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NOTE

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Acquired collateral venous pathways in a dog with cranial vena cava obstruction

Mario RICCIARDI[1)]* **and Marcello LANCI**[2)]

[1)]Pingry Veterinary Hospital, Via Medaglie d'Oro 5-70126, Bari, Italy
[2)]Fanum Fortunae Veterinary Hospital, Via Persiutti 2-61032, Fano, Italy

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ABSTRACT. An 8-year-old neutered female Yorkshire terrier with mediastinal neoplasm and subsequent cranial vena cava invasion developed multiple venous collaterals from the brachiocephalic venous trunks to the caudal vena cava. Collateral venous pathways have been described in dogs with obstruction or increased blood flow resistance of the caudal vena cava but cranial vena cava collaterals have not been reported until now in veterinary patients. In this report, the CTA characteristics of such peculiar vascular routes are described and compared to similar findings reported in human medical literature. The recognition of such ancillary CT finding could help radiologists to reach a more accurate diagnosis of superior vena cava syndrome.

KEY WORDS: angiography, collateral vessels, computed tomography, cranial vena cava, dog

In dogs, cranial vena cava (CrVC) obstructions or increases in flow resistance have been reported as a consequence of different acquired conditions, such as chronic heartworm (Dirofilaria immitis) disease [7], neoplasia [4], fungal granuloma [1] and thrombosis [3]. When the CrVC becomes occluded, invaded or compressed, blood flow diverts into a network of collateral channels which regain patency to maintain venous drainage to the right atrium. In humans, collateral veins appear On CT images as enlarged tortuous vascular channels that are densely opacified and their pathways involve veins in chest, abdomen, and pelvis [5].

In dogs, acquired CrVC collaterals have never been described in detail and only a few contrast-enhanced radiographic images are available for review [1]. This report describes for the first time the computed tomography angiography of collateral venous pathways in a dog with CrVC obstruction.

An 8-year-old neutered female Yorkshire terrier dog was evaluated for a 5-days-history of dyspnea.

One year prior, the dog has been diagnosed with myasthenia gravis by the referring veterinarian and at time of evaluation he was still on treatment with pyridostigmine bromide (1 mg/kg, per os q12 h). Hematology, serum chemistry analyses and urinalysis results were within normal limits.

Orthogonal radiographic views of the thoracic region and thoracic ultrasound showed a large cranial mediastinal mass and bilateral pleural effusion that required drainage through bilateral chest tube insertion. Histopathologic evaluation of a mass sample, obtained by ultrasound-guided Tru-cut biopsy, revealed a thymic lymphoma. Based on the suspicious of primary neoplasm, multidetector computed tomography of the whole body was performed immediately after the ultrasound examination for regional anatomical characterization and complete staging. A 4-slice MDCT scanner (Toshiba Asteion; Toshiba Medical Systems, Tokyo, Japan) was used with the patient in sternal recumbency on the CT table under general anesthesia. Computed tomography images were acquired before and 21 sec after the manual intravenous injection of iodinate contrast medium (640 mg I/kg; Iomeron 300® Bracco Imaging SpA, Milan, Italy) in the right cephalic vein, using the following technical parameters: Standard acquisition algorithm, 120 kVp, 150 mAs, 1-mm slice thickness, pitch of 0.8, and 1 sec/rotation. Three-dimensional (3D) multiplanar reformatted images were obtained using a dedicated 3D software (Pixmeo, OsiriX; OsiriX DICOM-viewer; Pixmeo, Geneva, Switzerland). On computed tomography the cranial thoracic cavity was entirely occupied by a large, irregularly marginated mass isoattenuating to soft tissue with poor contrast-enhancement. Vascular invasion was evident from the junction of the two brachiocephalic veins to the right atrium. The CrVC was almost totally obstructed and enlarged by neoplastic tissue (Fig. 1A). The entrance of the azygos vein in the caval trunk was partially obstructed with secondary dilation of azygos trunk. The left cardiac chambers and Aorta were not involved by neoplastic proliferation.

Multiple tortuous vessels originating from the right, and a lesser amount from the left, brachiocephalic venous trunk, ran caudally through the mediastinum forming a complex vascular network on each side of the heart surface and ending in the caudal vena cava (CdVC) at the level of diaphragmatic hiatus (Fig. 1B and 1C). On the left side, the small vessels entered the CdVC via

