**NOTE** *Pathology*

# Pulmonary Angiomatosis and Hemangioma in Common Dolphins (*Delphinus delphis*) Stranded in Canary Islands

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ABSTRACT. Vascular tumors and disorders, like angiomatosis, are rarely described in cetacean species. A retrospective histological study was carried out on lung samples from 35 common dolphins (*Delphinus delphis*) stranded in the Canary Islands coasts looking for morphological vascular changes and likely related causes. Twenty-five out of thirty-five (71%) common dolphins showed focal or multifocal angiomatosis-like lesions. A high association between this type of vascular proliferation and parasitic infestation was observed. In addition, a single pulmonary cavernous hemangioma not previously reported in common dolphins is presented.

KEY WORDS: angiomatosis, *Delphinus delphis*, hemangioma, lung parasites, vascular proliferation.

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Despite of being an organ with a rich vascular network, vascular disorders are rarely found in the respiratory system of terrestrial and marine species. The most common tumors of vascular origin described in the respiratory system of humans include hemangioma and lymphangioma as benign tumors and epithelioid hemangioendothelioma, angiosarcoma and Kaposi's sarcoma among malignant ones [7]. In veterinary medicine, primary pulmonary vascular tumors have been very infrequently reported, and most commonly cited circulatory disturbances have been edema, thrombosis, embolism, hemorrhage, vasculitis and vascular pulmonary hypertension [1].

The first report in the scientific literature of pulmonary hemangioma and angiomatosis in dolphins was described by Turnbull and Cowan (1999); however, the authors had firstly recognized angiomatosis in 1992, as an important factor of morbidity in common bottlenose dolphins (*Tursiops truncatus*). In this article, they described a vascular alteration not previously recognized in this species, which was defined as angiomatosis. This disease was characterized by proliferation of small, thick-walled blood vessels diffusely throughout the lungs, without inflammation, exudation, or alveolar hemorrhage and by proliferative hypervascularity in the visceral pleura as well as in lung-associated lymph nodes [6]. The authors also mentioned similar lesions in bottlenose dolphins and common dolphins (*Delphinus delphis*) stranded in Atlantic regions of the United States, however, its etiology remains unknown.

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More recently, Kuwamura *et al.* (2007) reported a chronic bronchopneumonia due to lungworm infestation in a common bottlenose dolphin associated with vascular proliferation consistent with "pulmonary angiomatosis". They argued that parasites could play an important role on angiogenesis and/or acquired vascular anomalies raising the question about its likely relationship [5].

The aim of this study was to search retrospectively for this peculiar kind of morphological vascular proliferation in a set of common dolphins stranded in the Canary Islands coasts during a ten years period (1992 to 2011). A special attention was taken to the presence and/or association with pulmonary parasites.

Lung samples, formalin fixed and paraffin embedded, from 35 common dolphins stranded on Canary Islands coasts from 1992 to 2011 were subjected for histopathological examination. Hematoxilyn-eosin, Masson's trichrome and also Verhoeff's stain, for elastic fibers, were used for pulmonary tissue assessment. Vascular disturbances (i.e., angiomatosis-like) as well as parasitic structures and/or inflammatory reactions were thoroughly examined. From these 35 common dolphins, 4 were considered as very fresh, 19 fresh and 12 moderately autolytic carcasses [4].

High vascular proliferation characterized by small, irregularly thick-walled blood vessels, composed of collagen and smooth muscle, describing a very tortuous pattern (angiomatosis) was seen in 25 out of 35 animals (71%), affecting mainly bronchial-bronchiolar submucosa and pleura, bronchoinsterstitial areas were also involved in a few cases (Figs. 1 and 2). From these 25, 11 (44%) showed evident intralesional parasites (nematodes) (Fig. 3), 24 (96%) showed different stages of bronchointerstitial pneumonia, and 8 (32%) showed sclerotic nodules most likely caused by chronic parasitic infestation (Table 1).

In one common dolphin (No. 35), a non-capsulated but well circumscribed lesion was found beneath of the pleura,

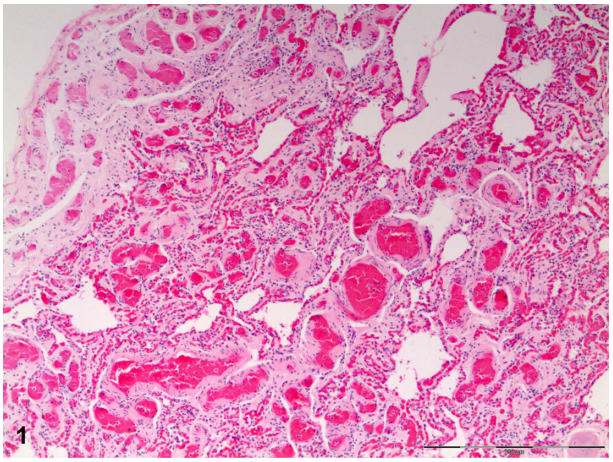

Fig. 1. Subpleural and interstitial angiomatosis characterized by proliferation of small, irregularly thick-walled blood vessels showing a tortuous pattern. Hematoxylin-eosin stain. Bar=200 $\mu$m.

