Balloon valvuloplasty for pulmonic stenosis

in two dogs: case report

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Abstract

Balloon valvuloplasty for correction of congenital pulmonic stenosis (PS) in two dogs by intervention technique was first reported in Thailand. Both dogs did not show any clinical signs related to congestive heart failure. Physical examination in both dogs revealed heart murmur. Electrocardiographs of both dogs were recorded and showed normal sinus rhythm with deep S wave. In the first dog, thoracic radiograph revealed cardiomegaly with enlargement of the main pulmonary artery and left deviation of the apex due to right ventricular enlargement. Definitive diagnosis of PS was performed by echocardiography. Computed tomography (CT) of both dogs demonstrated stenosis of the pulmonic valve with immediate post-stenotic dilatation of the pulmonary trunk. Both left and right coronary arteries originated from their aortic sinuses. In addition, in dog no.2, the CT scan showed slight narrowing of the subvalvular area, corresponding to that seen during echocardiography. Both dogs received PS correction by balloon valvuloplasty under fluoroscopic guidance at the Small Animal Teaching Hospital, Faculty of Veterinary Science, Chulalongkorn University. The procedures were successful as suggested by reduced pressure gradient without major complications. Seven days after the operation the pressure gradient reduced as assessed by echocardiography and both dogs remained healthy.

Introduction

Pulmonic stenosis (PS) is one of the most common congenital cardiac diseases in dog (Kittelson and Kienle, 1998; Schrope, 2015). Clinical signs include syncope and exercise intolerance (Bussadori et al., 2001). PS is classified into supravalvular, valvular and subvalvular PS (Schrope, 2005). The preferable choice of treatment for PS is balloon valvuloplasty (BV); dogs that undergo BV have proved to live longer (Ewey et al., 1992; Johnson et al., 2004). PS can also be classified as type A and type B. Type A is characterized by mild thickening of the pulmonary valve and fusion of leaflets with valve doming in systole. The pulmonic valve (PV) annulus is not narrow or minimally affected. The ratio of aortic annulus diameter to pulmonary annulus diameter is normal (≤ 1.2). There is post-stenotic dilatation of the pulmonary trunk with no subvalvular obstructive lesions. PS type B is characterized by moderate to severe thickening of valve leaflets. The PV annulus is hypoplasia with minimal fusion. In this type, the ratio of aortic to pulmonary annulus diameter is more than 1.2. There is severe infundibular hypertrophy and rare post-stenotic dilation of the pulmonary trunk. Although the cutout point may not be absolute, PS type A may be an excellent choice with good outcome for BV (Bussadori et al., 2001). Moreover, some breeds (i.e. boxer and bulldog) may have single right coronary artery while left coronary arises from the right and circles around the pulmonary artery, resulting in stenosis (Buchanan, 1990; Buchanan, 2001). This study is the first to report the performance of BV in two cases of dogs with type A pulmonic stenosis without aberrant left coronary artery originating from single right coronary artery in Thailand.

Case History

Case 1: A one-year-old, intact male, Chihuahua weighing 2.0 kg was presented to the Small Animal Teaching Hospital, Chulalongkorn University, Bangkok, Thailand, with a history of heart murmur grade IV/VI. No remarkable clinical signs related to cardiovascular disease such as coughing, exercise intolerance or syncope were observed. Physical examination revealed heart rate and respiratory rate of 128 beats/min and 42 breaths/min, respectively.

Case 2: A 15-month-old Cavalier King Charles Spaniel weighing 6 kg was referred from another veterinary hospital for echocardiography. Neither history of syncope nor exercise intolerance was found. Physical examination revealed that the dog was bright and alert. Heart rate and respiratory rate were 120 beats/min and 32 breath/min, respectively. Systolic murmur grade V/VI was presented along with precordial thrill from chest palpitation.

Assessment

Blood tests (i.e. complete blood count, blood parasite, SGPT, ALP, BUN, creatinine, total protein and albumin) in both dogs were within normal limits. Electrocardiographs of both dogs were recorded and showed normal sinus rhythm with deep S wave (Figure 1).

Thoracic radiograph was performed in the first dog and revealed cardiomegaly (vertebral heart score = 10.4) with enlargement of the main pulmonary artery and left deviation of the apex due to right ventricular enlargement (Figure 2). Mild interstitial pattern of caudal lung lobe was observed. Normal pulmonary parenchyma was found.
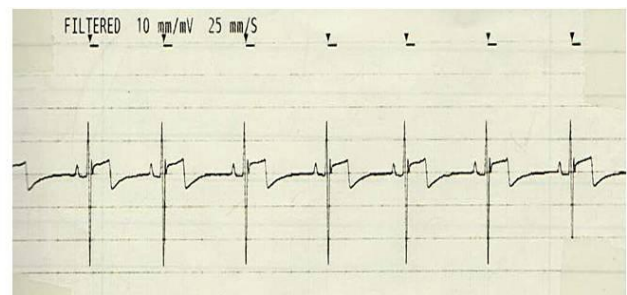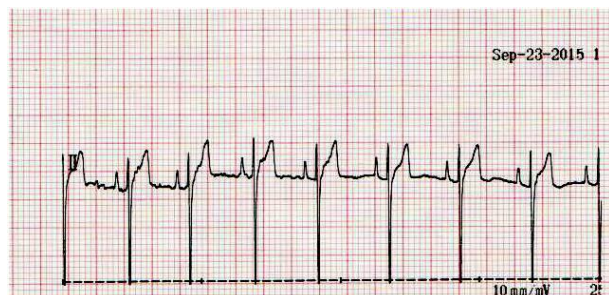

