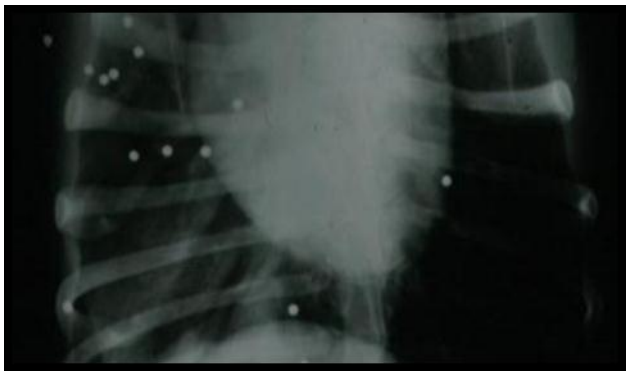
cpdsolutions
transferring knowledge through excellence in training

Thoracic Radiology 'Mini Series'

Session 3: The Pleural Cavities, Mediastinum and Thoracic Boundaries

Esther Barrett

MA VetMB DVDI DipECVDI MRCVS
RCVS & European Specialist in Veterinary Diagnostic Imaging



Esther Barrett MA VetMB DVDI DipECVDI MRCVS esther@wales-and-west-imaging.co.uk

The Pleural Space

Normal Anatomy

- The pleural cavities consist of the space (usually < 1mm across) between the visceral & parietal pleura, with a tiny amount (2-3ml) of lubricating pleural fluid
    - Visceral pleura lines the surface of the lung & forms the interlobar fissures
    - Parietal pleura lines the thoracic wall laterally, the mediastinum medially & the diaphragm caudally
- In dogs, right and left pleural cavities are connected via fenestrations through the caudoventral mediastinum
- In cats the parietal pleura forming the mediastinum is more often intact
    - Hence unilateral pleural disease is more common
- In the normal cat/dog the pleural space is not visible
    - Fine radio-opaque lines corresponding to the folds of visceral pleural between the lung lobes are occasionally seen if positioned exactly parallel to the X-ray beam
    - Thickening or calcification of the pleura in older cats & dogs can make it more visible

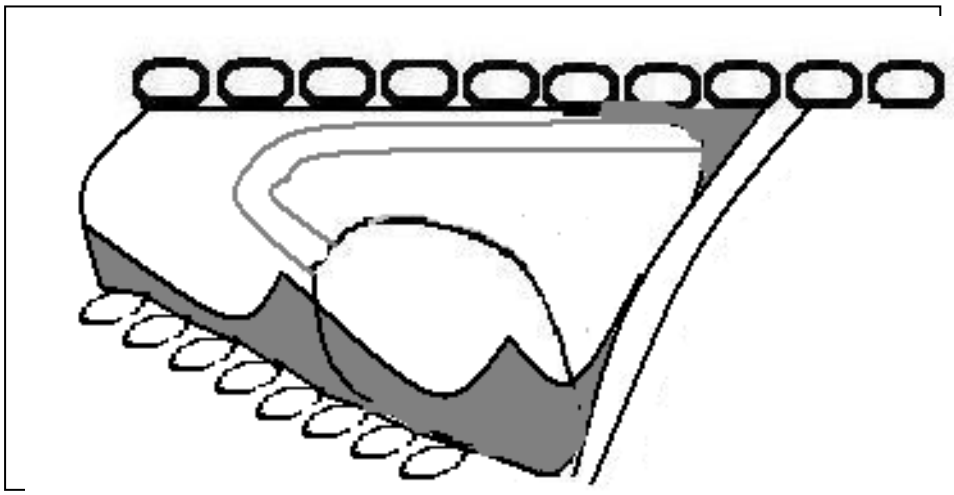
Radiographic Abnormalities

Pleural effusion

- Characterised by the collection of fluid (soft tissue opacity) in the pleural space
- The more fluid there is, the easier it is to recognise
    - <100ml (dog) or <50ml (cat) unlikely to be radiographically apparent
- Seen as a homogenous soft tissue opacity within the pleural space
    - Small amounts cause blunting of the costo-diaphragmatic recess (VD view) and the thoraco-diaphragmatic recess (lateral view)
        - Beware normal retraction of lungs from the spine in the cat
    - With more fluid there is scalloping of the ventral lung lobes (lateral view) and widening of the pleural fissures (lateral and VD)
        - These fissures are consistent in location
    - The cardiac silhouette merges with the fluid and becomes obscured
    - Differentiate from sternal fat which is seen ventral to the heart and lungs, but is more radiolucent than the heart
- **Differential diagnoses** for pleural effusion include:

