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Transjugular occlusion of patent ductus arteriosus using an Amplatz canine ductal occluder in a Cocker spaniel dog

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Abstract : A 5-year-old female Cocker spaniel dog (body weight 7.0 kg) was presented with primary complaints of exercise intolerance and loud precordial thrill which was noticed since she was a puppy. Physical examination revealed a grade V/VI continuous murmur over the maximal point of the left basal area, bounding femoral pulse, but no differential cyanosis. Tall R waves were detected in electrocardiogram, suggesting left ventricular enlargement. Diagnostic imaging studies showed enlarged left ventricle, bulged descending aorta (dAo), markedly dilated right pulmonary artery, and continuous shunt flow between the dAo and main pulmonary artery. Based on these findings, the dog was diagnosed as left to right shunted patent ductus arteriosus (PDA). The patent ductus arteriosus was treated by lodging a PDA duct occluder via the transvenous approach. Clinical signs were markedly improved after the ductal occlusion, the shunt flow was mildly persistent. The case presented is the first case of PDA occluded by the PDA duct occluder via the transvenous approach in a small breed of dog. Although the residual shunt flow was mildly persisted, the dog was clinically normal without detectable murmurs.

Keywords : congenital heart defect, dog, ductus closure, occluder, PDA

Patent ductus arteriosus (PDA) is the most common congenital cardiac disease in dogs accounting for almost 30% of all congenital defects [1]. Uncorrected, PDA often results in left-sided congestive heart failure with a mortality rate reported to be greater than 65% within the first year [2, 7]. While surgical ligation has historically been the most utilized correction technique, interventional or minimally invasive catheter-based procedures have become commonplace over the past decade [3, 10]. Successful surgical ligation has been reported in Korea [11]. In this case report, we described the transvenous occlusion of PDA using an 8 mm Amplatz canine ductal occluder (ACDO) in a small breed dog.

A 5-year-old female Cocker spaniel dog (body weight 7.0 kg) was presented with primary complaints including exercise intolerance and loud precordial thrill noticed since puppyhood. In physical examination, there was a bounding femoral pulse (hyperkinetic) and a grade V/VI continuous heart murmur over the maximal point of left basal area was heard, lasting throughout systole and diastole. The 12-lead surface ECG presented a tall R wave (3.6 mV in lead II) indicating left ventricular enlargement and splintered QRS complex. Diagnostic imaging studies presented prominent descending aorta, left auricle, and main pulmonary artery (MPA) on the dorsoventral projection and the appearance of an aortic bulge ("ductus bump") near the origin of the ductus was also documented. Echocardiography presented increased left ventricle dimension and a mildly decreased fractional shortening. Moreover, continuous turbulent shunt flow between the aorta (Ao) and pulmonary artery (PA) at the pulmonary artery level short-axis view was present on color flow Doppler echocardiography (Fig. 1).

Based on diagnostic findings, the case was diagnosed as left to right PDA. We decided to occlude the PDA by coil embolization or ductal occlusion. Since the duct was large (~5.5 mm), we chose to conduct transarterial ductal occlusion (8 mm). However, the femoral artery was too narrow to install a 7 French (Fr) catheter (delivery catheter), so we decided to attempt transvenous coil embolization and a 6.5 mm (4 loops) coil was initially

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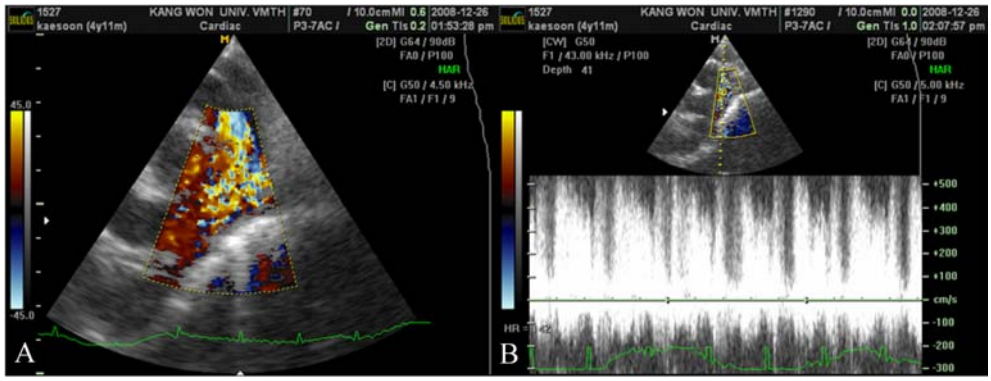

Fig. 1. Color (A) and spectral (B) Doppler echocardiography revealed a shunt flow between the aorta and pulmonary artery.

chosen.

