Applied Anatomy

Thoracic limb

- Elbow luxation
- Fracture of the lateral humeral condyle
- Premature closure of the distal ulnar physis
- Nerve paralysis
- 2ndary centres of ossification & physeal lines
- Ununited anconeal process
- Intravenous injection
The **elbow** is a very strong and stable joint, but its action is restricted to flexion and extension in a sagittal plane. These features are largely due to the presence and very precise fit of the **Proc. Anconeus** in the **Fossa olecrani** when the joint is extended.

The precise fit of the **Proc. anconeus** also makes elbow luxation (dislocation) impossible (without fracture or collateral ligament rupture) when the joint is extended.

Luxation can only occur when the elbow has been flexed to an angle of 45° or less (i.e. when the anconeal process is free of the olecranon fossa).

**Lateral luxation** of the radius and ulna occurs most frequently because the lateral condyle is smaller than the medial condyle.

**Medial luxation** is possible but is usually associated with severe damage to the ligaments.
While fractures of the medial humeral condyle are very rare, fractures of the lateral condyle are quite common.

Typically, the fracture line starts from the most distal aspect of the articular surface and extends proximally, through the For. supratrochleare and into the metaphysis, running parallel to the bone’s longitudinal axis.

The reasons for the lateral condyle’s susceptibility to fracture lie in its structure: the lateral humeral condyle projects laterally, it is smaller than the medial condyle and its dorsal support (Crista supracondylaris lateralis) is not well-developed.

Of particular significance is the fact that the lateral condyle’s articular surface, the Capitulum humeri, articulates mainly with the radius, the main weight bearing bone of the antebrachium (bears 90-95 % of the load carried by the limb). If the animal jumps or falls from height and lands on fully extended thoracic limbs, the force of impact is largely concentrated (via the radius) on the lateral condyles.

Given their relative biomechanical weakness, their predisposition to fracture is easily understood.
Thoracic limb – 2ndary centres of ossification & physeal lines - bones

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Scapula

Tub. supraglenoidale

Caput humeri

Humerus

Tub. minus
Tub. majus

Condylus humeri

Radius

Caput radii

Trochlea radii

Ulna

Proc. styloideus ulnae

Tuber olecrani

Proc. anconeus

Metacarpal bones

Basis Ossa metacarpale I (not shown)

II III IV V

Caput Ossa metacarpalia II-V

Caput metacarpalia II-V

P. 2 Radiographs
The parts of the long bones all have their own centres of ossification and are thus, by definition, *secondary centres of ossification* (i.e. epi- and apophyses). On a radiograph of an immature animal, each part will therefore appear to be separated from the body of the bone (i.e. metaphyses and diaphysis, the primary centre of ossification) by a thin radiolucent (black) line representing the open (unossified) *Cartilago physialis*. It is obviously very important for the clinician to be able to *distinguish* radiologically between *physeal and fracture lines*. 
In certain large breeds, especially the German shepherd, St. Bernard and basset, the ossification centre of the Proc. anconeus occasionally fails to fuse with the olecranon.

The loose fragment (i.e. the ununited anconeal process) causes joint instability, pain, a weight-bearing lameness and usually initiates degenerative joint disease.
In general, the **shape of a physeal cartilage** can be described as being a transverse plate. However, in the dog, the physeal cartilage of the distal ulnar epiphysis (i.e. between the *Corpus ulnae* and *Proc. styloideus ulnae*) is conical in shape (and thus V-shaped on longitudinal section, and on radiographs).

In immature animals, the shape of this physeal cartilage is the reason that trauma to the distal ulna seldom causes a physeal cartilage fracture. Instead, trauma to the region often compresses the physeal cartilage, damaging it sufficiently to cause its premature closure and longitudinal growth of the ulna effectively ceases.

This is a serious injury as the distal epiphysis is responsible for 75-85% of the ulna's longitudinal growth. If the radius’ distal growth plate is not also damaged, the radius continues to lengthen (the distal radial physis is responsible for 70% of the bone's longitudinal growth). However, since the radius and ulna are joined by ligaments, the radius’ normal development is impeded by the short, under-developed ulna.

This results in a variety of abnormalities such as **curvature of the radius**, **deviation of the paw** and **subluxation of the radio-carpal and elbow joints**.

In the **cat**, the physeal cartilage of the distal ulnar epiphysis is a transverse plate and trauma to the distal ulna (immature animal) can quite easily cause a physeal cartilage fracture.
N. radialis

< If the nerve is injured proximal to the origin of the branches to the M. triceps brachii, the limb cannot support body weight at all because it cannot extend the elbow. The elbow hangs and the limb appears to be "too long"; the digits are flexed and their dorsal surfaces rest on the ground. There is also a significant reduction in the ability to flex the shoulder as the long head of the triceps is non-functional. This condition is referred to as high radial paralysis and will also be seen when the radial nerve's roots are contused against the first rib.

< If the nerve is injured between the branches to the triceps and the R. profundus, the limb will be able to support weight but on the dorsal surface of the Manus; this is because the carpus and digits cannot be extended. This condition is referred to as low radial paralysis. Some animals learn to adapt by rapidly flexing the elbow and flipping the Manus forward in an extended position.

N. ulnaris & medianus

Paralysis of the N. medianus and/or the N. ulnaris has no obvious clinical effect although the carpal and digital flexors are inactivated. Weight bearing may cause the carpus to slightly overextend and this is seen as a slight sagging or dropping of the joint. Normally, when a dog lying in a sternal position is pulled caudally, it will attempt to resist by digging its claws into the ground. This is not possible if the carpal and digital flexors are non-functional.

N. axillaris

Paralysis of this nerve has little clinical effect because the long head of the M. triceps brachii and the M. latissimus dorsi also flex the shoulder (this is known as compensatory adaptation); the non-functional M. cleidobrachialis has no discernable effect on the animal's gait.

N. subscapularis

Experimental neurectomy (transection of a nerve) of the N. suprascapularis causes no change in gait.

N. musculocutaneous

Paralysis causes no appreciable lameness but the elbow will be slightly more extended than normal. The animal may have some difficulty in raising the antebrachium and will use the carpal and digital extensors (e.g. M. extensor carpi radialis) to flex the elbow.
The *V. cephalica* is routinely used for intravenous injections.

Note that the vein is flanked by the cutaneous branches of the *N. radialis* and the branches of the *A. antebrachii superficialis cranialis*.

These structures are damaged by poor intravenous needle placement technique, and when irritating substances are injected subcutaneously instead of intravenously.