

Introduction

Interpretation of paediatric joint radiographs is challenging. Anatomical development is complex, changes with age and is complicated by developmental variation.

Epiphyses and apophyses are cartilaginous at birth with progressive, often non-uniform or fragmented ossification causing difficulty in interpretation following trauma, especially by inexperienced clinicians. Specialist paediatric MSK Ultrasound is a potential adjunct in these situations.

Findings

We present cases where Ultrasound aided diagnosis and guided imaging or clinical management in children where radiographs appeared normal or equivocal, predominantly following trauma but also those limping or not using their arm.

Several involved the elbow, a joint readily open to misinterpretation with complex anatomical development involving progressive ossification of epiphyses and apophyses according to the mnemonic CRITOL. X-rays were difficult to interpret initially or showed unexpected changes on follow up when Ultrasound helped problem-solve.

We illustrate normal variants, occult fractures and displaced cartilaginous structures including a neonate with complete separation of the distal humeral epiphysis invisible on X-ray and associated with NAI. Acute and chronic apophyseal traction injuries and unexpected sites of ossification during follow-up where ultrasound revealed original injuries were more complex than initially believed. Where postulated intra-articular bodies were normal ossification centres viewed on oblique projections. We describe cases where we ascertained a presumed widened, subluxed ACJ was normal and small ossific fragments at the olecranon and Achilles insertion which lay within cartilage representing tiny secondary ossification centres rather than avulsed fragments from ligamentous injury.

Conclusion

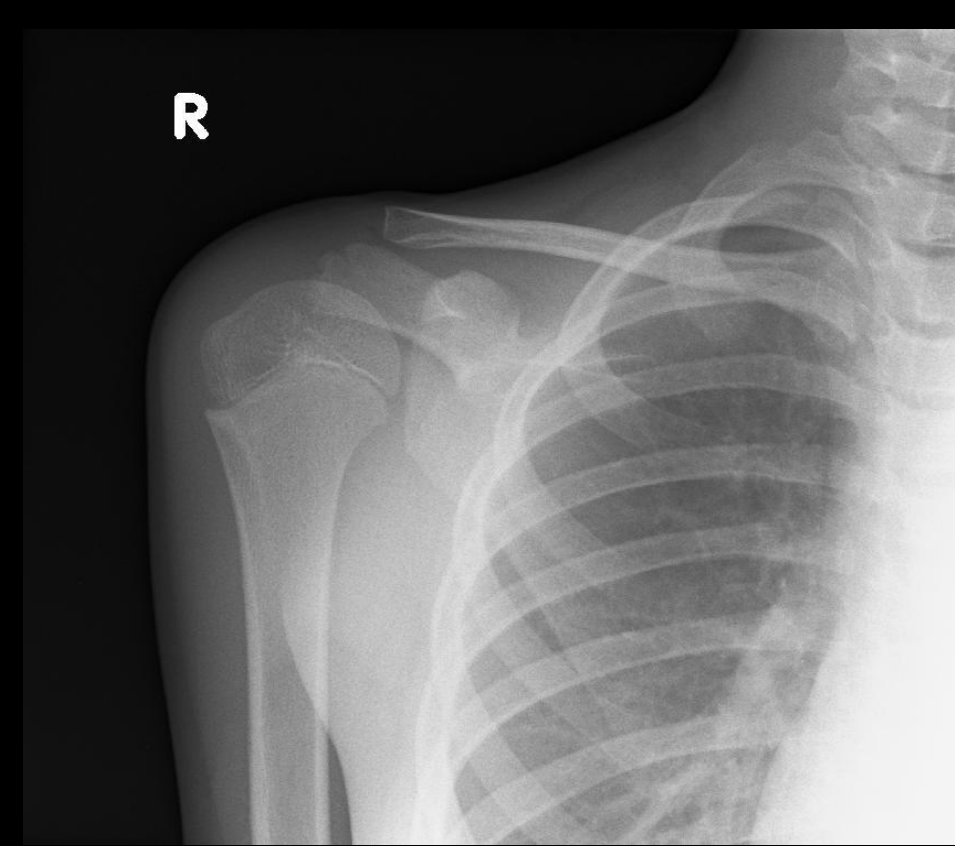
Ultrasound is a useful adjunct in interpretation of equivocal paediatric joint x-rays, quickly performed in the acute setting to confirm or refute potential injuries. Visualisation of cartilaginous structures is particularly helpful to assess the presence, normal position and alignment of non-ossified epiphyses and apophyses not seen on X-ray without the delays or general anaesthetic often required for MRI. Unexpected findings on follow up x-rays can also be interrogated. Providing this service requires specialist understanding of normal and pathological appearances of paediatric joints on all imaging modalities in combination with senior clinical discussion when the presentation is unclear or unusual.