Esther Barrett MA VetMB DVDI DipECVDI MRCVS esther@wales-and-west-imaging.co.uk

- Transudate / modified transudate, eg secondary to heart failure (especially cats), secondary to liver disease, protein losing diseases (true transudate), neoplasia, lung lobe torsion etc
- Exudate
  - Sterile eg due to FIP, neoplasia, occasionally pneumonia
  - Septic (pyothorax) eg due to trauma, foreign material, oesophageal rupture, rupture of lung abscess
- Chylothorax eg idiopathic, due to heart disease, cranial mediastinal mass
- Haemothorax eg due to trauma, coagulopathy, rupture of intrathoracic mass



Characteristic appearance of a pleural effusion

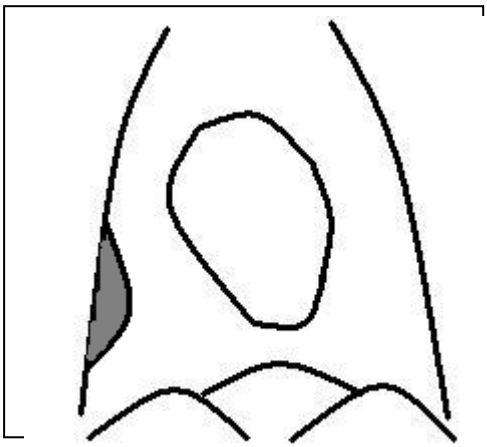
Pneumothorax

- Characterised by the collection of air within the pleural space
- Free air results in 'elevation' of the heart from the sternum by a gas lucency on the lateral view (as the patient is in lateral, the heart is actually falling away)
- Lung margins are retracted from the thoracic wall, diaphragm & spine in both views, with no lung markings visible in the periphery
  - Usually less easy to appreciate on the DV view
  - Overexposed or overinflated lungs and skin folds can be mistaken for a pneumothorax on the DV view
  - Use a bright light to look for lung markings
- Where the lungs are partially collapsed due to the surrounding pneumothorax, they will contain less air and will appear more radio-opaque than usual
- Pneumothorax is most commonly bilateral

Esther Barrett MA VetMB DVDI DipECVDI MRCVS esther@wales-and-west-imaging.co.uk

Extrapleural lesions

- Arise outside the pleural space, between the parietal pleura and the body wall
- Typically broad based lesions causing an 'inward bulging' of the pleural surface
- Differential diagnoses include subpleural haemorrhage and neoplasia of extra pleural structures (eg ribs)

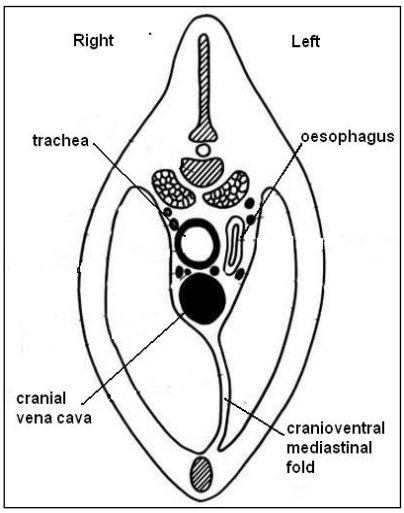


Typic xtrapleural lesion

The Mediastinum

Normal Anatomy

- The mediastinum is the space between the left & right pleural cavities, communicating cranially with the fascial planes of the neck, caudally with the retroperitoneal space & enclosing the midline thoracic structures
- Anatomically divided into cranial, middle and caudal areas
- Apart from the trachea and any air in the oesophagus, all mediastinal structures are of soft tissue opacity



Esther Barrett MA VetMB DVDI DipECVDI MRCVS esther@wales-and-west-imaging.co.uk

The Cranial Mediastinum

- Contains a surprisingly large number of structures including the thoracic trachea, oesophagus, cranial vena cava, brachycephalic trunk, cranial mediastinal lymph nodes, sternal lymph nodes and thymus
- Seen on the lateral view as a soft tissue band surrounding the air filled trachea and extending cranially from the heart base to the thoracic inlet
- Seen on the DV / VD view as a band of soft tissue superimposed on the thoracic spine
    - In a cat it should be no greater than the width of the thoracic spine
    - In a dog it should normally be no greater that 2x the width of the thoracic spine
        - Up to 3x in obese and some brachycephalic dogs
- The cranioventral reflection of the mediastinum
    - Seen on the lateral view as a narrow soft tissue band running towards the sternum, separating the apex of the left lung (cranial) from the apex of the right lung (more caudal)
    - Seen on the DV/VD view as a curved thin soft tissue band to the left of the spine
    - Contains the thymus, sternal lymph nodes, internal thoracic arteries & veins

