# Cardiac neoplasia

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**Overview:**
Cardiac neoplasms are uncommon tumours in dogs with an incidence between 0.2% to 3%. They may arise from various cardiac sites, including the atria, auricles, valves, ventricular wall, heart base, pericardial tissue, and the great vessels; the most commonly identified primary cardiac tumours are haemangiosarcomas, chemodectomers (heart base tumours) and mesotheliomas. Other tumours identified include ectopic thyroid carcinomas, sarcomas, lymphoma, myxoma and osteosarcomas. Metastatic neoplasms, namely haemangiosarcoma (from the primary splenic site) and multicentric lymphoma, melanoma and carcinomas, have been demonstrated.

**Clinical signs and laboratory findings:**
Clinical signs are secondary to location, degree of compression of the cardiac structures, presence of effusions, haemodynamic compromise and less so due to the underlying histopathology. Dogs present clinically with signs ranging from none (incidental finding) to weakness and collapse, pale mucous membranes, reduced pulse quality, muffled heart sounds, jugular distension, tachycardia, tachypnoea and syncope. Right heart failure with pleural and abdominal effusions may present depending on the chronicity. The pleural and abdominal effusion is often a clear-straw-coloured modified transudate secondarily to increased hydrostatic/ obstructive pressure. The pericardial effusion, however, is predominantly haemorrhagic, especially if tumour bleeding is evident (haemangiosarcomas), yet may also be modified-transudate to non-septic exudate as well (chemodectomers and mesotheliomas). As alluded to earlier, heart base tumours may be incidentally found on routine radiographs or echocardiograms.

A full blood count may demonstrate thrombocytopaenia and left-shift leucocytosis with haemogram changes of anaemia, schistocytosis and acanthocytes. The biochemistry changes of azotaemia and elevated hepatic enzymes may be present secondarily to congestion, hypotension and hypoxia. Coagulation profile prolongations and abnormalities may be present specifically with haemangiosarcomas. Despite the biochemistry and full blood count (FBC) changes, no abnormalities are pathognomic for the primary neoplasm.

**Haemangiosarcomas:**
Haemangiosarcoma, the most common primary cardiac neoplasm in dogs (up to 46%), is a highly aggressive malignant endothelial cell tumour arising predominantly along the right atrium or auricle. The tumour has an invasive growth pattern and may extend through the atrioventricular junction into the right atrium and ventricular wall. It has also been identified in the heart base as an additional location. Cardiac haemangiosarcomas can represent a secondary metastatic site from primary splenic lesions. These tumours are often demonstrated in middle-aged to older (median nine years), with an increased prevalence in German shepherd dogs, Golden retrievers, and Labrador retrievers reported.

**Chemodectomers/ aortic body tumours/ heart base tumours:**
These tumours are the second most common primary neoplasm and originate from chemoreceptor tissues along the heart base and aortic root. An increased prevalence is seen in brachycephalic dogs such as the Boxer, Boston terrier and English bulldog. A potential aetiology for this breed being over-represented is the stimulation and proliferation of chemoreceptor cells due to chronic hypoxia. The tumours are relatively slow growing, may invade the atria and are considered "benign" with rare metastasis. The median age at presentation is also nine years.

**Mesotheliomas:**
These neoplasms are of mesothelial cell origin along the pleural, peritoneal and pericardial surfaces, resulting in secondary effusions in the various cavities. The pericardial changes identified on ultrasound or computed tomography may not always be present, and therefore the strongest differential is idiopathic pericardial effusions. The median age of presentation has been reported as ten years old.

**Secondary neoplasia:**
As briefly mentioned, secondary cardiac tumours are less common and part of a multicentric neoplastic disease. Carcinomas, melanomas, lymphomas, sarcomas and haemangiosarcomas may all metastasise to the heart. The anatomic location is commonly the ventricular wall compared to the other primary cardiac neoplasia sites.

**Diagnosis:**
Diagnostic imaging is the cornerstone for making a non-invasive and presumptive diagnosis. Radiography is a good screening tool for cardiomegaly, yet it demonstrates poor sensitivity and specificity. Cardiac neoplasms with pericardial effusions display the typical rounded globoid cardiac silhouette. Yet, for those without pericardial effusion, a soft tissue opacity mass could be evident along the heart base with a deviation of the trachea and potential compression of the mainstem bronchi.