References

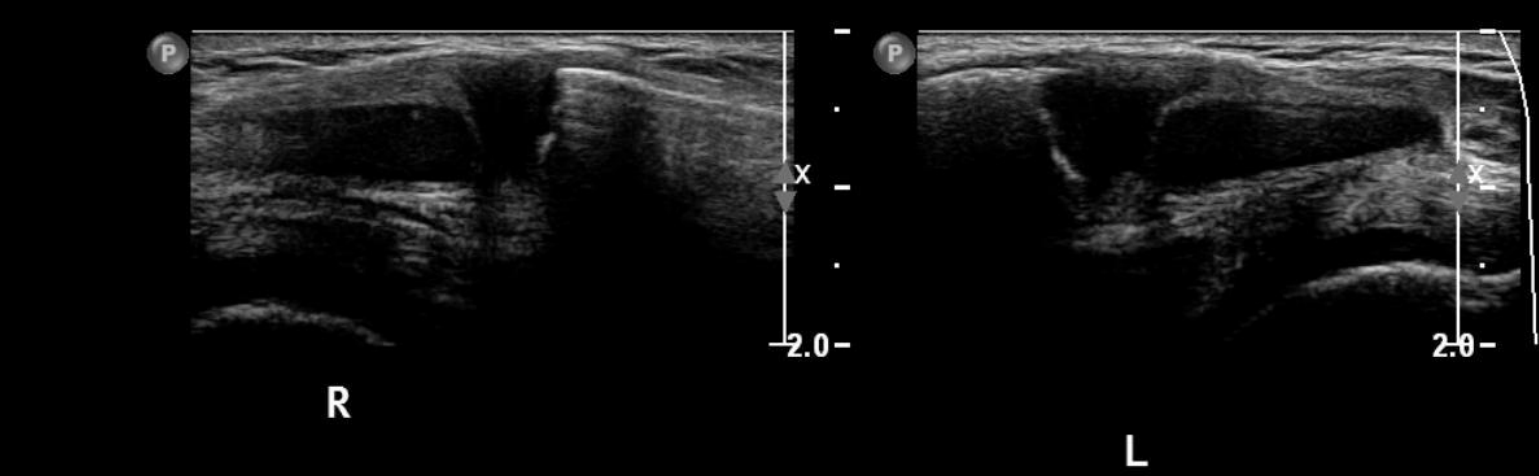
- Chambers G, Kraft J, Kingston K. The role of Ultrasound as a problem solving tool in the assessment of paediatric musculoskeletal injuries. Ultrasound. 2019 Feb;27(1): 6-19. Cases 6 and 9.

Clinical cases

Right ACJ subluxation?

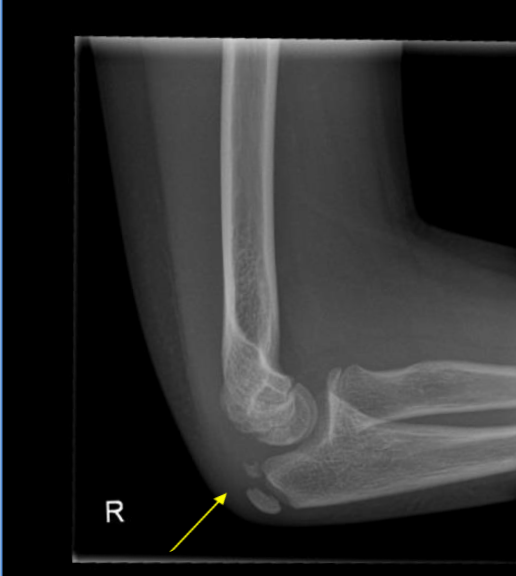


Clinical history: 10 yo fell during football with FOOSH injury
Prominence and tenderness over right ACJ.
Clinicians concerned regarding AC subluxation on chest radiograph, therefore US offered.

