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Source: Journal of Zoo and Wildlife Medicine, 44(1) : 200-203

Published By: American Association of Zoo Veterinarians

URL: <https://doi.org/10.1638/1042-7260-44.1.200>

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PATENT DUCTUS ARTERIOSUS IN AN ADULT AMUR LEOPARD (*PANTHERA PARDUS ORIENTALIS*)

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Abstract: A clinically healthy 16-yr-old female leopard (*Panthera pardus orientalis*) was diagnosed with a patent ductus arteriosus on echocardiography and later confirmed on necropsy. A murmur was heard on auscultation during a routine examination, and the congenital defect was an incidental finding. The animal had been asymptomatic its entire life. This deformity is rarely observed in nondomestic felids and may be asymptomatic, as has been described in domestic cats.

Key words: Patent ductus arteriosus, *Panthera pardus orientalis*, echocardiography, congenital cardiac disease, carnivores.

BRIEF COMMUNICATION

The ductus arteriosus is a normal fetal structure that allows pulmonary arterial blood to bypass the unexpanded lungs and enter the descending aorta for oxygenation in the placenta. At birth, the increase in oxygen tension causes a functional closure of the duct, followed by its anatomic closure during the first weeks of life. If the duct fails to close, blood shunts from the descending aorta to the pulmonary artery.⁹

A 16-yr-old, captive-born, female, sexually intact Amur leopard (*Panthera pardus orientalis*) was anesthetized with a combination of medetomidine (Domitor®, Janssen Santé Animale, Issy-les-Moulineaux, 92787, France; 70 µg/kg, i.m.) and ketamine (Imalgene®1000, Merial, Lyon, 69348, France; 2.5 mg/kg, i.m.) for a routine examination. The animal was suspected to be a hybrid cross between *Panthera pardus orientalis* and *Panthera pardus japonensis* and had a previous history of diarrhea and vomiting of unknown origin. The animal weighed 41 kg, and its body condition score was 4/5. The abdomen was distended, and a fluid wave was elicited by palpation. Serum blood analyses, collected from the jugular vein, revealed

moderate azotemia (elevated urea 31.42 mmol/L, reference range 12.14 ± 3.570 mmol/L; elevated creatinine 205.97 µmol/L, reference range 212 ± 71 µmol/L).⁷ Infectious disease testing (Idexx Reference Laboratories, Westbrook, Maine, USA; feline immunodeficiency virus–antibody ELISA, feline leukemia virus–antigen ELISA, coronavirus–indirect fluorescent antibody, and feline herpesvirus–antibody) was negative at the exam.

The cardiac auscultation revealed a moderate (grade III/VI) continuous murmur located at the upper left sternal border. This murmur had first been identified 3 years prior, but no further investigation was performed at that time.

Ultrasonography and echocardiography were performed a few weeks later at the Veterinary Campus of Vetagro-Sup, Lyon, France. The animal was anesthetized with the intramuscular medetomidine and ketamine combination as previously described. Abdominal ultrasound showed moderate ascites and uterine enlargement with anechoic fluid content.

Two-dimensional echocardiography revealed a left ventricular overload. Subjectively, the left auricle and pulmonary trunk appeared enlarged while the right atrium appeared of normal size, with a LA/Ao ratio of 1.41. The right atrium was normal in size, but the pulmonary trunk looked somewhat dilated. Left ventricular diameter in M-mode measured at 2.4 cm in systole and 4.1 cm in diastole. The fractional shortening was calculated at 42.2%. Color flow Doppler from a left cranial parasternal view revealed a continuous left-to-right turbulent flow through a patent ductus arteriosus (PDA) (Fig. 1). The maximal flow velocity through the ductus was measured at 6.35 m/s in systole, which is equivalent to a pressure gradient of 161 mm Hg using the modified Bernoulli equation ($\Delta P = 4V^2$). The

