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CASE REPORT

# Aneurysm of the pulmonary artery in a sheep with pulmonary adenocarcinoma

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**ABSTRACT.** Aneurysm of the pulmonary artery is a rare condition in animals, and to our knowledge it has never been reported in association with pulmonary neoplasia. This report describes a case of an adult female sheep of the "Churra Galega Bragançana" breed with an aneurysm of the pulmonary artery associated with lung cancer (ovine pulmonary adenocarcinoma).

*Key words*: aneurysm, pulmonary adenocarcinoma, sheep.

An aneurysm is a localised dilation or blood-filled sac of a thinner and weakened portion of a blood vessel. Aneurysms usually develop at the point where the blood vessel branches form, as it is structurally the most vulnerable part (Curtis *et al.*, 2019). They may occur in any blood vessel, but arteries seem to be more predisposed to the development of this lesion (Markovitz *et al.*, 1989). A true aneurysm comprises the three layers of the wall of a blood vessel: intima, media and adventitia whereas a pseudoaneurysm contains no layer of the wall of the vessel. They can result in thrombus development and subsequent embolization (Kim & Han, 2015). Aneurysms are potentially fatal if they rupture, with death occurring within minutes (Curtis *et al.*, 2019).

Aneurysms of the pulmonary artery are rarely seen in humans or animals. Most cases are idiopathic, but some causes include copper deficiency in pigs, parasites in cetaceans, syphilis, mycotic infection, chronic pulmonary hypertension, bacterial endocarditis, neoplasia, trauma, vasculitis and Marfan's syndrome in humans (Sadek *et al.*, 2008, Lafita *et al.*, 2007, Martineau *et al.*, 1986).

Aneurysms of the pulmonary artery associated with pulmonary neoplasia have been rarely reported in humans and, to the author's knowledge, have not yet been reported in veterinary medicine.

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An adult (3 years) female sheep of the "Churra Galega Bragançana" breed (autochthonous Portuguese breed) presented progressive weight loss (from 60 kg to 40 kg in 3 months), body condition of 1 (in a 1 to 5 scale), sporadic soft cough, dyspnea and change in the breathing pattern, wheelbarrow test positive, and flow of mucous and frothy fluid (50 mL) from both nostrils and crackle to auscultation. A thoracic radiography and electrocardiogram (ECG) were performed. Radiography revealed a nodular pattern with small and diffuse nodules in the pulmonary parenchyma and a larger lesion in the cause-dorsal lung field. The electrocardiographic trace showed an irregular narrow-QRS rhythm (QRS, 0.045s; normal, <0.06s) and a heart rate of approximately 105 bpm. The QRS had deep negative deflection (amplitude, 0.6 mV; normal, <0.3 mV). All QRS were preceded by a P wave (positive deflection in lead II; duration <0.04 s; amplitude <0.13 mV) and a consistent PR interval (<0.14s). The animal died within a few days of being examined.

At *post mortem* examination, the lungs failed to collapse and were enlarged and heavy with multifocal to coalescing subpleural pearly-white nodules, located in diaphragmatic pulmonary lobes (figure 1A). The nodules were dry and firm at cross section. Consolidation of cranial regions and alveolar emphysema areas were noted (figure 1B). The pulmonary artery had a focal dilatation at base of ~ 2.5 cm, interpreted as aneurysm, apparently with reduced wall thickness (figure 1C). Eccentric right ventricular hypertrophy was also observed. The mediastinal and bronchial lymph nodes had grey areas interpreted as metastatic neoplastic tissue. No additional gross lesions were detected in this animal.

