

Comparison of Different Anatomic, Hemodynamic, and Pathophysiological Types of Atrial Septal Defect in Three Small Dogs

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Abstract : Three small breed dogs weighing less 5 kg were admitted with dyspnea and cardiac murmurs. One dog had primum type ASD and chylothorax was concurrently noted. Two dogs had secundum type ASD with and without concomitant pulmonic stenosis. Although medical treatment was attempted, two dogs with secundum type ASD died and a dog with primum type ASD was successfully managed with medication. Defects were confirmed by the postmortem examination in two cases. We first describe the comparison of clinical and diagnostic features in different anatomic, hemodynamic, and pathophysiological types of ASD in small breed dogs and they show some differences with ASD in large breed dogs.

Key words : atrial septal defect, congenital heart disease, dog.

Introduction

An atrial septal defect (ASD) is a congenital cardiac defect which allows blood flow between the two atria and this causes shunting of blood from the left to the right which results in right heart failure (2). If there are concomitant right heart abnormalities, the hemodynamic changes the reversed blood flow which results in a reverse type of ASD (8). There are three anatomic types of ASD, depending on the anatomic location of the septal defect (3). An 'ostium primum' ASD has the defect in the lower portion of the atrial septum, and it produces the large defect and poor prognosis (10,12). An 'ostium secundum' ASD has the defect located in the mid-portion of the atrial septum and is the most common canine ASD (1). Less frequently, a 'sinus venosus' ASD has been described in a dog with the defect of the dorsal atrial septum (9).

The prevalence of ASD has been considered to be relatively rare in dogs especially in small sized dogs, though it is a common congenital heart disease in human. However, after the appearance of readily available modern imaging techniques in veterinary medicine, the incidence of canine ASD has been higher than previously thought (3). It might be by facilitating earlier detection of ASD in young dogs that are small size. Generally, large breed dogs like as a Boxer are known to be predisposed to ASD (4) and the overall prevalence in small breed dogs is uncommon. Although there was a retrospective studies of 113 dogs with ASD, almost of population was made

up of large breed dogs (3). In this case report, we described the ASD in small breed dogs weighing less than 5 kg.

The aims of this study were to describe the clinical and diagnostic features in different anatomic, hemodynamic, and pathophysiological types of atrial septal defect in small breed dogs.

Case history

An 8-year-old female Maltese weighing 3.5 kg (Case 1), a 5-month-old male Pekinese weighing 2.78 kg (Case 2), and a 5-month-old female Yorkshire terrier weighing 720 g (Case 3), were presented with history of dyspnea, particularly evident during exercise. On cardiac auscultation, all dogs had moderate to severe systolic murmur with maximal intensity over the cardiac base, and the dog of Case 1 had muffled cardiac sound. The blood pressure was measured by automated oscillometric method. The blood pressure was mildly decreased in Case 1 and 3 (systolic blood pressure: 112 and 108 mmHg, respectively), and normal blood pressure were shown in Case 2 (systolic blood pressure: 147 mmHg). In all patients, the ECG revealed deep S waves in leads I, II, III and aVF. Additionally, Case 1 had a low voltage R wave. On thoracic radiography, cardiomegaly was evident in all cases. Obscured cardiac margin associated with cardiac silhouette sign was noted in Case 1 (Fig 1). The 200 ml of pleural effusion in Case 1 was removed by thoracocentesis. The fluid was milky colored and the predominant cells were small lymphocytes consistent with typical chylothorax. On 2-D echocardiography of Case 1, a defect was localized to the lower part of the atrial septum (Fig 2A). The final diagnosis was ostium

