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Double Outlet Right Ventricle in a Cat

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Abstract : A 10-month-old intact male Scottish Fold was presented with cardiomegaly. The cat showed exercise intolerance after birth. Radiographs showed cardiomegaly with bulging of the main pulmonary artery and dilation of pulmonary arteries. Echocardiogram revealed abnormally arisen aortic root toward right ventricle with left-to-right shunted perimembraneous ventricular septal defect located underneath the aortic root. Based on imaging studies, the cat was diagnosed as subaortic type of double outlet right ventricle (DORV) without concurrent abnormalities.

Key words **:** Double outlet right ventricle, Echocardiography, Scottish Fold.

Introduction

Double outlet right ventricle (DORV) is a congenital cardiac malformation when both aorta and pulmonary artery (PA) originate from the right ventricle (RV) (5). Based on the relationship between ventricular septal defect (VSD) and great arteries, DORV can be classified into the following four groups: DORV with subaortic VSD, DORV with subpulmonary VSD, DORV with doubly-committed VSD, and DORV with non-committed VSD (7,9). Clinical manifestations of DORV are affected by the location of VSD because VSD provides the only avenue where blood flows from the left ventricle (LV). Additional abnormalities such as pulmonic stenosis (PS), pulmonary hypertension, and coarctation of the aorta should be considered. When VSD is subaortic or subpulmonary, cyanosis can occur due to great resistance to blood flow into pulmonary circulation (1,8). In this report, we describe the clinical findings, electrocardiogram, thoracic radiography, and echocardiography findings of a Scottish Fold cat with DORV.

Case

A 10-month-old intact male Scottish Fold (body weight of 3.65 kg) was referred to Gyeongsang National University Veterinary Medical Teaching Hospital for unexplained cardiomegaly. The cat showed exercise intolerance since birth.

The cat was alert and responsive at presentation. There was a mild systolic heart murmur (grade II). The loudest murmur was detected at the left ventral thorax. Laboratory tests revealed thrombocytosis (platelet count 1206×10^9/L; reference range: $300\text{-}800 \times 10^9$/L) and mild increase of hematocrit (45.5%; reference range: 24-45%). No remarkable finding was revealed by 12-lead electrocardiogram (ECG) (Fig 1).

Thoracic radiography showed cardiomegaly (vertebral hear scale 9.0 v), enlargement of the main pulmonary artery (PA), and dilation of PA (Fig 2).

On echocardiographic examination, aortic root lied toward the right ventricle (RV) at right parasternal long axis 5 chamber view. Turbulent flows of left-to-right shunts through subaortic VSD were also found on Color Doppler mode at the same window during end-systole and end-diastole (Fig 3). At right ventricular outflow tract level, dilation of pulmonary arteries without PS and pulmonary regurgitation (peak velocity 1.43 m/s, pressure gradient ~8.2 mmHg) were found on continuous wave Doppler mode (Fig 3). Based on these imaging findings, the case was diagnosed as DORV and further classified as subaortic type without other abnormalities.

This case was treated with atenolol (6.26 mg/cat, SID). Surgical treatment was not attempted. Currently, this case is in good clinical condition. However, the cat still shows mild exercise intolerance.

Discussion

In normal anatomy, great arteries of aorta originate from the left ventricle (LV) while pulmonary artery originates from the right ventricle (RV) (2). DORV is complicated congenital cardiac malformation in which both the aorta and PA emerge from the RV. VSD will result in blood being ejected from the LV into the RV since the LV has no direct communication with the great arteries. In human medicine, the incidence rate of DORV is reported to be 1% to 1.5% in patients with congenital heart disease. The prognosis of DORV appears to be poor in animals (1,4,7,12).

A few cases of DORV with variable clinical and pathologic findings have been reported in veterinary literature. However, no predisposition associated with signalment such as sex, breed, and so on to DORV has been demonstrated (1,4,5-8,11,13).

DORV can be classified as subaortic, subpulmonary, doubly-committed, and non-committed. In subaortic defect, the

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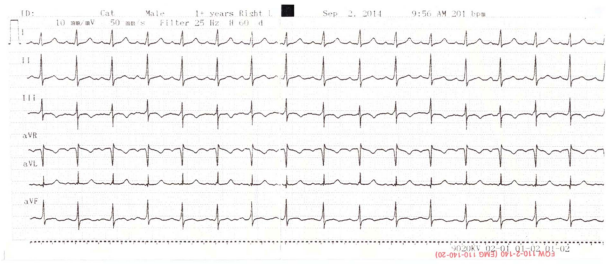

Fig 1. Electrocardiogram of the cat. ECG revealed no particular abnormality.

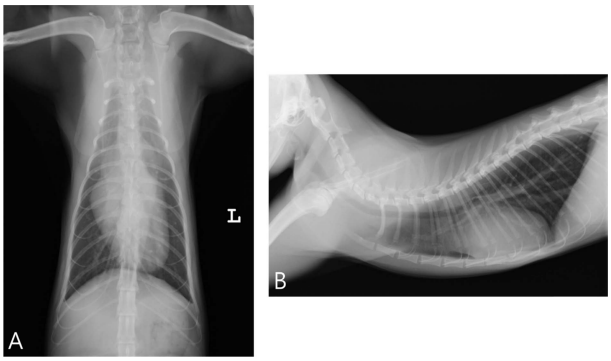

Fig 2. Thoracic radiography of the cat. A, Ventrodorsal projection of thoracic radiography showing dilation of the main pulmonary artery. B, Lateral projection of thoracic radiography showing cardiomegaly (vertebral heart scale 9.0 v) and dilation of the pulmonary arteries.