*Correspondence to: Ricciardi, M.: ricciardi.mario@alice.it

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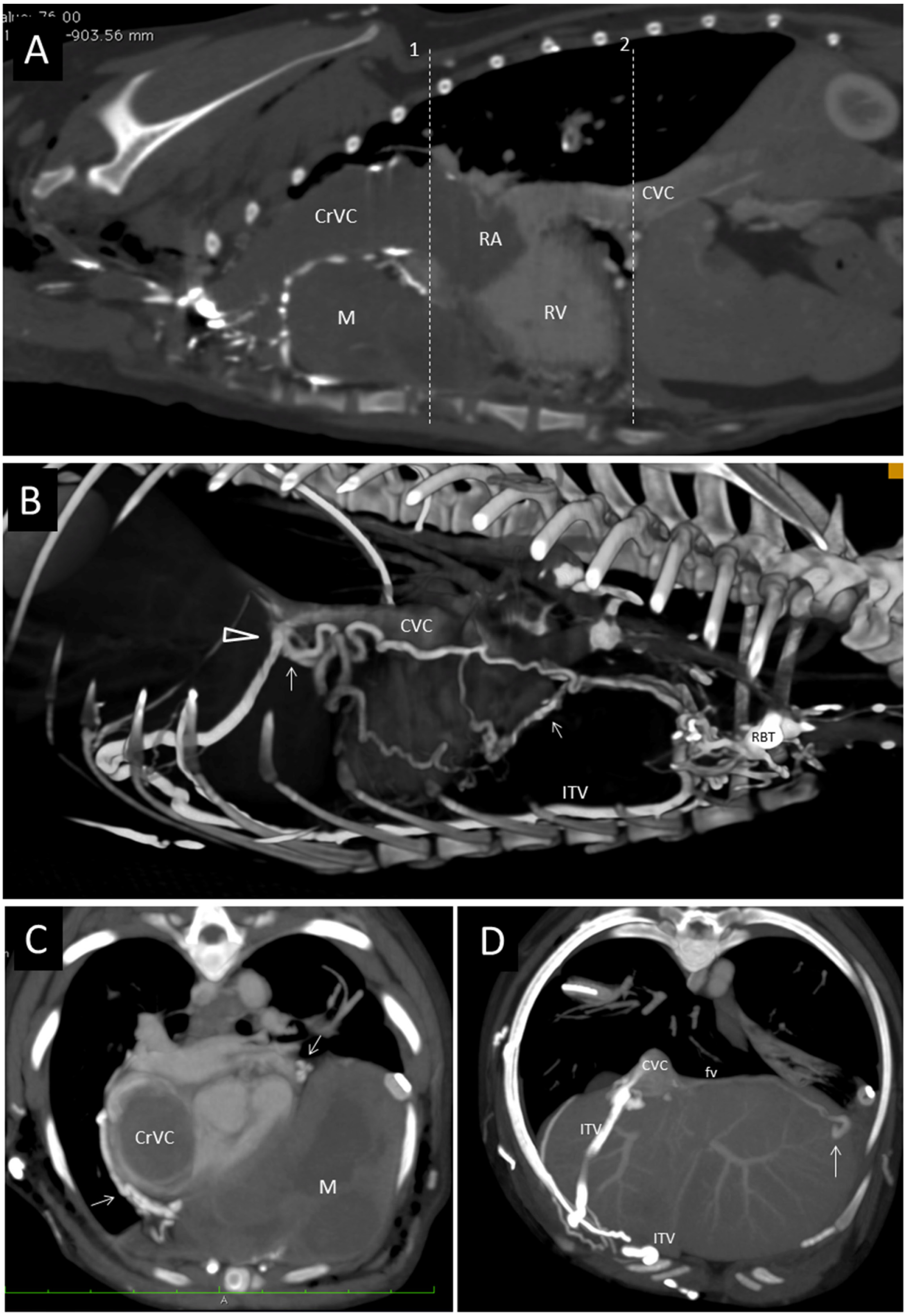

Fig. 1. A) Right parasagittal multiplanar reformatted contrast-enhanced CT image of the thorax. A large, rounded mass (M) isoattenuating to soft tissue is evident in the cranial mediastinum associated with almost complete invasion of cranial vena cava (CrVC). The right atrium (RA) is also invaded by the neoplasm. B) Right parasagittal thick-slab multiplanar reformatted contrast-enhanced CT image of the thorax. Multiple small tortuous vessels (arrows), resembling varices, connect the right brachiocephalic venous trunk (RBT) with caudal vena cava (CVC) at level of diaphragmatic hiatus. The right internal thoracic vein (ITV) also joins the caudal vena cava at same point (arrowhead). C) Transverse thick-slab multiplanar reformatted contrast-enhanced CT image at level 1 of Fig. A. Mediastinal varices are evident adjacent to walls of heart (arrows). D) Transverse thick-slab multiplanar reformatted contrast-enhanced CT image at level 2 of Fig. A showing connection of mediastinal collaterals (arrow) with caudal vena cava via phrenic vein (fv) on left, and between right internal thoracic vein (ITV) and caudal vena cava (CVC) on right.