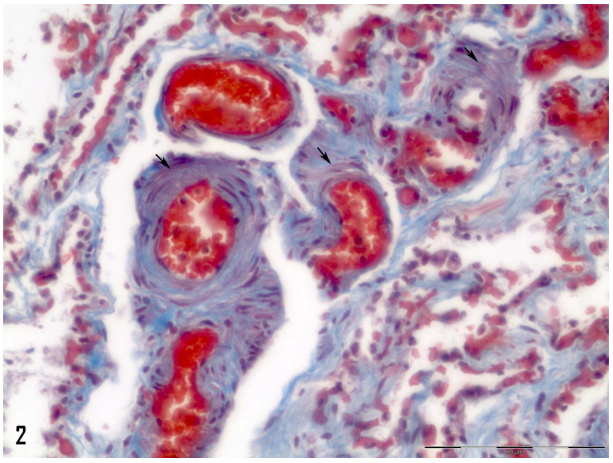

Fig. 2. Interstitial angiomatosis. Vascular proliferation describing a tortuous framework mainly composed of collagen (blue) and muscle fibers (red) (arrows). Masson's trichrome stain. Bar=50 $\mu$m.

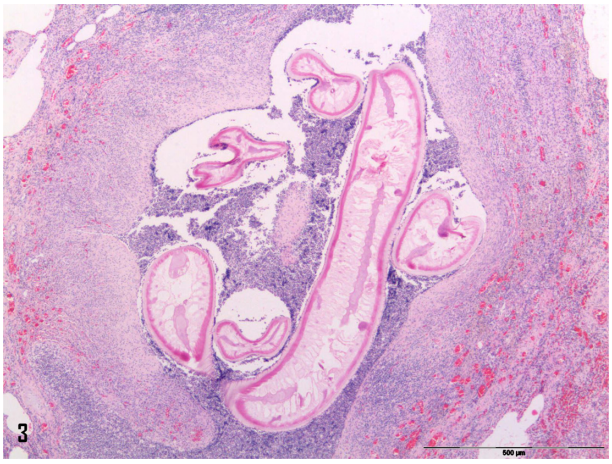

Fig. 3. Nematodes with a pyogranulomatous inflammation within respiratory tract, surrounded by connective tissue and angiomatous proliferation. Hematoxylin-eosin stain. Bar=500 $\mu$m.

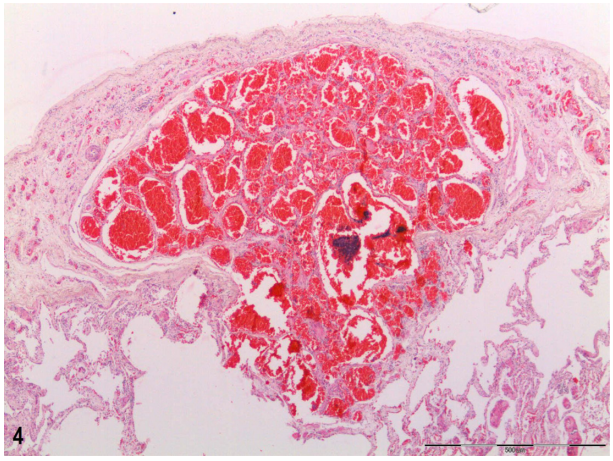

Fig. 4. Pulmonary cavernous hemangioma underlying pleura. Hematoxylin-eosin stain. Bar=500 $\mu$m.

it was histologically composed of variably sized vascular spaces filled with erythrocytes, leucocytes and lined by a single layer of uniform endothelial cells, supported by a thin and fibrous connective tisular stroma with, occasionally present, lymphocytes and polymorphonuclear cells infiltrates. Mitotic figures were absent and no malignant cellular neoplastic changes were observed. This lesion was defined as a pulmonary cavernous hemangioma (Fig. 4). Pulmonary hemangioma has been reported previously in Atlantic bottlenose dolphins [6].

Differentiation between cavernous hemangioma from hemangiomatosis or angiomatosis, was accorded to classical histopathological features [3]. Cavernous hemangioma has been traditionally defined as well circumscribed, composed of variably sized vascular spaces filled with erythrocytes and lined by a single layer of uniform endothelial cells. In the cavernous type, the large channels are separated by a fibrous connective tissue stroma, which can contain lymphocytes and other inflammatory cells. Otherwise, angiomatosis has been characterized by proliferation of small, thick-walled blood vessels showing a tortuous pattern of proliferation and a multifocal or diffuse distribution.

