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Primary pulmonic infundibular stenosis in 12 cats: Natural history and the effects of balloon valvuloplasty

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Abstract *Objectives:* To evaluate the natural history of primary pulmonic infundibular stenosis in cats and the effects of balloon valvuloplasty.
Background: Primary pulmonic infundibular stenosis is an uncommon congenital defect in cats. The natural history of the disease has not been described. Information regarding balloon valvuloplasty in the cat is limited.
Animals: Records between January 1, 1999 and December 31, 2005 were reviewed and cats with a confirmed echocardiographic diagnosis of primary pulmonic infundibular stenosis, a complete medical history, and no evidence of significant systemic disease were identified.
Methods: Echocardiographic, electrocardiographic, and radiographic findings are described. The natural history of those with severe disease was compared to those with mild to moderate disease. Balloon valvuloplasty was performed in six of the cats. The technique used is described.
Results: A stenotic gradient $\geq$70 mmHg and a right ventricular outflow tract (measured at the level of the stenosis) to pulmonary valve annulus ratio of $\leq$0.25 were consistent with clinical and echocardiographic severe disease. Cats with severe disease had a very guarded prognosis with a high incidence of congestive heart failure (CHF). Balloon valvuloplasty was successfully performed in 4 of the cats and appeared to improve prognosis, especially if performed prior to the development of CHF. Concurrent hypertrophic cardiomyopathy complicated the outcome in some cats.
Conclusions: Severe primary pulmonic infundibular stenosis carries a very guarded prognosis in the cat. Balloon valvuloplasty should be considered in the presence of severe disease and should be performed prior to the development of CHF if possible. The presence of concurrent hypertrophic cardiomyopathy may complicate the prognosis.

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Introduction

Congenital fixed obstruction of the right ventricular outflow tract (RVOT) is uncommon in the cat with an incidence of about 2–3% of congenital cardiac defects.[1–3] The RVOT consists of three components; a muscular portion extending between the right ventricle and the pulmonary valve (the infundibulum),[4] the pulmonary valve itself, and the pulmonary arterial tree. In humans, obstruction of the infundibulum is classified into two general categories based on the morphology and cause of the obstruction.[5,6] Obstruction resulting from anomalous and hypertrophied muscle bundles within the infundibulum is referred to as double chamber right ventricle (DCRV). Obstruction resulting from localized hypertrophy and fibrosis of the septal and/or parietal walls of the infundibulum is referred to as primary (pulmonic) infundibular stenosis. Pulmonic infundibular stenosis is rare but has been previously described in the cat and dog.[7,8] To the author's knowledge there are no published data describing the natural history of cats with primary pulmonic infundibular stenosis. A recent paper evaluating the natural history of DCRV in cats has been published.[9] Dynamic right ventricular outflow tract obstruction (RVOTO) has also been described in the cat.[10] Dynamic RVOTO results from systolic collapse of the infundibulum during mid-systole. This disease differs from primary pulmonic infundibular stenosis by the lack of a fixed obstruction/stenosis in the infundibulum. In addition to identification of a fixed stenosis via 2D imaging, Doppler echocardiography can also be helpful in differentiating the two abnormalities. The Doppler envelope associated with dynamic RVOTO has a ''dagger'' or ''ski-slope'' appearance to it consistent with mid-systolic obstruction. The fixed obstruction associated with primary pulmonic infundibular stenosis will produce a ''bullet'' shaped symmetrical Doppler envelope.

In the dog, balloon valvuloplasty (BV) has become the treatment of choice for valvular pulmonic stenosis and has been shown to improve prognosis.[11] In the cat, BV for valvular stenosis and also for infundibular stenosis has been reported but the studies were each limited to single cases.[12,13]

The purpose of this study was to evaluate the clinical findings, diagnostic findings, and natural history of 12 cats with primary pulmonic infundibular stenosis. In addition, between the years 2002 and 2005, balloon valvuloplasty was performed on six of the 12 cats. The procedural details and the immediate and long-term results are reported. It was hypothesized that balloon valvuloplasty would have a positive effect on prognosis as it does in the dog.

Animals, materials, and methods

Echocardiogram reports and medical records from January 1, 1999 to December 31, 2005 were reviewed to identify cats with primary infundibular stenosis. To be included in the study a complete signalment and history were required as well as, at minimum, echocardiographic confirmation of the lesion. Specifically, the cat had to have a discrete infundibular ridge with a ''bullet-shaped'' Doppler tracing at the level of the stenosis consistent with a fixed obstruction. Cats were not included if there was evidence of clinically significant systemic disease including hypertension or hyperthyroidism. Twelve cats were included based on the minimum criteria. The signalment of each of the cats is summarized in Table 1. The medical records were reviewed to identify onset of clinical signs, onset of congestive heart failure, specific medical therapy, and cause and age at death (Table 1).

Nine of the 12 cats had an electrocardiogram (ECG) available for review. The P wave and QRS complex amplitude and duration, and the PR interval were measured on three consecutive cardiac cycles and averaged. The mean QRS axis was also assessed. Seven of the cats had chest radiographs performed at the time of initial diagnosis. Lateral and ventrodorsal radiographs were available for review in six of the cats. The remaining cat had only a ventrodorsal radiograph available. Vertebral heart scores (VHS) were measured on all lateral and ventrodorsal radiographs.[14] A VHS of $\leq$8.5 was considered normal for the purposes of this study.

Echocardiograms were performed in all 12 cats. Standard left and right parasternal views were performed. Short- axis left atrial diameter (LAD) and aortic diameter (Ao) were obtained from a 2D right parasternal short- axis view at the point of maximal LA size. A LAD/Ao ratio of $\leq$1.5 was considered normal for this study. Long- axis left atrial (LLAD) and right atrial (RAD) diameters were obtained from a right parasternal long-axis view at the point of maximum left and right atrial size. Measurements of the RAD were performed using a method similar to published methods of measuring the LLAD in long axis.[15] The ratio of RAD to LLAD was calculated and considered normal if less than 1.0.[16] Right ventricular end-diastolic