A thorough evaluation of the pulmonary parenchyma for metastatic lesions should also be performed concurrently with radiography. Echocardiography is the most accessible modality of choice, which may demonstrate pericardial effusions, cardiac tamponade, masses at various locations, tumour thrombus extension and pericardial wall thickening. Echocardiography has reported a sensitivity of 82% and specificity of 100% for demonstrating masses but 50-78% in correctly identifying the underlying tumour type.

Haemangiosarcoma appearance ranges from heterogenous hypo- to iso-echoic to a more complex and cavitary appearance. Chemodectomers are often solid, homogenous, and hypo- to iso-echoic on ultrasound.

Mesotheliomas are not as clearly defined, whereby imaging has been reported negative in up to 55% of cases. Ultrasound changes, if present, are diffusely thickened pericardial walls, pericardial nodules and wall irregularity. Definitive diagnosis is further obfuscated as reactive mesothelial tissue displays similar characteristics. Clinical signs, imaging, histopathology and immunochemistry are required for a definitive mesothelioma diagnosis.

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The typical cardiac locations are suggestive of the tumour type, such as right atrial haemangiosarcomas and heart base chemodectomers, yet variations do occur. More advanced imaging modalities, namely: computed tomography (CT) and cardiac magnetic resonance imaging (cMRI) (becoming increasingly available), can provide additional information on tumour demarcation and invasiveness used for surgical or radiation planning.

Electrocardiography (ECG) changes occur from invasion and disruption of cardiac structures, conduction nodes and pericardial effusions. A multitude of changes may occur, such as: reduced QRS amplitudes, ST segment elevations, atrial fibrillation, and electrical alternans, to name a few.

Pericardial effusion evaluation is often haemorrhagic and unrewarding. The fluid has been reported non-diagnostic in 92% of cases, yet increased diagnostic yield has been demonstrated when effusion haematocrit is <10%. The varying degrees of cardiac tamponade and impaired function depend on the effusion accumulation's chronicity. Acute effusions (sudden bleeds from haemangiosarcoms) often result in acute collapse and animal compromise compared to slower-forming accumulations whereby the pericardial space can accommodate larger volumes. Significant volumes > 1 litre may be removed from the pericardial space.

Histopathology is the gold standard for diagnosis, yet tumour location and size may be difficult and high risk to obtain antemortem. Pericardectomy with histopathology (and immunohistochemistry) can be performed for both diagnostic and therapeutic purposes in certain cases, especially those with recurring effusions and cardiac tamponade. Caution, however, must be exercised as reported sampling complications have been haemorrhage, pneumothorax, cardiac puncture and arrhythmias.

**Treatment:**
Cardiac tumours are predominantly incurable. Palliative care can be provided to reduce patient compromise and mitigate tumour-related consequences. Pericardiocentesis is a relatively non-invasive, readily performed procedure that can be life-saving by reducing cardiac tamponade. The procedure should be performed with intravenous access in a sterile fashion on the right-sided thorax under ultrasound guidance, using a soft-tip catheter and appropriate patient control.

Caution with myocardial laceration, puncture and arrhythmic events when needles are used on poorly restrained animals. The author utilises ultrasound guidance, local region anaesthetic block and intravenous butorphanol for appropriate patient control. Laceration of the pericardial wall can also result in the alleviation of tamponade if the catheter cannot be placed appropriately within the pericardial space. Although life-saving, the effects are short-lived, with effusions reoccurring within days to weeks. If multiple pericardiocenteses are required with effusions persistently re-accumulating, a pericardectomy should be strongly recommended to clients. Pericardectomy can be therapeutic and diagnostic in cases with persistent pericardial effusion accumulations. If a mesothelioma diagnosis is made, appropriate additional therapies can be instituted. However, in cases with haemangiosarcoma, life-threatening bleeding may occur into the pleural cavity. Therefore pericardectomy is best utilised for chemodectomers and mesotheliomas, whereby active bleeds occur less frequently.

Additional novel therapies that are gaining traction are the polysaccharopeptide extract from the mushroom *Coriolus versicolour* and the Chinese herbal supplement Yunnan Baiyou.

These agents have been anecdotally or in preliminary pilot studies shown to control haemorrhage, delay metastasis and prolong survival in haemangiosarcomas. Further evidence is required before these agents are used readily. More specific tumour treatments can be divided into surgery, chemotherapy and radiation. Surgical removal is often not feasible due to the invasive nature and anatomical sites. There are. However, case reports describe specific surgical techniques.

