

<Case Report>

## Prolonged reflex bradycardia after occlusion of patent ductus arteriosus with an Amplatz canine duct occluder in a dog

Woong-Bin Ro, Min-Hee Kang, Chang-Min Lee, Seung-Gon Kim, Hee-Myung Park\*

*Department of Veterinary Internal Medicine, College of Veterinary Medicine, Konkuk University, Seoul 05029, Korea*

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**Abstract:** A 9-month-old intact male Maltese dog (1.52 kg) was diagnosed with a patent ductus arteriosus (PDA). Transcatheter occlusion of the PDA was performed by using the Amplatz canine duct occluder (ACDO). After occlusion, reflex bradycardia occurred and lasted for at least 15 h with normal systolic arterial pressure and slightly increased diastolic arterial pressure. The bradycardia slowly resolved, and the heart rate was normal in re-examinations after 7 and 30 days. This is the first case of reflex bradycardia after ACDO implantation, in which the bradycardia continued for a long time, even after recovery from anesthesia.

**Keywords:** Amplatz canine duct occluder, Branham-sign, patent ductus arteriosus, reflex bradycardia

Patent ductus arteriosus (PDA), in which there is the persistence of ductus arteriosus after the early neonatal period, is one of the most commonly diagnosed congenital cardiovascular anomalies in dogs [4]. Among many approaches and devices currently used in occlusion of PDA, Amplatz canine duct occluder (ACDO) is considered superior in ease of use, complication rate, and completeness of occlusion [10, 13].

A sudden occlusion of PDA can induce a transient bradycardia in some patients, and this reflex bradycardia is explained by a phenomenon called “Branham sign”, which is a decrease in heart rate (HR) and an increase in blood pressure after the sudden occlusion of arteriovenous fistula [2, 7, 12].

Reflex bradycardia after PDA closure has been reported in surgical ligation, and in most of the cases, the postligation bradycardia was transient for a few minutes [3, 14, 15]. To the author’s knowledge, this is the first case report of dog showing long duration of reflex bradycardia after occlusion of PDA with ACDO.

A 9-month-old (body weight, 1.52 kg) intact male Maltese dog was referred due to an episode of syncope (loss of consciousness for a few seconds when excited) and abnormal heart sounds. During physical examination, a grade V/VI continuous heart murmur was auscultated at the left base of the heart, with the point of maximal intensity at the pulmonary valve area. Heart rate was 128 bpm and blood pressure was within normal range (systolic pressure 128 mmHg, diastolic pressure 83 mmHg, and mean arterial pressure 95 mmHg; Cardell 9402 Veterinary Monitor; Midmark, USA). Complete blood count and serum chemistry results were

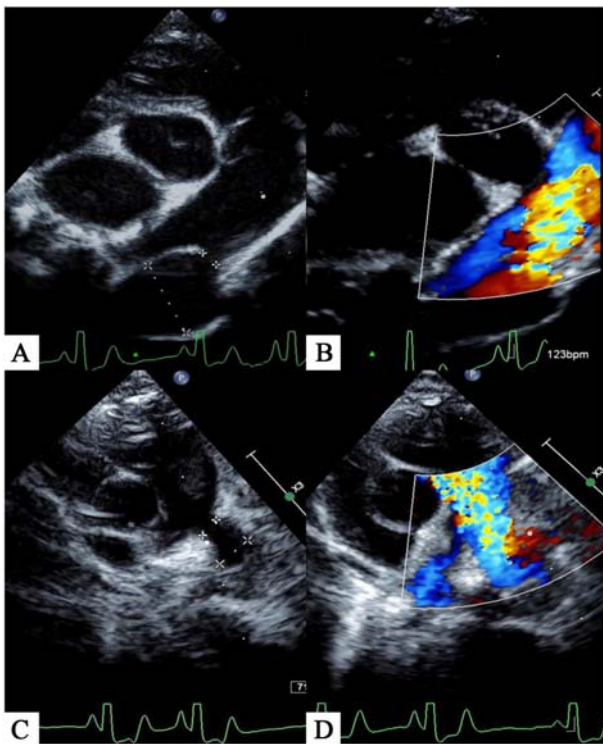
within normal range. Thoracic radiographs showed cardiomegaly (vertebral heart size = 11.8), increased pulmonary circulation, and left atrial and ventricular dilation were suspected. A left-to-right PDA was highly suspected on the basis of these findings. Transthoracic echocardiography (EPIQ 7 Cardiology Ultrasound Machine; Philips, USA) was performed for a definitive diagnosis. Dilation of the left atrium and ventricle (left-side volume overload) and a continuous turbulent flow in the main pulmonary artery were detected, and the PDA was visualized from both right parasternal view and left cranial parasternal view, with the minimum ductal diameter of 5 mm (Fig. 1). On continuous wave Doppler, the peak flow velocity coming from the PDA was 5.44 m/sec and the pressure gradient was 118 mmHg. The dog was diagnosed with a left-to-right PDA and interventional treatment using an ACDO was carried out. Before the interventional treatment, the dog was prescribed for 14 days with furosemide (1 mg/kg, twice daily, per orally [PO]; Handok Pharmaceutical, Korea), and an angiotensin converting enzyme inhibitor, ramipril (0.125 mg/kg, once daily, PO; Intervet Korea, Korea) to decrease the volume and pressure overload on the heart, therefore stabilizing cardiac condition before anesthesia.

