



## NOTE

Wildlife Science

# Atrial septal defect in a Korean wild raccoon dog

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**ABSTRACT.** An approximately two-year-old, male 6.1 kg body weight, Korean wild raccoon dog (*Nyctereutes procyonoides koreensis*) was captured by the wildlife medical rescue center of Kangwon National University. Upon physical examination, the heart rate was 87 beats per min and there were no clinical signs. The hematological, and blood biochemical profiles revealed no remarkable findings; however, thoracic radiographs showed cardiac enlargement, especially in the right atrium. On electrocardiogram, sinus node dysfunction and bradyarrhythmia were revealed. Echocardiography showed a left-to-right shunting atrial septal defect. Based on these findings, this Korean wild raccoon dog was diagnosed with atrial septal defect. This is the rare case report of atrial septal defect in wildlife.

**KEY WORDS:** atrial septal defect, echocardiography, electrocardiography, raccoon dog, thoracic radiography

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Atrial septal defect (ASD) is a congenital heart defect characterized by communication between the two atria due to a defect in the interatrial septum [3]. ASD is classified as an ostium primum defect, ostium secundum defect and sinus venosus defect based on the site of occurrence. Among these three types, ostium secundum defect, which is located in the region of the fossa ovalis, is more common in dogs [10]. Although ASD is one of the most common congenital heart defects in human medicine, ASD was believed to be rare in veterinary medicine; however, one group showed that 37.7% of all canine and feline congenital heart defects involved ASD [3]. Animals with ASD commonly have other cardiac malformations, and ASD usually results in a left-to-right shunting across the defect, regardless of the type of ASD [10].

The clinical signs of ASD are usually non-specific. Findings on physical examination are often non-remarkable for isolating ASD. One report demonstrated that 74.7% of dogs with ASD had no clinical signs, and only 18.4% of dogs with ASD had clinical signs, including exercise intolerance, syncope, dyspnea, cough and cyanosis [3]. In wildlife, congenital heart defects are especially rare, and there have been only a few case studies. Moreover, the prevalence rate of cardiovascular disease is difficult to estimate, because there are only a handful of published case reports [6, 12–14]. Especially in raccoon dogs, there are few reports about the congenital heart defects. In this study, we describe an ASD in a Korean wild raccoon dog (*Nyctereutes procyonoides koreensis*).

An approximately two-year-old, male 6.1 kg body weight, Korean wild raccoon dog was captured by the wildlife medical rescue center of Kangwon National University. Upon physical examination including auscultation examination, the heart rate was a little low (87 beats per min: reference range=94–134 beats per min [6]), and there were no clinical signs. The hematological and blood biochemical profiles revealed no remarkable findings (Table 1). However, thoracic radiographs showed cardiac enlargement, especially in the right atrium (Fig. 1). On electrocardiogram (Cardiovit AT-1 Vet, Schiller healthcare India PVT. L, Mumbai, India), sinus node dysfunction and bradyarrhythmia were revealed. On echocardiography (HD11 XE Ultrasound system, Philips, Andover, MA, U.S.A.) with color Doppler at the right parasternal long-axis 4-chamber view, a left-to-right shunting ASD was diagnosed, under the manual holding. The diameter of the septal defect was about 0.4 cm (Fig. 2A and 2B). The shunt had a maximum flow velocity of about 0.7 m/sec at the diastole and about 0.4 m/s at the systole, corresponding to a pressure gradient of 2.08 and 0.53 mmHg each (Fig. 2C and 2D). All values reported are the averages of three measurements. Based on the electrocardiographic and the echocardiographic examinations, ASD, which has a type of ostium secundum defect, was diagnosed.

