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Occlusion of Patent Ductus Arteriosus in a Chihuahua Dogs Using Amplatzer Vascular Plug though Femoral Vein

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Abstract : A 9 month-old female Chihuahua (weighing 1.5 kg) was referred with loud left basal murmur and exercise intolerance. 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 dorsoventral view of radiograph. Echocardiography revealed patent ductus arteriosus (PDA) duct and continuous turbulent shunt flow (maximal velocity 5.73 m/s) between the aorta and pulmonary artery with left to right direction. The PDA in this dog was successfully closed though femoral vein (transvenous approach) using an Amplatzer® vascular plug. To the best of author's knowledge, this is the first case of PDA occlusion treated with vascular plug through femoral vein.

***Key words* :** Amplatzer® vascular plug, patent ductus arteriosus, ductal occlusion, transvenous approach, dog.

Introduction

Patent ductus arteriosus (PDA) is the most common congenital heart defect in dogs and is caused by failure of the ductus arteriosus to close normally after birth (4,11). Due to shunting of blood from the aorta (Ao) to the pulmonary artery (PA), uncorrected PDA usually leads left sided congestive heart failure with the elongation of left ventricle (LV) and over-circulation of lung field. Untreated PDA has a mortality rate greater than 60% in the first year of life (16). PDA in dogs can be treated either by surgical ligation via thoracotomy or by minimally-invasive transvascular occlusion. Majority of dogs with PDA can be treated by transarterial PDA occlusion through femoral artery either with thromboembolic coils or self-expanding ductal occluder (2,3,5,6,9). Several studies demonstrated success rates of 80-86% for coils alone and as high as 94% for self-expanding devices such as the Amplatzer® canine duct occluder (ACDO) (13,14). Major problem encountering transarterial PDA occlusion in puppy or toy dogs under 2 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 occlusion device (1).

The transvenous approach (prograde) through jugular vein or femoral vein has been used successfully and safely to deliver detachable coils, Amplatzer® vascular plugs or Amplatzer® duct occluders in dogs and cats (1,3,7,9). Because the veins are more distensible, it is easier to accommodate larger size delivery system for occlusion device, although the approach to the ductus arteriosus is technically more difficult. Thromboembolic coils are the choice of option for PDA occlusion for small dogs (5). However it often caused residual shunt after occlusion and inadvertent pulmonary artery embolization. Amplatzer® vascular plugs or Amplatzer® duct occluders is recently developed PDA occlusion device, which is more secure to occlude PDA and has low incidence of inadvertent pulmonary artery embolization (13,14). In this case report, we successfully closed the PDA in toy dogs weighing 1.5 kg of body weight, using an Amplatzer® vascular plug through femoral vein (transvenous approach).

Case

A 9 month-old female Chihuahua (weighing 1.5 kg) was referred with loud left basal murmur and exercise intolerance. In physical examination, typical continuous quality cardiac murmurs (grade V/VI) were detected over the left basal area. No significant abnormalities were observed in complete blood count (CBC) and serum biochemistry, except mild anemia (5.4×10^6/uL, reference range $5.5\text{-}7.9 \times 10^6$/uL). The 10 lead-surface ECG revealed typical findings of left ventricular enlargement (tall and wide QRS complexes). Diagnostic imaging studies revealed the elongation of left ventricle (LV) with classic triple bumps on the main pulmonary artery (MPA), aorta (Ao) and left atrium (LA) on the dorsoventral view of radiograph (Fig 1A and 1B). There was marked dilation of LA without the evidence of pulmonary edema. Echocardiography revealed PDA duct (3-5 mm, depending on location

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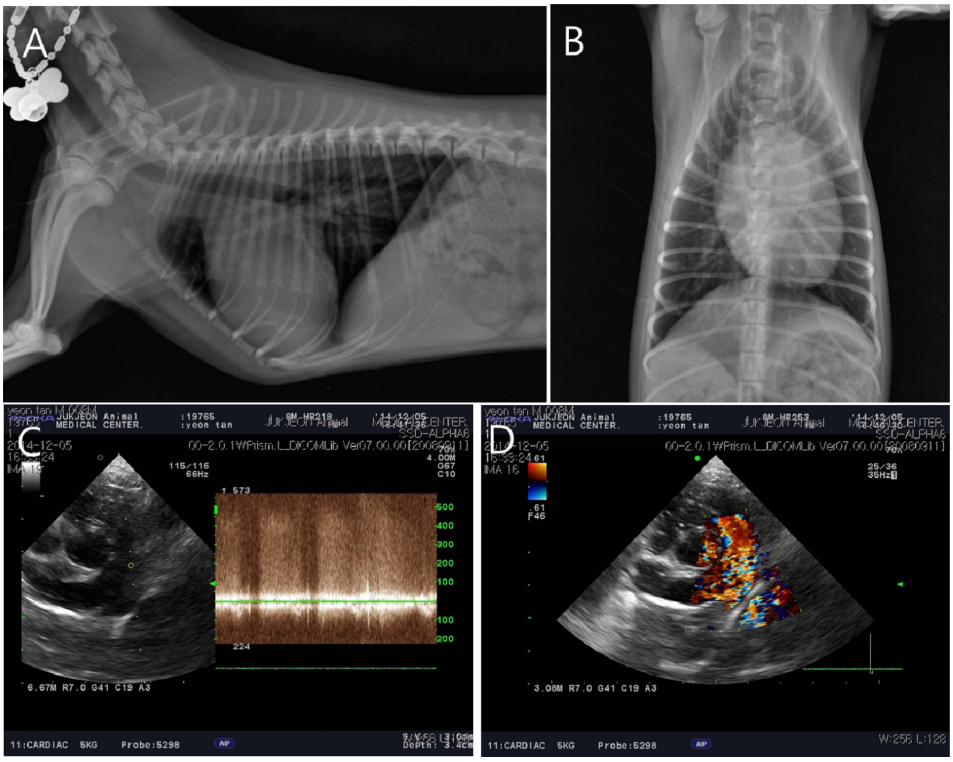

