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Bilateral Atrioventricular Valve Dysplasia in a Middle Aged Turkish Angora Cat: A Case Report

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Abstract : A castrated, 6-year-old, male Turkish Angora cat with a history of respiratory distress was referred to the hospital. Physical examination revealed a cardiac murmur, and thoracic radiographic findings revealed pleural effusion and cardiomegaly. Echocardiography showed abnormality of the tricuspid and mitral valve, and color-flow Doppler imaging revealed regurgitation between both atrium and ventricle. Based on the echocardiographic examination, tricuspid valve dysplasia concurrent with mitral valve dysplasia was diagnosed. However, the patient died a week after treatment. In necropsy, bilateral atrioventricular valve dysplasia and left ventricular hypertrophy were confirmed. This is the first report to describe a middle age Turkish angora cat having bilateral atrioventricular valve dysplasia which has high mortality and only been reported rarely in cats. This case report also describes its clinical signs, diagnostic imaging findings, treatment and discussions how the patient could live long.

Key words **:** bilateral atrioventricular valve dysplasia, cat**,** congenital heart disease, middle age, Turkish angora.

Introduction

Congenital heart disease is defined as a morphological heart defect present at birth. Tricuspid and mitral valve dysplasia are malformations of the valve apparatus, including the valve leaflets, papillary muscles, and chorda tendineae, causing valvular insufficiency (9,18,22). Malformation of the valve results in hemodynamic consequences, including mitral or tricuspid stenosis, valvular regurgitation, and dynamic left ventricular outflow tract obstruction (22). Atrioventricular valve dysplasia has been reported as an unusual malformation in cats (13,18). The ratio of atrioventricular valve dysplasia in congenital heart malformations is about 16% for cats (25). Another paper reported that the ratio of congenital heart defects in cats is 0.2% to 1%, and patients with atrioventricular valve dysplasia were 17% of diagnoses (18).

In the first few years after birth, congenital valve dysplasia can remain asymptomatic (20). Based on echocardiography, physical examination, electrocardiography, and/or radiography, valve dysplasia can be presumed (8). Mitral or tricuspid valve dysplasia is diagnosed based on the presence of valvular insufficiency including regurgitation confirmed by continuous wave and color-flow Doppler examination (13). A surgical intervention, such as bioprosthesis, is still in the experimental phase. The current therapy is administration of diuretics, angiotensin converting enzyme inhibitor, and positive inotropic drugs once the patient shows clinical symptoms (8).

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Case Report

A 6-year-old Turkish Angora male cat presented with intermittent dyspnea symptoms, starting a year ago. The patient had deteriorated for a week before visiting the hospital and had been prescribed diuretics for the symptomatic treatment of labored respiration and syncope. The patient did not improve and was subsequently referred to the hospital. In physical examination, tachycardia (220 bpm) and systolic murmur (grade IV/VI) were found. Blood pressure was normal.

Radiological examination revealed cardiac displacement to the left due to atrial cardiomegaly. Fissure line and scalloped

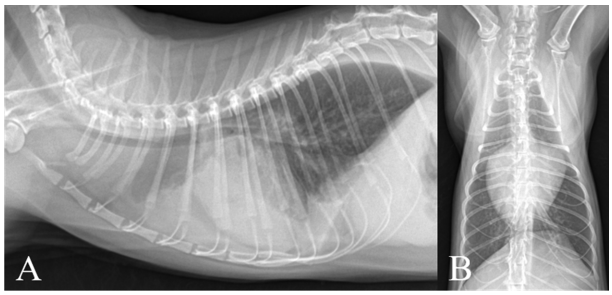

Fig 1. Lateral thoracic radiographs (A), the mildy enlarged cardiac silhouette caused dorsal elevation of the trachea and the cardiac ventral sihouette showing a fissure line and scalloped sign, indications of pleural effusion. The radiodensity of the right cranial lung lobe was increased before thoracocentesis. Dilation of the pulmonary vessels is seen. Ventrodorsal radiograph after thoracocentesis (B), cardiac silhouette shows cardiomegaly and valentain heart shape, indications of atrium enlargement.