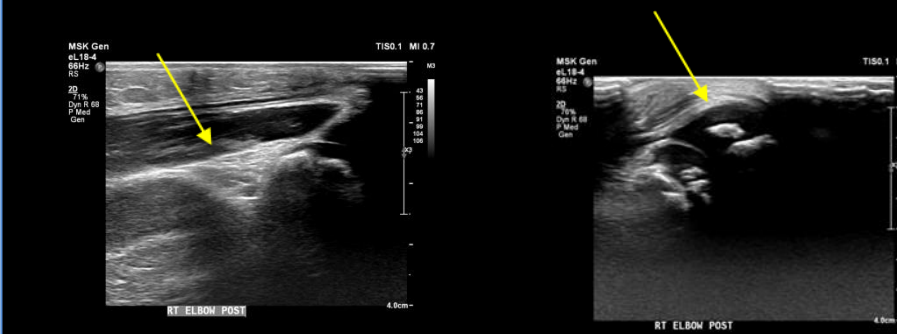


R ACJ Normal alignment of ACJs confirmed bilaterally on US.

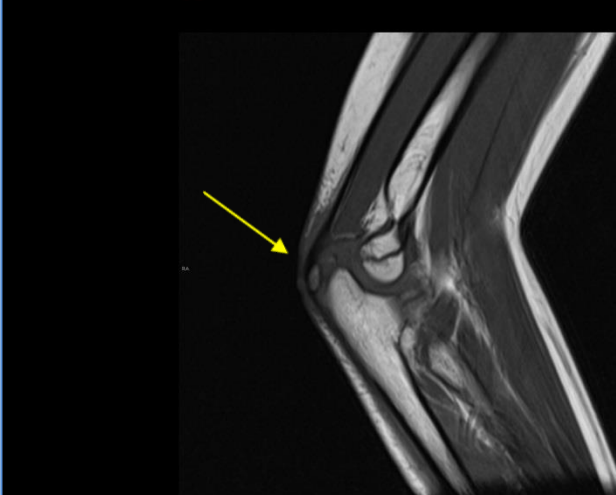
Olecranon fracture?



Clinical History: Fall onto elbow, pain over olecranon
Lateral radiograph shows two ossification centres for the developing olecranon - a normal developmental variant but site of clinical tenderness and misinterpreted as a fracture by clinical team.



USS confirms a normal appearance of the olecranon cartilage with two separate ossification centres and no joint effusion. Contusion/swelling in relation to the posterior soft tissues overlying the triceps.
Tender on scanning over the lateral epicondyle, though normal ultrasound appearance.

