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Closure of Patent Ductus Arteriosus in a Maltese Dog Using Amplatz Canine Duct Occluder through Femoral Vein

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Abstract : An 8 month-old male Maltese (weighing 2.0 kg) was referred with loud heart murmur at routine physical exam in local animal clinic. Electrocardiogram found left ventricular hypertrophy pattern (4.5 mV R-wave). Diagnostic imaging studies revealed the elongation of left ventricle (LV) with classic triple bumps on the main pulmonary artery, aorta and left atrium on the ventrodorsal view of radiograph. Echocardiography revealed patent ductus arteriosus (PDA) duct and continuous turbulent shunt flow (maximal velocity 4.83 m/s) between the aorta and pulmonary artery with left to right direction. The PDA in this dog was successfully closed through femoral vein (transvenous approach) using a 5 mm Amplatz® Canine Duct Occluder. To the best of author's knowledge, this is the first case of PDA occlusion treated with Amplatz Canine Duct Occluder through femoral vein.

Key words **:** Amplatz® Canine Duct Occluder, patent ductus arteriosus, ductal occlusion, delivery system, PDA.

Introduction

Several occlusion devices for closure of patent ductus arteriosus (PDA) including thrombogenic coils, the Amplatzer® vascular plug and the Amplatzer® duct occluder have been used through transvenous and transarterial routes (1-12). All techniques and devices have potential limitations and complications and no single technique appears suitable for all dogs (1,10). The Amplatz canine duct occluder (ACDO), a self-expanding device made from a Nitinol wire mesh device specifically developed to fit the size and shape of the canine PDA, is recently introduced in veterinary fields (2,8). After introduction of the ACDO in 2007, this device has been widely used among veterinary cardiologists for its ease of use, low potential for device migration, and completeness of ductal occlusion (1,2,8,10). Major problem encountering transarterial PDA occlusion using ACDO in puppy or toy dogs under 3 kg of body weight is a difficulty of vascular access, because small puppies or dogs generally have tiny femoral arteries which are not enough to accommodate the delivery system for ACDO (1,9). One retrospective study found the smallest dog for successful closure of PDA using ACDO was 2.6 kg of body weight whereas the PDA of dogs under 2.5 kg of body weight were closed successfully with thrombogenic coils by both the transarterial and transvenous routes (10). Furthermore, this study found that very small dogs (<3 kg) were more likely to have complications such as a femoral arterial laceration or inability to place a catheter in the smaller diameter and less distensible femoral artery (10). To date, the ACDO for dogs under 3 kg of body weight has yet become commercially available. Therefore, in this case report, we developed the closure of PDA using ACDO through transvenous route (femoral vein) in a dog.

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Case

An 8 month-old male Maltese (weighing 2.0 kg) was referred with loud murmur at the physical examination. According to a referring vet, the dog was the smallest among the littermates. In physical examination, grade V/VI continuous quality cardiac murmurs were detected over the left basal area. Heart rate and systolic blood pressure (measured by Doppler method) was ~190 bpm and 150 mmHg, respectively. The electrocardiogram revealed sinus tachycardia (190-210 bpm) and left ventricular hypertrophy pattern (tall R-wave 4.5 mV). No significant abnormalities were observed in complete blood count (CBC) and serum biochemistry. Thoracic radiography found the elongation of left ventricle (LV) with classic triple bumps on the main pulmonary artery (MPA), aorta (Ao) and left atrium (LA) on the ventrodorsal view of radiograph (Fig 1A and 1B). There was no evidence of pulmonary infiltration and LA dilation in this dog. Echocardiography revealed PDA duct (3-5 mm, depending on location and echocardiographical views; Fig 1C), continuous turbulent shunt flow between the aorta (Ao) and pulmonary artery (PA) on continuous wave (CW) Doppler echocardiography at the pulmonary artery level (maximal velocity of pulmonic regurgitant 4.83 m/s; Fig 1D) with flow direction from left to right chamber. In addition, there were marked turbulent jets