Tissue samples were collected and placed in 10% buffered neutral formaldehyde for histological examination and stained with hematoxylin-eosin (H&E) and Masson´s trichrome. Histologically, within the grossly affected portion of the pulmonary artery, all tunica layers were present. However, in comparison with the adjacent and grossly non-affected region of the pulmonary artery, the aneurysm wall was thinner (1.135mm vs. 2.424mm), and the tunica media had thinning, disorganisation,

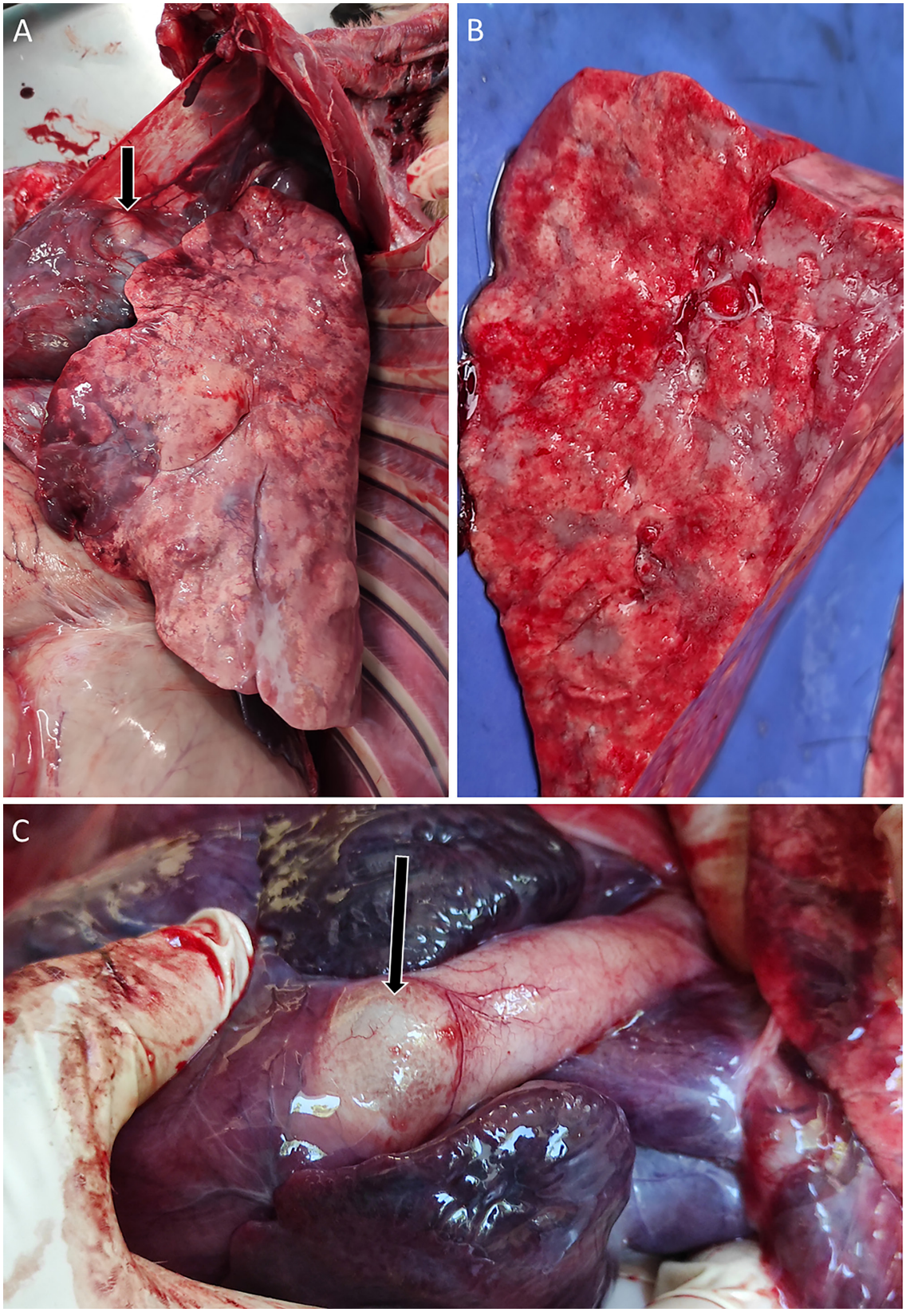


**Figure 1.** (A) Lungs of an adult female "Churra Galega Bragançana" sheep, are non-collapsed with multifocal to coalescing subpleural grey nodules, located in diaphragmatic pulmonary lobes. Aneurysm of the pulmonary artery is visible (arrow). (B) Macroscopic appearance of the lung at cut surface, whitish areas are observed corresponding to adenocarcinoma. (C) Pulmonary artery of an adult female "Churra Galega Bragançana" sheep with, focal dilatation of ~ 2.5 cm (aneurysm), close to pulmonary valve (arrow).