Figure 1   Representative body surface electrocardiograms recorded from pulmonic stenosis dogs (Dog no.1: left tracing and dog no.2: right tracing) which showed sinus rhythm with deep S wave suggesting right axis deviation.
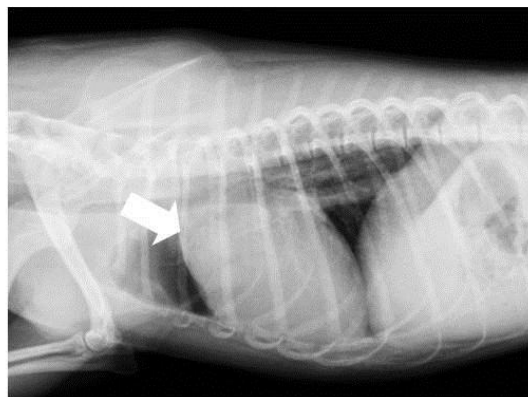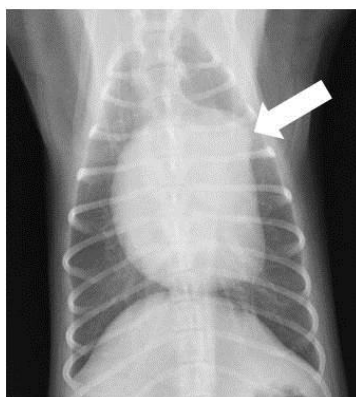

Figure 2   Thoracic radiograph of dog no.1 on ventrodorsal (left) and lateral (right) views showing a cardiac enlargement with reverse D shape and bulging of main pulmonary artery (arrow).

Echocardiography was performed by an ultrasound machine (EKO 7, Samsung Medison Co., Ltd., Gangnam-gu, Seoul, Korea) with 2-4 multi-frequency MHz phased array transducers on modified right parasternal cross section view. In dog no.1, the two-dimensional echocardiogram revealed fused pulmonic valve with domed shape during systole (Figure 3). Color Doppler echocardiography showed turbulent flow within the pulmonary artery during systole and regurgitant jet of pulmonic insufficiency during diastole (Figure 3) on the right parasternal short axis view at the base of the heart. Increased right ventricular wall thickness and severe post-stenotic dilatation of the pulmonary trunk were also observed (Figure 3). Pulmonary gradient was measured on the right parasternal short axis view at the base of the heart. Pulmonary flow velocity was 6 m/s with gradient 144 mmHg. In dog no.2, the echocardiographic imaging showed fusion of pulmonic valve leaflets. Additional stricture of subvalvular region of the pulmonic valve was demonstrated (Figure 4). Pulmonary flow velocity was 6.24 m/s with gradient 155.8 mmHg. Pulmonic insufficiency was also observed in this dog. The two-dimensional echocardiography revealed small left atrium and left ventricular chambers, i.e. psudohypertrophy secondary to under filling load condition.
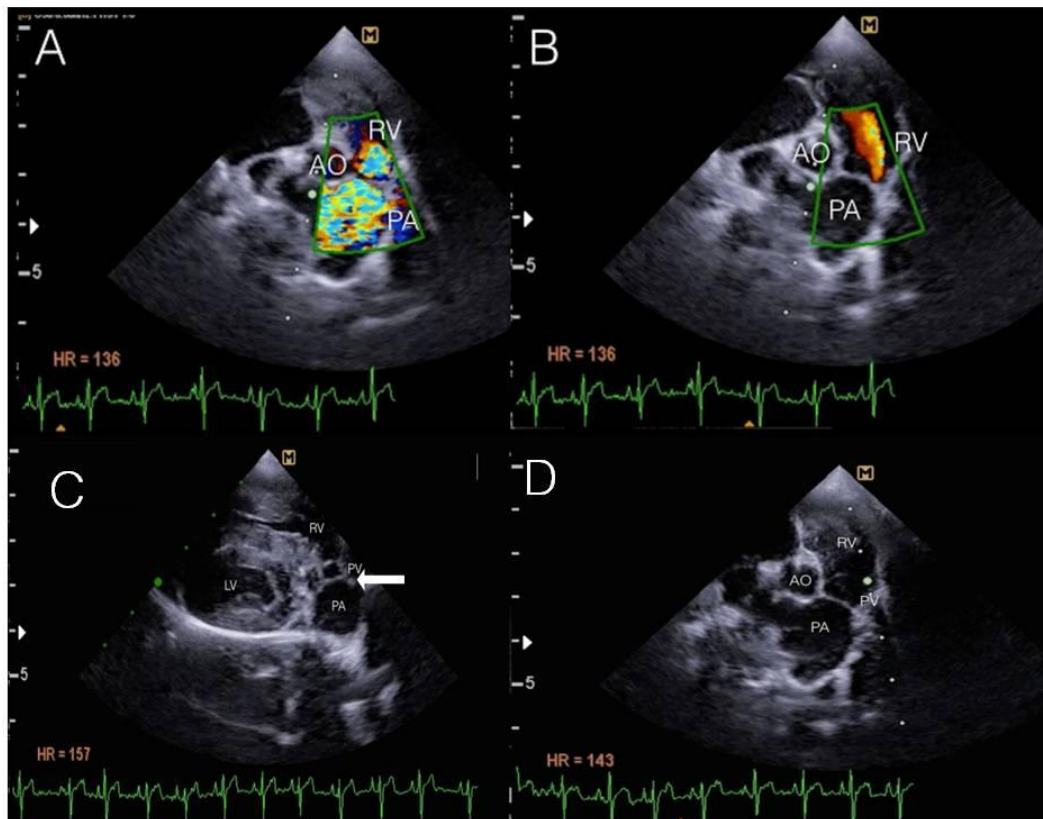