Angiography was performed using a nonionic contrast medium (Omnipaque, 1 mL/kg; GE Healthcare, USA), and the minimal ductal diameter was confirmed to be 5 mm. The 4-mm ACDO (Infiniti Medical, USA) was chosen due to a small size of the femoral artery. After the device was fully deployed, the continuous murmur disappeared immediately (Fig. 2).

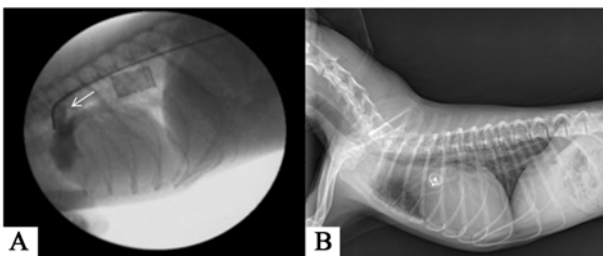
\*Corresponding author

Tel: +82-2-450-4140, Fax: +82-2-444-4396

E-mail: parkhee@konkuk.ac.kr



**Fig. 1.** Evaluation of the patent ductus arteriosus (PDA) by two-dimensional echocardiography. A structure with jet flow suspected to be a duct was found in the right parasternal cranial view (A and B) and the left parasternal cranial view (C and D).

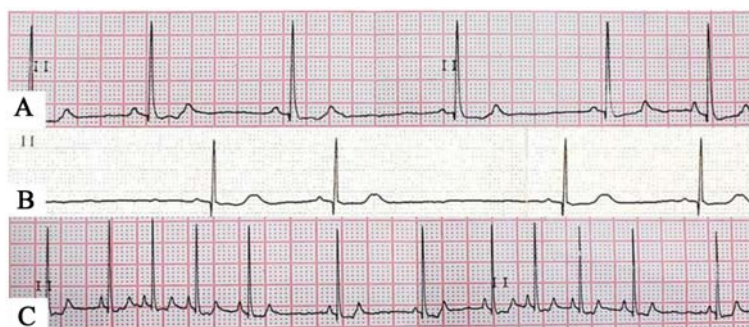


**Fig. 2.** PDA (white arrow) was detected on fluoroscopic angiography (A), and the placement of Amplatzer canine duct occluder (ACDO) was confirmed on thoracic radiography after the procedure (B).

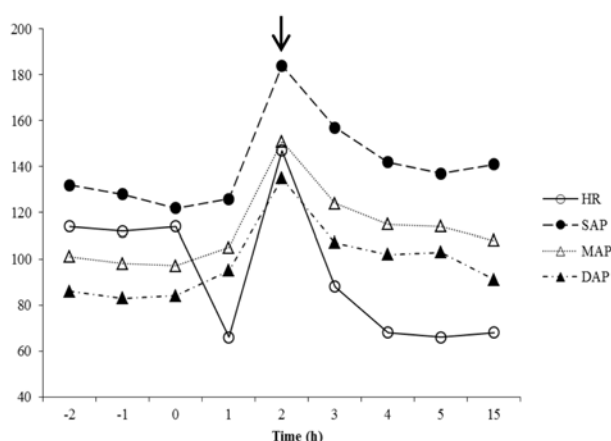
Although the patient was recovered completely from general anesthesia, the dog showed profound bradycardia (HR, 66 bpm) compared to the HR before the procedure (114 bpm), with normal systolic arterial pressure and slightly increased diastolic arterial pressure (126 mmHg and 95 mmHg, respectively). The electrocardiography (ECG) showed bradycardia with respiratory arrhythmia (sinus bradycardia) (Fig. 3). Glycopyrrolate (0.005 mg/kg, IV; Myungmoon Pharm, Korea) was treated and the HR, systolic, and diastolic blood pressure increased to 147 bpm, 184 mmHg and 135 mmHg, respectively. The HR slowly decreased back to bradycardia (68 bpm) in 2 h, and the systolic and diastolic blood pressure also decreased to 142 mmHg and 102 mmHg, respectively. The dog was monitored with holter ECG (KRUUSETelevet; Jørgen Kruse, Denmark) for 15 h, and the bradycardia was continued throughout the monitoring period (15 h) (Fig. 4). The dog was discharged the following day, with bradycardia still present (68 bpm). After 7 days, in a re-examination at local animal hospital, the HR was recovered to 137 bpm and the systolic and diastolic blood pressure was 140 mmHg and 86 mmHg, respectively. This normal HR was maintained in a re-examination after 30 days, and the dog had no clinical signs during the follow-up period of 1 year.