The Middle Mediastinum

- Contains the heart, great vessels, azygos vein, thoracic duct, oesophagus, tracheal bifurcation and tracheobronchial lymph nodes

The Caudal Mediastinum

- Contains the descending aorta, oesophagus and caudal vena cava
- The caudoventral reflection of the mediastinum
    - Created by the right accessory lobe pushing across to the left of the midline
    - Usually seen on a VD view (less consistent on DV) as a soft tissue band to the left of the midline from the cardiac apex to the diaphragm

Esther Barrett MA VetMB DVDI DipECVDI MRCVS esther@wales-and-west-imaging.co.uk

Radiographic abnormalities

- Change in position = **mediastinal shift**
- Change in size and/or shape
- Change in opacity

- **A mediastinal shift** is recognised by the movement of the mediastinal structures away from the midline, due to volume changes in adjacent structures
    - Recognised only on the VD/DV view
    - Mediastinal shift towards an abnormal area occurs due to volume loss on that side
        - Eg due to unilateral lung lobe collapse
    - Mediastinal shift away from an abnormal area occurs due to increased volume on that side
        - Eg large lung mass, emphysematous lung lobe, unilateral effusion

- **Changes in size +/- shape** of the mediastinum are most commonly seen due to the accumulation of fluid or the presence of a mediastinal mass
    - Fluid typically results in widening of the mediastinum +/- reverse fissures extending from the midline out between lung lobes
        - Best appreciated in the cranial mediastinum on a VD view
    - Mediastinal masses are most often seen cranially
        - VD view: widening of the mediastinum, often with a change in contour +/- tracheal displacement
        - Lateral view: increased depth of the mediastinum, dorsal tracheal displacement +/- obscuring of the cranial lung lobes
        - Lymphoma and thymoma most common
        - Very amenable to ultrasound examination

- The most frequently appreciated **change in opacity** is increased lucency due to a **pneumomediastinum**
    - Mediastinal structures not normally seen, such as the brachycephalic trunk, are highlighted by the surrounding air and can be recognised
    - Because the mediastinum connects with the fascial planes of the neck and the retroperitoneum, air can pass to/from these areas
        - A pneumomediastinum may lead to a pneumothorax, although the reverse is rarely seen

Esther Barrett MA VetMB DVDI DipECVDI MRCVS esther@wales-and-west-imaging.co.uk

The **Oesophagus**

- Runs throughout the length of the mediastinum
- Generally not visible unless air-filled or dilated with fluid / ingesta / foreign body
    - Air within the oesophagus of a sedated or anaesthetised animal may be an incidental finding

- **Oesophageal Abnormalities**
    - **Mega-oesophagus**
        - The enlarged oesophagus is most easily identified where it is gas-filled; it may also contain food material +/- fluid
        - Air within the cranial thoracic oesophagus will highlight the dorsal tracheal wall: the 'tracheal stripe sign'
        - A dilated oesophagus will often displace the trachea ventrally and to the right and displace the heart base ventrally
        - An important secondary finding with any oesophageal disease is the presence of aspiration pneumonia
            - The cranial and middle ventral lungs lobes should always be carefully assessed for pathological change

    - **Oesophageal foreign bodies**
        - Typically lodge at the thoracic inlet, the base of the heart or just in front of the diaphragm
        - May be radio-opaque (eg bones) and easily seen or radiolucent and easily missed
        - Aspiration pneumonia & oesophageal perforation are possible complications

    - **Contrast studies** may be useful in deciding whether oesophageal dilation is general or localized
        - Liquid or powdered Barium mixed with palatable food is fed to the animal and a thoracic radiograph taken immediately
        - Remember that there is a significant risk of aspiration if a barium meal is fed to a sedated animal or to a severely dysphagic patient
        - Barium must never be used if there is a suspicion of oesophageal perforation; use non-ionic iodine instead

Esther Barrett MA VetMB DVDI DipECVDI MRCVS esther@wales-and-west-imaging.co.uk

The Trachea

- The most visible structure in the cranial mediastinum
- Should be air-filled and of a consistent diameter with a smooth internal surface
    - Diameter should be >0.2 x the depth of the thoracic inlet
    - Diameter should not vary significantly between inspiration & expiration
- Some mineralisation of tracheal cartilages is a normal finding in older cats & dogs
- Divides into the mainstem bronchi at the carina
    - Normally located at the level of the 5th intercostal space

