THE ELBOW

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The elbow is a commonly injured joint in both children and adults. Interpretation of elbow radiographs is sometimes difficult because of the complex anatomy and obscurity of certain injuries. Errors can be avoided by using a systematic approach to interpreting radiographs based on knowledge of the important anatomical relations.

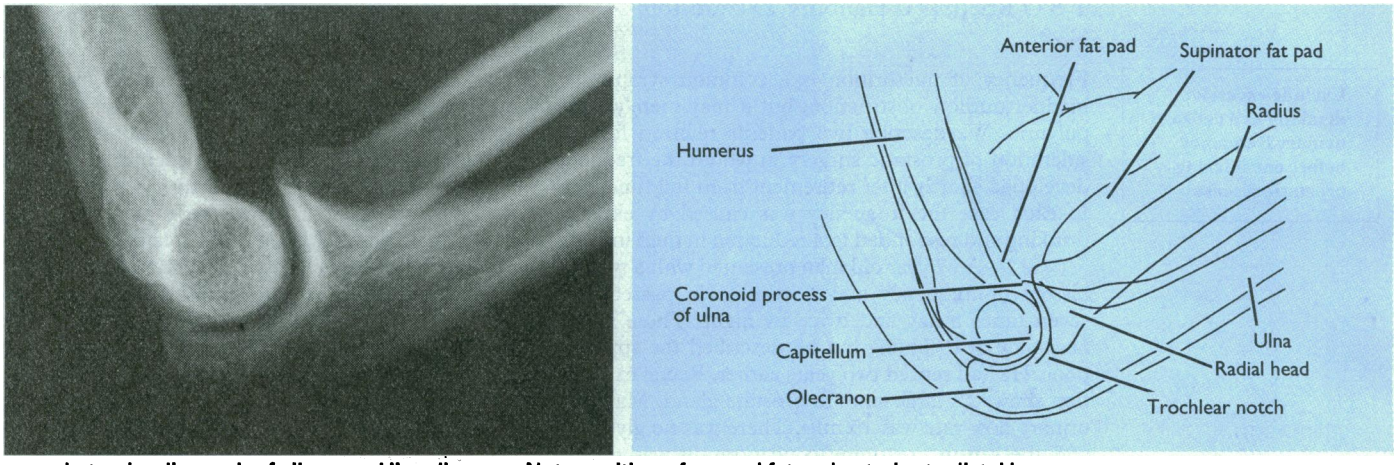

FIG 1—Lateral radiograph of elbow and line diagram. Note position of normal fat pad anterior to distal humerus.

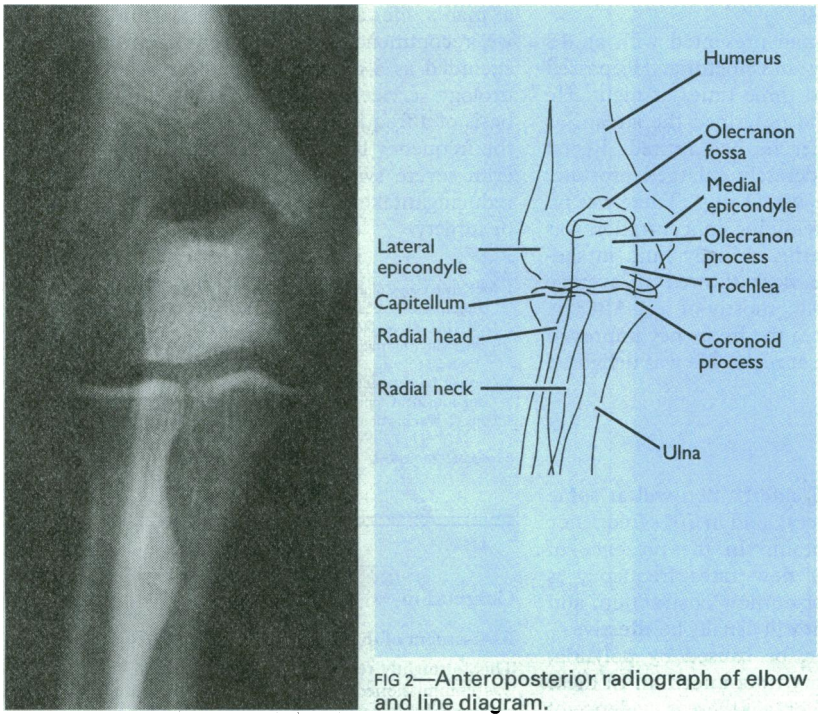

FIG 2—Anteroposterior radiograph of elbow and line diagram.