Systemic chemotherapy using doxorubicin-based protocols is recommended for haemangiosarcomas to improve survival times. These median survival times (MST) have been reported at 112 days for doxorubicin alone and 175 to 189 days when mass resection combined with doxorubicin has been employed. Surgery alone reports poor survival times ranging between 42 to 86 days.

No consistent data is available for a specific chemotherapy agent to manage chemodectomers; pericardectomy has reported MST of 730 days for these neoplasms. For mesotheliomas (pleural and pericardial), chemotherapy has been reported as the only treatment significantly associated with survival. Median survival times of up to 366 days have been reported with chemotherapy in comparison to 74 days without. Chemotherapy may be administered intra-cavitary, intravenously or both but without a clear benefit in the best protocol or agent. The most common agents utilised are cisplatin, carboplatin and mitoxantrone. If an intra-cavitary route is chosen, administer pleurally and avoid entering the pericardial space. Metronomic chemotherapy, the continual, daily low-dose chemotherapy protocol, has anecdotally been used in a few studies and case reports for haemangiosarcomas (non-cardiac) and chemodectomers. Convincing data for its recommendation is currently lacking.

Radiation therapy is an additional modality that can also be utilised. Stereotactic body radiation therapy (SBRT) performed in a study of 23 dogs with heart base tumours demonstrated overall survival times of 404 days, with most dogs displaying partial response or stable disease. These techniques are currently limited due to availability and cost in South Africa.

**Monitoring:**
Regular evaluations using echocardiography and thoracic radiographs are required to assess for fluid accumulations and cardiac dysfunction. Serial biochemistry and FBCs should also be performed, especially if animals are on chemotherapy protocols, and to monitor degrees of anaemia in haemangiosarcoma cases.

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# MULTIPLE-CHOICE QUESTIONS

**QUESTION 1**

**Which are the most common primary cardiac neoplasms?**

a) Haemangiosarcoma, lymphoma, chemodectomer
b) Haemangiosarcoma, ectopic thyroid carcinoma, lymphoma
c) Haemangiosarcoma, osteosarcoma, mesothelioma
d) Haemangiosarcoma, mesothelioma, lymphoma
e) Haemangiosarcoma, mesothelioma, chemodectomer

**QUESTION 2**

**Cardiac haemangiosarcoma may be present in which cardiac location?**

a) The left atrium and auricle
b) The right atrium and auricle
c) The heart base
d) Both b and c
e) None of the above

**QUESTION 3**

**Which complications may arise with pericardiocentesis procedure?**

a) Lung laceration
b) Myocardial puncture
c) Arrhythmic events
d) Pneumothorax
e) All of the above

**QUESTION 4**

**The most common cardiac location for splenic haemangiosarcoma metastasis?**

a) Heart base
b) Left atria or auricle
c) Right ventricle
d) Right atrium or auricle
e) Any cardiac location

**QUESTION 5**

**Which treatment may improve the outcome of cases with chemodectomers?**

a) Doxorubicin-based chemotherapy
b) Metronomic chemotherapy
c) Pericardectomy
d) Yunnan Baiyou
e) Intra-cavitary chemotherapy

**QUESTION 6**

**Cases with cardiac mesothelioma should be treated with which option?**

a) Pleural intra-cavitary chemotherapy
b) Pericardial intra-cavitary chemotherapy
c) Pleural and pericardial intra-cavitary chemotherapy
d) Metronomic chemotherapy
e) Pericardectomy only

**QUESTION 7**

**Which modality is best to accurately diagnose mesothelioma?**

a) Pericardiocentesis
b) Echocardiogram
c) Computed tomography
d) Histopathology
e) All of the above

**QUESTION 8**

**Heart base tumours are suggested to arise from…**

a) Aortic baroreceptors
b) Aortic chemoreceptors
c) Cardiac myocytes
d) Cardiac endothelial cells
e) Vascular progenitor cells

**QUESTION 9**

**The most common cardiac location of chemodectomers is...**

a) Ventricular walls
b) Left atria/ auricle
c) Right atria/ auricle
d) Heart base
e) None of the above

**QUESTION 10**

**Cardiac haemangiosarcomas should be treated with which option?**

a) Intracavitary carboplatin or cisplatin
b) Metronomic chemotherapy
c) Yunnan Baiyu
d) Pericardectomy only
e) Doxorubicin- based chemotherapy

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