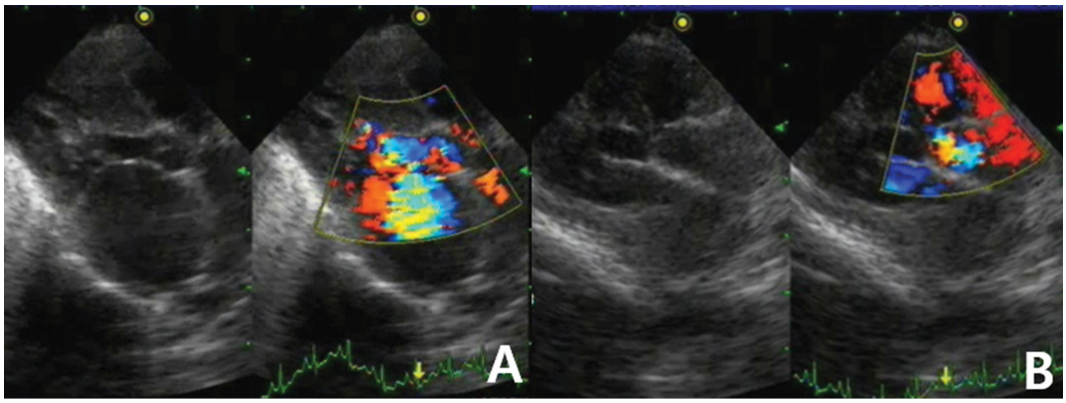

Fig 2. Color-flow Doppler echocardiogram on the right parasternal long-axis five chamber view (A), enlarged left ventriclular muscle and left artium are shown. Also, the interventricular septum is enlarged and the left ventricular cavity size is narrowed. On the right parasternal short axis pulmonary view (B), an enlarged right atrium and a shortened immobile tricuspid valve are shown. In both images, a mosaic pattern is shown between the atrium and ventricle, indicating mitral (A) and tricuspid (B) regurgitation.

sign were found, indicating pleural effusion (Fig 1A). To stabilize breathing, thoracocentesis was performed. Fluid analysis of the pleural effusion resulted in a modified transudate. After thoracocentesis, breathing became stable and additional radiological examinations were conducted (Fig 1B). The electrocardiogram identified notched P waves and P-mitrale with sinus tachycardia (234 bpm).

Echocardiography revealed shortened and immobile structure of the tricuspid valve, concentric left ventricular hypertrophy, and enlarged atriums of both sides. Color-flow Doppler echocardiography showed a mosaic pattern between the atrium and ventricle, indicating blood flow regurgitation due to valvular dysplasia or degeneration (Fig 2). In the M mode, systolic anterior motion was also not found by measuring E point to septal separation (EPSS). Also, fractional shortening and ejection fraction were within the normal ranges. In serum biochemistry, there was no remarkable findings, except mild azotemia induced by dehydration.

The patient was diagnosed with bivalvular insufficiency due to tricuspid and mitral valve dysplasia; additionally, primary hypertrophic cardiomyopathy was considered. To improve clinical symptoms, the patient was prescribed enalapril 0.5 mg/kg BID, clopidogrel 18.25 mg/cat SID, furosemide 1.5 mg/kg BID, and diltiazem 7.5 mg/cat TID. However, the patient was deceased a week later with respiration distress.

A necropsy was conducted with the owner's approval. In the thoracic space, pleural fluid and generalized congestion of the lung were found. In the cardiac section, there was a lack of secondary chorda tendineae in the mitral valve (Fig 3A) and fusions of the valve leaflets in the tricuspid valve (Fig 3B) were found. As a result, tricuspid and mitral valve dysplasia was diagnosed. As gross examination was enough to diagnose valvular disease, we didn't conduct further diagnostic evaluations after necropsy.

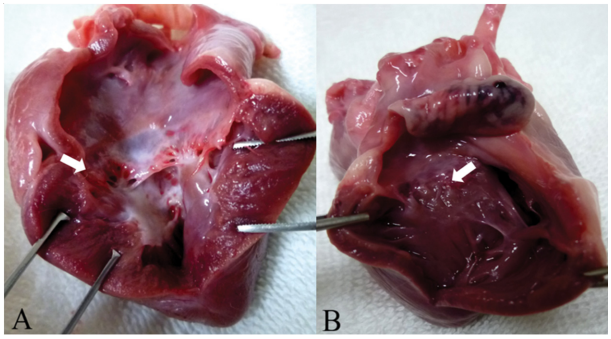

Fig 3. Heart: In the left atrium and ventricle (A), lack of secondary chorda tendineae in the mitral valve (arrow), left atrium enlargement, thickened left ventricular muscle, and a narrowed left ventricular cavity are shown. In the right atrium and ventricle (B), fusion of the valve leaflets with the interventricular septum (arrow) and right atrium enlargement are shown.

