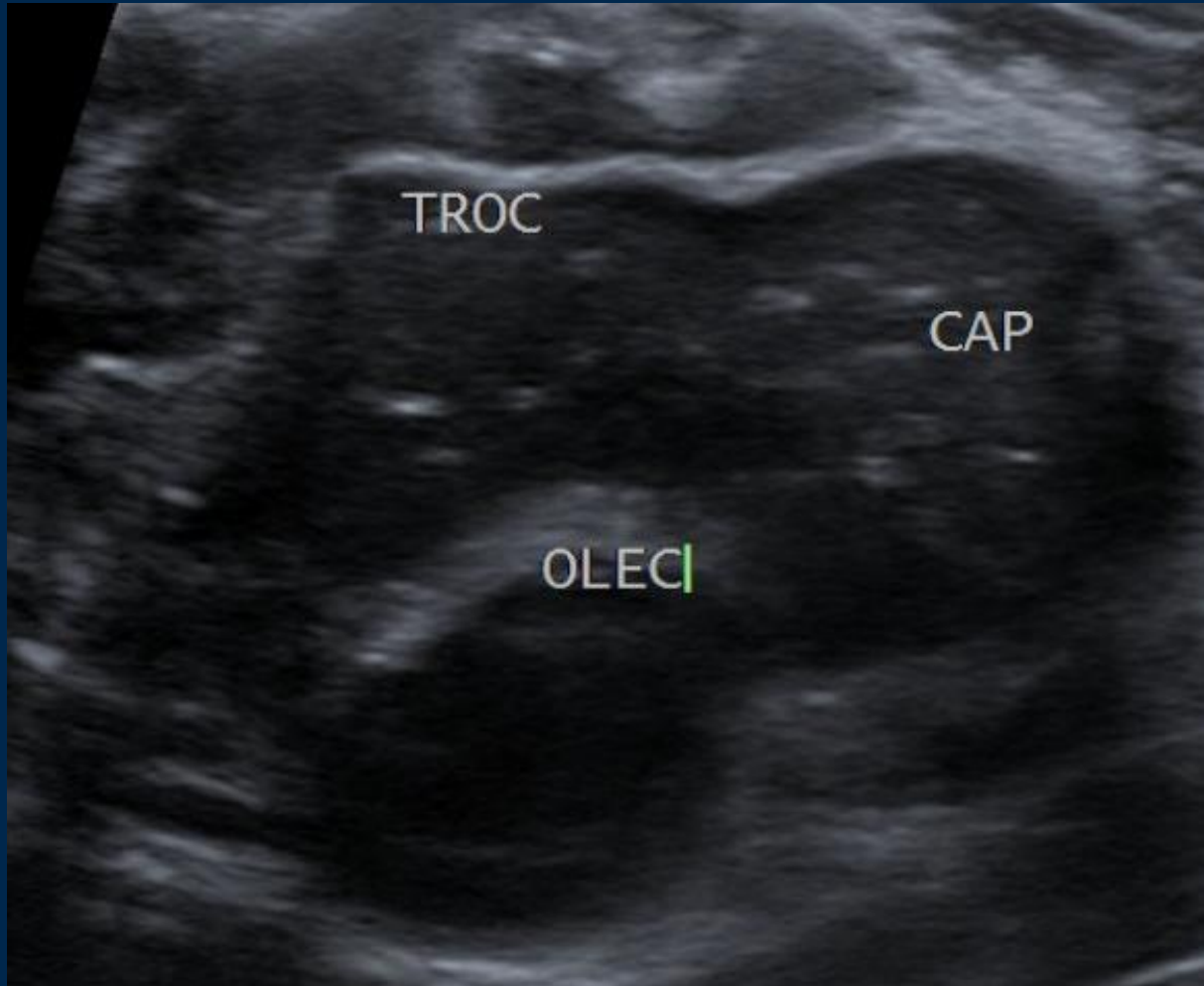


# Technique for Elbow Ultrasound, Medial Approach

- Technique for longitudinal medial evaluation of the elbow with arm fully extended
- Longitudinal sonographic image of the medial elbow demonstrating the non-ossified trochlea (T) and ossified ulna (U)



# Transverse View of Elbow Joint



*Anterior approach*



*Posterior approach*

TROC (trochlea), OLEC (olecranon), CAP (capitellum)

# Indications for Elbow Sonography in Children

- Elbow trauma with positive “fat pad” sign (either anterior or posterior) and radiographically occult fracture or negative radiographs with high clinical suspicion due to mechanism of injury or clinical examination findings
- Elbow trauma in a young child with non-ossified epiphyses and difficulty obtaining 2-plane radiographs to evaluate alignment
- Differentiation between radiocapitellar dislocation (congenital or traumatic), radiocapitellar subluxation and nursemaid elbow
- Clinical suspicion for septic elbow joint +/- associated osteomyelitis

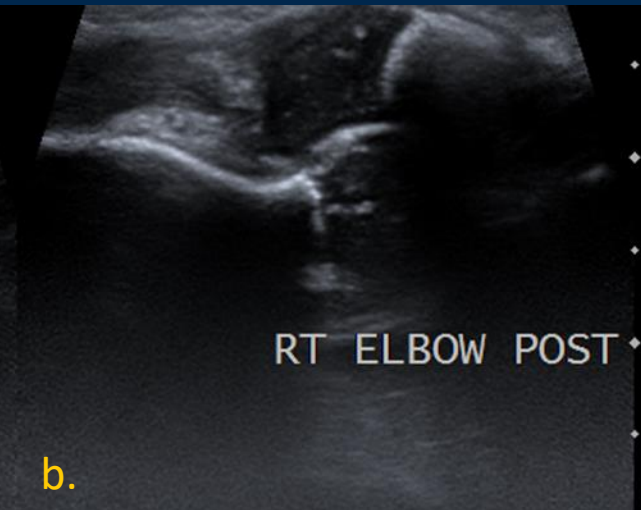
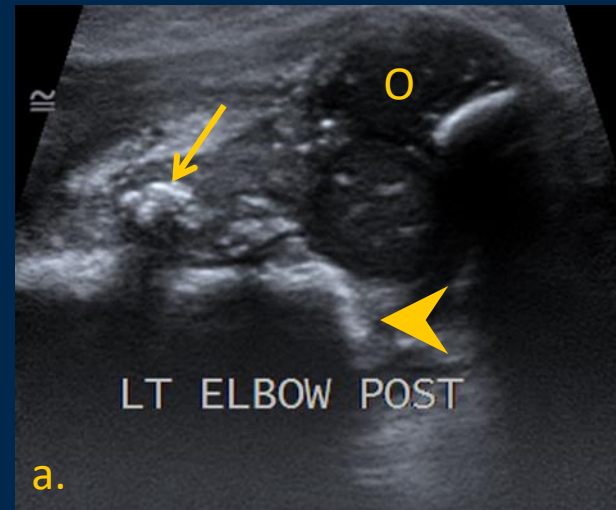
# Case Examples

# Case 1

Left elbow radiographs in an infant less than 1 year of age refusing to move arm. Evaluation of the anterior humeral and radiocapitellar lines are limited when the capitellum is non-ossified. Is this a fracture-dislocation? Arrow points to fracture fragment.



