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Cardiovascular Images

Congenital supravalvular aortic stenosis in a kitten☆

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Abstract A 3-month-old, male intact Norwegian forest cat without any clinical signs was referred to the cardiology service of the author's teaching hospital for evaluation of a cardiac murmur. The murmur was systolic with an intensity of 4 out of 6 with the point of maximal intensity at the left heart base. Echocardiography revealed a moderate mitral valve regurgitation and a moderate dynamic left ventricular outflow tract obstruction both resulting from systolic anterior motion of the mitral valve (SAM). Moreover, left ventricular concentric hypertrophy was noted. Oral atenolol therapy was initiated. Recheck examination 3.5 months later revealed unchanged murmur characteristics in the still asymptomatic kitten. Echocardiography showed no SAM, but there was a severe fixed aortic stenosis apparent caused by a discrete supravalvular lesion, 4 mm distal to the valve, with an hourglass morphology. Supravalvular aortic stenosis is a rare congenital anomaly in cats, which has not been reported antemortem yet.

An asymptomatic, 3-month-old, male intact Norwegian forest cat weighing 2.1 kg was referred to the author's teaching hospital for evaluation of a murmur. Physical examination findings were

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unremarkable except for a systolic cardiac murmur with an intensity of four out of six at the region of the left cardiac base.

Echocardiography revealed a moderate mitral valve regurgitation and a dynamic left ventricular outflow tract obstruction (DLVOTO) with a maximal Doppler-derived peak pressure gradient of 70—80 mmHg, both caused by the systolic anterior motion of the mitral valve (SAM, Fig. 1A and B). In addition, a concentric left ventricular hypertrophy and a mild dynamic right ventricular outflow tract obstruction were found. No apparent anatomical abnormalities were noted on the mitral valve. Atenolol was prescribed (6.25 mg q12h PO), and a recheck examination was recommended three months later.

Three-and-a-half months later, the kitten was presented for the recheck examination. According to the owner, the kitten continued to be healthy. The body weight was 3.8 kg. Physical examination findings and the murmur characteristics were comparable to the initial examination.

Image interpretation

Recheck echocardiography revealed no SAM nor mitral regurgitation (Fig. 1C). However, continuous-wave Doppler examination revealed a severe fixed aortic stenosis with a peak pressure gradient of 90—100 mmHg (Fig. 1D). A closer look at the aorta showed normal aortic valve morphology and a discrete supravalvular stenosis (Fig. 2, Video I). The previously detected left ventricular concentric hypertrophy was still present.

Discussion

In the present case, the initial echocardiographic examination revealed SAM and concentric left