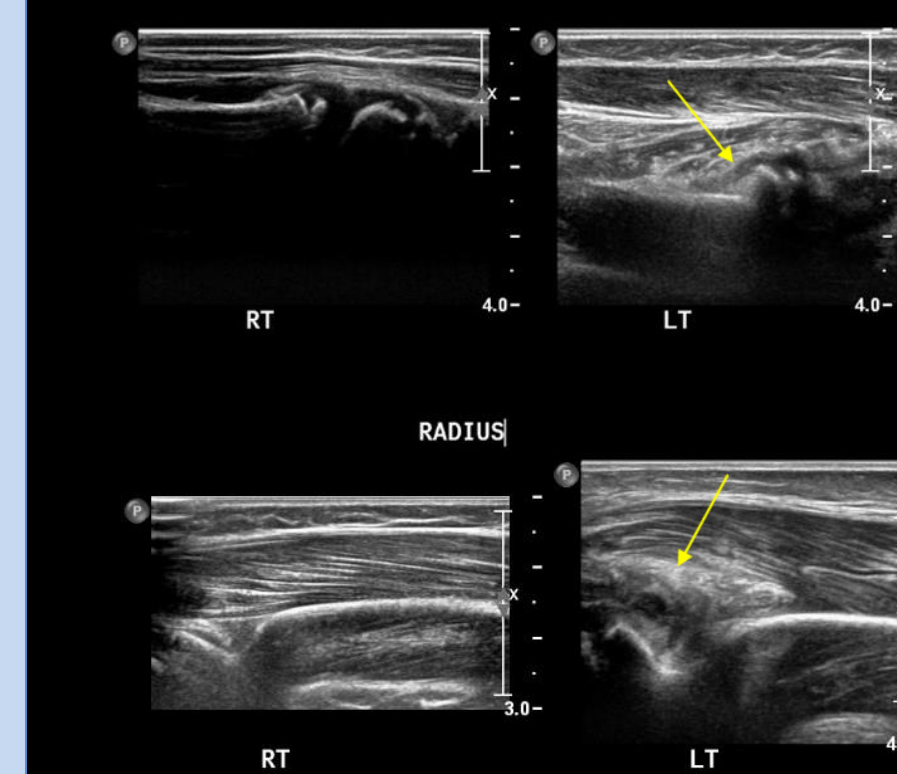


USS failed to reassure the clinical team and MRI was performed confirming two separate ossification centres (arrow) for the olecranon and no joint effusion or bone oedema here. MRI did reveal oedema/bone bruising in relation to the lateral epicondyle apophysis and its growth plate suggesting a non-displaced Salter-Harris 1 fracture.

Radial head fracture



Clinical History: FOOSH ?fracture
Radiographs at the time of injury show a subtle fracture through the left radial neck. This was missed but note was made of poor visualisation of the medial epicondyle.



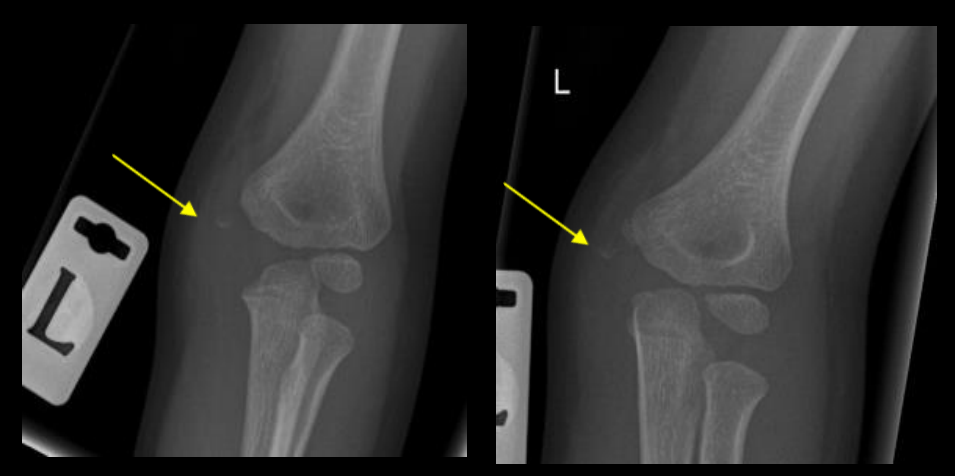
US followed due to clinical concern for medial epicondyle avulsion. Normal smooth proximal radius on the right and disruption of cortex on left (arrow) consistent with a fracture is demonstrated.
Normal appearance of the posterior joint space/olecranon fossa on the right and a joint effusion with elevation of the posterior fat pad on the left (arrow) also seen.



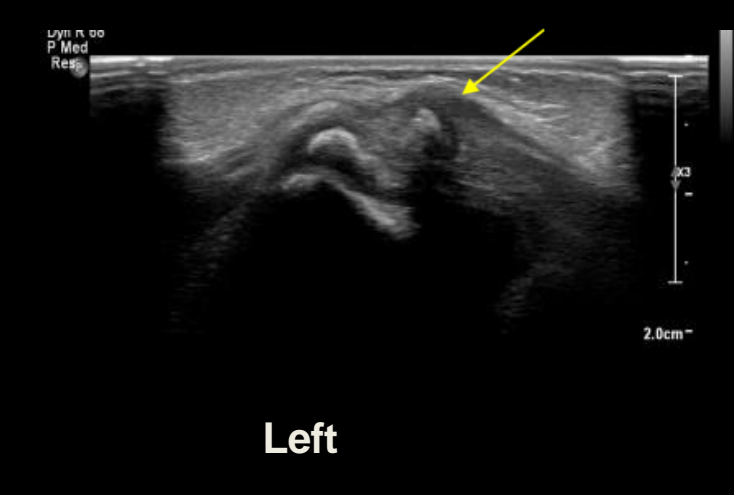
Follow-up radiographs confirm displaced fracture with healing callus. The normal medial epicondyle is now clearly visualised.