Adult

The elbow is composed of three joints: the humeroulnar, humeroradial, and radioulnar. All are contained in a single synovial cavity. The lower end of the humerus consists of a spherical portion (capitellum), which articulates with the radius, and a grooved portion (trochlea), which articulates with the ulna. The capitellum and trochlear portions of the humerus are at about 45° to the shaft, so that a line projected along the anterior humeral cortex should intersect the middle of the ossification centre of the capitellum.

The elbow ligaments consist of the ulnar collateral (medial), radial collateral (lateral), and annular ligaments. The annular ligament is attached to the ulna and clasps the head and neck of the radius in the superior radioulnar joint. There is no attachment to the radius, which is free to rotate in the annular ligament.

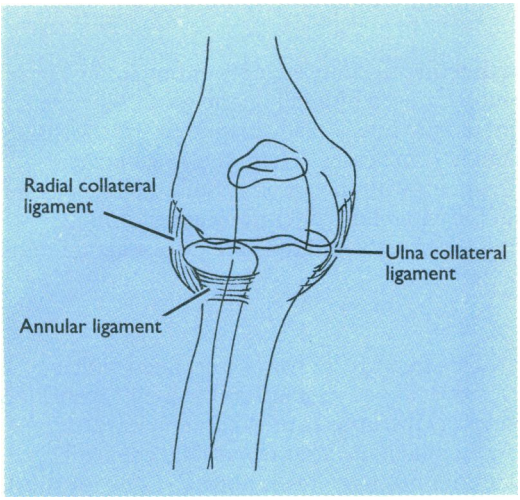

FIG 3—Ligaments of the elbow.

surfaces of the capitellum and trochlear. In front and behind it is carried above the coronoid and olecranon fossae. Distally the capsule is attached to the trochlear notch of the ulna and to the annular ligament, with no attachment to the radius. The capsule comprises an inner synovium and an outer fibrous layer separated by a layer of fat; this forms the basis of the "fat pad signs." Normally, only the anterior distal humeral fat is visible as the posterior fat is depressed within the olecranon fossa. The supinator fat plane is identified as a radiolucent line parallel to the cortex of the proximal third of the radius. In most adults it is within 1 cm of the cortex of the radius.

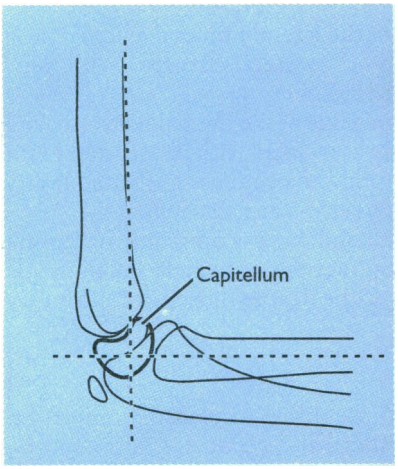

FIG 4—Line diagram showing anterior humeral line and central radial lines. These are two important lines which identify normal anatomical relations and are valuable in assessing fractures and dislocation. Both these lines intersect the middle third of the capitellum.

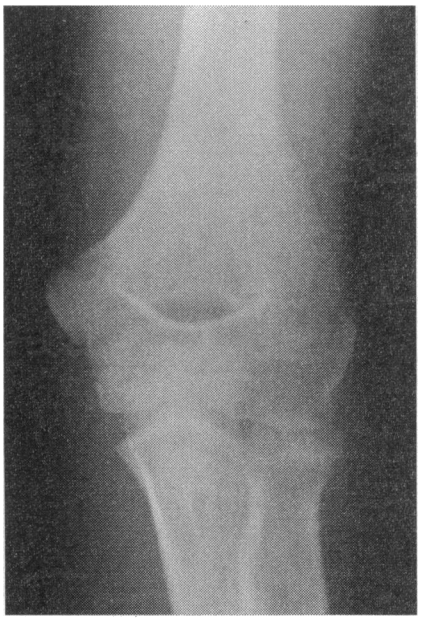

FIG 5—Anteroposterior radiograph of 12 year old child showing secondary growth centres.

Children

Epiphysial growth in the elbow is complex. The first secondary growth centre to appear in the humerus is capitellum at about 2 years (fig 4). The medial epicondyle is the next centre to appear (age 4-7 years) and is seen well before ossification of the lateral epicondyle. The accessory ossification apophysis of the olecranon appears between the ages of 8 and 11 and usually fuses by the age of 14.