Figure 3 Color Doppler echocardiography shows turbulent flow in pulmonary artery during systole (A) and regurgitant jet of pulmonic insufficiency during diastole on right parasternal short axis view at the base of the heart (B). Two-dimensional view of pulmonic stenosis shows systolic doming of the valve (arrow) on modified right parasternal short axis view (C). Two-dimensional echocardiography shows aortic and pulmonary annulus on right parasternal short axis view at the base of the heart (D). LV=left ventricle; RV=right ventricle; PV=pulmonic valve; PA=pulmonary artery; AO=aortic valve
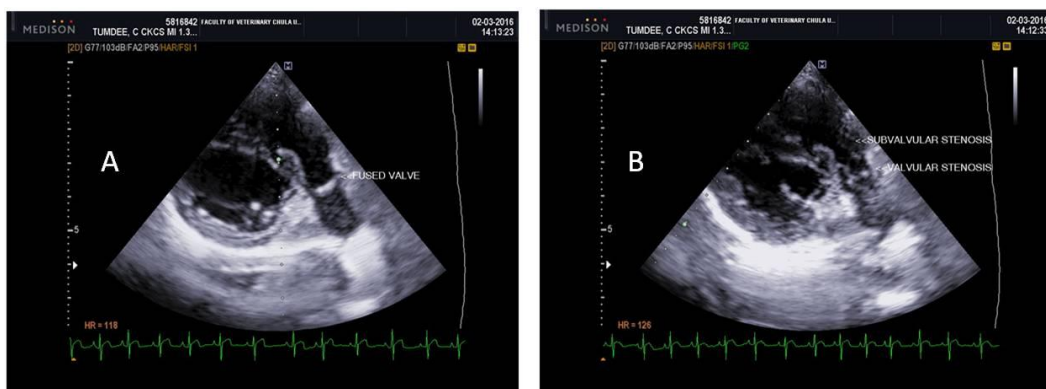

Figure 4 Echocardiography of dog no.2 showed pulmonic stenosis with fusion of leaflets (A). The stricture of both valvular and subvalvular areas was shown (B).

Therefore, diagnosis of PS was established. Diameter of the pulmonic valve annulus was 1.1 cm in both dogs. Ratios of aortic to pulmonary in dogs no.1 and no. 2 were 1 and 1.07, respectively, which were both considered as PS type A.

Sixty-four-slice ECG-gated computed tomography (CT) (Optima 660, GE Healthcare, USA) was performed in order to rule out the presence of aberrant right coronary artery in both dogs. Three milliliters of nonionic iodinated contrast (Iohexal 300, Bayer, Germany) was administered during the scan. Results in dog no.1 showed that both left and right coronary arteries originated from their aortic sinuses

and traveled across the surface of the heart within grooves normally. There was stenosis of the pulmonic valve with immediate post-stenotic dilatation of the pulmonary trunk (Figure 5A). In addition to the stricture of pulmonic valve, the CT scan of dog no.2 showed slight narrowing of the subvalvular area, corresponding to that seen during echocardiography (Figure 5B). The helical computed tomography technology could delineate clearly the origin and course of the anomalous coronary artery, which substantially enhanced its utility in the evaluation of aberrant coronary artery causing PS (Figure 6).
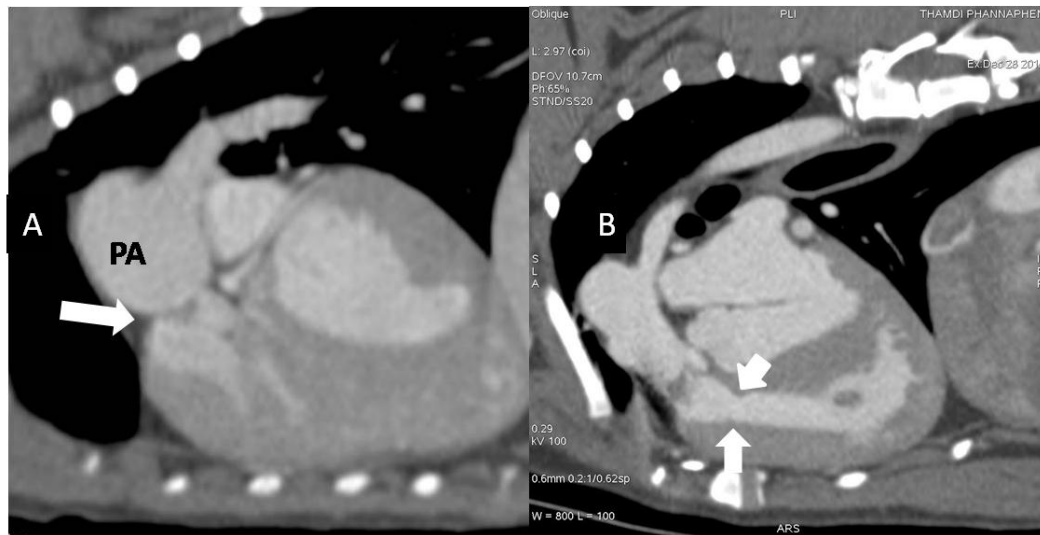