most common type, the infundibular septum is inserted into the anterior limbus of the trabecula septomarginalis, resulting in blood flowing from the LV through the VSD and flowing out the aorta with no or mild cyanosis (5,6). In contrast, in subpulmonary defect called Taussing-Bing syndrome, the infundibular septum continues with the posterior limbus of the trabecula, resulting in blood from the LV flowing through the VSD and flowing out the pulmonary artery with marked cyanosis (6,9). In non-committed VSD, the defect is located at the inlet or at the trabecular zone of the interventricular septum. In doubly-committed VSD, the infundibular septum is hypoplastic or absent. Both non-committed VSD and doubly-committed VSD resemble a large VSD where blood from ventricles is mixed in the RV (3,6,9). The most common type of DORV is the subaortic VSD with normally committed great arteries. A wide spectrum of morphological variations in DORV may result in different clinical manifestations that might require different therapeutic approaches (9). For definite diagnosis, histopathological examination after autopsy should be performed (11). However, this is not applicable for this case because the cat is still alive.

Clinical manifestations of DORV are variable depending on the location of VSD, co-existence of PS, and other associated cardiac anomalies. Cyanosis, respiratory distress, fatigue, and developmental retardation are often found (2,3,6). Exercise intolerance is found in this case.

DORV is difficult to be diagnosed accurately since abnormal ventriculoarterial connections are accompanied by other defects such as tetralogy of Fallot (TOF), ventricular septal defect (VSD), and transposition of the great arteries (TGA) (5). The diagnosis can be made when both great vessels arise from the morphologic RV. Typically, DORV is categorized according to the location of the VSD and the presence of PS (10,11). Two-dimensional echocardiography has contributed

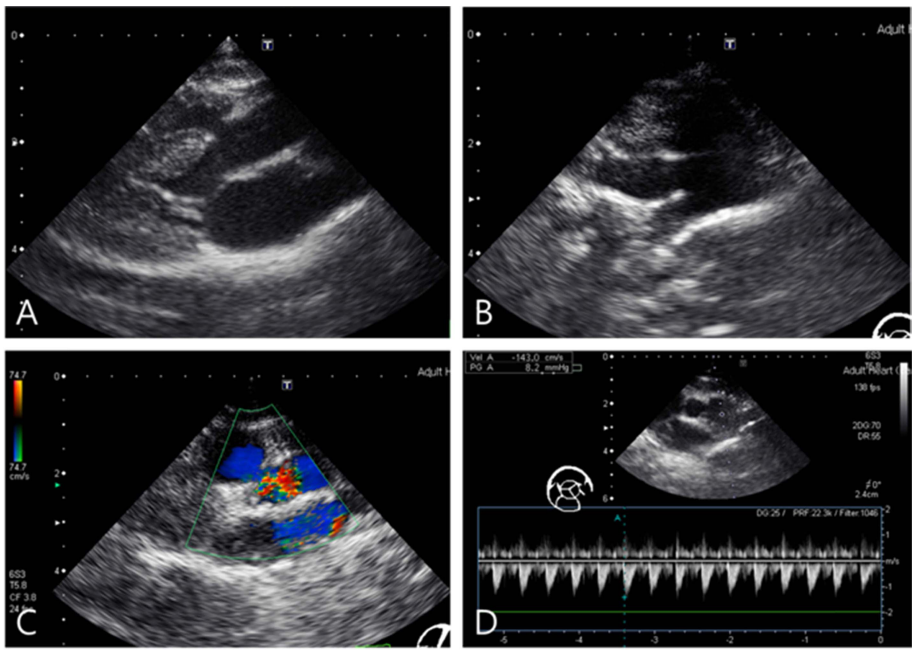

Fig 3. Echocardiographic images of the cat. A, Two-dimensional echocardiography taken at right parasternal long axis 5 chamber view showing subaortic ventricular septal defect and overridden aortic root lying toward the RV. B, Two-dimensional echocardiography in right parasternal short axis view at the right ventricular outflow tract (RVOT) level showing dilation of pulmonary arteries. C, Turbulent flow of left-to-right shunts through subaortic VSD were found on Color Doppler mode at right parasternal long axis 5 chamber view. D, At RVOT level, pulmonic stenosis and pulmonary regurgitation were not identified on continuous wave Doppler mode.

to the diagnosis of anatomic variations of DORV through accurate assessment of intracardiac abnormalities, making hemodynamic studies unnecessary. In addition, it has the advantage of being a non-invasive way to examine DORV (2,9). In this case, echocardiography showed that the aortic root lied toward the RV and the turbulent flow of left-to-right shunts flowed through subaortic VSD. The DORV in this case was a subaortic type without concurrent abnormalities.

In veterinary literatures, few surgical treatments for DORV have been described, although surgical repair of DORV has been well described in humans. The most appropriate surgical correction technique depends on the spatial relationship between the great arteries and the location of the VSD (1,8). Surgeries to connect the aorta to the LV through the VSD while maintaining the continuity between RV and PA may be performed based on echocardiography or angiocardiography (2,9). However, the outcome of surgical repair of DORV in animals has been reported to be unfavorable (4,6,13). This case is currently under conservative care with medications instead of surgery as symptoms are minor.

In conclusion, here we described a rare case of subaortic DORV. Echocardiography revealed that the aortic root was lying toward the RV and VSD shunted blood flows from the LV to the RV. To the best of our knowledge, DORV has only been reported in a dog in Korea (10). It has not been reported in cats in Korea.

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