Posterior longitudinal approach of the elbow. Image a. demonstrates posteriorly displaced fracture through the humeral physis (arrowhead) with small comminuted fracture fragments (arrow) in this case of distal humeral epiphysioloysis. Image b. is the normal right elbow for comparison. Olecranon (O)



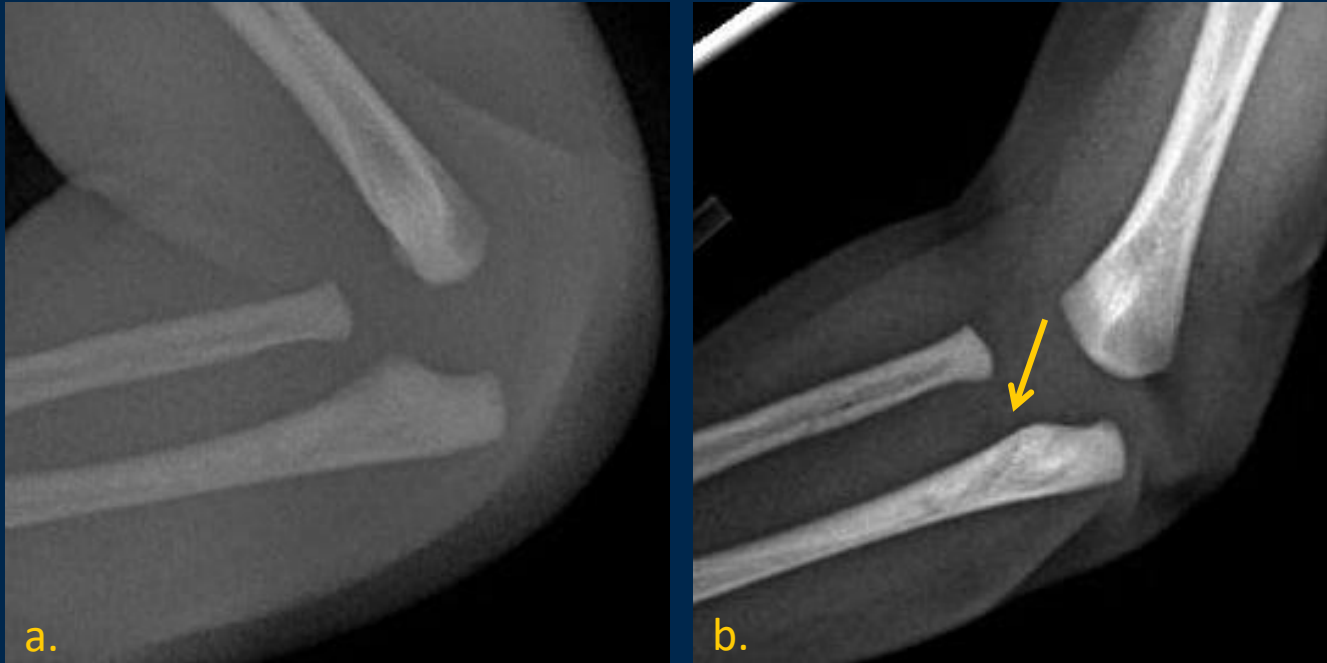
# Case 1 - Distal Humeral Epiphysiolysis

- This injury has been described in birth trauma and in non-accidental trauma
- Mechanism: elbow hyperextension or backward thrust of the forearm with 90 degrees of elbow flexion
- Usually a complete physal separation (Salter-Harris I or II fracture - if humeral fracture fragment then type II injury)
- Can be confused with radiocapitellar dislocation
- Difficult radiographic diagnosis secondary to non-ossification of growth centers

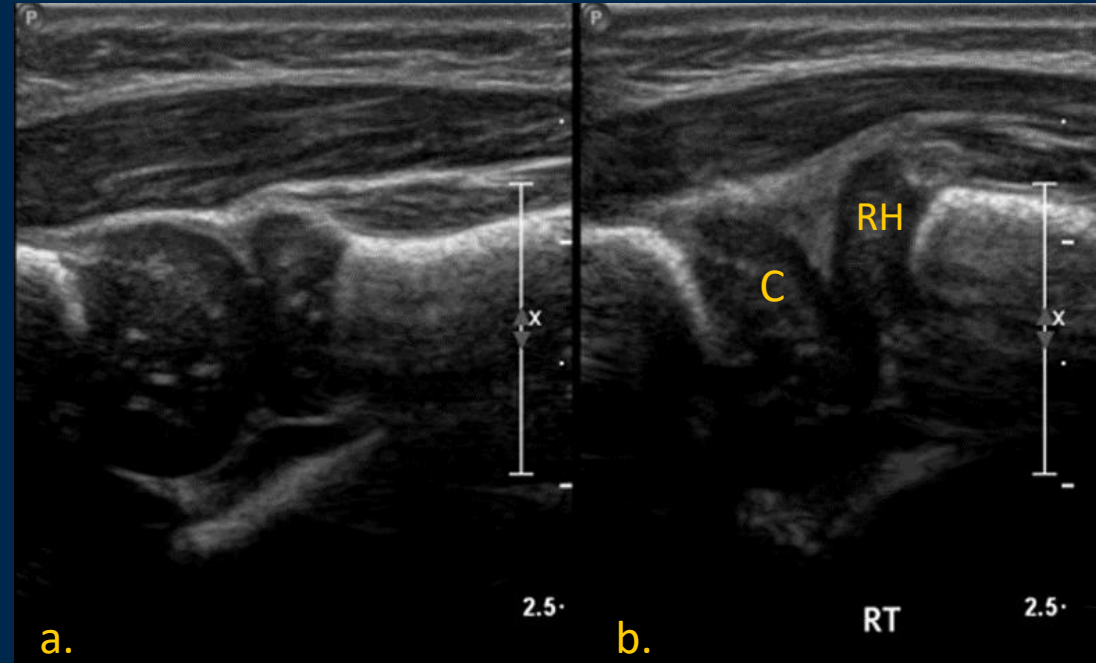


*Follow-up radiographs on the same child demonstrate exuberant periosteal reaction and callus surrounding site of fracture*