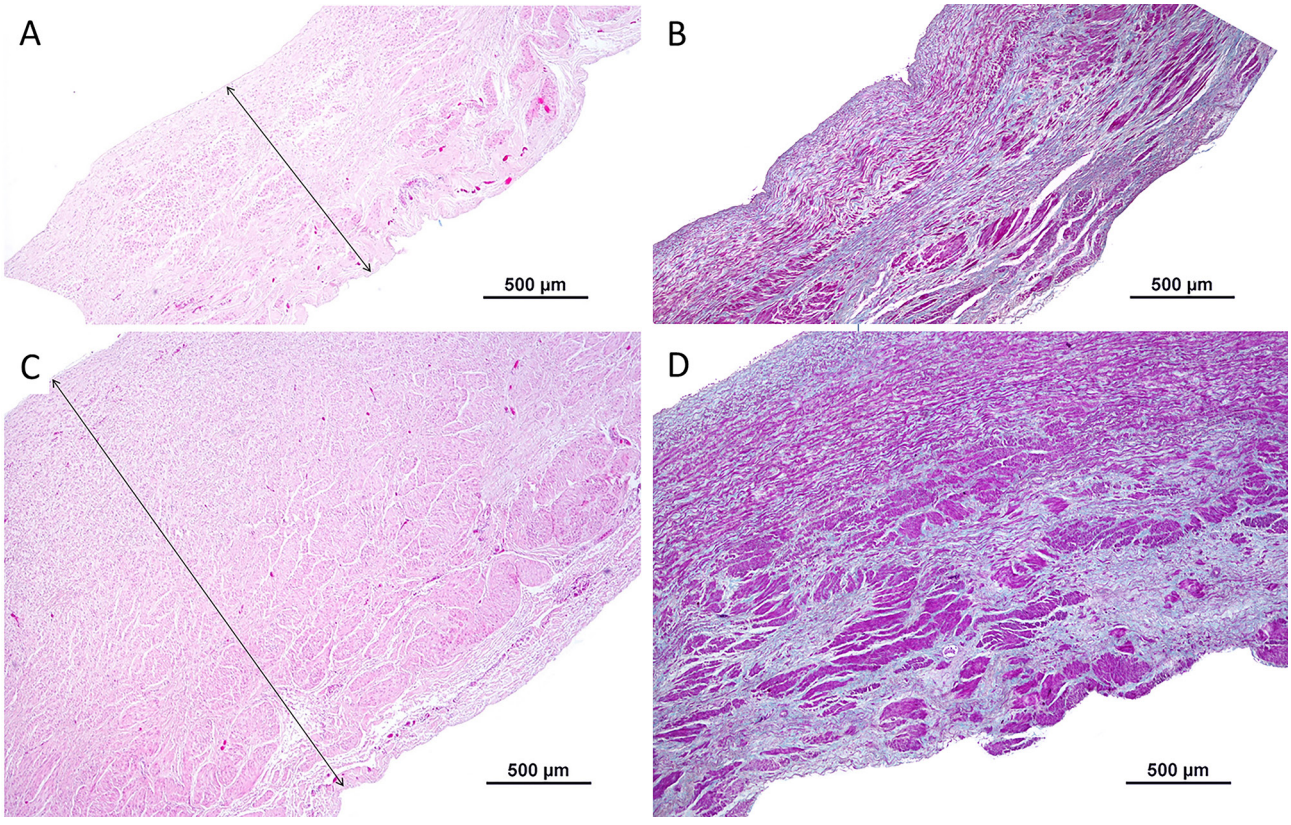


**Figure 2.** Pulmonary artery of an adult female "Churra Galega Bragançana" sheep. The wall of the artery is thin (aneurysm) (1.135mm); the tunica media exhibits thinning, disorganisation, fragmentation and loss of elastic fibres, and disorganisation and loss of smooth muscle cells: H&E (A) and Masson´s Trichrome stain (B). Pulmonary artery at the level of non-affected area (2.424mm): H&E (C) and Masson´s Trichrome stain (D).