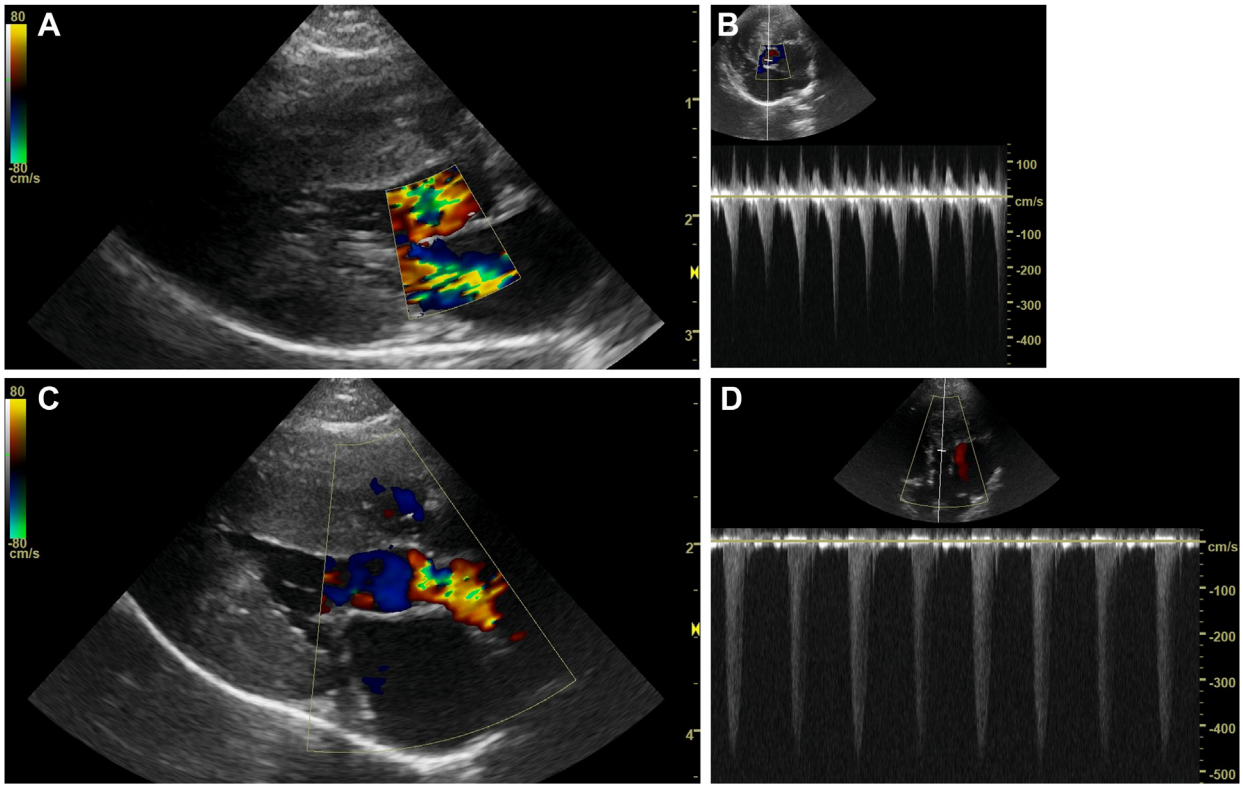

Fig. 1 A) Right parasternal longitudinal color Doppler echocardiographic image shows a moderate mitral valve regurgitation jet and aliasing artifact in the left ventricular outflow tract because of systolic anterior motion of the mitral valve in this systolic frame; B) Left parasternal continuous wave Doppler echocardiographic image shows a moderately increased blood flow velocity in the left ventricular outflow tract due to systolic anteriormotion of themitral valve.The flowprofile is dynamic, which is compatible with a dynamic left ventricular outflow tract obstruction caused by the systolic anterior motion of the mitral valve. The two-dimensional image is optimized for the left ventricular outflow tract and lacks the aortic valve and the supravalvular region; C) Right parasternal longitudinal color Doppler echocardiographic image shows the lack of mitral valve regurgitation and the presence of aliasing artifact in the aorta in this systolic frame. This examination was performed when the cat was treated with atenolol; D) Right parasternal longitudinal color Doppler echocardiographic image shows the lack of mitral valve regurgitation and the presence of aliasing artifact in the aorta in this systolic frame. This examination was performed when the cat was treated with atenolol.