## Case 2 - Radial Head Subluxation

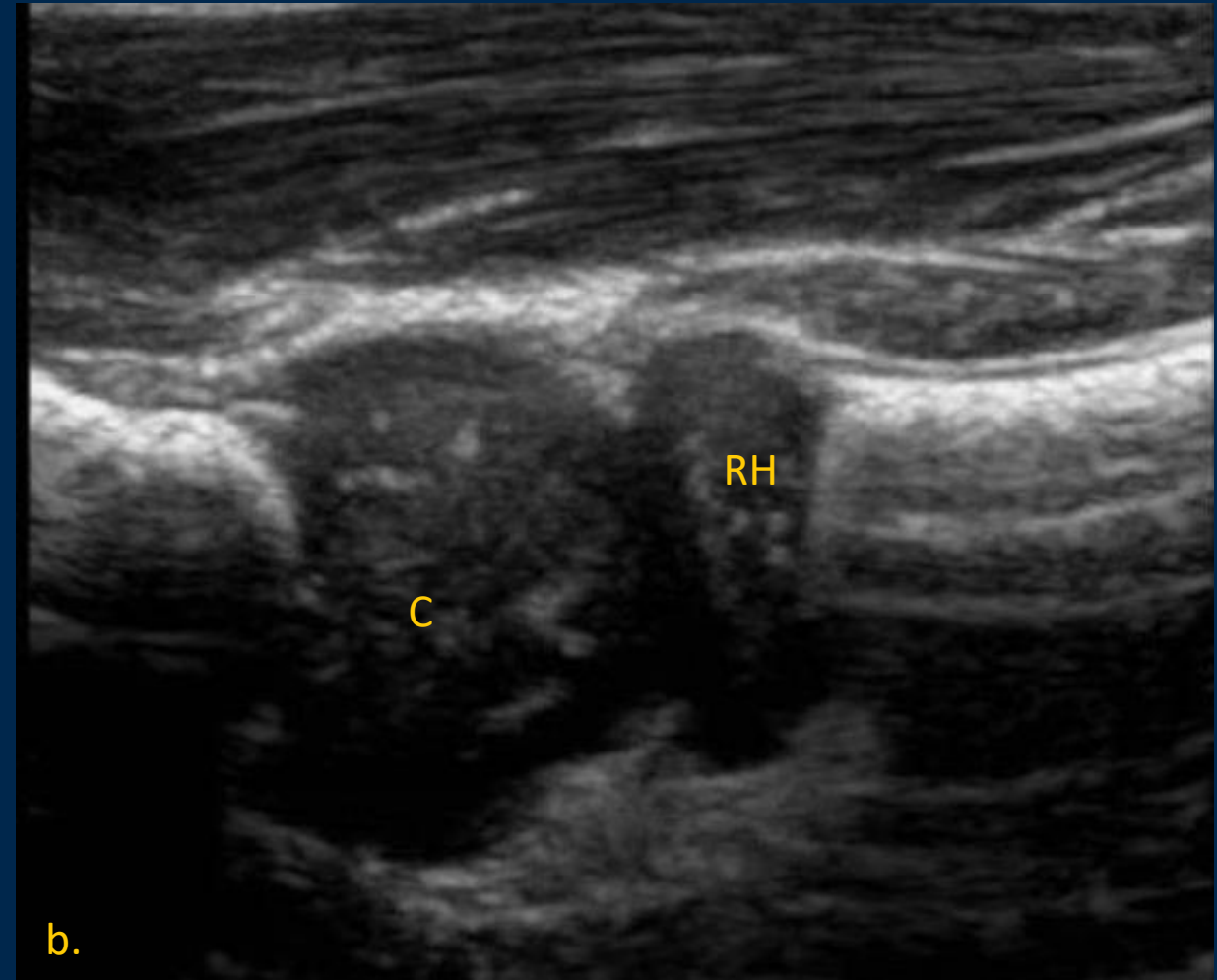
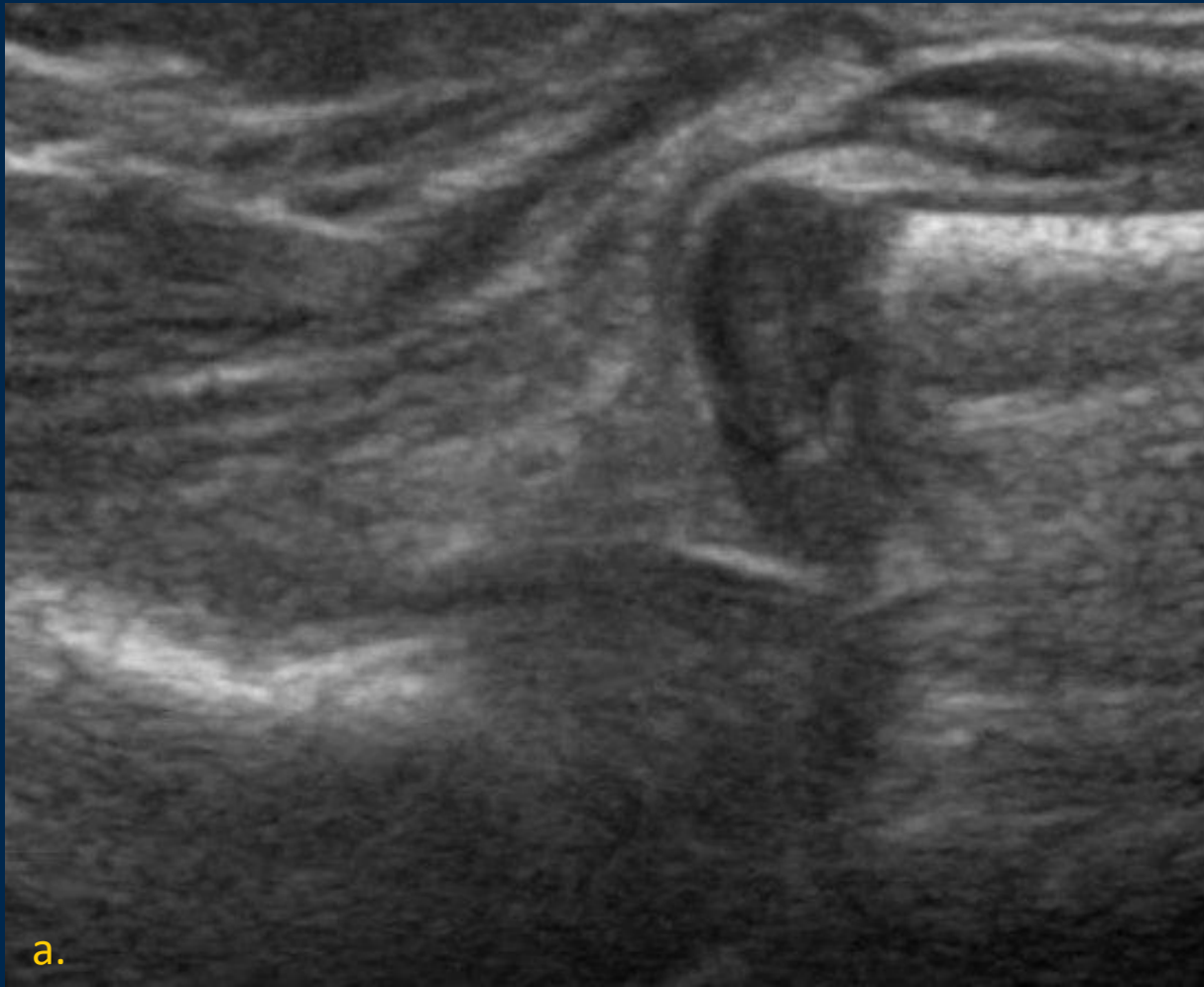


Elbow radiographs from a one-month old girl presenting with a palpable “popping” of the right elbow. No trauma. An oblique frontal view (image b) demonstrates widening between the radial neck and the olecranon (arrow). Notice the difficulty in obtaining true 2-plane radiographs in such a young child which adds to the challenge of diagnosing elbow pathology in this age group.