Figure 5   Computed tomography (CT) scan of pulmonic stenosis dogs showed (A) stenosis of pulmonic valve (arrow) and post-stenotic dilatation of pulmonic trunk (PA) of dog no.1 and (B) valvular and subvalvular stenosis (arrows) in dog no.2.
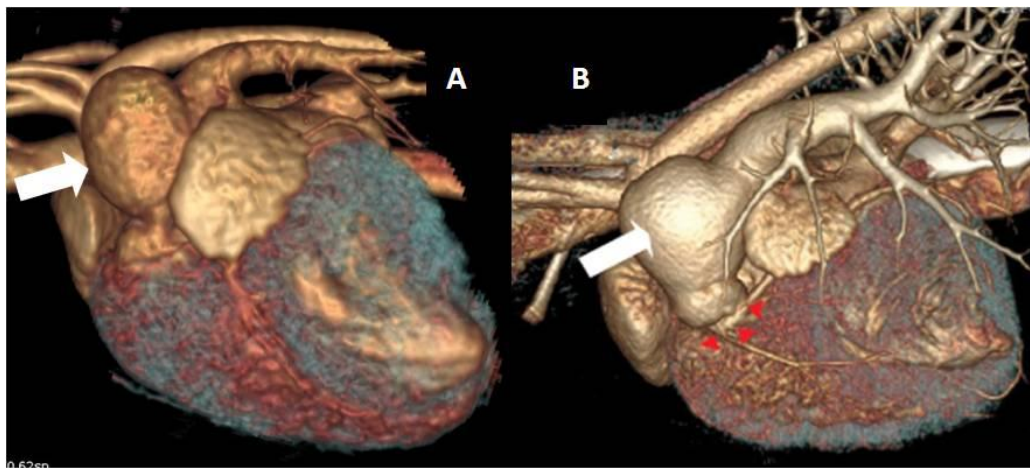

Figure 6   Computed tomography(CT) rendering 3D images showed pulmonary conus (long white arrows) in dog no. 1 (A) and in a pulmonic stenosis Bulldog (B). The aberrant coronary artery was shown in this Bulldog (short red arrow).

Treatment: pulmonary balloon valvuloplasty technique: Balloon valvuloplasty was performed in the two dogs. Methods of surgical anesthesia and recovery were described previously (Buranakarl et al., 2015). In brief, after premedication with midazolam (0.3 mg/kg) and fentanyl (3 µg/kg) intravenously, the induction of anesthesia was performed using etomidate 2 mg/kg, intravenously. After orotracheal intubation, anesthesia was maintained by sevoflurane (1-2.5%) in 100% oxygen. Prophylactic antibiotic (cephazolin 25 mg/kg,

iv) and intravenous fluid (Lactate Ringer Solution 10 ml/kg/hr) were administered via the cephalic vein. The dogs were placed in right lateral recumbency. The right inguinal region was prepared for surgery by aseptic technique. An incision (approximately 2-3 cm) was made over the right femoral triangle to visualize the femoral vein. The Seldinger technique was used to place vascular access sheets (5Fr.) into the femoral vein. Heparin (3 iu/kg, iv) was given to the dogs before the beginning of cardiac catheterization. A multipurpose

angiocatheter (5Fr, 100 cm) together with a guide wire (0.038", 150 cm) was introduced into the femoral vein via the vascular sheet. Under fluoroscopic guidance (OEC 9900 Elite, GE healthcare, USA), the tip of the angiocatheter was positioned in the pulmonary artery. After that the guide wire was removed, and pressure gradient between the right ventricle and the pulmonary artery was recorded by connecting the angiocatheter to a pressure transducer (Datascope Passport V, Mindray, NJ, USA). In the first dog, the right ventricular pressure (RVP) was 80/14 mmHg while the pulmonary artery pressure (PAP) was 18/12 mmHg; therefore, the pressure gradient was 62 mmHg. For the second dog, the RVP and PAP were 35/12 mmHg and 10/8 mmHg, respectively. This resulted in pulmonary pressure gradient of 25 mmHg. Once the pressure gradient was obtained, right ventricular angiography was performed by injecting iohexal (1 ml/kg) through an angiographic catheter. A J-tip Amplatz Super Stiff™ guide wire (0.035 in x 260 cm, Boston Scientific, USA) was advanced through the catheter and placed in the main pulmonary artery. The catheter and the vascular sheet were removed while the guide wire remained within the pulmonary artery. Oversized balloons were used with a balloon-to-valve hinge-point diameter ratio of approximately 1.2. In the first dog, size of the balloon catheter was 8 mm x 20 mm x 135 cm. In the second dog, a Mustang™ PTA balloon dilatation catheter (7Fr, Boston scientific, USA) with size of 12 mm x 20 mm x 75 cm was used (Figure 7A). The balloon catheter was pushed along the guide