fragmentation and loss of elastic fibres, and disorganisation and loss of smooth muscle (figures 2 A, B, C and D). Hypertrophy of cardiac myocytes of the right ventricle was also observed. The alveoli were lined with a single layer of cuboidal or columnar tumoural epithelial cells, within a moderate to abundant fibrous stroma. Tumour cells often form papillomatous projections into the alveoli. Anisokaryosis and anisocytosis were low to moderate with less than 2 mitoses per 10 high power field (400x). A large number of foamy macrophages were present in adjacent alveoli. Cranioventral areas showed suppurative bronchopneumonia with neutrophils in alveolar spaces and the bronchioloalveolar junction. Mediastinal lymph node metastasis was present.

The morphologic diagnosis was aneurysm of the pulmonary artery and pulmonary adenocarcinoma, with bronchopneumonia.

Aneurysm of the pulmonary artery is very uncommon in animals. To date, the bibliography only refers a few reports of true aneurysm in cattle (Breeze *et al.*, 1976) and cetaceans (Martineau *et al.*, 1986).

Aneurysm of the pulmonary artery could be congenital or acquired. In the present case, no prior clinical signs were observed. We speculate that the aneurysm, in this case, could have been acquired secondary to the associated neoplastic changes in the lung. Ovine pulmonary adenocarcinoma, also known as pulmonary adenomatosis or "jaagsiekte"(Griffiths *et al.*, 2010) is a contagious neoplasm of sheep and exceptionally goats, caused by a Betaretrovirus of the family Retroviridae (Lafita *et al.*, 2007, Youssef *et al.*, 2015). Although the typical form mainly affects the cranioventral lobes, the atypical form is characterised by tumour nodules in the diaphragmatic lobes, or diffuse, often associated with fibrosis as in the present case (Lafita *et al.*, 2007).

In human medicine, there are a few described cases of artery aneurysms or pseudoaneurysms of the pulmonary artery associated with pulmonary carcinoma (Kim & Han, 2015). This association may be caused by the erosion of the pulmonary artery or tumour expansion, which was not observed in this case (Kim & Han, 2015, Wiles *et al.*, 2021). The hyperplasia of the tunica media observed in the pulmonary vessels, the associated fibrosis and hypertrophy of the right ventricle suggest that the association of the aneurysm with pulmonary carcinoma is due to pulmonary hypertension and the consequent increase in pulmonary vascular resistance. The resultant increase in the post load of the right ventricle leads to its adaptation with dilatation of

the ventricular cavity and increase in myocardial thickness with myocyte hypertrophy (Koneru *et al.*, 2018, Wiles *et al.*, 2021) that predisposes and may be the cause of the aneurysm of the pulmonary artery.

Electrocardiogram findings may suggest a right ventricular enlargement (hypertrophy), according to the values described by Ahmed and Sanyal (2008). Nevertheless, there is no consensus in the literature on reference values for ECG interpretation in sheep and/or possible breed variability (Ahmed & Sanyal, 2008, Chalmeh *et al.*, 2015). It should be noted that the Churra Galega Bragançana breed, an indigenous breed from the north of Portugal, has a large ability to adapt to adverse environmental conditions, including very cold and hot temperatures.

Aneurysms are very difficult to diagnose in animals and often lead to sudden death. Although rare, they should be considered as a serious complication in animals with lung tumours.

To our knowledge, this is the first report of an aneurysm of the pulmonary artery in sheep and the first description of pulmonary neoplasia (ovine pulmonary adenocarcinoma) in animals associated with aneurysm of the pulmonary artery.

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