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CASE REPORT

Three-dimensional time of flight magnetic resonance angiography of the heart and associated vessels in a cat

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Abstract The aim of this study was to describe the normal magnetic resonance angiography (MRA) of the heart and associated vessels in a mature female cat using a 1.5-Tesla magnet. Non-contrast enhanced MRA was performed using a three-dimensional time of flight (TOF) sequence in parasagittal and dorsal aspects. Relevant cardiac and vascular structures were labelled on three-dimensional Time of flight images. Time of flight imaging showed details of the heart cavities and vessels lumen due to the high signal intensity of fast-flowing blood compared with bones, muscles, and lungs, which appeared with low signal intensity. Three-dimensional TOF sequences provided adequate anatomical details of the heart and good differentiation of the vascular structures that could be used for interpretation of cardiac images and to assist in future MRA studies.

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Abbreviations

BT	brachiocephalic trunk
CTA	computed tomography angiography
MRA	magnetic resonance angiography
TOF	time of flight

A 3-year-old mature male with a weight of 3 kg was used for magnetic resonance angiography (MRA) anatomic evaluation of the heart and associated vessels. This study was performed with informed consent of the pet owner and under the control of the Ethical Commission of Veterinary Medicine of Las Palmas de Gran Canaria University (agreement MV-2015/08). After clinical evaluation, a combination of butorphanol[d] (0.1 mg/kg), dexmedetomidine[e] (0.075 mg/kg) and ketamine[f] (15 mg/kg) administered IM was employed as preanesthetic medication. Later, the patient was prepared with an intravenous heparinised catheter in the cephalic vein and physiologic saline at 5 mL/h. Propofol[g] (10 mg/kg IV) was used for induction of general anaesthesia. The cat was connected to the anaesthesia device with vapour replacement support. A flow of O_2 was maintained at 0.8 l/min, and a vaporizer[h] with 3% of sevoflurane[i] was employed. Throughout the study, the patient was connected to an automatic ventilator.[j]

Time of flight (TOF) images were performed with a 1.5-Tesla magnet[k] using a human thorax coil with the animal positioned in dorsal recumbency on the MRI table. An electrocardiography gating was applied to minimize the effects of the cardiac movements. Moreover, a respiratory gating was employed by an elastic belt to negate the effects of breathing and to determine the best time in the respiratory cycle for data acquisition. In this study, a fast gradient-echo pulse sequence was used to obtain bright-blood three-dimensional TOF images in parasagittal and dorsal aspects. Parasagittal images were obtained using the following parameters: a repetition time of 4.3 ms; an echo time of 1.1 ms; 256 $\times$ 256 acquisition matrix; 2.6-mm slice thickness; and 1.3-mm spacing between slices. The acquisition time was 4 min 7 s. Dorsal TOF images were acquired with the following parameters: a repetition time of 18 ms; a echo time of 2 ms; 256 $\times$ 192 acquisition matrix; 2.4-mm slice thickness; and 2.4-mm spacing between slices. The acquisition time was 3 min 28 s.

The cardiac chambers and the main vascular trunks were identified on three-dimensional TOF images (Figs. 1—4). Two representative parasagittal TOF images of the heart and associated vessels that were observed on right and left lateral aspects are presented (Figs. 1 and 2). Figures 3 and 4 are dorsal TOF images obtained from the approximate level of the descending aorta (Fig. 3) to the root of the aorta (Fig. 4).

Three-dimensional TOF images showed the blood with a high signal intensity of the cardiac chambers (atrium and ventricles) and the main vascular structures compared with associated thoracic tissues such as the bones, muscles, and lungs, which appeared with low signal intensity. Therefore, the course of the cranial and caudal vena cava leading into the right atrium (Figs. 1—4) and other important vessels such as the right azygos vein (Fig. 1) were seen. In addition to these observations, several vessels such as the brachiocephalic, subclavian, and external jugular veins were also observed in all figures. Figures 1—4 show the course of the ascending aorta arising from the left ventricle, and the aortic arch is visible. The main branches such as the brachiocephalic trunk (BT), the left subclavian artery, and the descending aorta were easily identified in Figures 1—3. The descending aorta was seen ventrally to the vertebrae, reaching the diaphragm and concealing the full view of the pulmonary veins.

The BT and left subclavian artery, which arise directly from the aortic arch, are above the right atrium. The cranial branches of the BT such as the right subclavian (Figs. 3 and 4) and common carotid arteries (Figs. 1—4) were also identified. The pulmonary trunk located cranial to the left atrium was visible in Figures 3 and 4 compared to parasagittal images (Figs. 1 and 2), whereas pulmonary veins leading into the left atrium were especially visible in Figs. 1—3.

Discussion

Magnetic resonance angiography is a useful, noninvasive diagnostic imaging technique and one of the most optimal imaging modality for the morphological and functional assessment of the human heart and thoracic vasculature [1,2]. Time of flight

[d] Torbugesic, Zoetis, SLU, Madrid, Spain.
[e] Dexdormitor, Lab. Dr. Esteve SAU, Barcelona, Spain.
[f] Imalgene, Merial Laboratorios, Barcelona, Spain.
[g] Propovet, Lab. Dr. Esteve SAU, Barcelona, Spain.
[h] Sigma Delta Vaporizer Penlon, Dräguer plug-in, Penlon Limited, Abingdon, UK.
[i] Sevoflo, Abbot Laboratories SA, Madrid, Spain.
[j] Ventilator V725000 SurgiVet, Smith Medical PM, Inc, Norwell, MA.
[k] Signa Excite; General Electric Medical Systems, Madrid, Spain.

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