Mechanism of common types of injury

FIG 6—Anterior positive fat pad sign in a patient with a radial neck fracture—a subtle break is seen through the radial neck with disruption of the normal smooth cortical curve.

Most elbow injuries are caused by indirect trauma transmitted through the bones of the forearm. Direct blows account for very few fractures or dislocations.

Soft tissues

Soft tissue changes are often the most obvious radiological abnormality after trauma to the elbow. A positive fat pad sign is always seen with intracapsular injuries of the elbow as intra-articular haemorrhage causes distension of the synovium and displacement of the fat (fig 6). However, in severe injuries the anterior fat pad may be obliterated because of associated haemorrhage and oedema of the capsule.

Pulled elbow

Pulled elbow is common between the ages of 2 and 4 years, occurring when the child is lifted by the hand or wrist. It is due to subluxation of the radial head out of the annular ligament. Subluxation is diagnosed on clinical findings as the radial epiphysis is not ossified at this age.

Causes of fat pad sign

Haemorrhage

Inflammation

Trauma—found in over 90% of intra-articular skeletal injuries

Supracondylar fracture

This is the most common fracture in children, accounting for 60% of childhood fractures. It is usually caused by a fall on the oustretched hand. In most cases the transverse fracture line is easily identified but the distal epiphysis can cause confusion in some cases. There is usually posterior displacement of the distal fragment with the anterior humeral line passing through the anterior third of the capitellum or entirely anterior to it. However, a quarter of incomplete fractures show little displacement and may be overlooked.

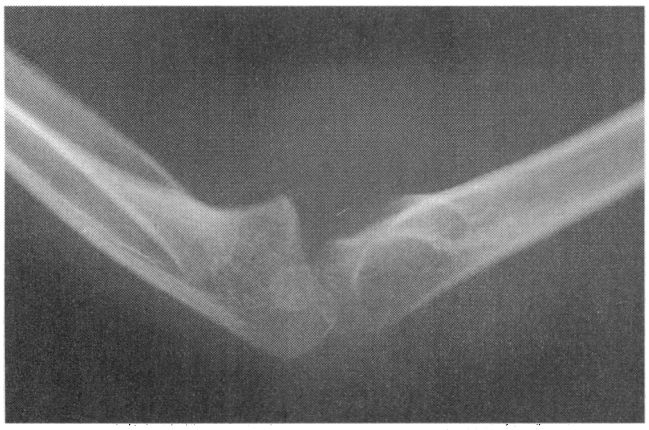

FIG 7—Lateral radiograph showing a supracondyl fracture in a child—the anteroposterior view appeared normal. There is a large joint effusion with positive anterior and posterior fat pad signs. Minimal cortical disruption is seen on the posterior aspect of the lower humerus but there is posterior displacement of the distal fragment with the anterior humeral line passing anterior to the capitellum.

This fracture is always associated with a positive fat pad sign unless the joint capsule is severely disrupted or torn. In about 5% of supracondylar fractures (usually greenstick) the anterior humeral line is normal. Look for subtle buckling of the cortex. Occasionally oblique views may be needed to confirm the fracture line.

Epicondylar injuries

Fracture of the lateral humeral epicondyle is the second most common fracture in children, occurring in 15%.

Half of avulsions of the medial epicondylar apophysis are associated with dislocation of the elbow. Avulsion can occur as an isolated injury due to a valgus stress during a fall on the outstretched hand or less commonly to repeated moderate contractions or a single violent contraction of the flexure muscles of the forearm.

FIG 8—Fracture and dislocation of lateral humeral epicondyl and capitellum. Note the severe swelling of soft tissue.

The avulsed medial epicondyle is almost always displaced inferiorly but some anterior or posterior displacement can also occur. Localised soft tissue swelling is always seen. The avulsed epicondyle may be drawn into the joint space between the trochlea and the coronoid process of the ulna causing entrapment. Such avulsion is clinically important and usually requires open reduction and internal fixation. In subtle cases a radiograph of the non-injured side may be needed for comparison. As the medial apophysis is intracapsular this separation produces a positive fat pad sign.