For general anesthesia, the dog was premedicated with atropine (0.05 mg/kg, SC) followed by a propofol induction (5 mg/kg, IV) and propofol maintenance (0.6 mg/kg/min). Heart rhythm, blood pressure, SpO2, pCO2 and rectal temperature were closely examined using a patient monitor (VSM7TM; VetSpecs, USA). After achieving surgical anesthesia, venipuncture was performed at right femoral artery with an 18G needle. A guide-wire (Fixed Core Wire Guides; Cook, USA) was inserted into the needle and located at the descending aorta. A 5 Fr introducer sheath (Check-Flo performer Introducer; Cook, USA) was then placed into the femoral artery along with the guide-wire. A 5 Fr angiocatheter (Headhunter Catheters; Cook, USA) was then inserted into the introducer sheath and located at the shunt with the guidance of fluoroscopy. After the large shunt (~5.5 mm) was visualized with contrast medium (Iohexol, Omnipaque 350; Sampoong, Korea; Fig. 2), a 6.5 mm embolization coil (Flipper detachable embolization coils; Cook, USA) was attached to a coil delivery system (Cook, USA) and inserted into the angiocatheter, which was pre-placed at the shunt. The coil was then released at the shunt. However, it dislodged into the caudal pulmonary artery. Therefore, we decided to try an ACDO (Infiniti Medical, USA) via the jugular vein.

The venipuncture was performed at the left jugular vein with an 18G needle. A guide-wire was inserted into the needle and located at the caudal vena cava. A 7 Fr guiding catheter was then inserted into the jugular vein along with the preplaced guide-wire and located at the shunt with the guidance of fluoroscopy.

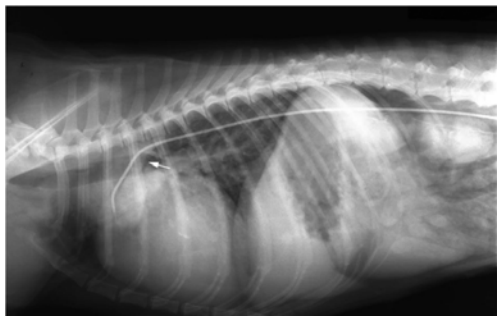

Fig. 2. A ~ 5.5 mm large shunt between pulmonary artry and descending aorta (dAo).

After the shunt was visualized with contrast medium, an 8 mm ductal occluder attached to a delivery system was inserted into the guiding catheter (7 Fr Flexer Tuohy-Borst Side-Arm Introducer; Cook, USA). The device was advanced until the flat distal disk was deployed within the main pulmonary artery. The partially deployed device, delivery system, and delivery cable were then all retracted as a single unit until the distal disk engaged the pulmonic ostium of the ductus which was recognized as a tugging sensation during retraction [6]. The delivery cable was then held in a fixed position while the delivery system was retracted to expose and deploy the waist of the device across the pulmonic ostium of the ductus, and the cupped proximal disk within the ductal ampulla (Fig. 3A). Then, to release the device, the delivery cable was detached by counterclockwise rotations with the use of the vise. Finally, the delivery cable and introducer were removed from the jugular vein (Figs. 3B and C).

The thoracic radiography taken after the ductal

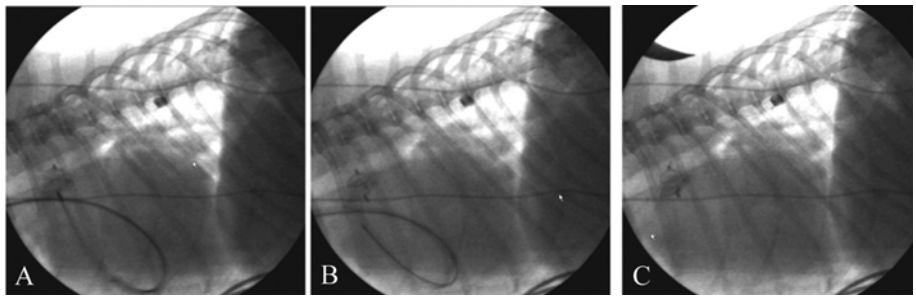

Fig. 3. The occlusion of patent ductus arteriosus using transvenous canine ductal occluder of this case. (A) An 8 mm ductal occluder was attached to an occluder delivery system and inserted into the angiocatheter via jugular vein. After locating at the shunt, the occluder was released. (B) The delivery cable and introducer were removed from the jugular vein. (C) After the removal of delivery cable and introducer, the coil and ductal occluder were visualized.

