Journal of Veterinary Cardiology (2018) ■, ■–■

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Journal of Veterinary Cardiology ESVC

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Left atrial deformation and phasic function determined by two-dimensional speckle-tracking echocardiography in dogs with myxomatous mitral valve disease

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Received 3 December 2016; received in revised form 14 November 2017; accepted 16 January 2018

KEYWORDS
Left atrium;
Strain imaging;
Canine

Abstract *Introduction:* Left atrial (LA) function can provide useful information in dogs with myxomatous mitral valve disease (MMVD). Recently, we have demonstrated the feasibility of measuring LA longitudinal deformation using speckle-tracking echocardiography (STE) to estimate LA function in healthy dogs. Whether LA strain and strain rate variables provide additional information about LA function and clinical cardiac status in dogs with MMVD remains unexplored.
Animals: Ninety-six client-owned dogs of different breeds with MMVD were prospectively enrolled.
Methods: LA longitudinal deformation was evaluated in each dog by STE and different STE variables were used to assess LA function.
Results: No STE variables differed between American College of Veterinary Internal Medicine Stage B1 and B2 dogs but were lower in Stage C dogs. Peak atrial longitudinal average strain $< 27.9\%$, left-atrial-to-aortic ratio > 2.2 and peak atrial

Presented in part as a poster at the 24th European College of Veterinary Internal medicine-Companion Animals (ECVIM-CA) Congress in Mainz, Germany, September 2014.

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https://doi.org/10.1016/j.jvc.2018.01.002

Please cite this article in press as: Caivano D, et al., Left atrial deformation and phasic function determined by two-dimensional speckle-tracking echocardiography in dogs with myxomatous mitral valve disease, Journal of Veterinary Cardiology (2018), https://doi.org/10.1016/j.jvc.2018.01.002

contraction average strain < 7.25% discriminated symptomatic MMVD dogs by receiver operating characteristic analysis with sensitivity and specificity of 100% and 100% (95% confidence interval [CI] 91—100%), 92% (95% CI 78—98%) and 98% (95% CI 87—100%), 100% (95% CI 91—100%) and 95% (95% CI 83—99%), respectively. In 12 dogs with similar left-atrial-to-aortic ratio, peak atrial longitudinal average strain and peak atrial contraction average strain differentiated dogs with subclinical disease from those with congestive heart failure (CHF).

Conclusion: Dogs with MMVD in CHF appear to have lower LA longitudinal strain and strain rate variables compared with dogs with subclinical disease. Further studies are needed to establish if our initial findings can provide useful information for the diagnosis, treatment, and prognosis of dogs with MMVD.

Abbreviations

ACVIM	American College of Veterinary Internal Medicine
CALS	conduit atrial longitudinal average strain
CHF	congestive heart failure
CSI	contraction strain index
LA	left atrium/left atrial
LA:Ao	left-atrial-to-aortic ratio
LV	left ventricle/left ventricular
MMVD	myxomatous mitral valve disease
PACS	peak atrial contraction average strain
PALS	peak atrial longitudinal average strain
SR	strain rate
SR_a	strain rate at atrial contraction
SR_e	strain rate in early diastole
SR_s	strain rate in systole
STE	speckle-tracking echocardiography

Introduction

Myxomatous mitral valve disease (MMVD) is the most common heart disease in dogs [1,2]. It is characterized by a progressive myxomatous degeneration of the leaflets and chordae tendineae of mitral valve with consequent valvular regurgitation [1,2]. Volume overload secondary to chronic and hemodynamically significant mitral regurgitation can cause left atrial (LA) enlargement and congestive heart failure (CHF) [1—4]. The degree of LA enlargement is an indicator of severity and prognosis in dogs with MMVD [1—3,5]. The left-atrial-to-aortic-root ratio (LA:Ao) assessed with two-dimensional echocardiography from the right parasternal short axis view is commonly used for detecting LA enlargement in veterinary clinical practice [6,7].

The LA is a complex structure, consisting of a truncated spheroidal LA body, a conical left auricle, a pulmonary venous confluence, and the mitral valve. This makes assessment of linear or area dimensions less than optimal in human and veterinary medicine [8,9]. Moreover, LA assessment needs to consider all phases of atrial function during the cardiac cycle: reservoir phase during ventricular contraction, conduit phase during early ventricular diastole, and booster pump phase during atrial contraction. Indeed, studies of LA volume and function provide evidence of limitations of simple linear estimates of LA size and pathology [8,10—12]. Conventional Doppler and tissue Doppler ultrasonography has been used to indirectly assess LA function in dogs and cats [3,13—16], although these techniques have limitations which can affect accurate interpretation of LA function [17,18].

Our recent study demonstrated the feasibility of measuring LA longitudinal strain and strain rate (SR) variables using speckle-tracking echocardiography (STE) to estimate LA function in healthy dogs [19]. Speckle-tracking echocardiography is a novel, angle-independent echocardiographic technique that uses standard two-dimensional images for tracking analysis of natural acoustic markers (speckles), which are followed frame by frame during the cardiac cycle [20—22]. Speckle-tracking echocardiography assesses myocardial deformation by measuring the strain (the percentage change from the original dimension) and SR (the velocity of myocardial deformation) of the myocardium.

Longitudinal LA strain curves show a LA deformation profile during the cardiac cycle, consistent with LA physiology [19,22]. During the reservoir phase, the LA stretches, because of pulmonary venous inflow against a closed mitral valve,

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