wire until the balloon reached the pulmonary ostium. Then, the balloon was inflated twice (~5 seconds) by manually injecting saline contrast mixture (1:4 dilution) until the stenotic point of pulmonic valve (waist) on the balloon disappeared (Figure 7B). After that the pressure gradient was rechecked. In dog no.1, the pressures in RV and PA were 56/12 mmHg and 21/12 mmHg, respectively. In dog no.2, the pressures in RV and PA were 20/10 mmHg and 18/11 mmHg, respectively. Hence, the pressure gradients of both dogs were reduced to 35 mmHg and 2 mmHg, respectively. However, in dog no.2, it was noticed that the pressure in RV was elevated at some locations when the catheter was slowly withdrawn. The peak pressure in RV was 61/8 mmHg. Thus, a second angiography was performed and the subvalvular stenosis was visualized. The balloon valvuloplasty was reperformed at the subvalvular region. At this location, the balloon was inflated 3 times. Interestingly, the waist of the stenosis did not completely disappear. The recorded RVP declined to 23/9 mmHg. The RVP was within acceptable range; therefore, the procedure was stopped. The vessel was sutured with 6/0 suture material and the incision was closed with routine manner. Analgesic (fentanyl) and another dose of cephazolin were given and the patient was admitted in the hospital one night for post-operative monitoring. Dog no.1 was prescribed atenolol after the procedure while dog no.2 did not receive any cardiac medication.
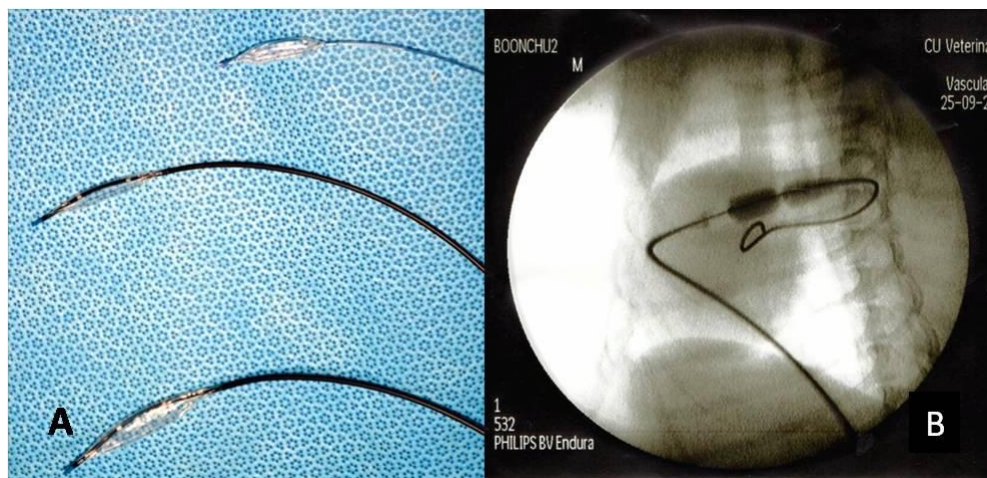

Figure 7   Balloon valvuloplasty catheters (A) and fluoroscopic picture showing point of pulmonic stenosis impressed on balloon while it was inflated in dog no.1 (B).

The echocardiography data before and 7 days after the balloon valvuloplasty in both dogs are shown in Table 1. In dog no.1, the 2-D echocardiography after BV revealed a wider opening of the pulmonic valve during systole (Figure 8). However, the pulmonary flow velocity (5.8 m/s) and the pressure gradient (135.4 mmHg) were still high. In contrast, the pressure gradient of dog no.2 after valvuloplasty reduced dramatically (66.6 mmHg vs 155.8 mmHg, respectively). Although cardiac function measured from M-mode echocardiography of the first dog after BV was not determined, the cardiac function of the second dog improved when compared with the value

before surgery (i.e. fractional shortening, left ventricular internal diameter diastole).

