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Post-Mortem Investigation into Respiratory Distress / Dyspnoea in Adult Dogs

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When performing a post-mortem investigation on an adult dog which has died with the primary complaint of respiratory distress/ dyspnoea, the following check lists can be utilised to ensure that the most common causes of difficult/impaired respiration are investigated in a systematic fashion.

NASAL CAVITY AND SINUSES

- Foreign bodies
- Mycotic rhinitis
- Allergic rhinitis
- Infectious rhinitis
- Lymphoplasmacytic rhinitis
- Oronasal fistula
- Neoplasia

Foreign bodies

Grass awns are the most common foreign bodies involved in initiating florid rhinitis, which is frequently proliferative, leading to nasal passage occlusion and resultant dyspnoea.

Once these foreign bodies have breached the nasal respiratory epithelial surface, they move in a random and unpredictable fashion and tend to produce persistent and progressive proliferative inflammation. Some foreign bodies are a vehicle for carrying bacteria/fungi to subepithelial sites thereby bypassing the protective epithelial surfaces.

Allergic rhinitis

Allergic rhinitis is usually characterised by a chronic rhinitis with proliferation and thickening of the nasal mucosa, often with lymphoid nodular hyperplasia and the formation of nasal polyps (which may resemble neoplasia). Cytological examination of nasal mucosal impression smears or scrapings frequently reveals significant numbers of eosinophils.

Mycotic rhinitis

Aspergillus fumigatus is the usual and most common cause of mycotic rhinitis in dogs. Exposure to high levels of environmental fungi by inhalation is believed to be the primary route of infection. Fungal infection due to suppression of normal nasal defences is rarely documented in dogs.

Pathology is usually focal within the nasal cavity or paranasal sinuses and characterised by large yellow green or black proliferative mats of fungal hyphae, which erode and excavate the nasal conchae with distortion and destruction of nasal bones and the nasal septum with nasal airway passage obstruction. Cytological examination of impression smears or tissue scrapings usually reveal large numbers of parallel walled, septate fungal hyphae with or without fruiting bodies.

In Western Australia in particular, Cryptococcosis (*Cryptococcus gatti*) is an important cause of mycotic rhinitis and upper airway disease. Unlike *C. neoformans* which is only reported in immunocompromised dogs, *C. gatti* is a primary pathogen. Post-mortem lesions are characterised by gelatinous masses, granulomas and/or ulcerating nodules in the nasal cavity and upper airways. Impression smears from lesions for cytology are extremely useful diagnostic procedures due to the unique cytological characteristics of *Cryptococcus*. In cytological smears yeasts are 4-8 µm in diameter, with thick clear staining mucoid capsule (creating the halo effect) and narrow based budding, creating the diagnostic "Mickey Mouse" morphology.

Bacterial rhinitis

Streptococcus canis and *Streptococcus equi* ssp. *zooepidemicus* have been associated with outbreaks of acute suppurative and frequently necro-haemorrhagic rhinitis. These outbreaks are most commonly seen in kennels, shelter environments and intensive breeding facilities

Idiopathic lymphoplasmacytic rhinitis

This is an extremely important disease syndrome of dogs characterised by unilateral or bilateral rhinitis characterised by excessive surface mucous, mucosal inflammation and turbinate destruction. The cause and pathogenesis of this disease remain unknown. It seems reasonable to consider that following an unknown initial insult, there develops a self-propagating cycle that involves dysregulation of the local immune system, resulting in mucosal damage and further infection by normally non-pathogenic commensal flora and self-sustaining inflammation.

Oronasal fistula

These fistulous tracts are abnormal passageways between the nasal and oral cavities. They occur because of injury, infection, or disease. Dolichocephalic (long nosed) breeds of dogs are most likely to develop this condition, especially Dachshund's. The most common location is where the root of the 4th premolar on the upper jaw enters the palate.

Neoplasia

Nasal carcinomas are the most common nasal tumours in dogs with adenocarcinoma variants the most frequently diagnosed. These tumours grow slowly with the pathology induced by space occupation with local destruction and invasion, metastasis is uncommon and a late stage event.