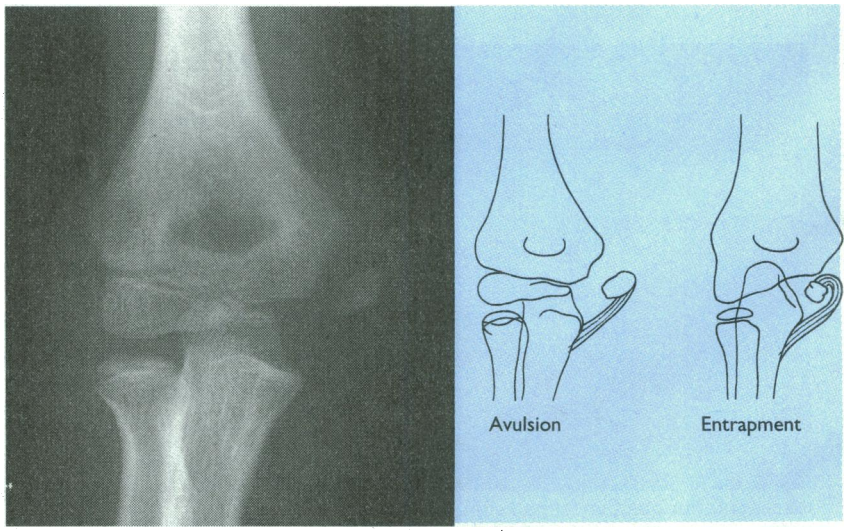

FIG 9—Left: Anteroposterior radiograph of avulsion of medial epicondyle with associated soft tissue swelling. Right: Line diagram showing avulsion and entrapment of medial epicondyle.

FIG 10—Slightly displaced fracture through the distal humerus.

Radial head or neck fractures

Fracture of the radial head is the most common injury in adults (fig 6), accounting for about half of all fractures about the elbow. Both head and neck fractures are caused by a fall on the outstretched hand with the forearm in supination. Displacement in radial neck fractures varies and they can be impacted. Often no cortical break is seen and only a slight angulation of the normally smooth concave cortex of the radial neck can be detected. It is therefore important to identify the secondary signs; virtually all radial head or neck fractures are associated with positive anterior and posterior fat pad signs and displacement or obliteration of the supinator fat plane. Radial head fractures may be classified as: linear non-displaced, marginal, depressed, or comminuted.

Fractures of olecranon

Fractures of the olecranon account for a fifth of elbow injuries in adults. They occur either indirectly by a fall on the outstretched hand with the elbow flexed or directly by a blow to the olecranon. The fracture line is usually transverse passing into the trochlear notch. Occasionally the olecranon is comminuted and distracted. Associated soft tissue swelling of the olecranon bursa is an important sign when the fracture line is undisplaced.

Fractures of long bones

Fractures of the distal humerus in adults occur after a fall on the flexed elbow. The trochlear ridge of the ulna is impacted against the trochlear groove of the humerus, causing a "T" or "Y" shaped fracture of the distal humerus. If an angular force is applied during injury an oblique epicondylar fracture may occur. Transcondylar fractures are rare but occur in elderly people with osteoporotic bones. The fractures may be undisplaced and difficult to identify.

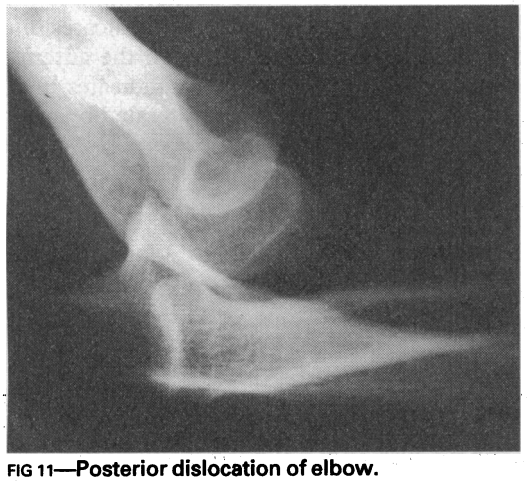

FIG 11—Posterior dislocation of elbow.

Monteggia's fracture

Monteggia's fracture is a fracture of the proximal third of the ulna with anterior angulation at the fracture site and anterior dislocation of the radial head. Most result from a fall on the outstretched hand with forced pronation of the forearm, the minority occurring after a direct blow to the posterior aspect of the proximal forearm.

Dislocation

Backward displacement of the radius and ulna with respect to the humerus is the commonest type of dislocation, usually due to valgus angulation forces. In half of dislocations there is also a fracture of the medial epicondyle, radial head or neck, or coronoid process of the ulna. These fractures are commonly only identified on radiographs taken after reduction and are important because they represent loose bodies within the joint space that can impede complete reduction or lead to post-traumatic arthritis. Post-reduction radiographs should be taken routinely.