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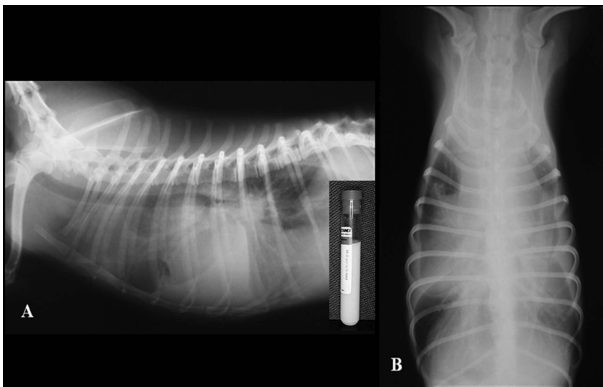


Fig 1. Lateral (A) and ventrodorsal (B) radiographs of a Case 1 with chyllothorax secondary to ASD. The inset in the right border of (A) picture shows milky and opaque pleural fluid. Note the loss of the cardiac and diaphragmatic silhouettes, and widened interlobar fissures.

primum type ASD and chyllothorax associated with right sided congestive heart failure. In Case 2, 2D-echocardiographic examination showed ostium secundum type ASD and the pulmonic valve leaflets were thick, echodense, and had reduced motion during systole (Fig 2B). Doppler echocardiogram revealed high velocity of pulmonary flow and tricuspid regurgitant flow (peak velocity, 2.5 and 3.31 m/second; pressure gradient, 25.0 and 43.9 mmHg, respectively) (Fig 2B and 2C). These findings indicated the ASD and concomitant pulmonary arterial hypertension (PAH) associated with pulmonic stenosis. To identify right-to-left intracardiac shunts, a small amount of agitated 0.9% saline was injected as a peripheral intravenous (IV) bolus during 2D echocardiographic examination. The air in the bubbles appeared as bright dots in the right atrium and ventricle, and crossed to the left side of the heart through the atrial septal defect which was consistent of reverse type ASD. On 2-D echocardiography, Case 3 was also diagnosed with ostium secundum type ASD with right cardiac chamber enlargement. Based on diagnosis, these patients were managed with furosemide (Lasix; Handok Pharma), 1 mg/kg twice daily, ramipril (Rimeditil, Sandos Pharma), 0.125 mg/

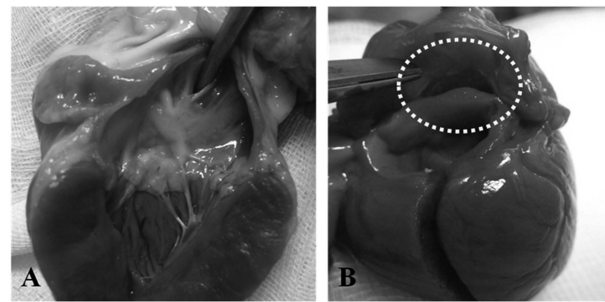


Fig 3. Photographs of the medial wall of the right atrium from Case 2 (A) and Case 3 (B). Opening of the anomalous atrial septum is indicated by the instrument (A) and dotted circle (B).

kg once daily, and oxygen supplement. Additionally, in Case 1 and 3, Digoxin (Digoxin; Handok Phrama), 0.005 mg/kg twice daily was prescribed for control pronounced congestive heart failure. However Case 2 died 75 days after the first presentation and Case 3 died with severe dyspnea at the day of presentation. In two cases (Case 2 and 3), postmortem examinations were carried out and the defects were found to be localized in the mid-portion of the atrial septum (Fig 3A and 3B). In Case 2, additionally, the valvular pulmonic stenosis and post-stenotic dilation was confirmed. In Case 1, remission of the clinical signs was observed post treatment. Two years after diagnosis and treatment, the dog was still alive without recurring of the chyllothorax. The clinical, physical examination, blood pressure, ECG, and radiographic findings observed in all dogs are summarized in Table 1, and the comparison of the 2D, M-mode, and Doppler echocardiographic findings with postmortem characteristics are summarized in Table 2.