Discussion

In this case, the patient's morphological abnormalities were a lack of secondary chorda tendineae in the mitral valve, causing secondary left ventricular hypertrophy and fusion of valve leaflets in the tricuspid valve with interventricular septum. Generally, atrioventricular valve dysplasia includes fusion of chordae tendineae into a single chord, upward malposition of the papillary muscle causing malalignment of the chordae tendineae, clubbed tips with short thickened leaflets, thick and short chordae tendineae, rolling of leaflet edges, and insertion of the papillary muscle into the leaflets (15). Clinical symptoms are correlated with the degree of defects. If the mitral valve is defected, the animal generally displays signs of left-sided heart failure, including cough, weakness, and exercise intolerance. Alternatively, if the tricuspid valve is defected, signs of right heart failure including abdominal distention associated with ascites (22).

Because of the mitral and tricuspid valve's morphologic similarities, mechanisms for each valve's dysplasia are also similar (9). In tricuspid valve dysplasia, increased systolic inflow causes right atrial volume overload, which results in atrial dilation and ventricular accommodation (18). However, as the disease progresses, the right atrium and ventricle size continue to increase and the tricuspid valve annulus widens (13). Embryonic reactivation pathways for leaflet growth

in other animal species may result in the adaptation of the leaflets (7). This increase in size does not prevent further worsening of regurgitation and heart failure (4). This cycle ultimately results in massive regurgitation with loss of compensatory mechanisms, increased right atrial pressure and right-sided congestive heart failure in combination with systemic congestion, and a decreased forward flow into the pulmonary artery. The left heart becomes underloaded, and in the end, a decrease in systemic blood flow occurs (22).

In mammals, atrioventricular valve formation occurs in the late phase of the first trimester of gestation. The leaflets of the atrioventricular valve originate from the endocardial cushions, and the chordae tendineae is made by diverticulation and thinning of the ventricular wall. These occur simultaneously on both sides (16). In terms of pathology, developmental abnormality of one side's ventricle results in atrioventricular valve dysplasia, which can occur with the other side's ventricle developmental abnormalities (6). Therefore, association of tricuspid valve dysplasia with mitral deformation is possible (13). If either side has a genetic factor of atrioventricular valve dysplasia, there is a good possibility of bilateral atrioventricular valve dysplasia. Unfortunately, specific genetic abnormalities and patterns of inheritance have not been established in cat's valve dysplasia. According to a retrospective paper that included 162 cats with congenital heart disease, in cases of multiple congenital heart diseases, cats having tricuspid valve dysplasia concurrent with mitral valve dysplasia were more common than the other concurrent combination. Cases of bilateral atrioventricular valve dysplasia were 37.5% and the others were 6-7% in cases of multiple congenital heart diseases (25). In dogs, there have been many studies concerning valve dysplasia related to genetic factors and inheritance. A genetic study of Labrador retriever dogs revealed that tricuspid valve dysplasia is related to a single gene susceptibility locus on CAMP-like factor autotransporter 9 (CFA9) (1). In a study of 22 human infants with atrioventricular valve dysplasia, 45% had bilateral atrioventricular valve dysplasia, which can be caused by Edward's or Pattau's syndrome (3).