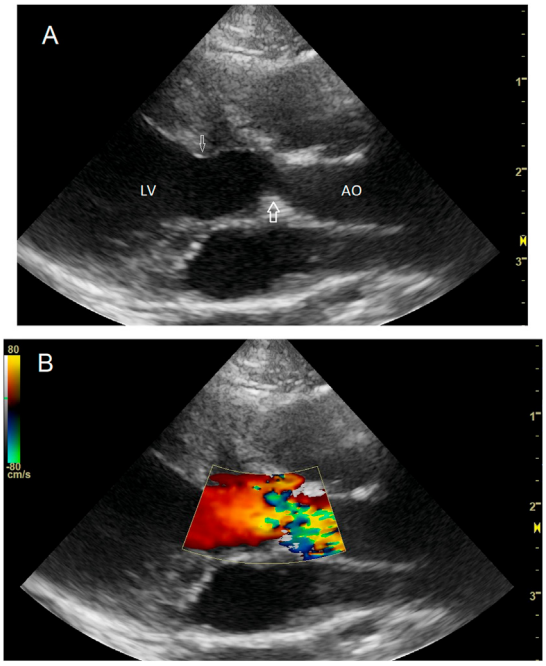

Fig. 2 Longitudinal echocardiographic image of the aorta from the left cranial parasternal standard view. **A.** This two-dimensional image shows a discrete supravalvular aortic stenosis with a thickened sinotubular junction (large arrow). On this systolic frame, the aortic valve is open. The stenosis has an hourglass morphology, and it is located 4 mm distal to the aortic valve annulus (small arrow). The diameter of the aorta at the level of the stenosis is 4 mm, at the level of the sinus of Valsalva is 7 mm, and the ascending aorta, about 1 cm distal to the stenosis (AO), measures 6.5 mm. LV = left ventricular lumen. **B.** Color Doppler image shows aliasing artifact caused by a discrete supravalvular aortic stenosis. The same systolic frame without color is shown in Fig. 2A.

ventricular hypertrophy. These findings can result from three different scenarios: (1) a primary myocardial disease (such as myocarditis or hypertrophic cardiomyopathy) with a secondary SAM, (2) a primary SAM caused by congenital mitral valve dysplasia, and the resulting DLVOTO would lead to left ventricular concentric hypertrophy due to pressure overload, or (3) a congenital fixed aortic stenosis, which would lead to concentric left ventricular hypertrophy due to pressure overload, and the hypertrophy would cause secondary SAM [1—3]. Differentiating these disorders is based on two-dimensional echocardiographic morphological features of the aorta and the Doppler flow profile of the aorta and the left ventricular outflow tract. Additionally, the intensity of the murmur could be a useful clue, as a severe congenital fixed aortic stenosis tends to cause a louder murmur than a severe DLVOTO [1—3]. Because of the dynamic flow profile of the Doppler spectrum in the left ventricular outflow tract, the first two possibilities were considered more likely at the initial assessment, and atenolol therapy was started to try to resolve the SAM and with that of the DLVOTO. Resolution of DLVOTO could result in reverse remodeling of the left ventricular concentric hypertrophy [1]. Recheck echocardiography revealed the resolution of SAM, but the left ventricular concentric hypertrophy was still present, and the blood flow velocity in the aorta and left ventricular outflow tract was higher than initially, but the flow profile was this time fixed. Retrospectively, the supravalvular aortic stenosis was recognizable on the initial two-dimensional echocardiographic images at three months of age. Aliasing artifacts in the left ventricular outflow tract caused by DLVOTO due to SAM made recognition of anatomical abnormalities in the supravalvular region of the aorta more challenging. The supravalvular aortic stenosis might have been detected together with the DLVOTO if both the aorta and the left ventricular outflow tract had been visualized on the same two-dimensional image when the continuous wave Doppler examination was carried out. Atenolol was likely responsible for the resolution of SAM due to its negative inotropic effect, as has been previously reported [1].

Fixed aortic stenosis is an uncommon congenital anomaly in cats, accounting for 7—17% of all congenital cardiac defects in this species [4,5]. Supravalvular aortic stenosis is extremely rare in cats and has so far only been reported as a postmortem finding in a single cat [6]. According to human classifications, supravalvular aortic stenosis has three types of morphology: the hourglass type, the membranous type, and the aortic hypoplasia type [7]. In humans, supravalvular aortic stenosis can be an isolated anomaly or part of a systemic elastin arteriopathy [7]. How the elastin disorder exactly leads to supravalvular aortic stenosis is unknown [7].

For treatment of supravalvular aortic stenosis, balloon dilatation was described in dogs [8,9].

Video #	Brief title	Description
I	Post-atenolol echocardiogram	Right parasternal longitudinal color Doppler echocardiographic image shows a turbulent blood flow in the ascending aorta originating from a discrete supravalvular stenosis. There is no mitral valve regurgitation or systolic anterior motion of the mitral valve present.

Because of the small femoral artery, balloon dilatation in cats would likely require a carotid arterial or a surgical hybrid approach via the left ventricular apex.

In conclusion, this is the first report of antemortem diagnosis of a congenital supravalvular aortic stenosis in a cat.

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Conflict of Interest Statement

The authors do not have any conflicts of interest to disclose.

Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jvc.2022.04.001.

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