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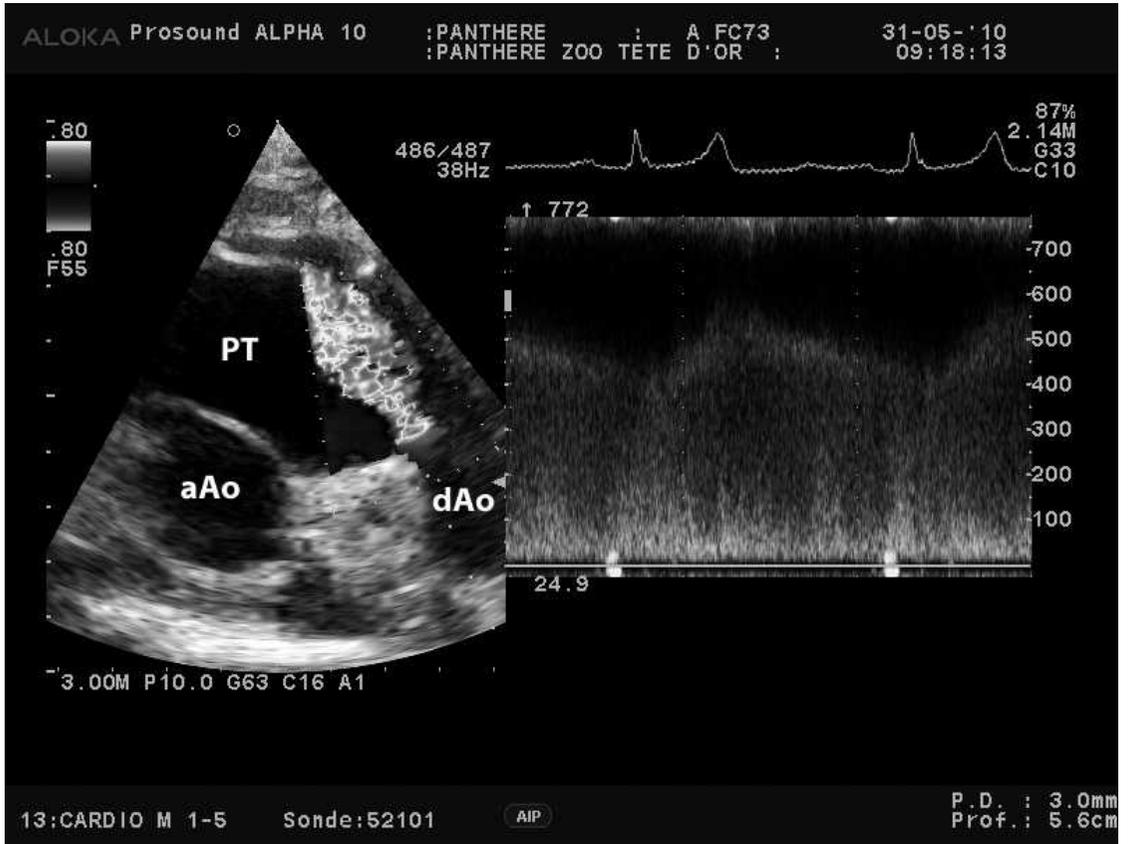


Figure 1. Echocardiographic image from a left parasternal window (modified short-axis view). The picture on the left side (two-dimensional mode) shows a turbulent flow in the pulmonary trunk starting at the level of the orifice of the patent ductus arteriosus on the pulmonary trunk side (left-to-right shunting). The picture on the right (continuous Doppler) shows the very high-velocity continuous flow coming from the PDA (speed scale in cm/sec on the right side). (PT) pulmonary trunk, (aAo) ascending aorta, (dAo) descending aorta.

aortic flow was laminar with a peak flow velocity at 1 m/s. Mild mitral and aortic insufficiencies were present. The pulmonary flow was laminar with a normal velocity.

Electrocardiogram revealed a heart rate of 70 bpm and was otherwise unremarkable.

Considering the overall clinical condition, age, and hybrid status of this leopard, and according to the European Association of Zoos and Aquaria code of ethics and in consultation with the European Captive Breeding Programme species coordinator, the decision was made to euthanize the leopard.

On necropsy, 100 ml of a brownish fluid was collected from the abdominal cavity. The uterine horns were both dilated and contained 250 ml of translucent brownish fluid. The uterine mucosa was thickened, with a whitish color. The left thyroid gland was slightly enlarged with numerous small cysts (1–5 mm). Both parathyroid

glands were slightly enlarged. The renal medulla was diffusely whitish. The heart examination revealed a very small orifice of the PDA, with an internal diameter of 0.5 mm (Fig. 2). The common pulmonary artery and left atrium were slightly dilated.

Histologically, bilateral thyroid cysts and parathyroid hyperplasia were considered to be age related with no clinical relevance. The kidneys displayed rare minimal perivascular amyloid deposits in the renal medulla and areas of mild interstitial nephritis. The uterine wall was thin with muscular and mucosal atrophy. In the chorion, the remaining glands were small and tortuous, confirming the suspicion of mucometra.

There were no hepatic or pulmonary histologic lesions consistent with cardiac failure. A longitudinal section of the PDA was examined with an orcein-hematoxylin stain for elastic fibers and immunohistochemistry (α -smooth muscle actin).