Ultrasound was performed to evaluate dynamic instability of the radial head. Image a. demonstrates the normal left radiocapitellar relationship. Image b. is the symptomatic side demonstrating subluxation and mild hypoplasia of the radial head (RH) in this girl with congenital radial head subluxation. Capitellum (C).

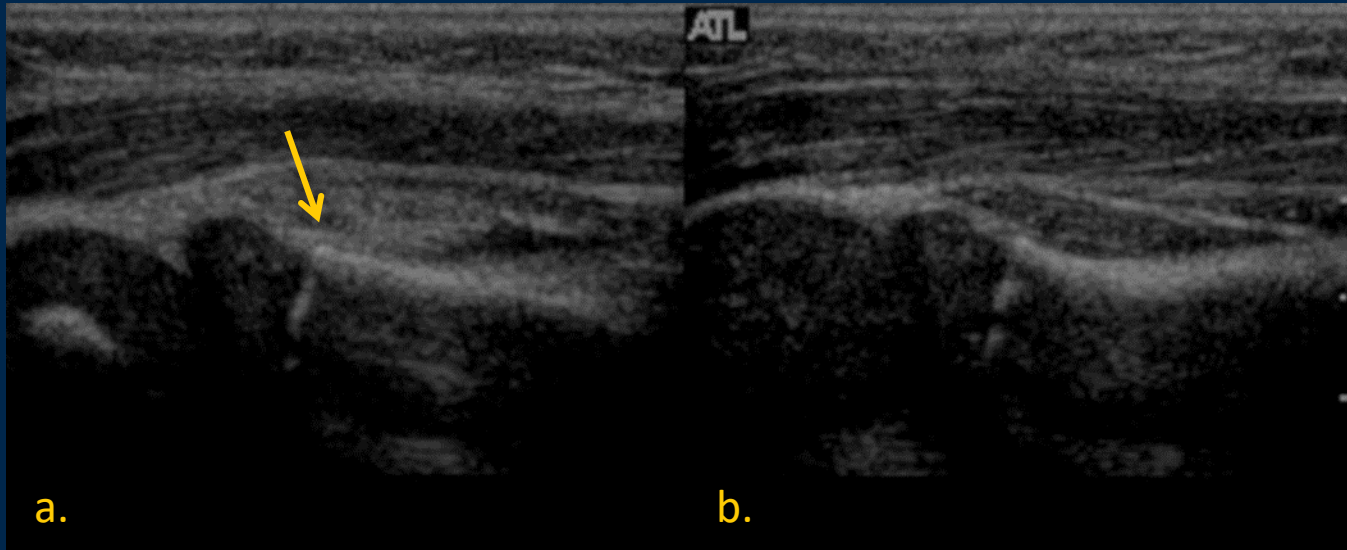
# Case 3 (Companion Case) - Congenital Radial Head Dislocation



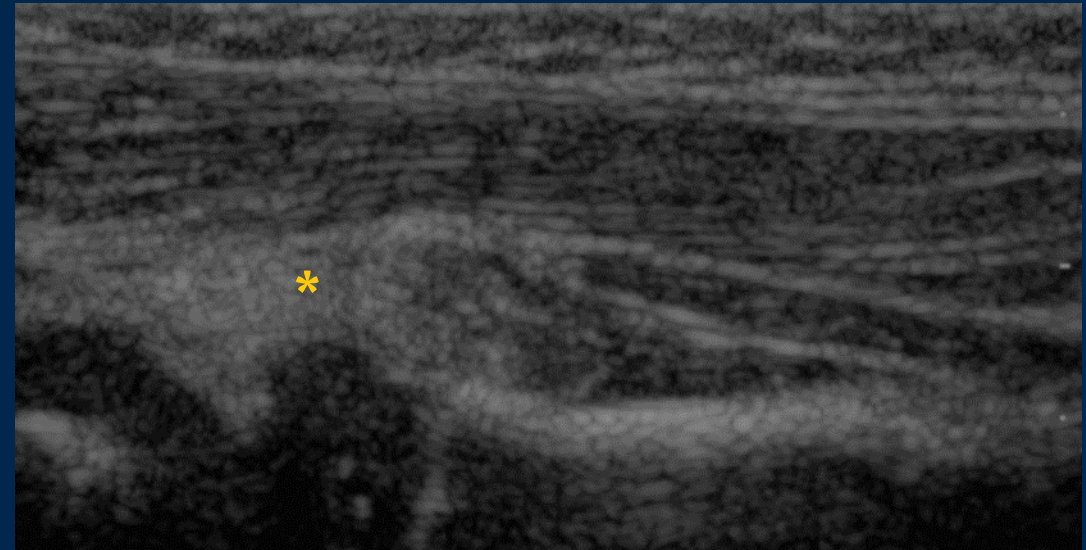
*Side by side images of the elbow in a child with congenital radial head dislocation. (Negative radiographs not shown). Image a. is from the symptomatic side demonstrating malalignment of the radiocapitellar line. Normal contralateral side for comparison (Image b.). Radial head (RH), Capitellum (C). Radial head dislocation can be congenital or post-traumatic and can also be associated with brachial plexus injury.*