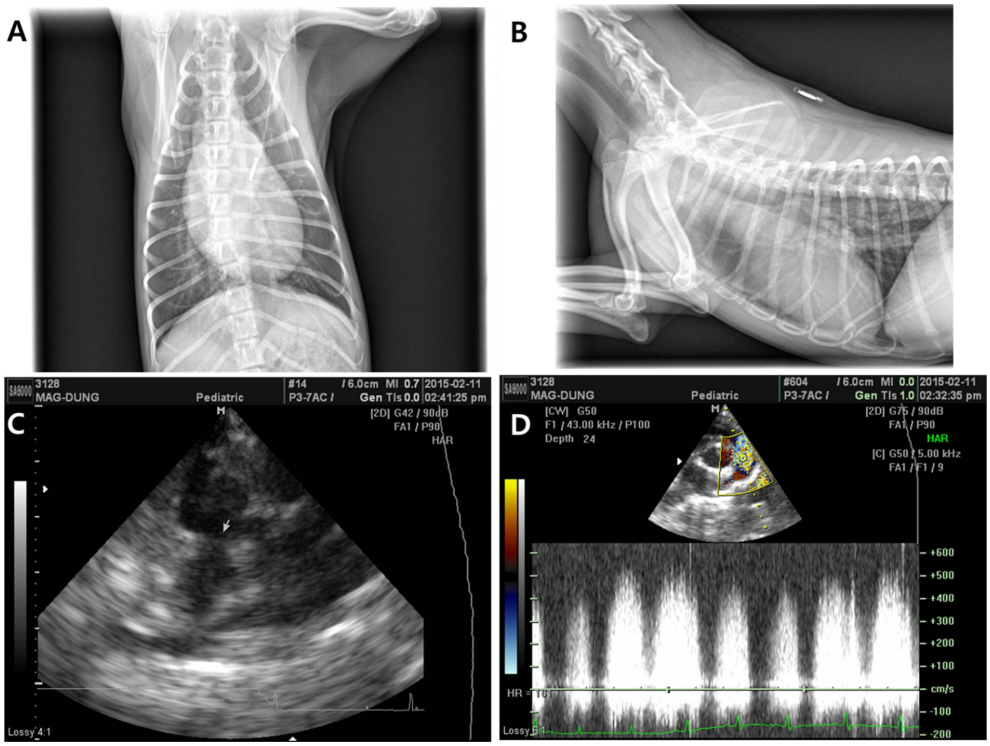

Fig 1. Diagnostic imaging studies of this case. A: Thoracic radiography revealed the elongation of left ventricle with classic triple bumps on the main pulmonary artery, aorta and left atrium. B: Thoracic radiography revealed generalized cardiomegaly without dilation of left atrium and pulmonary infiltration. C: The 2-D echocardiography taken at left apical 5 chamber view revealed PDA duct (3-5 mm). D: Continuous wave Doppler echocardiography taken at right parasternal short axis of the pulmonary artery level revealed continuous turbulent shunt flow between the aorta and pulmonary artery (maximal velocity of pulmonic regurgitant 4.83 m/s) with flow direction from left to right chamber.