Conclusion: Radial fracture with joint effusion, normal medial epicondyle.

Medial epicondyle partial avulsion



Elbow injury with medial joint swelling
Radiograph at presentation shows normally located medial epicondyle apophysis overlying adjacent humerus as expected. A small displaced fragment of bone lies inferomedial to this (arrow), with associated soft tissue swelling.



USS of left elbow showing a fractured and partially avulsed medial epicondyle apophysis, in comparison to the right elbow with a normal appearance of the medial epicondyle. The avulsed fragment is capped with cartilage and has common flexor tendons attached.



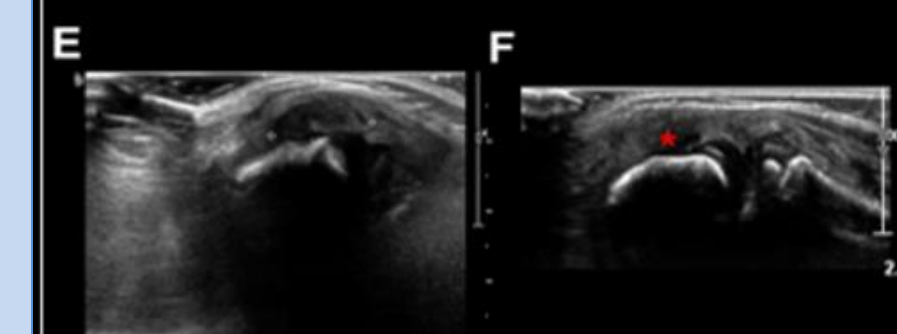
Conclusion: Partial avulsion fracture of the distal pole of the medial epicondyle along with common flexor tendon origin.

Lateral epicondyle apophysis avulsion

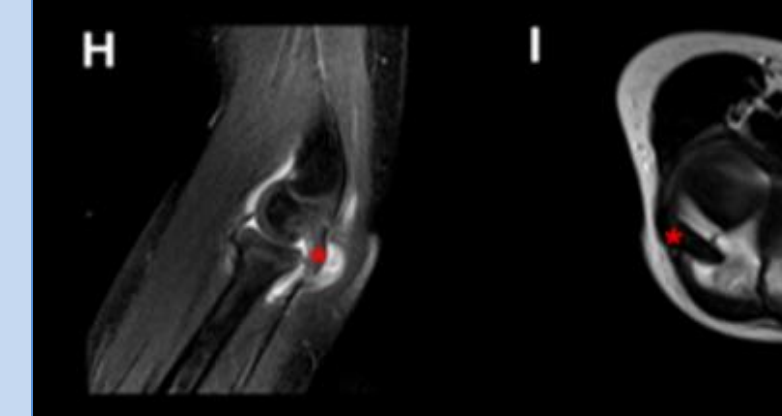


Clinical History: Fell from roof with stiff elbow.

Radiographs at presentation were normal. Radiographs at clinic follow up (C,D) show small bone fragment adjacent to the radial head.



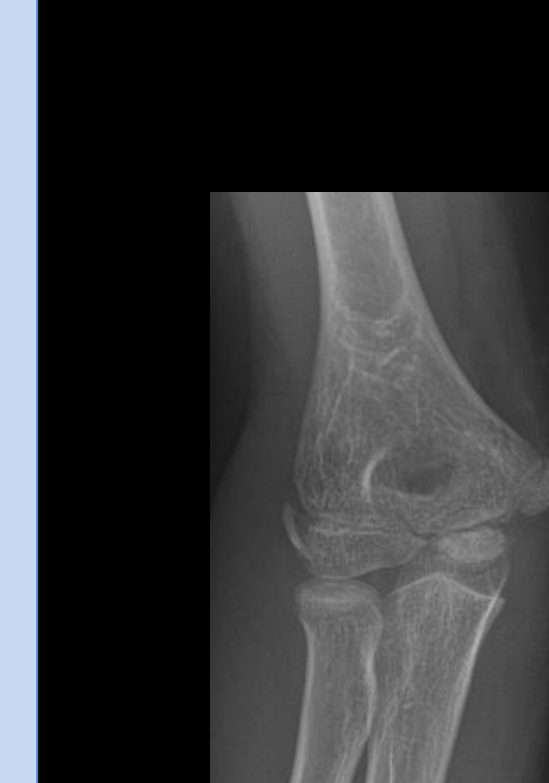
E: USS - Cartilage covering the posterior aspect of the capitellum is deficient with an irregular appearance of the bone. Posterior to this is a 15mm cartilaginous loose body, with CEO fibres attached. F: USS - Right anterior-lateral CEO with absence of cartilage apophysis (F*).