# Case 4 - Nursemaid's Elbow

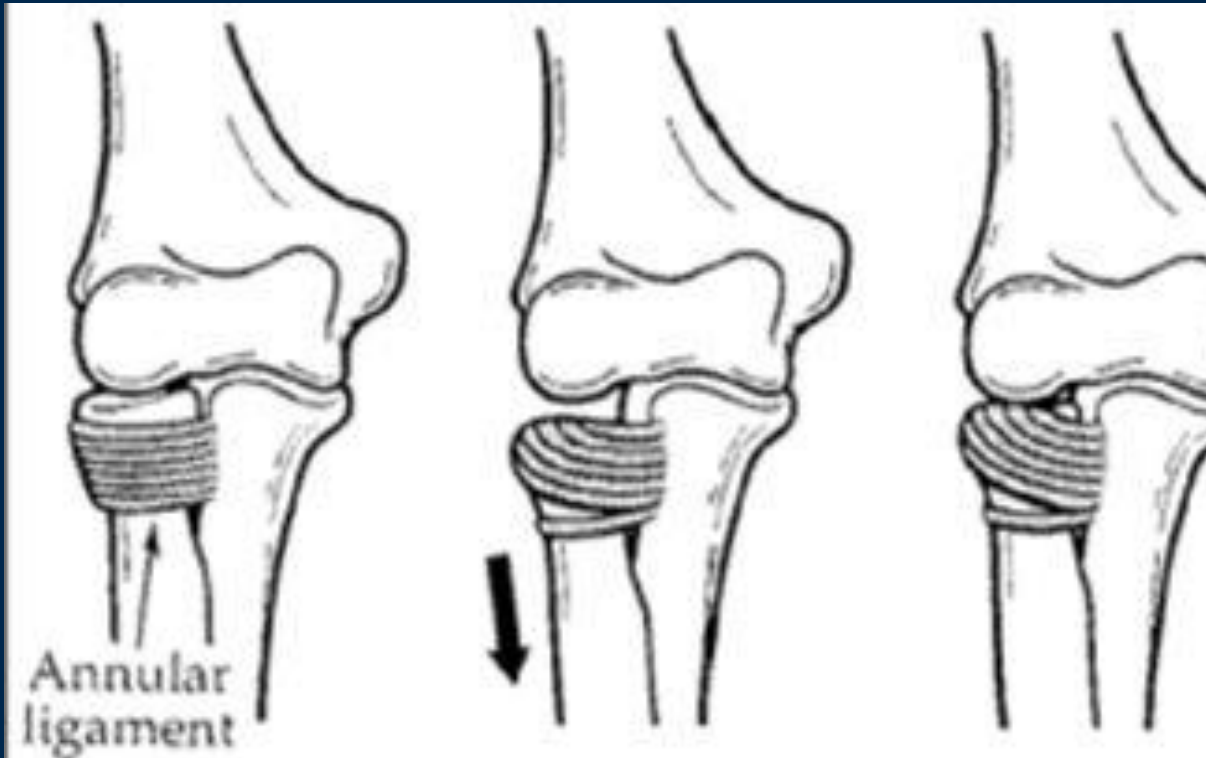


Sonographic images from a 1-year-old boy presenting with right arm pain after the babysitter pulled on his arm. Image a. (right elbow) demonstrates increased echogenicity and thickening of the annular ligament extending into the supinator muscle (**arrow**) and slight subluxation of the radial head in this case of “nursemaid’s” elbow (radiographs were normal - not shown). Image b. is of the normal left elbow for comparison.



Longitudinal lateral magnified image of the abnormal right elbow showing edema of the annular ligament (\*), which often gets partially entrapped in the radiocapitellar joint.

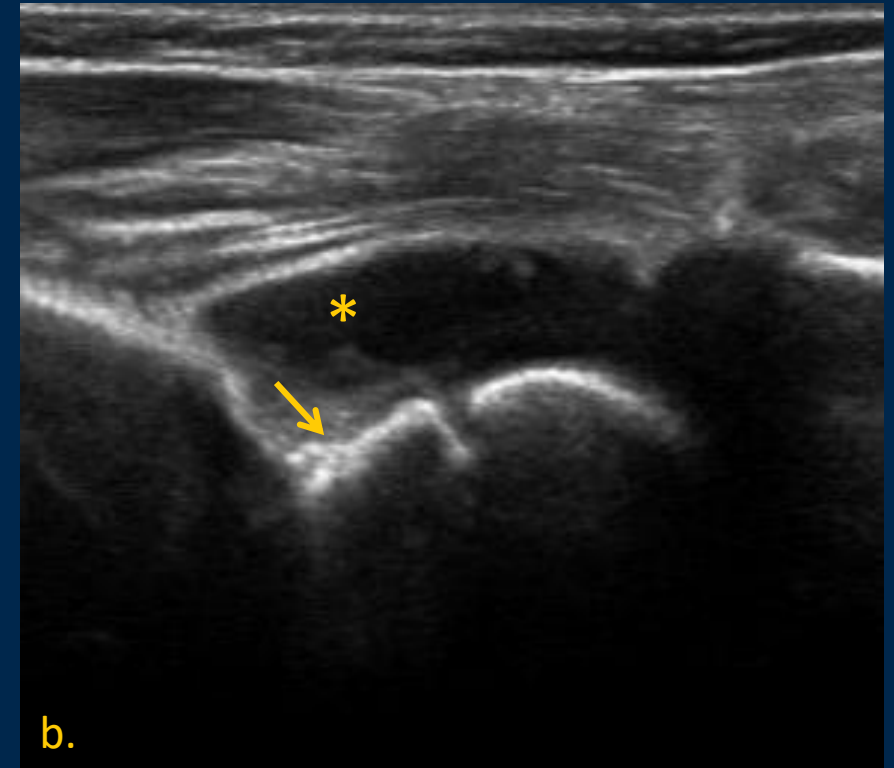
## Case 4 - Nursemaid's Elbow



- *New Illustration????*

- Age peaks: 6 months and 3 years
- Annular ligament slips and traps between radial head and humeral condyle as a result of pulling the arm in extension with forearm pronated
- Normal radiographs
- Injury typically reduces spontaneously or with elbow flexion and forearm supination

# Case 5 - Supracondylar Fracture

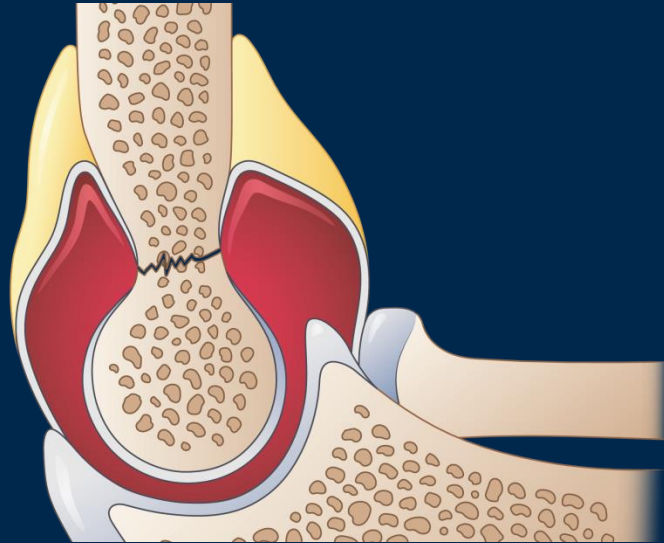


*Radiographs in a 4-year-old girl who fell off the monkey bars demonstrate an elbow joint effusion on the lateral view with an elevated anterior fat pad (arrow) without a fracture detected. Given high clinical and radiographic suspicion, ultrasound was performed.*

*Ultrasound of anterolateral left elbow demonstrates complex, mixed echogenicity effusion (\*) and anterior cortical irregularity (arrow) consistent with a non-displaced supracondylar fracture.*