Fig 1. Diagnostic imaging studies of this case. A: Thoracic radiography revealed generalized cardiomegaly with marked dilation of left atrium. However, there was no evidence of pulmonary edema in this dog. B: Thoracic radiography revealed the elongation of left ventricle with classic triple bumps on the main pulmonary artery, aorta and left atrium. C: 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 5.73 m/s) with flow direction from left to right chamber. D: Color Doppler echocardiography taken at right parasternal short axis of the pulmonary artery level revealed mosaic pattern turbulent flow between the aorta and pulmonary artery.

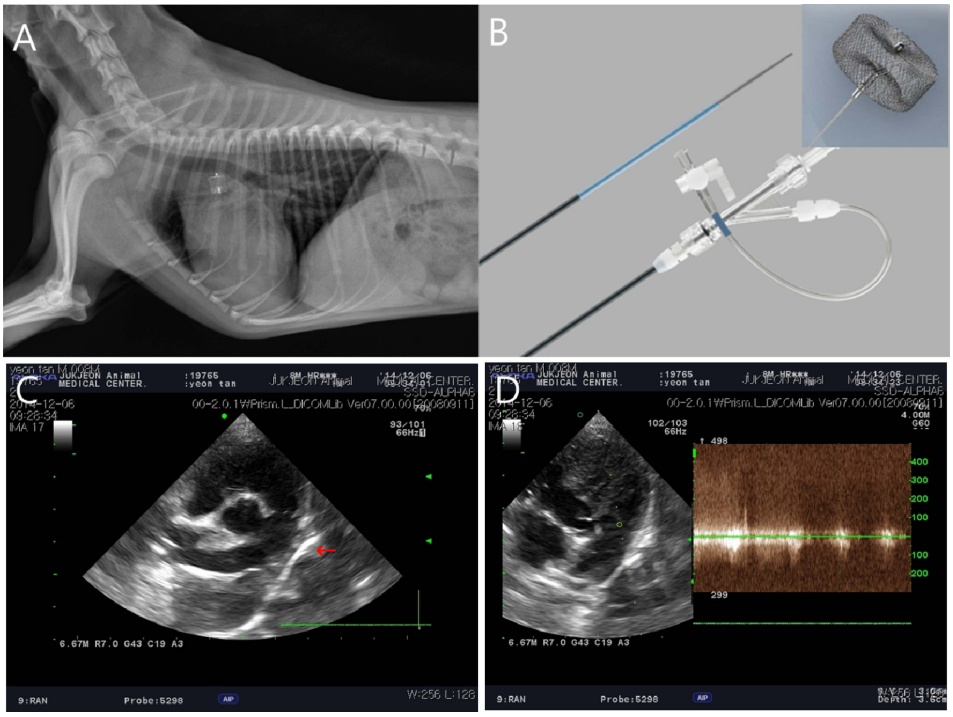

Fig 2. Diagnostic imaging studies after successful occlusion in this case. A: The thoracic radiography taken after the ductal occlusion revealed successful occlusion of PDA. B: Amplazer® vascular plug (inset) and the delivery system (Flexor® Shuttle® Guiding Sheath, Cook medical, USA). C: 2D echocardiography revealed successful occlusion of ductus arteriosus. Arrow indicate vascular plug at the ductus arteriosus. D: Continuous wave Doppler echocardiography revealed minimal residual shunt at the ductus arteriosus.

and echocardiographical views), 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 5.73 m/s; Fig 1C) with flow direction from left to right chamber. In addition, there was marked turbulent jets at PA (Fig ID). Although the %fractional shortening was within normal range (35%), there was a marked dilation of LV (LV dimension at diastole to aorta ratio ~3:1) with increased E-point septal separation (0.9 mm) in this dog. However, there was no mitral regurgitation. Based on these diagnostic findings, this case was diagnosed as left to right PDA. We decided to occlude the PDA using an Amplatzer® vascular plug through femoral vein (transvenous approach), because the femoral artery of the patient was too tiny to insert the delivery system for occlusion device.