Possible causes of sudden bradycardia after PDA occlusion include traction or entrapment of vagal trunk during surgical procedures, an effect of drug administration, and a phenomenon called “Branham sign”, which is the most commonly known reason for bradycardia after PDA ligation [12, 14, 15]. Since the patient in this case had an interventional procedure through transarterial approach, the possibility of direct irritation of vagal trunk is very low. Also, no medication which can induce bradycardia was applied in this patient. Therefore, “Branham sign” was thought to be the cause of bradycardia in this patient, a phenomenon which was first observed in an arteriovenous fistula patient [1, 2, 9].

PDA and arteriovenous fistula are very similar in hemodynamics, and understanding mechanism of one allows anticipation of the other. When the arteriovenous fistula is compressed, the diastolic arterial pressure suddenly increases, with less increase of systolic arterial pressure [8, 11]. Thus, the increased mean arterial pressure stimulates an arterial barore-



**Fig. 3.** Electrocardiograms before (A), immediately after (B), and 7 days after (C) the occlusion of PDA, showing a respiratory sinus arrhythmia (A) with normal heart rate at 114/min (50 mm/sec and 5 mm/mV), a profound respiratory bradycardia (B) at 66/min (50 mm/sec and 2.5 mm/mV), and the recovered heart rate (C) at 137/min (25 mm/sec and 5 mm/mV), respectively.



**Fig. 4.** Changes in heart rate (HR), systolic, mean and diastolic arterial pressure after the occlusion of PDA. Time 0 refers to the time just before the start of anesthesia. Profound bradycardia was observed after the procedure with increment of diastolic arterial pressure (DAP). Rises in HR, systolic arterial pressure (SAP), mean arterial pressure (MAP), and DAP showed in response to glycopyrrolate administration (arrow), however which diminished within 2 h and the bradycardia prolonged for at least 15 h. The results during anesthesia were omitted to exclude the influence of anesthesia.

ceptor (carotid sinus and aortic arch) to decrease HR through vagus nerve activation [1, 5, 9]. This phenomenon, known as “Branham sign”, also occurs in PDA ligation [7, 12]. In the present case, bradycardia after occlusion of the ductus and the increased diastolic arterial pressure with normal systolic pressure coincide with “Branham sign”, and also a response to antimuscarinic drug (glycopyrrolate) confirmed the involvement of vagus nerve.

The incidence of profound “Branham sign” in PDA ligation is 3% in one report and 7% (1 case in 14 dogs) in another report [14, 15]. Among possible reasons of small incidence rate and diverse severity in each patient, the size of a ductus can be a contributing factor. In arteriovenous fistula, patients with the largest arteriovenous communications tended to have the most marked changes in blood pressure when the fistula was occluded or released [8]. In the same manner, a larger ductus in PDA patients would have more change in blood pressure when occluded, giving more stimulus to the baroreceptor reflex. In the present case, the patient had a relatively large ductus diameter (5 mm) compared to the body weight (1.52 kg) [6], and this large size of the ductus would have contributed to the occurrence of severe and prolonged bradycardia, which is different from other existing reports of transient bradycardia for a few minutes.

Since the “Branham sign” is a transient homeostatic adaptation to the increased blood pressure, some authors do not recommend the use of antimuscarinic agent (atropine, glycopyrrolate) for this reflex bradycardia [7]. In the present case, administration of glycopyrrolate increased HR to normal

range, but severe hypertension was observed in systolic and diastolic arterial pressure. Therefore, no intervention of drug on this state of patient is recommended, unless the patient shows a severe bradycardia (HR below 50 bpm), serious arrhythmia such as cardiac arrest, hypotension or clinical signs related to bradycardia. Heart rate became normal without any treatment, and no clinical sign was present.

In conclusion, this report demonstrates the prolonged reflex bradycardia after an occlusion of PDA with ACDO. To our knowledge, this is the first case to describe a sudden bradycardia in a PDA patient after an ACDO plantation, in which the bradycardia remained at least for 15 h.

## Acknowledgments

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