



Reversed patent ductus arteriosus in a dog

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Abstract — A 5-year-old cocker spaniel with tachycardia, > 2 s capillary refill time, arrhythmia, split S2 heart sound, right ventricular enlargement, flattened interventricular septum, dilated pulmonary artery, and slight tricuspid valve insufficiency was diagnosed with reversed patent ductus arteriosus (right-to-left vs the more common left-to-right shunt). Two years later, the dog was still stable.

Résumé — Canal artériel persistant inversé chez un chien. Un Épagneul de 5 ans avec tachycardie, temps de remplissage capillaire > 2 s, arythmie, dédoublement du deuxième bruit, dilatation ventriculaire droite, septum interventriculaire aplati, artère pulmonaire dilatée et légère insuffisance de la valvule tricuspide a été diagnostiqué d'un canal artériel persistant inversé (shunt droite-gauche alors que le plus fréquent est gauche-droite). Deux ans plus tard, la condition était encore stable.

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A 5-year-old, 10-kg male cocker spaniel was presented to an emergency clinic for a head tilt of 1 week's duration. The dog had exhibited a gradual onset of head shaking and lethargy, and the owners reported a recent seizure. A presumptive diagnosis of inner ear infection was made, and the dog was treated with cephalexin tablets (Novo-Lexin; Novopharm, Toronto, Ontario), 25 mg/kg body weight (BW), q12h, for 21 d.

A more detailed examination and diagnostic tests were scheduled for the following day (day 1). Tympanic membrane rupture was suspected, and a cardiac arrhythmia was noted. Radiographs of the tympanic bullae could not be taken, because the dog's mucous membranes became cyanotic when the dog was restrained. The owners reported that, since puppyhood, the dog had experienced exercise-associated episodes of hind end weakness, collapse, and cyanosis, and, recently, had experienced what they perceived to be a seizure.

The cardiovascular system was examined on day 4. Significant findings included tachycardia (200 beats/min), prolonged capillary refill time (> 2 s), dark and congested oral mucous membranes, and weak femoral pulses. No cardiac murmur was detected, but the previously noted arrhythmia was present. A congenital heart anomaly was suspected, with the head tilt being attributed to inner ear disease.

Abnormalities on a complete blood cell (CBC) count were a high erythrocyte count ($9.4 \times 10^{12}/L$; reference

range, 5.5 to $8.5 \times 10^{12}/L$), an elevated hematocrit (HCT) (0.62 L/L; reference range, 0.37 to 0.55 L/L), and hemoglobinemia (213 g/L; reference range, 20 to 180 g/L).

An electrocardiogram showed right axis deviation, suggesting either aberrant conduction through the myocardium or right ventricular enlargement. The cause of syncope and possible seizure activity was not apparent. A cardiac arrhythmia was not present at this time.

Approximately 6 wk later, the dog was examined by a veterinary cardiologist. A very mild left head tilt and left facial paralysis persisted. A split S2 heart sound and arrhythmia were noted. Thoracic radiographs showed right ventricular enlargement and changes compatible with pulmonary hypertension. Cardiac ultrasonography confirmed marked right ventricular enlargement and revealed a flattened interventricular septum, a significantly dilated pulmonary artery, and a very slight tricuspid valve insufficiency. The history, physical examination, and results of diagnostic procedures suggested that right-to-left shunting was occurring. Shunting may be intracardiac at the level of the atria or ventricles, or extracardiac between the aorta and pulmonary artery. A contrast study was performed as follows to differentiate these possibilities.

Microbubbles of air were injected into a peripheral vein to provide contrast, while the descending aorta was viewed on ultrasound. The results confirmed an extracardiac communication between the pulmonary artery and the aorta (right-to-left shunt), and the final diagnosis was reversed patent ductus arteriosus (PDA).

As there is no effective treatment for this condition, the owners were advised to restrict their dog's exercise and to minimize stress and excitement. It was recommended that the dog's HCT be checked every 2 mo, more often if the dog became symptomatic, and that phlebotomy be performed to prevent the effects of severe polycythemia, if the HCT exceeded 0.65 L/L.

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Manju Arora will receive a copy of *Saunders Comprehensive Veterinary Dictionary* courtesy of Harcourt-Brace Canada.

Two weeks later, the HCT was unchanged (0.62 L/L); approximately 3 mo later, it was 0.56 L/L, and the dog's clinical condition had not deteriorated. Nearly 2 y after the initial diagnosis, the dog's condition was unchanged, and he had not had follow-up veterinary visits.

The ductus arteriosus, a fetal communication between the aorta and the pulmonary artery, allows passage of oxygenated venous umbilical blood into the aorta, bypassing the nonfunctional fetal lungs. Functional closure of the ductus arteriosus normally occurs by 72 h after birth (1,2). Patent ductus arteriosus is one of the most commonly reported congenital cardiac defects in dogs (2–4). Blood usually shunts with the pressure gradient from the aorta to the pulmonary artery (left-to-right shunt). The reported occurrence of reversed PDA (right to left shunt) is as low as 1% to 2% (3).

In dogs with reversed PDA, severe pulmonary arterial hypertension exceeds systemic arterial pressure. The origin of fetal pulmonary hypertension is unexplained, but it may be associated with a large ductal defect (1,5) and probably persists into adulthood (1). Clinical signs occur at an early age, and episodes of caudal paresis during exercise or times of excitement are reported from puppyhood, as in this dog. There have been no documented reports of reversed PDA developing in dogs over 6 mo of age (1).

Dogs with reversed PDA may have cyanotic mucous membranes in the caudal portion of the body (differential cyanosis). This occurs because the shunt occurs distal to the brachiocephalic and left subclavian arteries, allowing the head and forelimbs to receive normally oxygenated arterial blood, while the caudal portion of the body receives mixed arterial and venous blood. Systemic hypoxemia stimulates increased erythrocyte production and secondary polycythemia. Affected dogs may show fatigue, dyspnea, tachycardia, and hind limb weakness. The history may include episodes of incoordination, syncope, or seizures (6) caused by sludging of hyperviscous blood in the microvasculature, with subsequent hypoxia of the brain and other tissues (7). Such a vascular event might cause a head tilt, but in this dog, the head tilt responded to antibiotic treatment and was probably caused by an ear infection unrelated to the reversed PDA.

Surgical correction is the treatment of choice for PDA with left-to-right shunt. In contrast, surgical cor-

rection of reversed PDA is contraindicated. By allowing small amounts of blood to move through the ductus, the PDA acts as a pressure relief valve, preventing excess pressure from building in the right heart. If the ductus is ligated, severe pulmonary hypertension causes acute right heart overload and failure (1,5).

There is no effective medical treatment for reversed PDA. Exercise and stressful or exciting situations exacerbate right-to-left shunting and cyanosis (1) and should be limited. Anesthesia should be avoided, if possible. Hematocrit should be monitored regularly, maintained at approximately 0.62 L/L or less (1), and never allowed to exceed 0.68 L/L (3). Phlebotomy should be performed if the HCT exceeds 0.68 L/L, or if clinical signs warrant intervention, but repeated phlebotomies do not offer a long-term solution. Dogs with reversed PDA eventually become debilitated because of hypoxemia, or die suddenly due to arterial thrombus formation or fatal cardiac arrhythmia (3). Few affected dogs survive beyond 5 to 7 y of age (2,3,8).

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