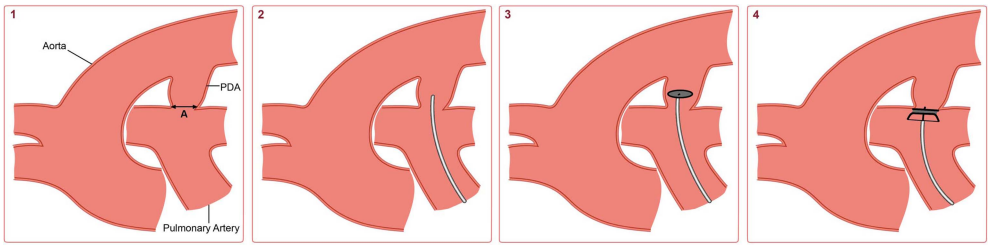

Fig 2. Procedure of transvenous PDA closure using an Amplatz duct occluder A: Schematic diagram of patent ductus arteriosus. B: Under fluoroscopic guidance, the device was advanced within the delivery system by pushing the attached delivery cable. C: The device was advanced until the flat distal disk was deployed within the ductus ampulla. The partially deployed device, delivery system, and delivery cable were then all retracted as a single unit until the distal disk engaged the ductus ampulla. D: After confirming of disappearance of heart murmur, 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 distal disk within the ductal ampulla.

at PA (Fig 1D). Although the %fractional shortening was within normal range (35%), there was a marked dilation of LV (LV dimension at diastole to aorta ratio ~2.3:1) without the evidence of LA dilation (LA/Ao ratio 1.23). However, there was no mitral regurgitation. Based on these diagnostic findings, this case was diagnosed as left to right PDA. Initially, we planned to close the PDA using thromboembolic coil through femoral artery (transarterial approach). However, the supplier (Cook medical, Korean branch) stopped to sell thromboembolic coils in Korean market. Therefore, we changed the plan to close PDA using an ACDO through either femoral vein or jugular vein (transvenous approach), because the femoral artery of the patient was too tiny to insert the delivery system for ACDO.

For general anesthesia, the dog was premedicated with butorphanol (0.2 mg/kg, IV; Donga Pharmaceuticals) followed by alfaxalone induction (2 mg/kg, IV; Jurox, Australia) with 1-5% isoflurane (Forane, Boxter, USA) maintenance. After achieving surgical anesthesia, the right femoral vein was exposed surgically and 18G intravenous catheter was inserted into the exposed femoral vein. Then a guide-wire (150 cm × 0.035" angled Weasel Wire®; Infiniti medical, USA) was inserted into the catheter and located at the descending Ao through PA. Along with pre-installed guide-wire, the delivery system (KSAW-5.0-18/38-90-RB-SHTL-HC, 4Fr, 90 cm, Flexor® Shuttle® Guiding Sheath, Cook medical, USA; Fig

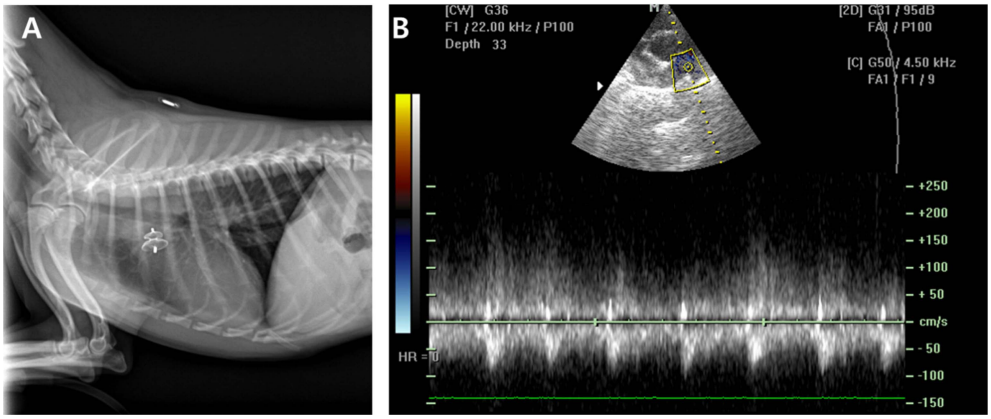

Fig 3. After the closure of patent ductus arteriosus. A: Thoracic radiography taken after the PDA closure revealed successful occlusion of PDA. B: The echocardiography taken at the first day after the PDA closure revealed minimal residual shunt over the duct.