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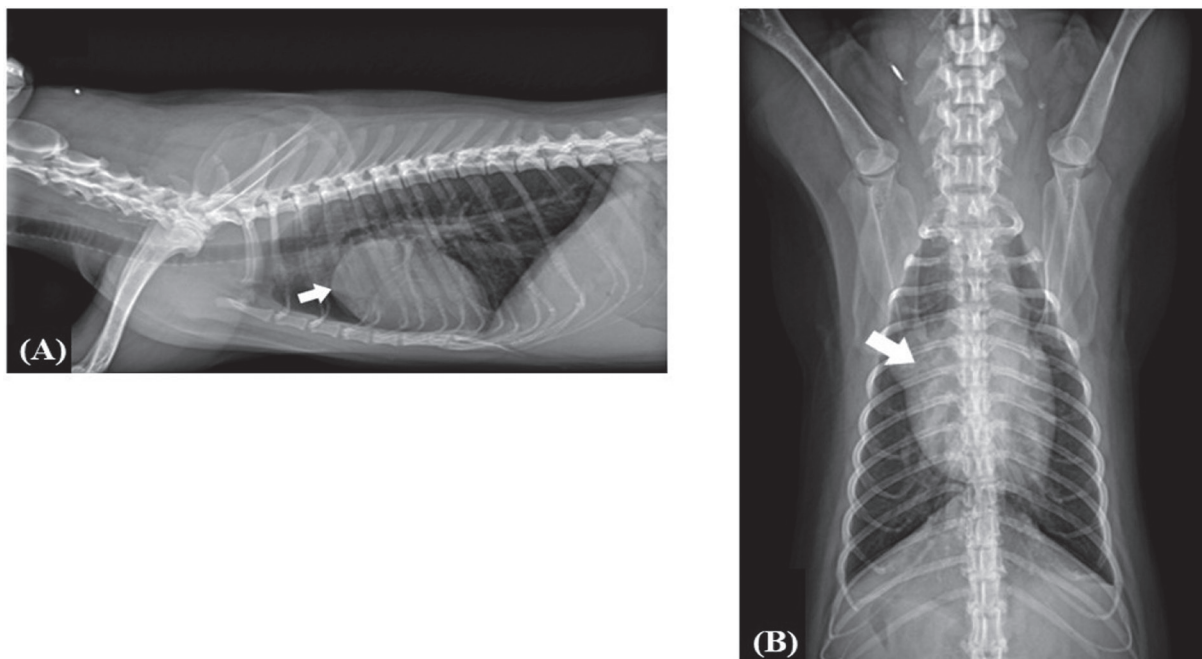


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**Table 1.** Hematological and blood chemistry profiles in the raccoon dog

Variable	Value	Reference range <sup>a)</sup>
Red blood cell count ( $\times 10^{12}/l$ )	8.91	6.26 $\pm$ 1.19
Hematocrit (%)	48	32 $\pm$ 8
Lymphocyte ( $\times 10^9/l$ )	2.37	4.21 $\pm$ 2.97
Monocyte ( $\times 10^9/l$ )	0.88	0.26 $\pm$ 0.62
Eosinophil ( $\times 10^9/l$ )	0.86	2.58 $\pm$ 2.75
Basophil ( $\times 10^9/l$ )	0.06	0.0 $\pm$ 0.0
Glucose (mg/dl)	105	111.2 $\pm$ 72.4
Blood urea nitrogen (mg/dl)	21	75.9 $\pm$ 29.7
creatinine (mg/dl)	0.7	0.4 $\pm$ 0.2
Phosphorus (mg/dl)	4.6	5.6 $\pm$ 1.6
Calcium (mg/dl)	8.7	9.4 $\pm$ 0.8
Total protein (g/l)	72	67 $\pm$ 8
Albumin (g/l)	29	30 $\pm$ 5
Alanine aminotransferase (U/l)	45	121.9 $\pm$ 148.5
Aspartate aminotransferase (U/l)	56	90.2 $\pm$ 86.3
Alkaline phosphatase (U/l)	17	109.3 $\pm$ 96.0
Total bilirubin (mg/dl)	<0.1	0.79 $\pm$ 0.39

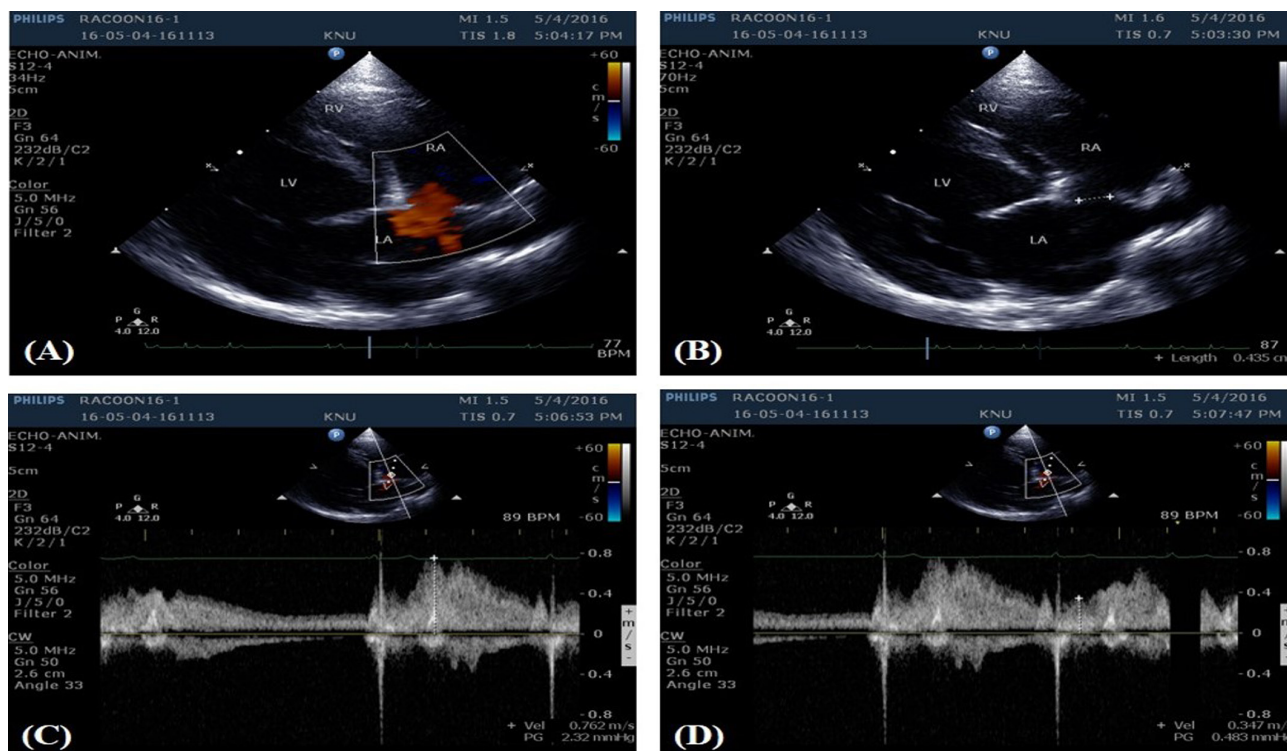
a) Refer [7]