H-J: MRI confirms loose body (H, I) * and deficient cartilage covering the posterior aspect of the capitellum. (J) *

Conclusion: Displacement of the lateral epicondyle apophysis together with tendons of common extensor origin. Cartilage from the posterior aspect of the capitellum is also avulsed.

Acute traction apophyseal injury



Clinical History: 11 yo boy presenting with medial left elbow pain following an injury at a hockey match.

Elbow radiograph- normal appearances
US right elbow shows normal appearance of the Common flexor origin in LS and TS.
US of the left elbow shows elevation and angulation of the apophysis and common extensor origin away from the bone in LS and TS as a partial avulsion acute traction injury.



Right (normal)



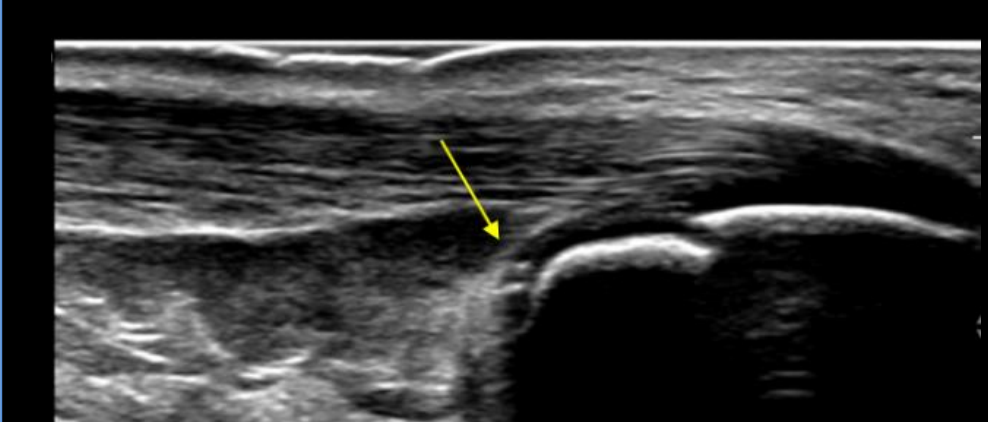
Left (avulsed)

Achilles insertion injury?

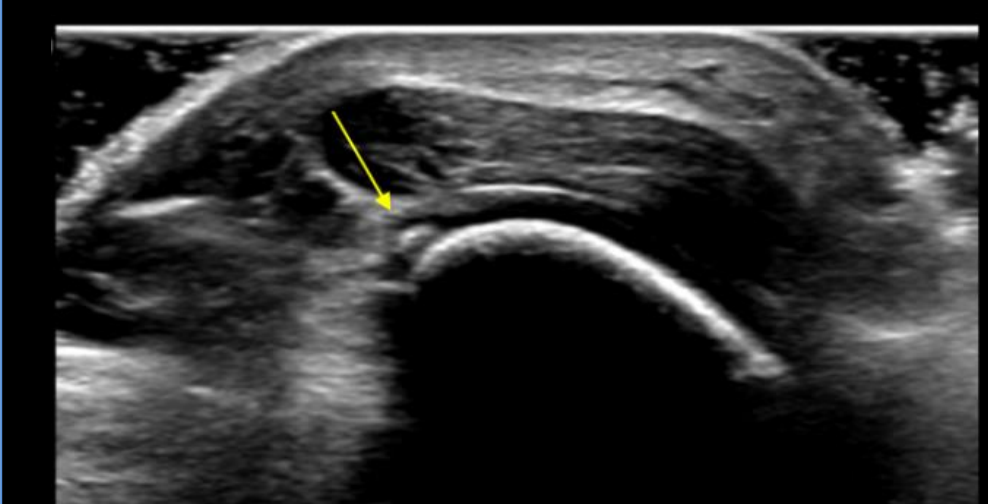


11 yo girl tender at left achilles tendon insertion following injury.

ED doctors concerned about possible flake avulsion fracture on x-ray. Felt most likely to be secondary centre of ossification so offered US to see.