2B) was then inserted into the femoral vein with aid of vein lifter (St. Jude medical, USA) under the guidance of fluoroscopy. After the shunt was visualized with contrast medium (Iohexol, Omnipaque 350; Sampoong, Korea), a 5 mm ACDO (Infiniti medical, USA) was then inserted into the delivery system. Under fluoroscopic guidance, the device was advanced within the delivery system by pushing the attached delivery cable (Fig 3B). The device was advanced until the flat distal disk was deployed within the ductus ampulla. The partially deployed device, delivery system, and delivery cable were then all retracted as a single unit until the distal disk engaged the ductus ampulla (Fig 3C). After confirming of disappearance of heart murmur, 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 distal disk within the ductal ampulla (Fig 3D). Proper positioning and stability of the device were confirmed by with gentle push-pull motions of the delivery cable. After confirmation of successful placement of ACDO, the delivery cable was detached by counterclockwise rotations

The thoracic radiography taken after the PDA occlusion revealed successful occlusion of PDA (Fig 3A). The loud cardiac murmur was weakened immediately after the PDA occlusion by ACDO. On the echocardiography taken at the first day after the PDA occlusion, we confirmed the successful occlusion of PDA with ACDO (Fig 3B). The next day of PDA closure, the dog was released without medication. On the clinical examination performed a month after the occlusion of PDA using ACDO, the dog had no clinical signs related to heart failure and PDA.

Discussion

The transvenous approach using either jugular vein or femoral vein has been used successfully with detachable thromboembolic coils, Amplatzer® vascular plugs or ACDO in dogs (1,2,7,9). It is easier to accommodate larger size delivery system for occlusion device with this route, since the veins are more distensible, even though the approach is technically more complicated. Before the introduction of ACDO, thromboembolic coils was the choice of option for PDA occlusion in dogs (3,4-7,9), although it often resulted in residual shunt after occlusion and inadvertent pulmonary artery embolization. Amplatzer® vascular plugs or Amplatzer® duct occluders have been recently introduced in veterinary fields and found to be more secure to occlude PDA and had low incidence of inadvertent pulmonary artery embolization (8,12).

One retrospective study evaluated clinical outcomes and complications among the 3 different occlusion devices placed by different approaches that were used to noninvasively close PDAs in dogs (10). This study found the overall success rate of the procedures was higher in ACDO group. The severity of residual flow 24 hours post-procedure was significantly less in the ACDO group. However, the procedure time was much longer for the transvenous method. This study concluded the ACDO was superior in ease of use, complication rate, and completeness of occlusion, although the use of ACDO was restricted to very small dogs (> 2.6 kg of body weight) (10). In this study, we also found the closure of shunt was immediate after the placement of ACDO at PDA. Furthermore, there was no residual shunt 1 day after the ductal closure. Since we used transvenous route with right femoral vein, bleeding and vascular laceration were no problematic in this case. Furthermore we could successfully insert 4Fr delivery sheath for 5 mm ACDO, because the femoral vein was larger in diameter and more distensible in this dog. However, the approach to PDA was more complicated and troublesome and thus took almost twice longer than transarterial route, because the delivery sheath for ACDO was much more rigid and less flexible than delivery catheter for thromboembolic coil. To reach the ductus arteriosus, several guidewires were used in this case study. The guidewire used in this case study had angled flexible tip and thus was easier to explore the location of the ductus arteriosus. Therefore, the key for successful installation of ACDO via femoral vein was the selection of guidewire for exploring ductus arteriosus. To the best of author's knowledge, this dog was the smallest PDA dog closed with ACDO in veterinary literatures. It might not be possible, if we used transarterial approach in this case.

In conclusion, this dog was successfully treated through femoral vein (transvenous approach) using an ACDO. We found the transvenous approach was a good alternative for PDA occlusion in dogs having small femoral artery. To the

best of author's knowledge, this is the first case of PDA occlusion treated with ACDO through femoral vein.

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