



Two-dimensional echocardiographic estimates of left atrial function in healthy dogs and dogs with myxomatous mitral valve disease^{☆, ☆☆}

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Abstract Objectives: To provide reference intervals for 2-dimensional linear and area-based estimates of left atrial (LA) function in healthy dogs and to evaluate the ability of estimates of LA function to differentiate dogs with subclinical myxomatous mitral valve disease (MMVD) and similarly affected dogs with congestive heart failure (CHF).

Animals: Fifty-two healthy adult dogs, 88 dogs with MMVD of varying severity.

Methods: Linear and area measurements from 2-dimensional echocardiographs in both right parasternal long and short axis views optimized for the left atrium were used to derive estimates of LA active emptying fraction, passive emptying fraction,

[☆] Preliminary data from this study were presented at the 24th ECVIM-CA Congress in Mainz in 2014.

^{☆☆} A unique aspect of the Journal of Veterinary Cardiology is the emphasis of additional web-based materials permitting the detailing of procedures and diagnostics. These materials can be viewed (by those readers with subscription access) by going to <http://www.sciencedirect.com/science/journal/17602734>. The issue to be viewed is clicked and the available PDF and image downloading is available via the Summary Plus link. The supplementary material for a given article appears at the end of the page. To view the material is to go to <http://www.doi.org> and enter the doi number unique to this paper which is indicated at the end of the manuscript.

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expansion index, and total fractional emptying. Differences for each estimate were compared between healthy and MMVD dogs (based on ACVIM classification), and between MMVD dogs with subclinical disease and CHF that had similar LA dimensions. Diagnostic utility at identifying CHF was examined for dogs with subclinical MMVD and CHF. Relationships with bodyweight were assessed.

Results: All estimates of LA function decreased with increasing ACVIM stage of mitral valve disease ($p < 0.05$) and showed negative relationships with increasing LA size (all r^2 values < 0.2), except for LA passive emptying fraction, which did not differ or correlate with LA size ($p = 0.4$). However, no index of LA function identified CHF better than measurements of LA size. Total LA fractional emptying and expansion index showed modest negative correlations with bodyweight.

Conclusions: Estimates of LA function worsen with worsening MMVD but fail to discriminate dogs with CHF from those with subclinical MMVD any better than simple estimates of LA size.

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Abbreviations

2D	two-dimensional
CHF	congestive heart failure
ECG	electrocardiograph(y)
LA	left atrium (atrial)
LA _{ACT}	left atrial active emptying fraction (based on linear measurements)
LA:Ao	ratio of the left atrial dimension to the aortic annulus dimension
LAA:AoA	ratio of the left atrial area to the aortic annulus area
MMVD	myxomatous mitral valve disease
ROC	receiver operating characteristic
RPSA	right parasternal short axis
RPLA	right parasternal long axis

Left atrial (LA) function is increasingly evaluated in veterinary cardiac patients to help identify disease severity [1–6]. Left atrial function comprises 3 components: it acts as a reservoir during ventricular systole (atrial diastole), it acts as a conduit during early ventricular diastole and diastasis and as an active pump during late ventricular diastole (atrial systole) [1,4,7].

Although simple measures of LA size (e.g. left atrial-to-aortic ratio) correlate with disease severity and are predictive of clinical outcomes in dogs, clinicians often observe dogs with LA of similar size that have different clinical disease status, e.g. subclinical disease vs. congestive heart failure (CHF). Whether these dogs might have different LA function to explain their clinical status remains largely undetermined.

While 3-dimensional assessment of function might be more accurate than 2-dimensional (2D) assessment [4], most clinicians performing echocardiographic evaluations of patients do not possess technology capable of 3-dimensional imaging and do not have the time for substantial off-line analysis. Furthermore, volumetric accuracy is not required if simpler methods are precise enough to successfully differentiate groups of patients with different LA function or clinical status. Two-dimensional echocardiography is commonly available, and evaluation of function requires little, if any, off-line analysis, and is minimally time-consuming.

To the authors' knowledge, no studies have determined reference intervals for 2D echocardiographic non-volumetric indices of LA function in healthy dogs. Furthermore, few studies have evaluated indices of LA function in dogs with varying degrees of LA pathology secondary to myxomatous mitral valve disease (MMVD) or examined the ability of these indices to identify the clinical status of these dogs. These studies suggested that LA function decreases with worsening MMVD and might differentiate dogs with different clinical disease classifications [3,4]. However, these studies failed to examine the benefit of estimating LA function over simply measuring the size of the LA. In addition, these studies failed to examine the ability of functional indices to discriminate between subclinical MMVD and CHF in dogs that had similar degrees of cardiac remodeling (i.e. dogs with similarly marked LA and LV enlargement that did, or did not, have the evidence of CHF).

Therefore, we sought to establish reference intervals for 2D echocardiographically derived

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