LARYNX AND TRACHEA

- Laryngeal paralysis
- Laryngeal oedema
- Laryngitis

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- Brachycephalic airway syndrome
- Tracheal collapse
- Neoplasia

Laryngeal paralysis
This condition is documented most commonly in older male, large/giant breed dogs. Hereditary links have been made in Bouviers, Rottweilers, white coated GSD'S and Husky-Malamute mixes. Recurrent laryngeal neuronopathy, generalised neuromuscular disease and hypothyroidism are other causes. Pathology is characterised by swelling and inflammation of the laryngeal folds with aspiration pneumonia and megaoesophagus being common accompanying lesions.

Laryngeal oedema
Significant laryngeal oedema leads to severe respiratory compromise with outspoken dyspnoea due to restriction of the laryngeal opening into the trachea. Inhalation of irritant materials, local trauma, anaphylaxis, or hyperthermia are the most common causes.

Brachycephalic airway syndrome
This is a pathological condition that affects the "short-nosed" breeds of dogs and can lead to severe and life-threatening respiratory distress. Four different anatomical abnormalities are associated with this condition, and patients may have one, multiple or all of them. These abnormalities include everted laryngeal saccules, elongated soft palate, hypoplastic (under-developed) trachea and narrow (stenotic) nasal airways/passages.

The net outcome is interference with the normal respiration, leading to difficulty in breathing. This dyspnoea is severely exacerbated by stress, exercise, and heat (hyperthermia). The inability of these animals to breathe effectively, i.e. take deep enough and fast enough breaths, reduces their ability to adequately dispose of carbon dioxide from the respiratory system. The increased levels of carbon dioxide further increase the respiratory demand to meet tissue oxygen requirements, resulting in further increases in the respiratory and heart rates to compensate and this rapidly develops into a life-threatening situation.

Tracheal collapse
This is a condition most commonly involving middle-aged dogs of the miniature breeds. The condition is characterised by dorsoventral flattening of the trachea (cartilage necrosis is the central lesion) with laxity of the dorsal tracheal ligament. Lesions often extend to involve the bronchial airways with airway collapse as well.

LUNGS

- Lung lobe torsion
- Atelectasis
- Secondary over-inflation of alveoli
- Pulmonary oedema
- Pulmonary mineralisation
- Bronchiectasis
- Infectious pneumonias
- Diffuse alveolar damage
- Pneumoconiosis

Lung lobe torsion
Lung lobe torsion most often affects the right middle lobe of large deep-chested breeds of dogs. This is presumed the result of the narrow waist at the hilus, whereas the left cranial lobe is more commonly affected in small-breed dogs. Most cases are idiopathic, but a minority have neoplasia, pneumonia, or atelectasis of the affected lobe, congenital dysplasia or hypoplasia of the bronchial cartilage, previous thoracic surgery, or pneumothorax. The affected lobe is twisted at the hilus and deeply congested. Pleural effusion is consistently present and may be transudative, chylous, exudative, or bloody.

Atelectasis
Various forms of acquired atelectasis are described including obstructive, compressive, and total. **Obstructive atelectasis** is caused by complete airway obstruction. Whether atelectasis follows obstruction depends on the size of airway obstructed and the degree of collateral ventilation. A lobular pattern of atelectasis suggests bronchial obstruction as the cause.

Compressive atelectasis is caused by pleural or intrapulmonary space-occupying lesions including fluid accumulations (hydrothorax, haemothorax, exudative pleuritis), and tumours.

Abdominal distension, as in severe ascites may cause partial atelectasis, typically in the cranial regions where ventilatory movements are most easily compromised by intra-abdominal pressure. **Total atelectasis** is seen in animals that die while breathing 80-100% oxygen during anaesthesia or intensive care.

Secondary "alveolar emphysema" (over-inflation of alveoli)
Primary alveolar emphysema does not occur in dogs whereas over-inflation of alveoli is common. This alveolar over-inflation is always secondary to some obstructive condition, usually airway obstruction or spasm. Over-inflated alveoli most commonly located at the apices of the lungs.

Pulmonary oedema
Pulmonary oedema severely compromises lung function through reduction in pulmonary compliance (blocking ventilation, obstructing gas exchange, reducing area of air liquid interface of alveoli).