US confirmed the fleck of bone is contained within the cartilage and is not an avulsion fracture.

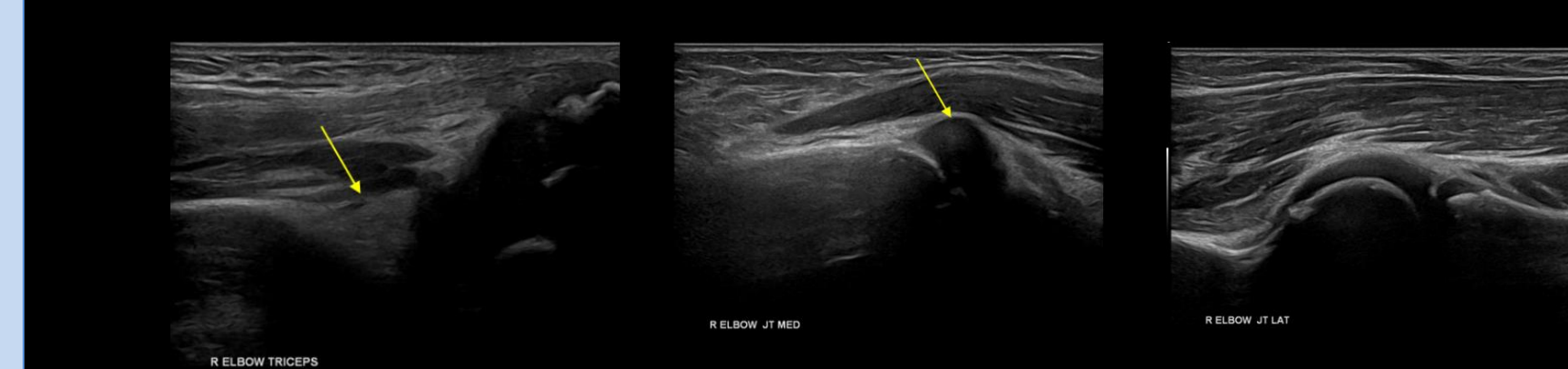


Intra-articular elbow fragment?

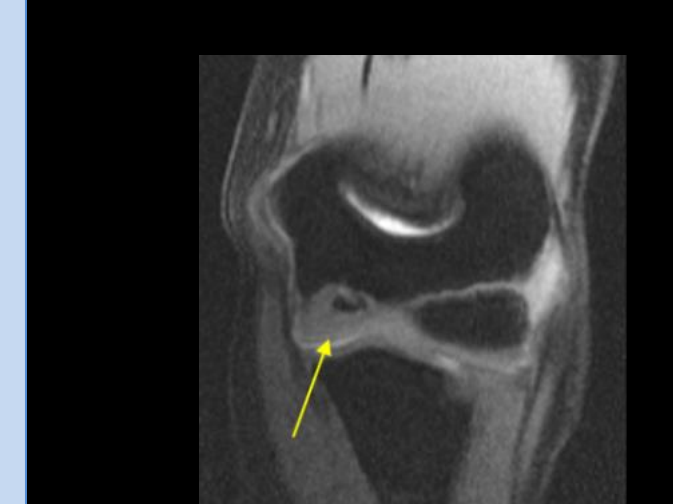


12 yo boy with painful elbow since fall several months ago.

Radiograph raised possibility of small intra-articular fragments and suggested US.

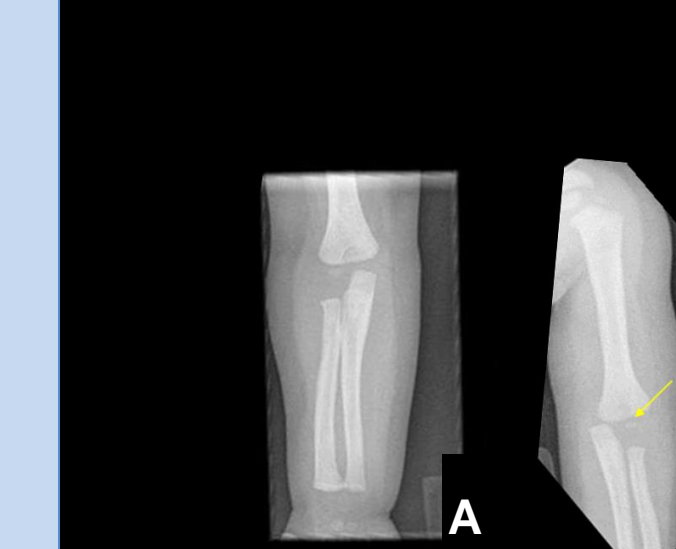


US: No joint effusion in posterior recess. Elbow alignment normal. Trochlear is predominantly cartilaginous with small foci of ossification within it, most likely to account for the plain film findings.



