Radiography and radiology of the forelimb

Radiography of the forelimb is a commonly performed diagnostic procedure used to determine the causes of forelimb lameness in canine and feline patients. However it is important to understand the limitations of radiography particularly in the elbow joint where superimposition of structures makes diagnosing the primary lesion somewhat difficult. This section is meant as an overview of thoracic limb radiography and readers are referred to further radiology textbooks if they require greater detail.

As is the case for all radiography, well positioned orthogonal views are required to maximise the potential for diagnosing lesions. Extra views such as stressed or oblique may also be required and those required will be discussed below in the relevant section. Contrast and exposure settings should be such as to allow the clinician to primarily assess the osseous structures but also to give consideration to soft tissue opacities, particularly in the distal antebrachium and manus.

General forelimb radiography

It is important when taking radiographs of any limb, or any part of the body, to centre on the area of interest. All too commonly images are taken of the entire limb on one plate and then interpretation of, for example, the elbow is attempted. This is unsatisfactory and will lead to artifactual changes being misdiagnosed. In cases of antebrachial growth deformities it is imperative to radiograph the antebrachium initially, including the elbow and carpal joints to assess alignment, but then to radiograph the elbow joint separately using the standard views. Although this may be time consuming, assessment of the congruity of the elbow is NOT possible when the beam is centred on mid radius and ulna.

Radiographic diseases that may be present in the thoracic (and pelvic) limbs generally include:

- Fractures
- Panosteitis
- Neoplasia
- Cranio-mandibular osteopathy
- Metaphyseal osteopathy

Fractures

Orthogonal views are needed to assess the location, degree of comminution, open or closed and involvement of other structures (e.g. joints) if repair is to be attempted it is useful to radiograph the contralateral limb to facilitate fracture planning and possible preoperative plate contouring.

Panosteitis

Initially radiographic changes may be absent (10-14 day lag) Earliest sign (not commonly seen) is increased radiolucency, usually centred on the nutrient foramen. Later, increased radiopacity is seen in the same areas with loss of the normal trabecular pattern and the development of nodular/circumscribed areas of increased radiopacity (“thumbprint” lesions). Endosteal thickening and periosteal new bone may be seen. With resolution the lesions become more lucent with a coarse trabecular pattern.

Figs 1 and 2 – the ML view appears normal but the CC view of the shoulder revealed an avulsion fracture of the glenohumeral ligament
Neoplasia
The radiographic appearance of primary bone tumours can be very variable (they can even be radiolucent), but typically there is a combination of bone lysis and new bone formation. Pathological fracture may be seen. Inflated lateral views of the thorax should be taken (or CT).

Craniomandibular Osteopathy
Dramatic periosteal new bone formation of mandible and/or TMJ. Irregular initially but smoothen with time. Occasionally this may be seen on the thoracic and pelvic long bones.

Maries Disease - a rare secondary radiographic and clinical pathology caused by a mass in the thorax (or abdomen) Palisading periosteal reaction is evident primarily in the distal limb but may appear proximally too. Soft tissue oedema may also be evident.

Shoulder
With the exception of Osteochondritis dissecans (OCD) plain radiography of the shoulder is an insensitive diagnostic modality. This is because most causes of shoulder lameness are due to injuries to the soft tissue structures surrounding the joint. The probability of detecting lesions can be increased using positive contrast to highlight some of the intraarticular structures. Mediolateral and craniocaudal views should be taken.

Osteochondritis dissecans (OCD)
Radiography: (usually gives definitive diagnosis) should include both shoulders and a plain ML radiograph. The radiographic features are: a subchondral defect with flattening of caudal humeral head +/- a sclerotic margin, “joint mice” (only if mineralised), secondary OA (periosteal new bone (PNB) around the caudal humeral head) and “vacuum” phenomenon - gas (NO) accumulates between cartilage and subchondral bone resembling a negative contrast arthrogram.
Positive contrast arthrography: A positive contrast arthrogram (low volume: 1-2ml of water soluble iodine contrast) may help to identify a non-mineralised flap and may delineate joint “mice” in caudal joint capsule or bicipital tendon sheath if these are not mineralised.