Types of view

Standard radiographic projections

Anteroposterior
Lateral
Oblique

The routine projections of the elbow include the anteroposterior and lateral. The anteroposterior view is taken with the arm fully extended and the lateral with the arm flexed to 90°. Correct positioning of the elbow is essential for interpretation as minor degrees of obliquity or rotation can obscure a positive fat pad sign or incorrectly identify the alignment of fracture fragments. Supplementary oblique views are occasionally valuable for further assessment of subtle injuries of the radial head and distal humerus.

A single projection of a long bone is inadequate to assess trauma. Films at right angles must be taken to assess displacement and decide on management. The entire long bone should be included on the film.

System of radiological assessment

ABCs system of radiological assessment

Adequacy
Alignment
Bones
Cartilage
Soft tissue

Catches to avoid

- Epiphysial lines and epiphyses can cause confusion (fig 4). Radiographs of the unaffected elbow may help
- Entrapment of the medial epicondyle can be mistaken for the ossification centre of the trochlea but this centre is irregular and never ossifies before the medial epicondyle
- Fracture of the lateral humeral epicondyle can be mistaken for the radiolucency of the epiphysis
- The radial tuberosity can be misinterpreted as a lucent lesion on the lateral radiograph (fig 10)

Summary

Check the adequacy and quality of the radiograph

Check alignment of bones
- Anterior humeral line
- Central radial line
- Elbow joint

Check bone margins and density
- Humerus
- Radius
- Ulna

Check the cartilage and joints

Check the soft tissues
- Anterior and posterior fat pads
- Supinator fat pad

Lateral radiograph

The ABCs system of radiological interpretation should be followed.

Check the adequacy and quality of the radiograph—The lateral radiograph is the most important projection as it gives most information on abnormalities of bones and soft tissues. Optimum positioning is essential so that the structures can be adequately assessed. After acute trauma, however, it can be impossible to position the patient optimally. The trochlea and capitellum should be superimposed, indicating there is no humeral rotation. When the forearm is correctly supinated the proximal shaft of the radius should be projected above the ulna. On adequately exposed radiographs the normal muscle and fascial planes are identified as linear or curvilinear radiolucent shadows because of the surrounding adipose tissue.

Check alignment of bones—Check the anterior humeral and central radial lines. The notch of the olecranon process of the ulna and the trochlea of the humerus should be in line. The coranoid process of the ulna is superimposed on the radial head.

Check bone margins and density—Examine the cortical surfaces of the humerus, radius, and ulna clockwise. Subtle breaks in children with supracondylar fractures can be difficult to detect (fig 7). Examine the internal trabecular pattern of the bones for radiolucencies or bands of increased density. Impacted radial neck fractures cause a faint broad transverse band of increased density at the junction of the head and the neck.

Check the cartilage and joints—The trochlea should be concentric to the ulna. Note the capitellum is superimposed over this joint.

Check the soft tissues—The normal anterior fat pad appears as a thin elongated radiolucency parallel and adjacent to the distal humeral cortex. A positive fat pad sign may occur when there is intra-articular fluid from any cause, including haemarthrosis after trauma. The displaced fat is seen as triangular shaped radiolucent shadows anterior and posterior to the distal end of the humerus (fig 7). A positive anterior fat pad sign indicates injury only when it is raised and becomes more perpendicular to the anterior humeral cortex. A positive posterior fat pad sign always indicates injury. Check the supinator fat plane; this may be altered or obliterated by trauma (especially radial head or neck fractures) or inflammatory processes (fig 6). Check the olecranon bursa for collection of fluid.

Anteroposterior radiograph

Check alignment of bones—The relative positions of the elbow joint are easily seen in this projection.

Check bone margins and density—The cortex of the radial neck and head should form a smooth continuous concave arc extending from the radial shaft to the base of the radial head. The cortical margin of the radial head should be sharply defined. About half of radial head fractures are undisplaced, making it difficult to identify the fracture line. Subtle cortical disruptions, depressions, or steps should be carefully assessed. The articulating surface of the radius is continuous with the capitellum. Check the presence and position of the medial epicondyle. Absence of the medial epicondyle may be due to avulsion and entrapment of the centre (fig 9).

Check the cartilage and joints—The joint margin of the distal humerus appears scalloped because of the rounded capitellum and the medial and lateral borders of the trochlea. With avulsion and entrapment of the medial epicondyle there is often subtle widening of the elbow joint medially.

Check the soft tissues—Severe swelling of medial soft tissue always occurs in medial epicondyle injuries (fig 9).

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The line drawings were prepared by Mary Harrison, medical illustrator.
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