



# Echocardiographic anatomy of the mitral valve in healthy dogs and dogs with myxomatous mitral valve disease



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## KEYWORDS

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**Abstract Objectives:** To further characterize the echocardiographic anatomy of the canine mitral valve apparatus in normal dogs and in dogs affected by myxomatous mitral valve disease (MMVD).

**Animals:** Twenty-two normal dogs and 60 dogs with MMVD were prospectively studied.

**Methods:** The length (AMVL), width (AMVW) and area (AMVA) of the anterior mitral valve leaflet were measured in the control group and the affected group, as were the diameters of the mitral valve annulus in diastole ( $MVA_d$ ) and systole ( $MVA_s$ ). The dogs with MMVD were staged based on American College of Veterinary Internal Medicine (ACVIM) guidelines and separated into groups B1 and B2/C. All measurements were indexed to body weight based on empirically defined allometric relationships.

**Results:** There was a statistically significant relationship between all  $\log_{10}$  transformed mitral valve dimensions and body weight. The AMVL, AMVW, AMVA,  $MVA_d$  and  $MVA_s$  were all significantly greater in the B2/C group compared to the B1 and control groups. The AMVW was also significantly greater in the B1 group compared to the control group. Interobserver % coefficient of variation (% CV) was <10% for AMVL, AMVA,  $MVA_d$  and  $MVA_s$ , but was 29.6% for AMVW. Intraobserver % CV was <10.4% for all measurements.

**Conclusions:** Measurements of the anterior mitral valve leaflet and the mitral valve annulus in the dog can be indexed to body weight based on allometric relationships.

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Preliminary reference intervals have been proposed over a range of body sizes. Relative to normal dogs, AMVL, AMVW, AMVA, MVA<sub>d</sub> and MVA<sub>s</sub> are greater in patients with advanced MMVD.

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### Abbreviations

ACVIM	American College of Veterinary Internal Medicine
AMVA	anterior mitral valve leaflet area
AMVL	anterior mitral valve leaflet length
AMVW	anterior mitral valve leaflet width
MMVD	myxomatous mitral valve disease
MVA <sub>d</sub>	mitral valve annulus diameter in diastole
MVA <sub>s</sub>	mitral valve annulus diameter in systole
RC	repeatability coefficients
% CV	% coefficient of variation

## Introduction

The most common acquired cardiac disease in canine patients is myxomatous mitral valve disease (MMVD).<sup>1,2</sup> Gross pathology of affected mitral valve leaflets exhibits a wide spectrum of lesion severity; some dogs develop only mild nodular thickening of the leaflets, while others are found to have lengthening or rupture of the chordae tendineae with elongated and severely thickened leaflets.<sup>3,4</sup> Dilation of the mitral valve annulus also develops in association with long-standing mitral regurgitation due to MMVD.<sup>5</sup> Histopathology of affected leaflets shows an accumulation of proteoglycans and glycosaminoglycans in combination with connective tissue derangements.<sup>4–8</sup> Standardized echocardiographic criteria distinguish between normal and abnormal mitral valve morphology in humans, but despite the high prevalence of MMVD in dogs, similar criteria for use in canine echocardiography have not been established.<sup>9–11</sup> The lack of objective or quantitative echocardiographic criteria has hampered systematic investigation of the relationships between structural mitral valve abnormalities and clinical assessments of disease severity. Additionally, the prognostic relevance of abnormal mitral valve anatomy associated with MMVD in dogs has not been fully evaluated. In humans, mitral valve leaflets measuring 5 mm or greater in width during diastole are known to be a predictor of

complications associated with MMVD.<sup>12</sup> The prognostic relevance of systolic thickness of the anterior mitral valve leaflet has been investigated in dachshunds, but this variable was not predictive of increases in left atrial and left ventricular end-diastolic diameters over a 3-year period.<sup>13</sup> Further study of prognostic indicators related to mitral valve anatomy in dogs is needed.

The image plane utilized most commonly for evaluation of the mitral valve in people, especially with regard to diagnosis of mitral valve prolapse, is the parasternal long axis view. This view corresponds most closely to the veterinary image plane known as the right parasternal long-axis left ventricular outflow view, which allows visualization of the aorta in addition to the left atrium, left ventricle and mitral valve leaflets.<sup>14</sup> The right parasternal long-axis 4-chamber view, though not a standard image plane in human cardiology, is also considered a standard echocardiographic view for assessment of the canine mitral valve.<sup>7,14,15</sup> Both views provide visualization of the mitral valve apparatus; however, the optimal image plane for assessment of the mitral valve in dogs has not been critically assessed.

The goals of this study were: 1) to evaluate the relationships between mitral valve measurements and body size; 2) to propose preliminary reference intervals for echocardiographic measurements of the anterior mitral valve leaflet and the mitral valve annulus in normal dogs; 3) to determine which echocardiographic view provides more repeatable measurements of the mitral valve apparatus in dogs, and 4) to compare these echocardiographic measurements among groups of dogs defined by clinical stage of MMVD.

## Animals, materials and methods

The control group was made up of healthy dogs owned by faculty, staff and students of the Virginia Maryland Regional College of Veterinary Medicine as well as dogs presenting for pre-breeding cardiac screening to both the Virginia Maryland Regional College of Veterinary Medicine and the Kansas State University Veterinary Teaching Hospital.

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