There is no report of a cat with bilateral atrioventricular valve dysplasia living for as long as presented in this study. In this case, particularly, the patient survived 6 years, which is much longer than any reported study of cats with this disease. Valve dysplasia's survival times vary because the severity and clinical signs depend on the severity of the valve malformation (20). The prognosis is generally very poor when clinical symptoms such as respiratory distress caused by atrioventricular valve dysplasia are shown. Also, the pulmonary vascular bed in cats is more prone to hypoxemia than dogs. For this reason, cats are susceptible to serious pulmonary hypertension caused by mitral valve dysplasia (17). In a case of mitral valve dysplasia, an 8-week-old Rottweiler dog was referred to the hospital for the evaluation of a heart murmur and diagnosed with mitral valve dysplasia and was euthanized shortly after with consent from the patient's guardian (19). In another example, a 9-month-old female mixed breed dog presented with exercise intolerance and dyspnea and was diagnosed with congenital mitral valve dysplasia. Two months after treatment, the patient died, and echocardiographic findings were confirmed by necropsy (14). In cases of tricuspid valve dysplasia, a 5-month-old female English Cocker Spaniel dog appeared to be effectively treated, only to die 48 days after first presentation, and a 4-month old male mongrel dog died 4 days after drug treatment (23). Another article reported a Bulldog puppy with tricuspid valve dysplasia who died 1 day after birth (21). In humans, tricuspid valve dysplasia and Ebstein's anomaly are uncommon diseases with high mortality rates in utero, and they commonly die shortly after birth (2). In cases of bilateral atrioventricular valve dysplasia, a 2-month-old domestic short hair cat ended up euthanized because of a poor prognosis (12). A 10-week-old male intact mixed breed dog with pulmonary, tricuspid, mitral valve dysplasia was also euthanized (11). Another case is of 4-year-old Labrador retriever dog who had tricuspid and mitral valve dysplasia and presented anorexia and abdominal distension from 6 months previously. The patient received thoracocentesis, abdominocentesis, and drug therapy but died of respiratory distress 1 month after treatment (5).

Although the valve malformation was very severe in this case, the patient showed no symptoms until the patient entered the hospital. Predictably, it was related to the heart's morphologic response to the loss of function and hemodynamic compensation. In compensating mechanism to valve dysplasia, at first, tricuspid valve dysplasia caused increased right ventricular end diastolic volume. In response, the right ventricle become a state of eccentric hypertrophy and the right ventricle ejected a larger volume to compensate for the decreased stroke volume. At this stage, the heart still compensated the tricuspid valve malformation (24). Also, because of these mechanisms, effects of the atrioventricular valve dysplasia and systolic regurgitation vary. Therefore, survival rates with valve dysplasia depend on the extent to which the valve's normal function is compromised. Surprisingly, some animals with severe valve dysplasia, especially tricuspid valve dysplasia, show no clinical symptoms for a relatively long time until they ultimately suffer congestive heart failure (20).

In mitral valve dysplasia, the main clinical symptom is respiratory distress due to lung congestion and pleural fluid. However, in this case, the onset of clinical symptoms was not apparent for quite some time. Hemodynamically, in tricuspid valve dysplasia, the right ventricle lacks contractility because of tricuspid regurgitation, which diminishes the amount of blood flow into the pulmonary artery and leaves the left atrium relatively underloaded (10). Moreover, the remarkable right ventricle's myocardial hypertrophy was not identified in necropsy. This may also reduce the volume of blood flow into the left atrium. In the circumstance of the right ventricle ejecting short cardiac output, the heart compensates and shows only mild sinus tachycardia. Overall, these reasons delayed the occurrence of severe lung congestion and pleural fluid. Furthermore, if the lack of right ventricular contractility reduced unwanted flow to the right atrium, absence of ascites can be explained to some extent. The tricuspid valve is structurally more stable than the mitral valve, and the likelihood of atrial congestion is lower than the left heart because the right side's dynamic is weaker than the left side. Also, for this reason, even if the tricuspid valve dysplasia is severe, symptoms do not appear clinically (20). It is assumed that

this case died of respiratory failure, caused by pleural effusion, and systemic hypotension, caused by heart failure, before the occurrence of ascites due to right atrial congestion, although the case was in a severe condition with tricuspid valve dysplasia. Commonly, cats with atrioventricular valve dysplasia result in sudden clinical deterioration (18).

When the patient suffered from intermittent breathing difficulties 1 year prior, one could assume that the patient had already exceeded heart's capacity to compensate and the patient had continued to deteriorate since then. In the end, the patient deteriorated rapidly and was taken to the hospital, where the patient died.

Conclusion

In cats, bilateral atrioventricular valve dysplasia is a rare defect, and middle-aged cats with this disease have not been reported. Although cats are more susceptible to valve dysplasia than dogs, this patient survived for quite a long time due to the balance of hemodynamics according to the bilateral atrioventricular valve dysplasia, as well as inherent compensation of heart. This case report is a good example for veterinary clinicians to treat bilateral atrioventricular valve dysplasia.

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