Discussion

This is the first report on the performance of BV in dogs with PS in Thailand. In the present report, both dogs were male, corresponding to a previous report on the prevalence of PS that PS occurs in male slightly more than female (Francis et al., 2011). However, one study reported that the percentage of PS found in female and male dogs was 55% and 45%, respectively (Schrope, 2015). In the present study, dog

no.1 was Chihuahua and dog no.2 was Cavalier King Charles Spaniel. Chihuahua is one of the most popular breeds of pet dogs in Thailand, whereas Cavalier King Charles Spaniel is uncommon. Previously, it was reported that the PS-affected breeds varied including Terrier, English Bulldog, Boxer, Beagle, Mastiff and Samoyed (Buchanan, 1992; Bussadori et al., 2001). The relative risk of PS in bulldogs was 19 times higher than that in other breeds. Some of them had left coronary originating from a single right coronary artery, which constricted the right ventricular outflow tract (RVOT)

in a band-like fashion at the level of pulmonic valve (Buchanan, 2001). In another situation, circumpulmonary left coronary artery might be anomalous, causing constriction of RVOT at the subvalvular level, classified as subvalvular stenosis. The ages when these two dogs were diagnosed with PS were 12 and 15 months of age, respectively. One study reported that the first clinical presentations were found when the ages of dogs were less than 20 months (72%) with a median age of 11 months (Francis et al., 2011).
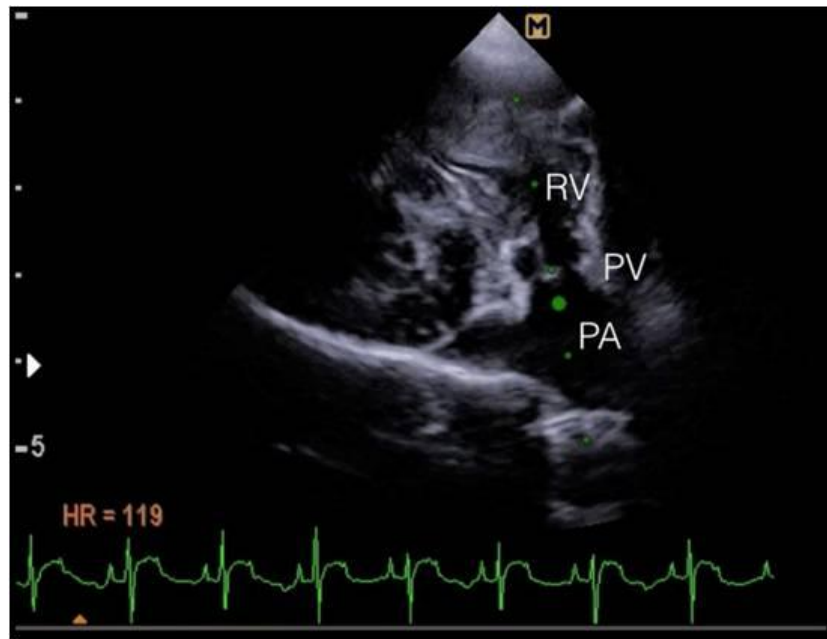

Figure 8 The 2-dimensional echocardiography of dog no.1 shows pulmonic valve post-balloon valvuloplasty. RV=right ventricle; PV=pulmonic valve; PA=pulmonary artery

Table 1 The echocardiographic parameters in two dogs before and 7-day after balloon valvuloplasty

Parameters	Dog no.1			Dog no.2		
	Normal Range	Pre-BV	Post-BV	Normal Range	Pre-BV	Post-BV
PV (m/s)	<1.6	6.0	5.8	<1.6	6.24	4.08
PG (mmHg)	<10.24	144	135.4	<10.24	155.8	66.6
PI (ms)	-	2.20	2.07	-	1.69	1.84
PI (mmHg)	-	19.71	17.12	-	14.42	13.53
PHT (ms)	-	196	125	-	246	412
IVSd (mm)	5.3-7.3	5.7	ND	6.3-7.9	8.8	7.1
LVIDd (mm)	7.5-19.3	9.9	ND	16.5-28.3	14.8	21.2
LVPWd (mm)	4.2-5.8	7.5	ND	5.0-6.4	7.0	5.4
IVSs (mm)	7.9-10.2	5.3	ND	9.5-11.3	7.0	8.7
LVIDs (mm)	1.8-12.1	5.5	ND	8.0-18.3	13.0	15.8
LVPWs (mm)	7.1-9.2	9.0	ND	8.4-10.1	8.3	7.3
FS (%)	33-46	44.5	ND	33-46	11.9	25.3
LA/Ao	0.8-1.1	1.2	ND	0.8-1.1	0.56	0.98

Values are presented as an average of 3 cardiac cycles. Ao=aorta; BV=balloon valvuloplasty; d=diastole; FS=fractional shortening; IVSd=interventricular septum diastole; IVSs=interventricular septum systole; LA=left atrium; LVIDd=left ventricular internal diameter diastole; LVIDs=left ventricular internal diameter systole; LVPWd=left ventricular posterior wall diastole; LVPWs=left ventricular posterior wall systole; mm=millimeter; ms=millisecond; m/s=meter per second; mmHg=millimeter of mercury; ND=not determine; PG=pressure gradient; PHT=pressure half-time; PI=pulmonary insufficiency; PV=pulmonic valve; s=systole

Both dogs in our study did not show any crucial signs of heart failure (HF) while others reported that the incidence of HF was 25% or higher (Bussadori et al., 2001; Francis et al., 2011). The most common clinical signs are syncope and exercise intolerance,

depending on the severity of valvular stenosis (Bussadori et al., 2001; Francis et al., 2011). Right ventricular overload can be confirmed by thoracic radiograph showing right ventricular enlargement and by ECG showing right ventricular hypertrophy which

is characterized by deep S wave in lead II, III, aVR, CV_6LL, CV_6LU with right axis deviation. Without BV, affected dogs with severe, moderate, and mild PS will suffer cardiac death by 50%, 10% and 4%, respectively (Francis et al., 2011).