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 (0.038" Fixed Core Wire Guides; Cook, 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, 90 cm, Flexor® Shuttle® Guiding Sheath, Cook medical, USA; Fig 2B) was then inserted into the femoral vein with aid of vein lifter (St. Jude medical, USA) with the guidance of fluoroscopy. After the shunt was visualized with contrast medium (Iohexol, Omnipaque 350; Sampoong, Korea), a 6 × 7 mm Amplatzer® vascular plug (9-PLUG-006, St Jude medical, USA: Fig 2B inset) was then inserted into the delivery system. The vascular plug was then pushed into the ductus. After confirming of disappearance of heart murmur, the vascular plug was deployed.

The thoracic radiography taken after the PDA occlusion revealed successful occlusion of PDA (Fig 2A). The loud cardiac murmur was weakened immediately after the PDA occlusion by vascular plug. On the echocardiography taken at the first day after the PDA occlusion, we confirmed the successful occlusion of PAD with vascular plug (Fig 2C, although there was minimal shunt flow was persistent on the echocardiography (Fig 2D). The next day of coil embolization, the dog was released without medication. On the clinical examination performed a month after the coil embolization, the dog had no clinical signs related to heart failure and PDA.

Discussion

The ductal occlusion in small dogs (< 2.5 kg) with PDA has a specific problem for transarterial approach. Therefore it is frequently requiring surgical ligation due to failure of catheter based approaches. In very small dogs, the size of the femoral artery severely is too small to insert the delivery system for occlusion devices (8,12). One study found that a 3 Fr catheter is the only available catheter for coil deployment in very small dogs (8). Because the recently developed ductal occlusion devices (e.g., vascular plugs or canine ductal occluder) requires a minimum sheath size of 5 Fr, its use in very small dogs with body weight less than 2.5 kg would likely have been impossible (14). Furthermore, the option for the interventional occlusion in these dogs is uncontrolled coil delivery with 3 Fr catheter, which was associated with increased rate of inadvertent pulmonary artery embolization (20% incidence of embolization) and an lower occlusion success rate of 80% (8). Therefore the transvenous approach is good alternative for PDA oocclusion, since the vein is more distensible so as to accommodate larger diameter of delivery system. For the transvenous approach, either jugular vein or femoral vein is the choice of vein for the ductal occlusion. However, the approach through jugular vein is technically more difficult, because it should go through right atrial and ventricle to reach to the PA. The approach through femoral vein is technically easier, because it is reached to the PA through caudal vena cava. In this case, we could insert 5 Fr delivery system into the femoral vein, and easily locate to the ductus arteriosus. Therefore we could successfully place the vascular plug in this dog.

Residual ow after PDA occlusion has been noticed in coil occlusion and ACDO occlusion in dogs (15). However, one retrospective study found the clinically relevant determinant of success for closure of PDA is not immediate complete cessation of residual ow but the absence of hemodynamically consequential shunt (15). Spontaneous resolution of trivial residual ow has been reported in literatures (7,15). Furthermore, one study also found 29% late closure rate even in dogs with moderate immediate post-operative residual ow (15). Even in cases where residual ow fails to spontaneously resolve, the second PDA occlusion is only indicated in cases having hemodynamically significant shunt causing consequential volume overload. In this study, the residual flow still existed immediate after PDA occlusion. However the amount and velocity of shunt flow markedly reduced in this dog. Further echocardiographic study found no hemodynamically significant shunt causing consequential volume overload.

In conclusion, this dog was successfully closed though femoral vein (transvenous approach) using an Amplatzer® vascular plug. We found the transvenous approach is good alternative for PDA oocclusion in dogs having small femoral artery. To the best of author's knowledge, this is the first case of PDA occlusion treated with vascular plug through femoral vein.

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동맥관 개존증에 걸린 치와와 개에서 대퇴정맥을 통한 Amplatzer 혈관플러그를 이용한 중재술적 치료

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요 약 : 9개월령 암컷 치와와(체중 1.5 kg)가 운동 불내성과 좌측 흉벽 심기저부의 큰 심잡음으로 의뢰되었다. 방사선 검사의 배복상에서 좌심실 종대 및 주폐동맥, 대동맥, 좌심방 확장의 전형적인 소견인 트리플범프(triple bump)가 확인되었다. 심초음파 검사에서 동맥관이 확인되었으며 대동맥과 주폐동맥 사이에 좌우 방향의 연속적인 와류(최고 속도 5.73 m/s)가 측정되었다. 이 환자는 대퇴 정맥(정맥을 통한 접근)으로 접근하여 Amplatzer® vascular plug를 이용해 동맥관을 성공적으로 폐쇄하였다. 본 증례는 PDA를 대퇴 정맥으로 접근하여 vascular plug를 이용해 막은 국내 최초보고이다.

주요어 : 혈관플러그, 동맥관개존증, 동맥관폐쇄, 정맥 접근, 개