Possible causes of pulmonary oedema include increased venous hydrostatic pressure (left heart failure, over-hydration), increased permeability/damage of the alveolar barrier (pneumonia, diffuse alveolar damage, endotoxemia/septicaemia, anaphylaxis, inhalation anaesthetics, endotheliotropic viruses), neurogenic pulmonary oedema secondary to brain trauma (brain-lung syndrome) and acute upper-airway obstruction (strangulation).

Pulmonary mineralisation
Dogs with renal failure (acute/chronic) may develop pulmonary mineralisation with deposition of mineral within the smooth muscle and connective tissue of alveolar septae, walls of pulmonary veins and bronchioles (uremic pneumopathy). Pulmonary mineralisation is also an important indicator of cholecalciferol rodenticide poisoning. Grossly the lung may be gritty and porous with pulmonary oedema.

Bronchiectasis
This is permanent dilation of bronchi because of chronic bronchial obstruction and infection. The lesions most commonly affect the right cranial or middle lung lobes in dogs.

Infectious Pneumonias

- Bacterial bronchopneumonia (*Bordatella*, *Streptococcus* spp, *Pasteurella* spp., *Staphylococcus* sp, *Escherichia coli*, anaerobic bacteria). Bacterial pneumonias present as bronchopneumonia's with or without pleuritis. The presence of pleuritis definitively confirms bacterial involvement, while its absence would not exclude bacterial pneumonia

- Viral interstitial pneumonia. Viral pneumonias classically present with an interstitial pattern of pneumonia (canine distemper, canine influenza, HPAI).

- Mycotic pneumonia. Usually as an extension of nasal aspergillosis, particularly in German shepherd dogs. Pulmonary cryptococcosis results from wider dissemination from upper respiratory tract infection. Both fungi have unique cytological characteristic and therefore, impression smears from lesions are useful diagnostic procedures.

Diffuse alveolar damage
Diffuse alveolar damage is a form of interstitial lung disease with non-viral causes including thermal injury (smoke inhalation), paraquat poisoning, aspiration of gastric acid, oxygen poisoning, pancreatitis, endotoxemia/enterotoxaemia and anaphylaxis.

Pneumoconiosis
Pneumoconiosis is the syndrome resulting from inhalation and retention of inorganic dusts.

Anthracosis (carbon) is commonly documented in city dwelling dogs, while silicate pneumoconiosis is the only other well documented pneumoconiosis in domestic animals.

Neoplasia
Epithelial tumours are the most common primary pulmonary neoplasia in dogs.

The lung does, however, serve as a common metastatic site for many different neoplasia's.

PLEURA

- Pleural effusions (non-inflammatory)
- Pneumothorax
- Pyothorax
- Mesothelioma

Pleural effusions (non-inflammatory)

- Hydrothorax – accumulation of clear, watery, light-yellow fluid with low protein and cell content. Causes include increased venous pressure, lymphatic obstruction, and hypoproteinaemia.
- Haemothorax – free lying blood in the pleural space. Causes include thymic haemorrhage (idiopathic, coumarin derivative rodenticides), aortic rupture (*Spirocerca lupi*) and ruptured cardiac hemangiosarcoma.

Pneumothorax

- Rupture of pulmonary blebs and bullae are common **primary spontaneous** causes of pneumothorax in dogs. There is a breed predisposition to their development in deep chested, large breed dogs. Lesions present as distended bubbles at the apices of cranial and middle lobes.
- Secondary spontaneous pneumothorax – is associated with underlying lung disease, where rupture of lesions forms a communication between the airway and pleural space (parasitic cysts, abscesses, pyogranulomas). Barotrauma (forced ventilation during anaesthesia) is an important cause of pneumothorax in the dog.
- Traumatic pneumothorax – usually due to accidental puncture of the thoracic wall and/or visceral pleura. It can also be a complication of cardiac resuscitation.

*In all cases of anaesthesia associated death, lungs should be submerged under water and then infused with air via the trachea/bronchus to identify ruptured blebs.

Pyothorax/thoracic empyema
This syndrome is characterised by filling of the pleural space with exudate. This condition is most common in rural dogs.