**Fig. 1.** Thoracic radiographs of a wild raccoon dog. Right lateral (A) and ventrodorsal (B) views. Cardiac enlargement was revealed, especially in the right side of the heart (arrow).

Cardiovascular diseases are anecdotally common in wild animals, but there are few clinical reports of its diagnosis and treatment [6]. In wildlife, most cardiovascular diseases are diagnosed by necropsies after death. The most commonly identified cardiovascular diseases in wildlife animals are cardiomyopathy caused by infections, not by congenital defects [6]. Indeed, there have been only a few reports of congenital heart defects in wildlife [12, 14]. Among the congenital heart defects in wildlife animals, one case report showed the ASD only in Florida Panthers [4]. For diagnosis of congenital heart defects in living animals, auscultation, electrocardiography, radiography and echocardiography should be performed. These tools are commonly used in companion animals [10], but their use in wild animals is rare [4]. There is no exact comparison of cardiovascular anatomy, physiology and disease between raccoon and companion animals, however, these factors are almost similar in mammals [9]. In this study, we diagnosed ASD in a wild raccoon dog with auscultation, electrocardiography, radiography and echocardiography.

Ostium secundum defect in ASD is common in dogs [10]. In this study, we found that a wild raccoon dog also had an ostium secundum defect. In ostium secundum defect in ASD, spontaneous closure occurs frequently in young patients with small defects



**Fig. 2.** Echocardiography of a wild raccoon dog. Left-to-right shunting blood flow was imaged by Color Doppler (A). The septal defect diameter was 0.436 cm (B). The maximum flow velocity of the left-to-right shunting blood flow was 0.716 m/sec and 0.364 m/sec, respectively, at the diastole (C) and the systole (D).

in human medicine [5]. In veterinary medicine, there are no reports about the spontaneous closure of ASD, although there is one report of spontaneous closure of ventricular septal defect in dogs [2]. The existence of ASD in this raccoon dog was an incidental finding without clinical signs; however, if spontaneous closure of ASD does not occur, severe clinical signs could follow.

The main cause of congenital heart defects, including ASD, is gene mutation. The cardiac phenotypes most frequently seen in mutation carriers are ostium secundum atrial septal defects in human medicine [11]. Few studies have included gene analysis of ASD cases in veterinary medicine. One of these reports showed that the canine GATA4 gene, which is an important factor of ASD in human medicine, was not related to ASD in Doberman Pinschers [8]. Even though the inheritance of ASD and genetic etiology are not well understood, it is still doubtful that gene mutation is a major factor in ASD in veterinary medicine. A few reports indicated that such harmful genetic mutations in wildlife animals can threaten the lives and eventually endanger species [1]. The environmental destruction commonly occurs worldwide, especially in isolated species in limited area. These isolated populations have low genetic diversity and are subject to inbreeding, which can ultimately cause genetic mutations [4]. In this case report, we could not perform gene analysis, so we cannot anticipate about the cause of ASD. More studies will be needed by gene analysis to reveal the causes of congenital cardiac defects in wildlife.

To the best of our knowledge, this is the first case report of ASD in a wild raccoon dog. Based on this study, we suggested that congenital cardiac defects should be considered in wildlife.

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