Discussion

In human medicine, three causative genes (NKX2.5, TBX5, GATA4) and one genetic locus (6p21) have been identified in congenital heart disease including atrial septal defect (6,13). However several studies could not demonstrated these genes were responsible in the dogs. Generally, dogs predisposed to ASD are large breeds is common, including Old English

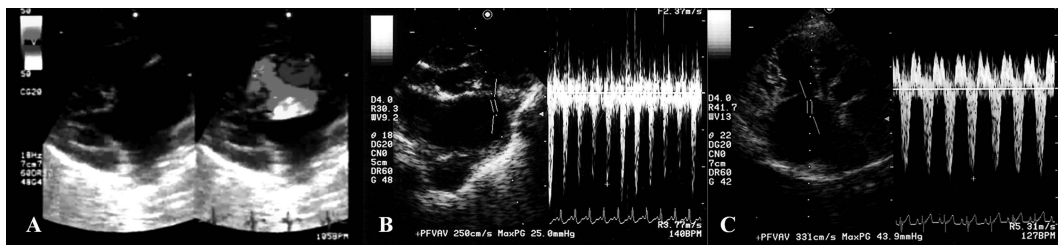


Fig 2. Two-dimensional echocardiogram of dogs with ASD (right parasternal, long axis four chamber view) in Case 1 (A). The location of the defect in the atrial septum is consistent with an ostium primum ASD. Continuous wave Doppler echocardiogram from right parasternal short axis heart base view of Case 2 (B) revealed high velocity (peak velocity, 2.5 m/second; pressure gradient, 25 mmHg) of systolic pulmonary blood flow was observed. Spectral continuous wave Doppler echocardiogram from left parasternal, apical four chamber view of Case 2 (C) revealed high velocity (peak velocity, 3.31 m/second; pressure gradient, 43.9 mmHg) of tricuspid regurgitant flow.

Table 1. Summary of clinical, physical examination, blood pressure, electrocardiographic (ECG), and radiographic findings in 3 small breed dogs with different type atrial septal defect (ASD)

Case	Signalment	History	Physical examination	Blood pressure	ECG	Thoracic radiography
1	Maltese, 8 years old, F, 3.5 kg	Dyspnea	Muffled heart sounds, Soft systolic murmur (Grade III/VI)	Hypotension (systolic, 112 mmHg)	Sinus tachycardia Low QRS wave Deep S wave	Cardiac silhouette sign, interlobar fissures
2	Pekinese, 5 months old, M, 2.78 kg	Exercise intolerance	Soft systolic murmur (Grade III/VI), Poor body condition	Normotension (systolic, 147 mmHg)	Sinus arrhythmia, Deep S wave	Cardiomegaly (VHS, 10.7), pulmonary overcirculation, MPA bulging
3	Yorkshire terrier, 5 months old, F, 720 g	Dyspnea, failure to grow, syncope,	Poor body condition, Pale mucous membrane, Systolic murmur (Grade IV/VI)	Hypotension (systolic, 108 mmHg)	Sinus tachycardia, Deep S wave	Cardiomegaly (VHS, 13.8), reverse D shaped heart pulmonary overcirculation

F: Female, M: Male, ECG: electrocardiography, VHS: vertebral height score.

Table 2. Echocardiographic findings, postmortem characteristics, and definite diagnosis in 3 small breed dogs with different type atrial septal defect (ASD)

Case	2D echocardiography	Doppler echocardiography	Postmortem findings	Diagnosis
1	Defect of the lower part of the atrial septum	Systolo-diastolic jet between two atria,	ND	Ostium primum ASD
2	Defect of the upper part of the atrial septum	Systolo-diastolic jet between two atria, High velocity systolic flow across pulmonic valve and tricuspid regurgitant flow	Ostium secundum ASD, Pulmonic stenosis	Ostium secundum ASD, Pulmonic stenosis, Pulmonary arterial hypertension
3	Defect of the upper part of the atrial septum	Systolo-diastolic jet between two atria,	Ostium secundum ASD,	Ostium secundum ASD

ASD: atrial septal defect, 2D: two dimensional, ND: not done.

sheepdogs, Samoyeds, Doberman pinscher, and Boxers (3). While Park (11) reported a case of ASD in a miniature schnauzer, the overall prevalence in small breed dogs are uncommon. In this case report, however, we described the ASD in small breed dogs weighing less than 5 kg.