There are several factors that should be considered for successful outcome before BV. These factors are patient's age, balloon-to-valve hinge-point diameter ratio, severity of stenosis, type of PS, existence of single right coronary artery and concurrent cardiac or systemic diseases (i.e. Tetralogy of Fallot, ventricular septal defect) (Kittelson and Kienle, 1998; Schrope, 2005; Locatelli et al., 2013). One report studied dogs without valvuloplasty and showed that factors negatively affecting survival rate were Doppler gradient, clinical signs, younger age of diagnosis and valve morphology type B (Locatelli et al., 2013). When compared between types of PS, patients with type A stenosis had better results and higher percentage to survive through 1-year follow-up with good clinical signs more than those with type B (Bussadori et al., 2001). Although the success rate is low in type B, BV is still recommended in severe PS. The single right coronary artery should be verified before performing the BV procedure. This can be investigated during the BV procedure by performing cardiac angiography. Computed tomography (CT) may be a convenient choice for vessel verification. It has been recommended for the investigation into the coronary artery in all boxer and bulldog with PS. If single right coronary artery exists with circumpulmonary left coronary artery, leading to narrow ventricular outflow tract, BV may not be a good choice of treatment due to a risk of vessel trauma (Kittelson and Kienle, 1998).

BV is recommended especially in dogs with severe PS in which the systolic pressure gradient is higher than 80 mmHg (Ewey et al., 1992; Johnson et al., 2004). In moderate stenosis (systolic pressure gradient ~50-80 mmHg), the guidelines for BV is unclear. One study reported that the probability of cardiac death in PS dogs would be higher if they presented tricuspid regurgitation (Francis et al., 2011). Moreover, improved clinical signs in moderate PS dogs after BV were demonstrated previously (Johnson et al., 2004). If no clinical signs are presented, the rate of progression of right ventricular hypertrophy and increased afterload may be options for consideration. Therefore, BV is suggested to be performed in moderate PS dogs with coexisting tricuspid regurgitation or clinical signs. In mild PS dogs (systolic pressure gradient < 50 mmHg), BV may not be necessary since they may have PS without clinical signs throughout their life span (Schrope, 2005).

In the current report, both dogs were type A with severe PS (systolic pressure gradient > 80 mmHg). These dogs had no concurrence of cardiac disease. By performing CT, no aberrant coronary artery was observed. Thus, cardiac intervention with BV was highly recommended.

The procedure for BV requires both special equipment and skill, and should be performed under fluoroscopic guidance although transthoracic echocardiography has been employed previously (Caivano et al., 2012). Angiocatheters are in French

sizes while guide wires are measured by external diameter in inches. The selected guide wires must pass through the selected catheter properly and the length should be verified before the procedure. A pigtail catheter is used for injecting radiographic contrast and for measuring pressures inside the right ventricle and pulmonary vessel. Measurement of the pressure inside the right ventricle and pulmonary vessel is crucial. Normal right atrial pressures are approximately 4-6/2-5 mmHg (systolic/diastolic) while pressures inside the right ventricle are 15-30/<5 mmHg (systolic/diastolic). Normal pulmonary arterial pressures in dogs are 15-30/5-15 mmHg (systolic/diastolic) (Schrope, 2005). It is recommended that the width of a balloon catheter should be 1.2-1.5 times bigger than the pulmonary valve annulus (Estrada et al., 2006). In our study, the procedure performed in the first dog was completely successful by the elimination of waist of the stenosis. However, the pressure inside the ventricle was minimally lower than before the balloon valvuloplasty. In the second dog, the first BV at the valvular region could reduce the pressure gradient dramatically. The heart rate was also reduced immediately. Although the second BV at the level of subvalvular area could not completely eradicate stenotic area, it reduced the pressure to almost the normal level. Thus, significant improvement was seen in the second dog. In addition, the pressure used for inflation of the balloon should be precise since rupture of the balloon may cause detrimental effects.

The pressure gradient across the stenosis is calculated as the difference between the peak systolic pressure in the right ventricle and the peak systolic pressure in the pulmonary artery. In general, the Doppler-derived pressure gradient is approximately 40-50% higher than the pressure obtained by catheterization. The reason may be due to the effect of anesthesia on cardiac function (Bussadori et al., 2001; Schrope, 2005). Thus, the pressure gradient of 50 mmHg in dogs under anesthesia is considered significant.

Complications related to BV were reported previously (Kittleson et al., 1992; Thomas, 1995; Baim and Grossman, 1996). Avulsion of circumpulmonary left coronary artery causing cardiac death was reported in 2 bulldogs undergoing BV (Kittleson et al., 1992). Additionally, rupture of the pulmonary artery leading to death was found (Baim and Grossman, 1996). Another complication found during operation was rupture of a catheter (Thomas, 1995). However, the unretrieved fragment of catheter did not cause any adverse effects and the dog remained healthy several years after BV (Thomas, 1995).