# Case 5 - Elbow Fracture

*Supracondylar fracture - most common pediatric elbow fracture*



*Lateral condylar fracture*



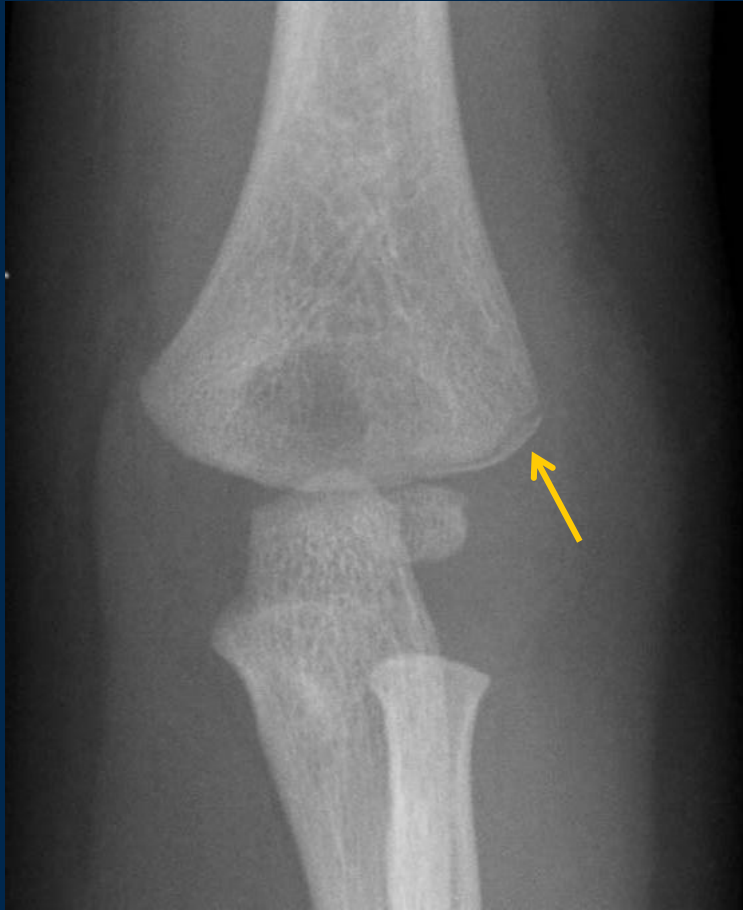
*Radial neck fracture*



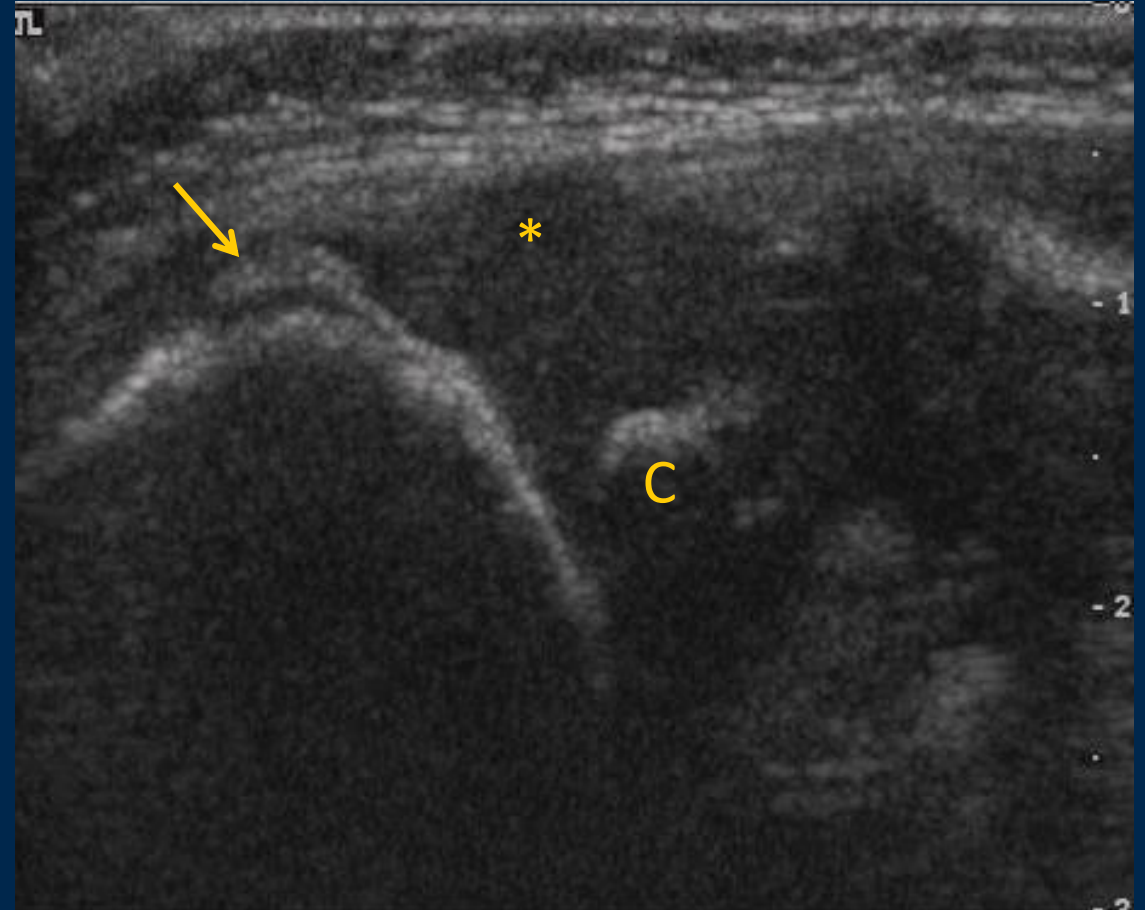
*Medial epicondyle fracture*



# Case 6 - Lateral Condylar Fracture (Type 1)



20-month-old boy presenting with elbow pain after trauma. Frontal radiograph demonstrates a minimally displaced lateral condylar fracture (arrow).

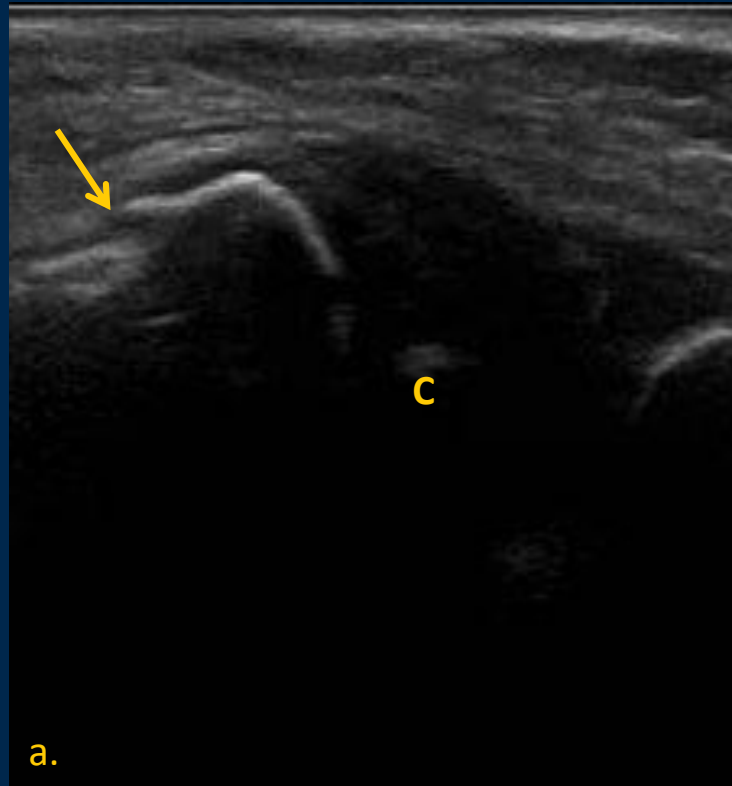


Longitudinal lateral sonographic image confirms the presence of fracture (arrow) and the absence of fracture extension through the capitellum in this type 1 lateral condyle fracture. Hemarthrosis (\*), capitellar ossification center (C).