In Turnbull and Cowan (1999), abnormal vascular proliferation (angiomatosis) was identified in 25 out of 54 common bottlenose dolphins. Fifteen out of twenty-five dolphins had demonstrable lungworms, and most of these had sclerotic nodules with fragments of identifiable lungworms. Four out of twenty-five dolphins had very similar sclerotic nodules but no demonstrable lungworms in either the nodules or elsewhere. Only six dolphins had neither worms nor nodules. They considered angiomatosis was incidental [6].

*De novo* vascular proliferation was characterized by presence of collagen and smooth muscle but absence of elastin

Table 1. Individual identification, sex, age and decomposition code are presented. Presence or absence of angiomatosis-like vascular proliferation, intralesional parasites, bronchointerstitial pneumonia, and sclerotic nodules are also shown

| Identification | Sex[a)] | Age[b)] | Decomposition code [c)] | Angiomatosis-like vascular proliferation | Intralesional parasites | Bronchointerstitial pneumonia | Sclerotic nodules |
|---|---|---|---|---|---|---|---|
| 1 | ND | ND | VF | – | – | + | – |
| 2 | ND | ND | F | + | – | + | + |
| 3 | M | ND | MA | – | – | + | – |
| 4 | ND | ND | MA | + | + | + | – |
| 5 | M | A | VF | + | – | + | + |
| 6 | M | ND | VF | + | – | + | – |
| 7 | F | C | F | – | – | + | – |
| 8 | F | ND | F | + | – | + | – |
| 9 | M | A | MA | + | – | + | – |
| 10 | F | A | F | + | + | + | + |
| 11 | F | ND | MA | + | – | + | + |
| 12 | M | C | MA | + | – | + | – |
| 13 | M | A | F | – | – | + | – |
| 14 | M | A | VF | + | + | + | – |
| 15 | F | J | F | – | – | + | + |
| 16 | F | A | F | + | + | + | + |
| 17 | M | C | F | – | – | + | – |
| 18 | F | A | F | + | – | + | – |
| 19 | F | C | MA | + | – | + | – |
| 20 | M | C | F | + | – | + | + |
| 21 | M | A | MA | + | + | + | – |
| 22 | M | A | F | + | + | + | – |
| 23 | F | A | F | – | – | – | – |
| 24 | M | A | MA | – | – | – | – |
| 25 | M | S | MA | + | – | + | – |
| 26 | Fe | A | F | + | – | + | – |
| 27 | M | A | MA | + | – | + | – |
| 28 | M | C | F | + | + | + | – |
| 29 | M | C | F | – | – | + | – |
| 30 | F | A | MA | + | + | + | – |
| 31 | F | J | MA | – | + | + | – |
| 32 | F | A | F | + | – | + | – |
| 33 | M | A | F | + | + | + | + |
| 34 | M | A | F | + | + | + | + |
| 35 | M | A | F | + | + | + | – |

a) ND: not determined. M: male; F: female. b) A: adult; C: calf; J: juvenile; S: subadult. C) VF: very fresh; F: fresh; MA: moderate autolysis.

[6]. In our cases, angiomatous vessels were also composed of collagen and smooth muscle and no elastin by using Masson's trichrome (Fig. 4) and Verhoeff's stains.

Kuwamura *et al.* (2007) concluded that vascular lesions were considered to be associated with inflammatory lesion and speculated about bottlenose dolphin may have a predisposition for angiomatosis when some insults happen in the lung [5]. Based on our present results, this vascular proliferation is also frequent in pulmonary sections of common dolphins, and is associated morphologically to a parasite-host interaction.

Parasitological identification was carried out on nematodes taken from several necropsied animals, and results on morphological examination have proved that the main genus involved in these cases has been *Stenurus* spp. Kuwamura *et al.* (2007) identified *Stenurus ovatus* to be related to vascular lesions observed [5].

How parasitic helminths achieve the formation of a parasite-defined vasculature as one of the prerequisites for successful parasitism is increasingly a topic of interest. A complete review on this topic has been published by Dennis *et al.* (2011). In this article, the authors list examples of both molecular angiogenic and antiangiogenic factors involved [2].

Vascular anomalies, i.e., abnormal, prominent vascular proliferation, angiomatosis or hemangioma, may take place after injury promoted by helminths [2]. Hereby, we also consider verminous pneumonias in cetacean species might be an adequate natural model for further investigations on angiogenesis and parasitic helminth-associated angiogenesis.

In addition to a high prevalence of angiomatosis lesions in the lungs of common dolphins stranded in the Canary Islands, here it is presented, to our best knowledge, the first description of a pulmonary cavernous hemangioma in a

common dolphin. Whether hemangioma arose primarily or came into the lung tissue eliciting a disseminated or metastatic condition remains undetermined, but absence of other vascular neoplasia in the rest of the examined organs in this dolphin, let us conclude that this is a primary benign tumor in the lung. The presence of this hemangioma associated with angiomatosis and parasites adds a new related question for further investigation.

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