Intraoperative complications may include bradycardia, tachycardia, desaturation and cardiac arrhythmia (Thomas, 1995; Baim and Grossman, 1996). One study found hypotension at 48.7% among 39 cases and another at 11% among 40 cases (Viscasillas et al., 2015). Ventricular fibrillation or cardiac arrest may also be encountered during BV, which may be due to disruption of blood flow (Thomas, 1995). For both dogs in our study, the blood pressure and heart rate were stable throughout the procedure without occurrence of arrhythmia or hypotension. However, hypothermia developed in the second dog after the operation. An

air-blow warming device was introduced during recovery without any complications. Similarly, in a previous report hypothermia was observed in 23 out of 40 cases (58%) (Baim and Grossman, 1996).

Restenosis appears at about 10% after successful BV (Schrope, 2005). One study showed restenosis developing in 6 from 22 dogs at approximately 5.5 months (ranging from 1.5 to 68.2 months) after successful BV (Sunahara et al., 2015). There is an association between restenosis and the administration of atenolol prior to BV.

In conclusion, this study is the first to report the procedure for BV performed in Thailand in two dogs with type A pulmonic stenosis, of which one dog had additional subvalvular stenosis. During the follow-up there were improvements in clinical signs in both dogs associated with enhanced pulmonary outflow due to the reduction in right ventricular afterload.

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บทคัดย่อ

การทำบอลลูนขยายลิ้นหัวใจสำหรับโรคลิ้นหัวใจพัลโมนิกตีบแคบในสุนัข

ชลลดา บูรณกาล[1*] อนุศักดิ์ กิจถาวรรัตน์[1] วสันต์ อุทัยเฉลิม[2] สิริลักษณ์ ดิษเสถียร สุรเชษฐพงษ์[3]

ทรายแก้ว สัตยธรรม[1] ภาสกร พฤกษะวัน[4] สุมิตร ดุรงค์พงษ์ธร[4]

รำไพภัทร ตั้งจิตเพียรพงศ์[5] นาฎทิวา ไชยวรวิทย์สกุล[5]

ทำบอลลูนขยายลิ้นหัวใจสำหรับแก้ไขโรคลิ้นหัวใจพัลโมนิกตีบแคบที่เป็นมาแต่กำเนิดด้วยการใช้สายสวนหัวใจในสุนัข 2 ตัว สุนัข
ทั้งสองตัวไม่มีอาการของโรคหัวใจล้มเหลว การตรวจร่างกายของสุนัขทั้งสองตัวพบเสียงการเต้นของหัวใจผิดปกติ การตรวจคลื่นไฟฟ้าหัวใจ
ของสุนัขทั้งสองตัวพบจังหวะการเต้นของหัวใจปกติและคลื่นเอสลึกมากกว่าปกติ การตรวจภาพรังสีช่องอกในสุนัขตัวแรกพบหัวใจโต หลอด
เลือดพัลโมนารีโต และปลายหัวใจเบี่ยงเบนไปทางซ้ายเนื่องจากหัวใจห้องล่างขวาขยายใหญ่ การตรวจวิจัยฉัยยืนยันว่ามีโรคลิ้นหัวใจ
พัลโมนิกตีบแคบด้วยการตรวจคลื่นเสียงสะท้อนความถี่สูงที่หัวใจ การตรวจด้วยเอกซเรย์คอมพิวเตอร์ในสุนัขทั้งสองตัวพบลิ้นหัวใจพัลโมนิ
กตีบ หลอดเลือดพัลโมนารีขยายใหญ่หลังรอยตีบแคบ หลอดเลือดโคโรนารีด้านซ้ายและขวามีจุดกำเนิดจากเออออร์ติกไซนัส ในสุนัขตัวที่สอง
พบการตีบแคบที่บริเวณด้านใต้ของลิ้นหัวใจพัลโมนารี ซึ่งสอดคล้องกับลักษณะที่พบจากการตรวจด้วยคลื่นเสียงสะท้อนความถี่สูง สุนัขทั้งสอง
ตัวได้รับการแก้ไขลิ้นหัวใจพัลโมนิกตีบด้วยวิธีการทำบอลลูนขยายลิ้นหัวใจโดยอาศัยเทคนิคการสวนหัวใจและใช้เครื่องฟลูโนโรสโคป ณ
โรงพยาบาลสัตว์เล็ก คณะสัตวแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย การผ่าตัดในสุนัขทั้งสองตัวประสบความสำเร็จเป็นอย่างดีเนื่องจาก
ความแตกต่างของความดันลดลงและไม่พบอาการแทรกซ้อนหลัก ภายหลังการผ่าตัดครบ 7 วัน พบว่าความแตกต่างของความดันลดลงจาก
การตรวจด้วยคลื่นเสียงสะท้อนความถี่สูง และพบว่าสุนัขยังคงแข็งแรงดี

คำสำคัญ: การทำบอลลูนขยายลิ้นหัวใจ การสวนหัวใจ สุนัข โรคลิ้นหัวใจพัลโมนิกตีบ

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