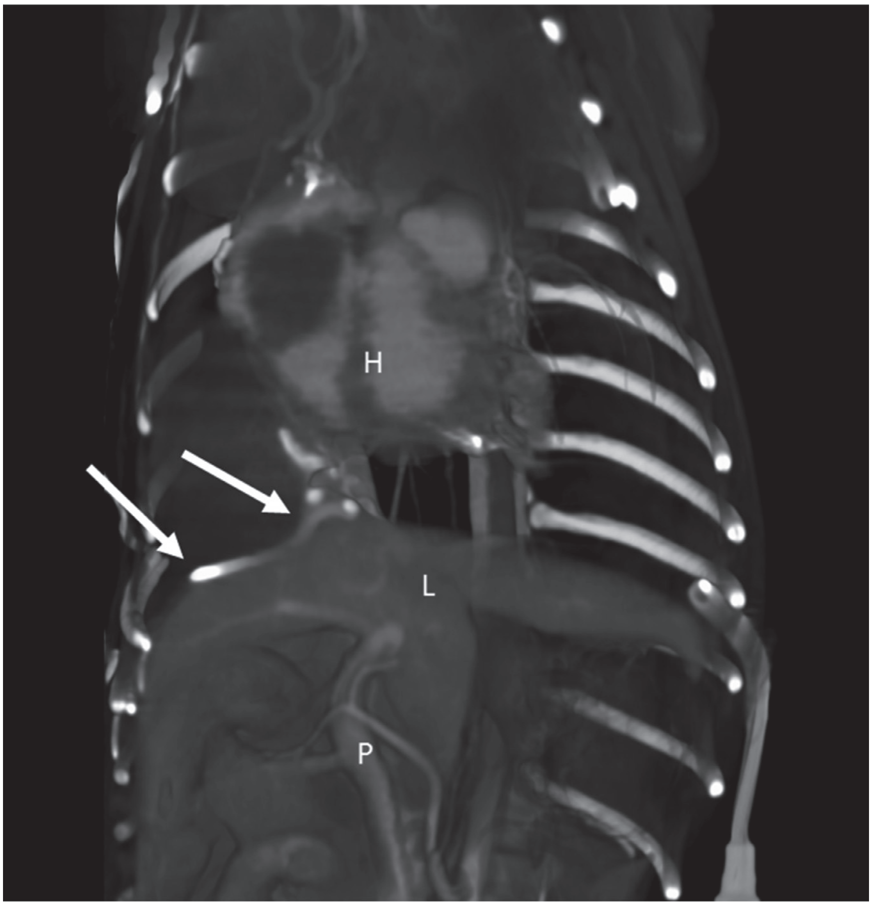

Fig. 2. Dorsal thick-slab multiplanar reformatted contrast enhanced CT image of the liver (L) showing in detail the course of the the right internal thoracic vein. It ran along the thoracic surface of the diaphragm (arrows), without anatomical relationships with the abdominal cavity or with the liver and entered the caudal vena cava at level if its diaphragmatic hiatus (not shown–see Fig. 1B). H, heart; P, portal vein.

the left phrenic vein (Fig. 1D). The right internal thoracic vein was enlarged and, at level of the caudal thorax, ran dorsally along the thoracic surface of the diaphragm (Figs. 1B and 2) and entered the CdVC at level if its diaphragmatic hiatus, at the same level of junction as the mediastinal tortuous vessels (Fig. 1B and 1D). Small amount of edema was present within the soft tissue of the neck.

Based on its size and vascular invasion, the neoplasm was considered not surgically resectable and chemotherapy was refused by the owner. The patient was discharged with supportive therapy with prednisolone (1 mg/kg per os q 24 hr) and a poor prognosis. Five days later, at telephone follow-up, the owner communicated spontaneous patient's death.

Overall, the acquired collateral vessels detected in the dog herein reported gave rise to a natural bypass from the brachiocephalic venous systems to the right atrium via mediastinal vessels, the right internal thoracic vein and the CdVC, to overcome the CrVC flow obstruction. Furthermore, the very small amount of edema within the soft tissue of the neck demonstrated an almost complete compensation of the venous drainage cranially to the point of obstruction, provided by collateral vessels.

In human medical literature it is well known that in the case of superior vena cava obstruction blood flow diverts into a network of collateral channels with variable extent and location in order to ensure superior vena cava drainage and avoid increase in venous pressure in upstream territories. Collateral routes involve veins in chest, abdomen, and even pelvis [5].

In our patient the collateral pathway appeared similar to caval-mammary (internal thoracic)-phrenic pattern and to mediastinal and esophageal venous plexus route as described in humans. In the caval-mammary-phrenic pattern, blood flows from the internal thoracic vein to the inferior phrenic vein, thus entering the CdVC in close proximity to the diaphragm. In the mediastinal and esophageal venous plexus pathway, blood flows through mediastinal, pericardial, and pericardiophrenic veins draining toward the inferior phrenic veins and ending in the inferior vena cava [2].

Collateral venous pathways have been described in dogs with obstruction or increased blood flow resistance of the CdVC [6] but, to the authors' knowledge, cranial vena cava collaterals have not been reported until now in veterinary patients. Our findings indicate that collateral venous pathway patterns, similar to those described in humans, are also present in dogs with cranial vena cava obstruction. It is our opinion that the recognition of such ancillary CT finding could help radiologists to reach a more accurate diagnosis of superior vena cava syndrome.

CONFLICT OF INTERESTS. The authors declare that there is no conflict of interest.

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