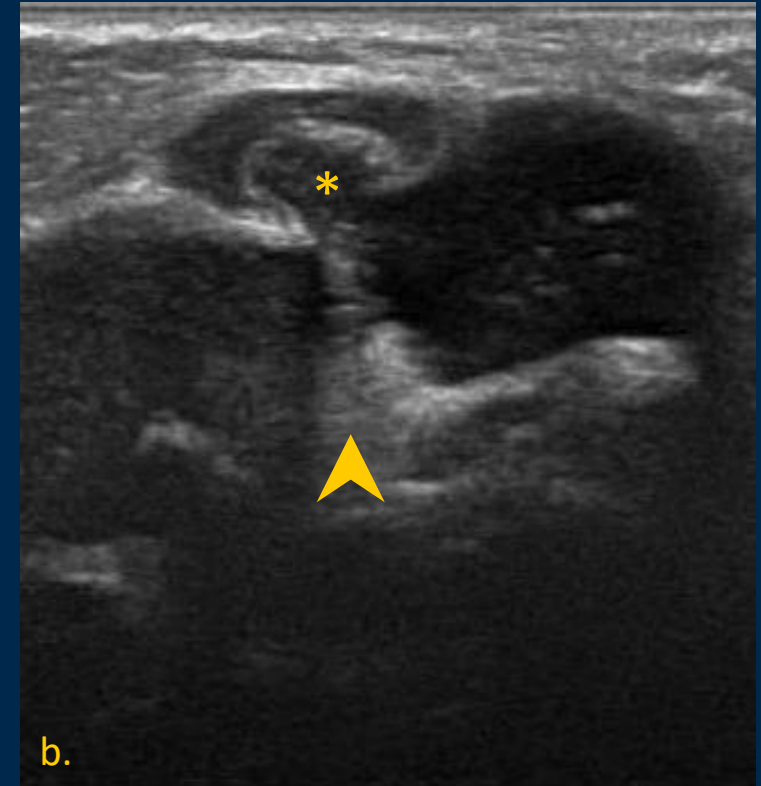
# Case 7 (Companion Case) - Lateral Condylar Fracture With Articular Extension



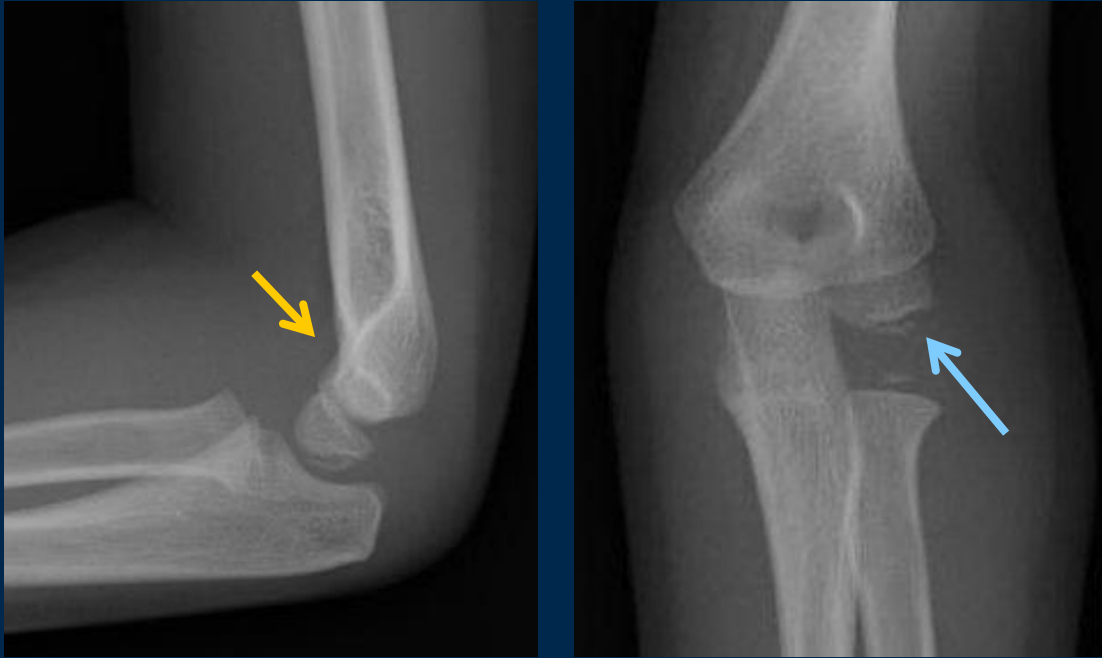
Frontal radiograph of the elbow in a 3-year-old boy presenting with elbow pain demonstrates a lateral condyle fracture (arrow). Incidental radioulnar synostosis (\*).



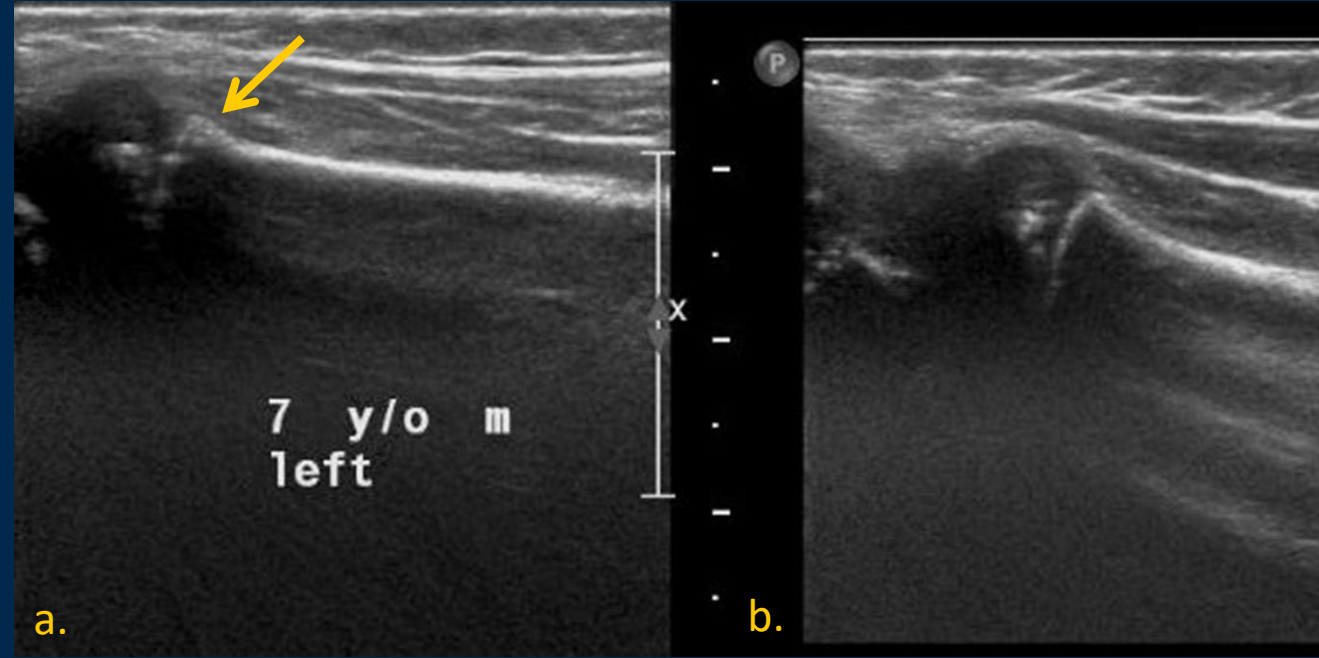
Ultrasound was performed to evaluate for intra-articular extension (Type II lateral condyle fracture). Image a. highlights the fracture (arrow), Capitellum ossification center (C). Image b. (posterior approach) demonstrates fracture extension through the capitellar cartilage (arrowhead) confirming type II lateral condyle fracture. Complex effusion (\*).