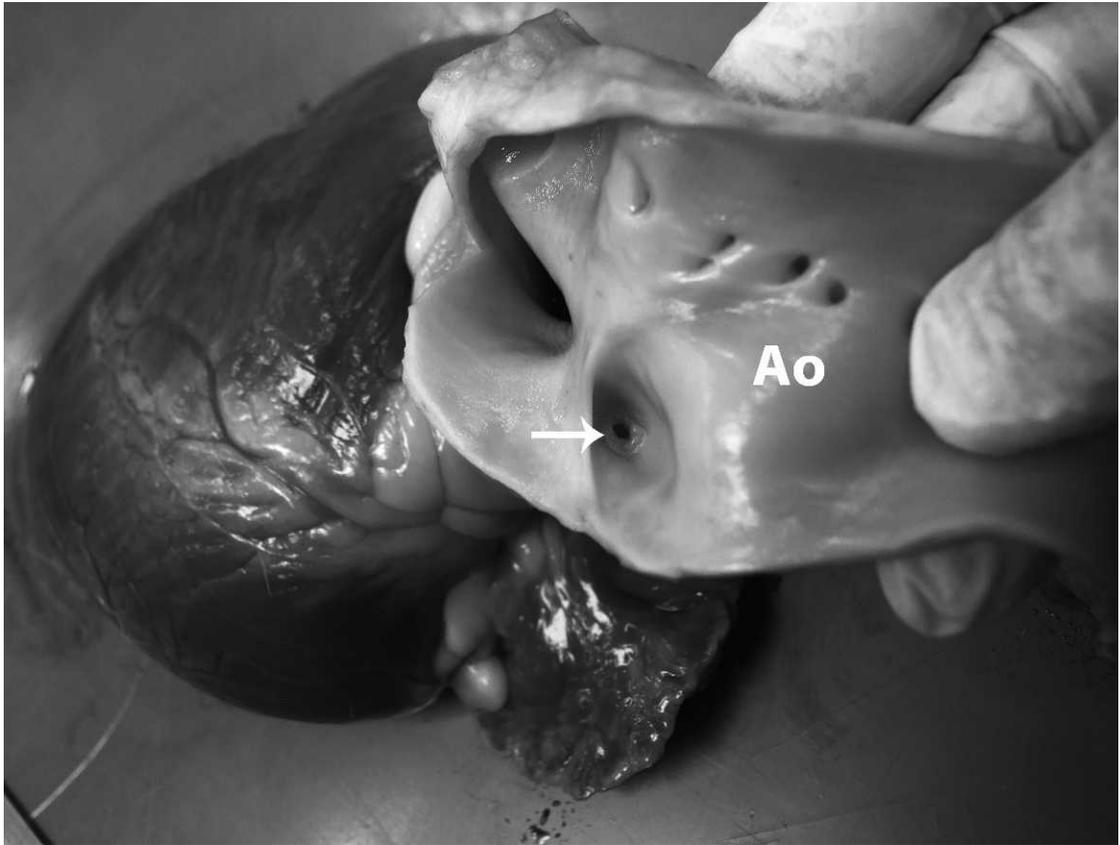


Figure 2. The cardiac necropsy examination revealed a very small orifice of the patent ductus arteriosus (internal diameter of 0.5 mm) on the pulmonary trunk side (arrow). (Ao) aorta.

Unfortunately, the proportions of smooth muscle fibers and elastic fibers could not be properly determined because of the very small sample size.

Only a small number of congenital heart diseases have been reported in nondomestic felids in the literature.^{1,4,9,12} Two related lionesses were reported to have produced several litters of lion cubs with congenital abnormalities of the heart, lungs, and mediastinum.⁹ The Florida panther subspecies has been described as having an increased incidence of congenital heart defects and heart murmurs.¹² A preductal aortic coarctation associated with a patent ductus arteriosus was diagnosed on necropsy in a Sumatran tiger cub.¹ Recently, the first case of pulmonic valve stenosis was described in a snow leopard.⁴

PDA is one of the most common congenital heart defects in dogs but is far less common in domestic felids, with a prevalence of 0.2 to 0.3 per 1,000.⁸ PDA in cats has often been reported in conjunction with other cardiac malformations, such as ventricular septal defects, subaortic

stenosis, and multiple other congenital defects.^{5,6,8,11} A retrospective study of 21 domestic cats in which PDA was confirmed by echocardiography, angiography, surgery, or necropsy revealed an age distribution from 1 mo to 11 yr, with 86% of the cases in animals younger than 1 yr. One third of the cases were reported to have been asymptomatic upon presentation.⁶ This percentage is probably underestimated because of the absence of clinical repercussion due to the small internal diameter of the ductus in some cats.

Clinical signs generally depend on the size of the PDA, direction of the blood flow, concurrent presence of other congenital lesions, and accompanying complications. In cases in which the arterial duct has a small diameter as in this case, blood flow from the aorta to the pulmonary artery (left-to-right shunt) is minimal during both systole and diastole, without any forward clinical signs.¹⁰

In dogs, PDAs are shown to be caused by a defect in the anatomy of the ductus arteriosus.

The ductus arteriosus is short, and the ductus muscle mass shows an asymmetrical distribution. The wall of the ductus adjacent to the aorta is thinner and contains predominantly noncontractile elastic fibers. Conversely, the ductus muscle mass is maximal near the pulmonary artery.³ These abnormalities are classified into six different grades, based on the extent of abnormal elastic tissue in the muscular ductus wall adjacent to the aorta. It appears that the smaller the PDA, the lower the grading score.² No such histologic study has been performed on a series of PDA cases in domestic cats. Unfortunately, in this Amur leopard, no cross-section of the PDA could be performed because of its short length.

To our knowledge, this case represents the first of PDA reported in an adult Amur leopard and only the fifth report of congenital heart disease in a nondomestic felid. As may be seen in domestic cats, this Amur leopard presented at an advanced age due to absence of clinical signs associated with a PDA.

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Received for publication 22 May 2012