Other causes of shoulder lameness.

Incomplete ossification of the caudal glenoid – an uncommonly seen osteochondrosis lesion, most commonly seen in Rotweillers but also other giant breed dogs. Care should be taken in diagnosing this in dogs less than 5-6 months of age as some delayed union may occur.

Biceps injuries – high volumes (8-10ml) may be useful in determining leakage around the sheath of the biceps or a lack of delineation of the biceps tendon in the case of a rupture. Modalities such as ultrasound, MRI and arthroscopy are more sensitive for this but radiography can provide a diagnosis

Elbow

Anatomy:

- The elbow is a composite joint in which the humeral condyle articulates with the head of the radius (humeroradial joint –most of load bearing), and with the semilunar or trochlear notch of the ulna (humeroulnar joint-joint stability).
The elbow joint is a ginglymus (hinge) joint capable of flexion, extension and rotation (supination and pronation).

Medial and lateral support is given to the joint by strong collateral ligaments and the anconeal process. Normal anatomy is shown in Figure 1:

Due to the complex architecture of the elbow radiography of the primary lesion may be limited. This is particularly the case with medial coronoid disease as most lesions are on the axial border of the coronoid so sandwiched between the abaxial border of the coronoid and the radial head. Unless the fragment is significantly displaced it is not seen. One should look for the appearance of osteophytes at typical sites - proximal border of the anconeal process, cranial aspect of the radial head, semi-lunar notch, and humeral epicondyles. The secondary changes will not appear for some weeks and thus there may be no signs evident on the first radiographic examination. It is therefore advisable to re-radiograph in 6-8 weeks in suspect cases.

Three standard views are required for the elbow:
1. Extended craniocaudal (with the elbow and shoulder aligned)
2. Extended mediolateral view
3. Flexed mediolateral view.

Alignment of the elbow and shoulder are very important with the craniocaudal view in order to prevent artefacts. The elbow and shoulder should be visually aligned and the antebrachium allowed to rest on the plate with no attempt to straighten it. If the radiographer concentrates on aligning the antebrachium then the elbow will appear rotated.

As previously mentioned the changes that are present on radiographs of elbow dysplasia are often secondary so a flexed view is taken to skyline the anconeal process. Secondary osteophytosis is seen here when elbow pathology is present. However, **an absence of secondary changes does NOT exclude elbow disease.** Subtrochlear sclerosis of the ulna is another radiographic sign of elbow disease although is subjective in its assessment.

**Figure 5: Normal lateral, medial and caudal anatomy of the elbow**
Osteochondritis dissecans (OCD) and ununited anconeal process (UAP) are more obviously seen on radiography. Either mediolateral view will demonstrate a UAP. OCD lesions are seen on a straight craniocaudal radiograph although it is reported that there may be an increased sensitivity with a 15° oblique view (the so called lazy man craniocaudal view where the antebrachium is laid flat on the plate with no consideration given to the alignment of the elbow and shoulder).

**Carpus**

**Anatomy (review ligamentous support in detail in surgical textbooks)**

The carpus is a 3-level hinge joint composed of antebrachiocarpal joint, middle carpal joint and carpometacarpal joint. There are seven carpal bones: the radial, ulnar and accessory carpal bones comprise the proximal row. Second, third and fourth carpal bones comprise distal row. Accessory carpal bone positioned palmar to ulna carpal bone. Numerous ligaments support the carpal joints, the most important being those that provide collateral and palmar support. The tough palmar fibrocartilage connecting the distal radius with carpal bones and metacarpal bones is important in stability.

![Figure 1: Bone of the carpus (a) dorsal and (b) lateral view](image)

Mediolateral and dorsopalmar views should be taken. In addition if instability is suspected stressed views using ropes to secure the limb should be considered. Oblique views may also be useful in detecting small chip fractures and undisplaced fracture lines.