# Case 8 - Radial Neck Fracture

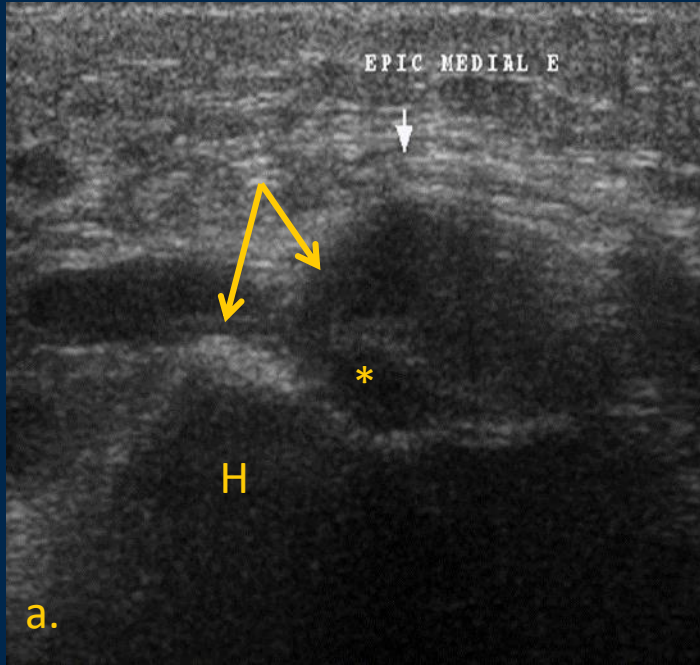


7-year-old male with elbow trauma. Lateral radiograph demonstrates elevation of the anterior fat pad (yellow arrow). Capitellar irregularity (blue arrow) was felt to represent a variation of capitellar ossification (follow up radiographs were confirmatory of this diagnosis - not shown).



Ultrasound was performed to evaluate for occult fracture. Image a. is a lateral longitudinal image of the left elbow demonstrating non-displaced radial neck fracture (arrow). Compare the appearance of the left radial neck to the smooth, normal right side (image b.).

# Case 9 - Medial Epicondyle Avulsion



*Negative left elbow radiograph in this 2-year-old child with elbow trauma.*

*Side-by-side sonographic images of the medial elbow demonstrating in the symptomatic left elbow (image a.), the non-ossified medial epicondyle displaced from the medial humeral (H) condyle (arrows) in this case of medial epicondyle fracture. A small amount of fluid is interposed between the epicondyle and the humerus (\*). Image b. is the normal right elbow for comparison. White arrows point to the hypoechoic, cartilaginous epicondyle.*

*Medial epicondyle avulsion (arrow) confirmed with MRI.*

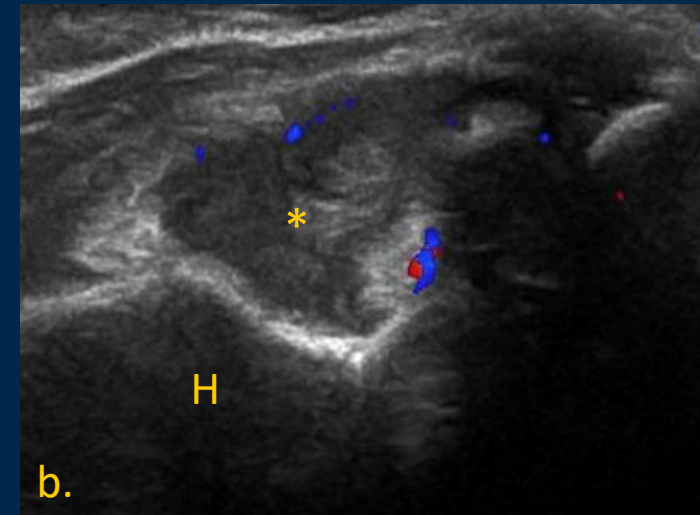
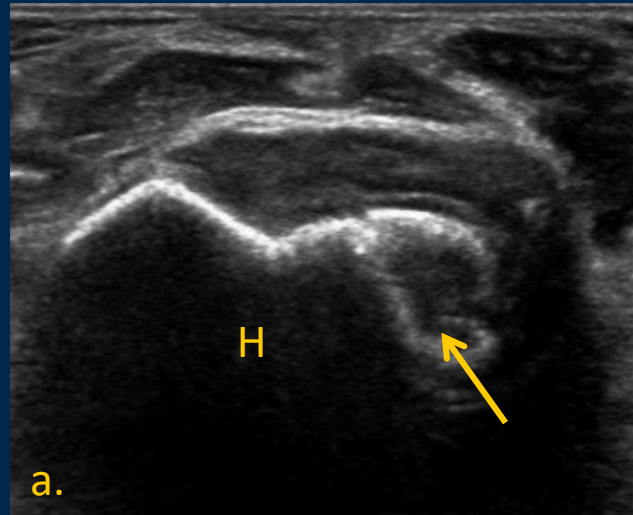


# Case 10 - Distal Humerus Osteomyelitis and Septic Arthritis

2-year-old presenting with a swollen elbow. No history of trauma. Radiographs show diffuse soft tissue swelling and a focal lytic lesion in the lateral humeral metaphysis (**arrow**).



Ultrasound was requested to evaluate for a septic joint. Image a. (transverse anterior approach) demonstrates the cortical erosion (**arrow**) and image b. (longitudinal posterior approach) demonstrates a complex joint effusion (\*) with surrounding hyperemia in this case of osteomyelitis and septic arthritis. Humerus (**H**)



# Case 10 - Osteomyelitis and Septic Arthritis

- Often radiographically occult; ultrasound findings will precede radiographic findings
- With progressive osteomyelitis, cortical erosions are common
- In our experience, with joint involvement, periosteal elevation is less common
- In infants, metaphyseal infection can pass to the epiphysis and joint as the blood vessels cross the epiphyseal plate

# Summary

- A simple approach to elbow ultrasound in children includes longitudinal evaluation of the joint from the anterior, posterior, medial and lateral approaches and transverse evaluation from the anterior and posterior approaches
- Ultrasound is useful in evaluating the elbow in the setting of inconclusive radiographs (occult fracture +/- effusion), high clinical suspicion with negative radiographs, and further evaluation of osteomyelitis and septic arthritis

Thank You