- **Tracheal abnormalities**
    - Displacement of the trachea may occur due to changes in patient positioning, adjacent masses and oesophageal dilation
    - Tracheal hypoplasia is diagnosed where the diameter of the trachea is <0.2 x the thoracic inlet
        - Can be 0.11 in Bulldogs & 0.16 in other brachycephalic
    - Tracheal collapse is seen as dynamic narrowing of the cervical trachea on inspiration and of the thoracic trachea on expiration
    - Tracheal foreign bodies may be recognised as opaque structures highlighted against the air filled lumen
        - At least 2 views should be taken for definitive localisation
    - Intraluminal masses (rare) may be similarly highlighted against the lucent background, provided they are of sufficient size
        - Differential diagnoses include parasitic nodules (Oslerus osleri), abscesses, granulomas, neoplasia

The **lymph nodes**

- Generally not seen unless enlarged
- Mediastinal lymph nodes lie ventral to the trachea in the cranial mediastinum
- Sternal lymph nodes are usually paired and lie just dorsal to the 2nd sternebra within the cranioventral mediastinal reflection
    - Occasionally normal sternal nodes are seen in big dogs
- Left, right and middle tracheobronchial lymph nodes are located in the middle mediastinum in between and either side of the tracheal bifurcation

Esther Barrett MA VetMB DVDI DipECVDI MRCVS esther@wales-and-west-imaging.co.uk

- Lymph node enlargement
    - Cranial mediastinal lymph nodes
        - Widening of the cranial mediastinum (often with an undulating ventral border)
    - Tracheo-bronchial lymph nodes
        - Soft tissue masses in the perihilar region, with ventral deviation of the mainstem bronchi (lateral view)
        - Widening of the angle between the mainstem bronchi
            - 'cowboy legs' sign (differential diagnosis= LA enlargement)
    - Sternal lymph nodes
        - Broad based soft tissue masses dorsal to the 2nd sternebra

The Thoracic Boundaries

- Defined by the thoracic inlet cranially, the spine dorsally, the sternum ventrally, the rib cage and thoracic wall laterally and the diaphragm caudally

- The **thoracic inlet** is demarcated radiographically as the area between the first pair of ribs
    - In the dog, the apex of the left lung may extend beyond the thoracic inlet when fully inflated
    - The dog's right lung & both cat lungs should extend to the level of the 1st rib

- The **thoracic spine** should comprise 13 thoracic vertebrae characterised by long dorsal spinous processes (DSPs)
    - The anticlincal vertebrae (usually T11) has the most dorsoventrally (vertically) orientated DSP
    - Vertebral spondylosis is a common incidental finding
    - Other possible radiographic abnormalities of the vertebrae include congenital abnormalities, traumatic damage, degenerative change, infection, neoplasia etc

- The **sternum** should consist of 8 sternebrae
    - The manubrium is the most cranial and the xiphisternum (or xiphoid process) the most caudal
    - Variations in normal sternal anatomy are a common incidental finding

Esther Barrett MA VetMB DVDI DipECVDI MRCVS esther@wales-and-west-imaging.co.uk

- **Pectus excavatum** is a congenital abnormality where the sternum is deviated dorsally into the thoracic cavity, displacing the heart and ribs

- There should be 13 pairs of **ribs** which articulate with the cranial aspect of each thoracic vertebra
  - The first 8/9 ribs should articulate with the sternum via the costal cartilages (sternal ribs)
  - Except for the last rib (in the dog) or 2 ribs (in the cat), the remaining ribs fuse with the last sternal ribs to form the costal arch
  - Turning the radiograph through 90^{o} provides a novel way of looking at the image which can help you focus on the ribs
  - **Rib fractures**
    - Recent fractures may be a significant finding following trauma
    - Healed fractures often seen as an incidental finding in older animals (especially cats)
  - **Rib tumours** are easily overlooked
    - Examine each rib for evidence of osteolysis +/- new bone production
    - Usually associated with an extrapleural mass +/- pleural fluid

- The **diaphragm** consists of the muscular right and left crura, and a central tendinous dome
  - The crura attach dorsally to the ventral aspect of L3/4
    - It is normal to see roughening of the ventral cortex of the vertebral bodies at the site of attachment
  - There are 3 openings through the diaphragm
    - Dorsal aortic hiatus (also contains azyos vein and thoracic duct)
    - Central oesophageal hiatus
    - Ventral caval hiatus (for CVC) to right of midline

  - **Diaphragmatic rupture** is characterised by
    - A loss of the clear diaphragmatic line
    - Presence of abdominal organs into the thoracic cavity
    - Absence of organs in the abdominal cavity

Esther Barrett MA VetMB DVDI DipECVDI MRCVS esther@wales-and-west-imaging.co.uk