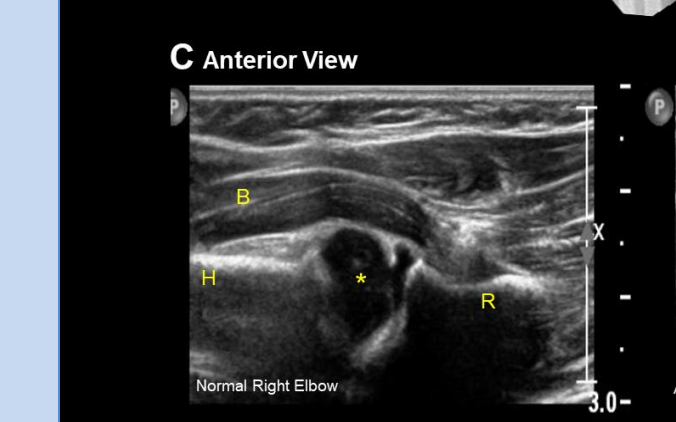
This was confirmed on MRI. No loose body seen.

Fracture separation of the distal humeral epiphysis

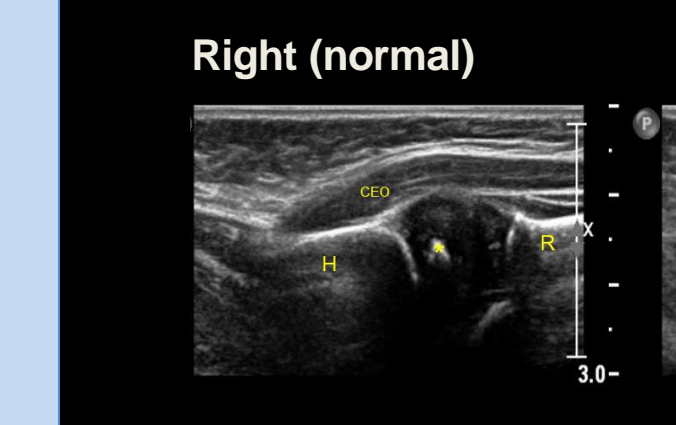


12 month old baby alleged fall off sofa, not using left arm.

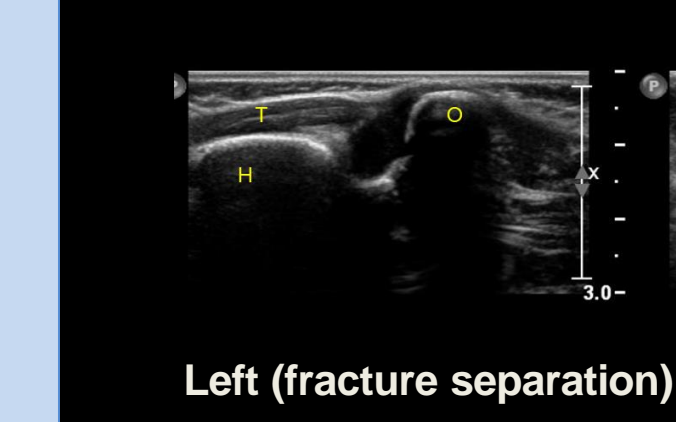
Radiograph of normal right (A) and left elbow (B) which shows posteromedial displacement of capitellar epiphysis relative to humerus (arrow) and radius and ulna displaced medially.



US right distal humerus is normal (B- Biceps, H-Humerus, R-Radius, O-Olecranon, T-Triceps, CEO- Common extensor origin.



Left side shows elevation of the fat pad and posteromedial displacement of the capitellar epiphysis relative to the humerus.



Conclusion: Fracture separation of the distal humeral epiphysis.
Management: Skeletal survey and CT head for completion.
Closed reduction and pinning of fracture.