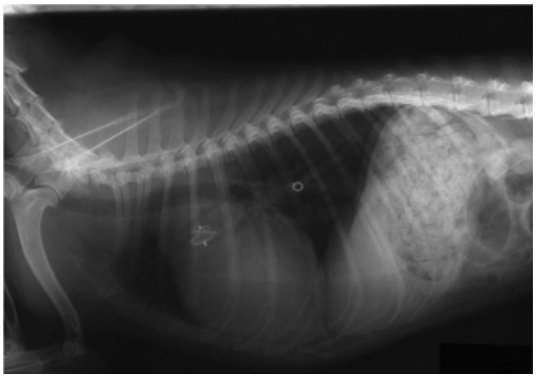

Fig. 4. Thoracic radiography taken after the occlusion using a ductal occluder. The occlude was successfully placed at ductus arteriosus, but reverse positioning.

occlude displayed successful occlusion of PDA (Fig. 4). The continuous murmur was not heard immediately after occlusion using a ductal occluder (Fig. 5). On echocardiography taken at the first day after transvenous occlusion using the ductal occluder, there was a minimal residual shunt flow between dAo and PA because of the reverse positioning of the occluder (Fig. 6). The condition of the dog gradually improved and started to eat voluntarily. On the clinical examination performed a month after the transvenous occlusion using the ductal occluder, the clinical condition was much improved and the ductal occluder in PDA located at the original site lodged. The dog is clinically healthy without detectable murmur, although the mild residual shunt flow are persisted, 6 month after the ductal occlusion.

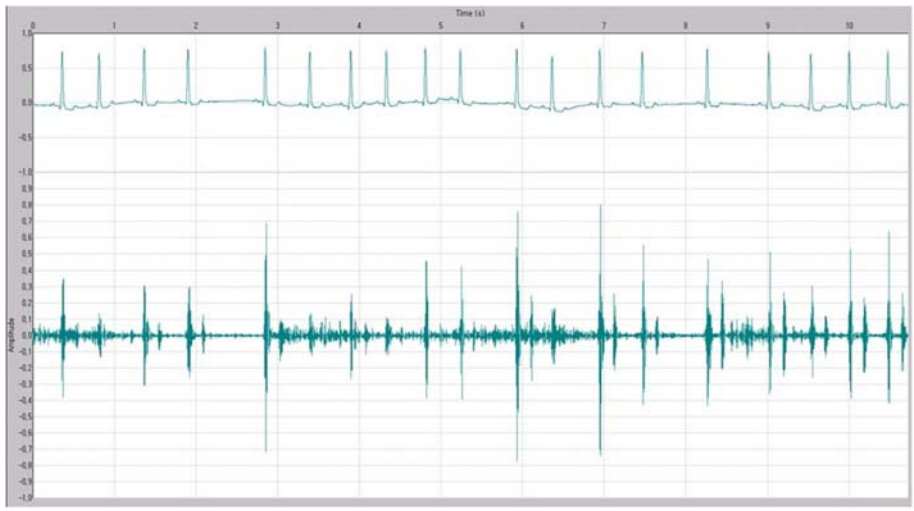

Fig. 5. Phonocardiogram recorded after the occlusion using a ductal occluder. The typical continuous murmur was disappeared after the successful occlusion.

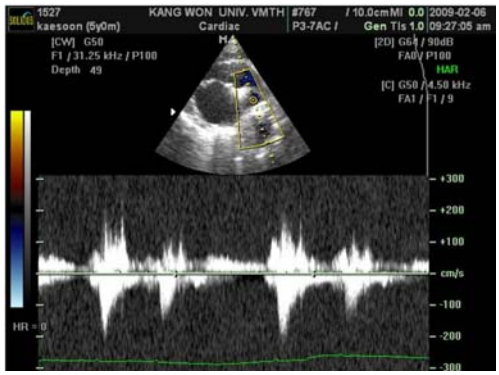

Fig. 6. Color Doppler echocardiography taken after the occlusion using a ductal occluder. There was a minimal residual shunt flow between dAo and pulmonary artery because of the reverse positioning of the occluder.

Correction with vascular occlusion coils via transarterial access is the most common technique and success rates are generally high (90%) while perioperative mortality rates are very low (< 1%) [9]. Some of the limitations with vascular occlusion coils include inadvertent pulmonary arterial or aortic embolization, incomplete occlusion and inadequate vascular access. Currently, a commercially available human duct occluder has been evaluated in dogs [4, 8].