The severity of murmurs in this study was higher than previously assumed (10). It might be due to the biological relevance of the significant difference in ASD size between large breed and small breed dogs.

On the ECG, contrast to a previous report (3), which showed normal ECG in most dogs with ASD, all cases in this report had a deep S wave, revealing right ventricular hypertrophy. It might be due to concomitant heart disease and severely compromised right sided heart. A common radiographic finding was an enlargement of the right side of the heart and pulmonary overcirculation.

In Case 1, chylothorax probably occurred due to the complicated nature of the ASD with anomalous venous return. Few reports of chylothorax secondary to cardiac disorders have been reported, however it is rare in dogs (5,14). To date, the compared efficacy of medical and surgical treatment of chylothorax has not been demonstrated in dogs. In the dog described here, medical therapy without surgical intervention was effective in resolving chylothorax.

In Case 2, pulmonary hypertension with concomitant pulmonary stenosis was detected and it produced reversed intracardiac shunt. Contrast echocardiography was useful for identifying right-to-left intracardiac shunts. The patient did not have polythemia and the dog was managed with conventional medication based on congestive heart failure. Unfortunately, a pulmonary artery dilator such as sildenafil was not used because it has been not approved in veterinary medicine in Korea.

Although interventional correction of canine ASD has been reported in previously (7), in our cases, for the reason of small sized patients weighing less than 5 kg and technical limitation, only medical therapy was indicated.

In all cases, furosemide and ramipril were employed to reduce venous congestion and afterload. In case 1 and 3, digoxin was also administered to control the pronounced congestive heart failure and sinus tachycardia. In contrast to a previous study (3) in large breed dogs, that affected dog belonged to 'ostium primum' ASD in this study, could be well-compensated by appropriate medication without surgical intervention. Because the primum type ASD in large dogs might be incompatible with a relatively normal life because of their aggressive activities. However, small breed dogs tend to be less active.

In conclusion, our study has shown that the clinical, physical examination, ECG, and radiographic findings of ASD in small breed dogs and they have some differences with ASD in large breed dogs. We first describe the comparison of clinical and diagnostic features in different anatomic, hemodynamic, and pathophysiological types of ASD in small breed dogs. Additional large scale investigations of ASD in small breed

dogs are needed to identify differences of characteristics between small and large breed dogs.

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세 마리의 소형견에서 발생한 다양한 해부학적, 혈액학적, 병태생리학적 타입의 심방중격결손 비교 고찰 사례

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요 약 : 5 kg 미만의 소형견 3마리가 호흡곤란과 심잡음을 주증상으로 내원하였다. 한 마리 환자에서는 일차 심방중격결손과 함께 유미흉이 진단되었다. 나머지 두 마리 환자들에서는 이차 심방중격결손이 확인되었으며, 이 중 한 마리의 환자에서는 폐동맥 협착증이 병발되었다. 내과적 치료를 시도하였으나, 이차 심방중격 결손을 가진 두 마리의 환자들은 폐사하였으며 일차 심방중격 결손이 있는 환자는 약물치료로 성공적으로 유지되었다. 폐사한 두 마리의 환자에서는 부검을 통하여 결손부를 확인하였다. 본 증례의 경우, 세 마리의 소형견에서 발생한 다양한 해부학적, 혈액학적, 병태생리학적 타입의 심방중격 결손의 임상증상, 진단학적 특징을 대형견에서의 특징과 비교 분석한 첫 증례보고이다.

주요어 : 심방중격결손, 선천적 심장 질병, 개