Lesions are usually bilateral and exudate which is frequently dark red and bloody in appearance. Bacteria most commonly involved include *Actinomyces*, *Nocardia* and *Bacteroides* spp.

Mesothelioma
An association between asbestos fibres and mesothelioma, as in humans, has not been confirmed in animals. These tumours arise from the serosal epithelial cells lining the pericardial, pleural, and peritoneal cavities and may involve all three locations.

They occur as multiple, firm, sessile or pedunculated nodules from a few millimetres to as large as 10 centimetre in diameter, or as villous projections, or as fibrous to sclerosing forms which are more plaque-like lesions. Tumours are frequently associated with a milky or blood tinged effusion and in sclerotic tumours these lesions may even resemble chronic granulomatous peritonitis. Virtually all tumours are malignant.

*Metastatic neoplasms (trans-pleural spread of carcinomas and sarcomas) of the pleura are more common than mesothelioma.

References

1. Maxie MG. 2016. *Pathology of Domestic Animals* 6th edition. Elsevier, St. Louis.
2. Meuten DJ. 2017. *Tumours in Domestic Animals* 5th edition. Wiley-Blackwell, Iowa.
3. Zachary JF. 2016. *Pathological Basis of Veterinary Disease* 6th edition. Elsevier, St. Louis.

MULTIPLE-CHOICE QUESTIONS

QUESTION 1

Which of the following statements about nasal aspergillosis in dogs is INCORRECT?

a. *Aspergillus fumigatus* is the most common fungal species involved in clinical disease
b. Suppression of nasal defences is commonly associated with infection
c. Pathology is usually focal in the nasal cavity
d. Distortion and destruction of the nasal septum may follow fungal infection
e. Fungal hyphae can be demonstrated in cytological smears

QUESTION 2

Which of the following bacteria HAVE been associated with outbreaks of suppurative and necro-haemorrhagic rhinitis in dogs in boarding kennel facilities?

a. *Streptococcus equi* ssp *zooepidemicus*
b. *Streptococcus equi* ssp *equi*
c. *Streptococcus pyogenes*
d. *Streptococcus suis*
e. *Streptococcus agalactiae*

QUESTION 3

Nasal tumours of dogs are MOST commonly which of the following?

a. Squamous cell carcinoma
b. Fibrosarcoma
c. Osteosarcoma
d. Chondrosarcoma
e. Adenocarcinoma

QUESTION 4

Of the following five anatomical abnormalities, one HAS NOT been associated with the brachycephalic airway syndrome, which one is it?

a. Everted laryngeal saccules
b. Elongated soft palate
c. Elongated tongue
d. Hypoplastic trachea
e. Stenotic nasal passages

QUESTION 5

What IS the central pathology causing tracheal collapse?

a. Laxity of the dorsal tracheal ligament
b. Tracheal ring cartilage necrosis
c. Chondrodysplasia of cartilage rings
d. Collagen disorder
e. Ossification of cartilage rings

QUESTION 6

Which of the following conditions TYPICALLY CAUSES partial atelectasis of the cranial regions of the lung?

a. Bronchial airway obstruction
b. Pulmonary neoplasia
c. Haemothorax
d. Oxygen toxicity during anaesthesia
e. Ascites

QUESTION 7

Of the following aetiological agents, which IS NOT associated with diffuse alveolar damage?

a. Thermal injury (smoke inhalation)
b. Paraquat poisoning
c. Aspiration of gastric acid
d. Pulmonary aspergillosis
e. Pancreatitis

QUESTION 8

Urban dogs commonly HAVE which of the following pneumoconiosis?

a. Silicosis
b. Anthracosis
c. Asbestosis
d. Siderosis
e. Aluminosis

QUESTION 9

Which of the following IS CONSIDERED an important potential serious complication of manual ventilation of dogs under anaesthesia?

a. Pulmonary oedema
b. Pulmonary haemorrhage
c. Tracheal collapse
d. Pneumothorax
e. Bronchiectasis

QUESTION 10

Which of the following bacterial ARE most commonly associated with pyothorax in the dog?

a. *Actinomyces* sp
b. *Escherichia coli*
c. *Staphylococcus aureus*
d. *Pseudomonas* sp
e. *Pasteurella* sp

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