Ideal method for PDA occlusion in small dogs (< 10 kg) with minimal ductus diameters < 4 mm is detachable coils, whereas the ductal occlusion using Amplatz canine ductal occluder is more appropriate in large dogs (> 20 kg) with large PDA diameters [5]. The Amplatz canine ductal occluder is a self-expanding nitinol wire meshed device and consists of a distal flat disk (placed on the PA side of the ductal ostium), a proximal cupped disk (placed on the dAo side) and dense nitinol mesh (occluding the communication between the PA and Ao). The ACDO is attached to long delivery cable and vise (a 110, 120, or 135 cm, depending on the size of ACDO) [5].

Angiography is necessary for appropriate sizing of PDA and selecting proper size of ACDO. Although no guideline for ACDO selection has been established, it is wise to select the ACDO which is 1.5 times or 2-3 mm larger than the actual size of PDA diameter, based on authors' experience and literature [5].

However, in our case, although the diameter of ductus arteriosus was large (~5.5 mm), the femoral artery was too narrow to install 7 Fr guiding catheter. Therefore, coil embolization (6.5 mm in diameter with 4 loops) was initially performed. However, it dislodged to caudal pulmonary artery. Afterwards, an attempt to occlude the PDA with the ductal occlude was tried via jugular vein and was successful.

After the procedure, no murmur was heard and a minimal residual shunt flow was detected in the color Doppler echocardiography after PDA ductal occlusion. The advantages of canine ductal occluder for the closure of PDA are short duration of the procedure and rapid postoperative recovery. The device also effectively occludes a wide range of PDA shapes with minimal ductal diameters (MDDs) and has a low potential for device migration and residual ductal flow. Furthermore, the deployment procedure is straightforward and feasible in a large variety of dog weights and somatotypes [6]. However, in our case, there was a minimal residual shunt flow between dAo and PA because of the reverse positioning of the occluder via transjugular approach. On the clinical examination performed a 6 month after the ductal occlusion, the clinical condition was fine, but minimal residual shunt flow between dAo and PA was persisted.

PDA can be treated by either surgical ligation or transcatheter procedures using detachable embolic coils, vascular plugs and ACDOs. Since surgical ligation requires invasive open chest surgery with long hospital stay, transcatheter procedures are rapidly replacing surgical ligation. The major advantages of transcatheter procedures using occlusion devices are that these procedures are minimally invasive, require only one night stay after procedure and short anesthetic time, and have minimal risks of surgery related complications, although the cost of occlusion devices are substantially higher than surgical ligation. Although several occlusion devices have been successfully applied to dogs and cats with PDA, no particular advantages have yet been established. The differences among devices (e.g. coils, plugs and ACDOs) are the size of delivery catheter requiring the device placement and price for each device. Since the coils require smaller diameter of delivery catheter (4-5 Fr), they are more appropriate for small or toy breed dogs and cats, although the coil dislodgement and residual shunt are the technical obstacles we have to improve, especially when it uses larger size coils. Compared to coils, vascular plugs and ACDO can occlude PDA more securely, although they require larger diameter of delivery catheters (7-8 Fr).

Problems using transcatheter coil occlusion encounter in small or toy dogs with larger size PDA (> 5 mm), since larger size coil occlusion can cause the coil dislodgement and residual shunts. Although the double coiling can increase success rate, it is a technically difficult procedure. Furthermore, although vascular plugs and ACDO can be a good alternative method, it is technically limited to larger dogs having larger size of femoral arteries. Therefore transvenous (transjugular) approach of ACDO placement is an excellent alternative for overcoming the limitation of vascular plug and ACDO placement in smaller dogs, although it is technically sophisticated since it should go through the right cardiac chambers. Although one study successfully deployed ACDO via femoral veins [4], femoral veins in small and toy breed dogs are not still larger enough to insert proper diameter of delivery catheters of ACDO. Therefore, tranjugular approach is more technically advantageous. Furthermore one current retrospective study described transarterial placement of ACDO in a 3.8 kg of dog [6], the mean body weight of those study population was ~20 kg, indicating there is a technical difficulty for ACDO placement in small and toy breed dogs, since the minimum diameter of delivery catheter for ACDO is 6 Fr, which may be too large to insert in small and toy breed dogs. Therefore, in this study, we developed the methodology of transjugular placement of ACDO in this study and found to be applicable in small dogs (< 7 kg) with larger PDA shunt (~5.5 mm) without any complications.

In conclusion, the case presented is the first case of PDA occluded by the Amplatz canine ductal occluder via the transjugular approach in a small breed of dog.

Acknowledgments

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