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Echocardiographic assessment of canine degenerative mitral valve disease

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Abstract Degenerative mitral valve disease (MVD), the most common acquired heart disease in small-sized dogs, is characterized by valvular degeneration resulting in systolic mitral valve regurgitation (MR). Worsening of MR leads to several combined complications including cardiac remodeling, increased left ventricular filling pressure, pulmonary arterial hypertension, and myocardial dysfunction. Conventional two-dimensional, M-mode, and Doppler examination plays a critical role in the initial and longitudinal assessment of dogs affected by MVD, providing information on mitral valve anatomy, MR severity, left ventricular (LV) size and function, as well as cardiac and vascular pressures. Several standard echocardiographic variables have been shown to be related to clinical outcome. Some of these markers (e.g., left atrium to aorta ratio, regurgitation fraction, pulmonary arterial pressure) may also help in identifying asymptomatic MVD dogs at higher risk of early decompensation, which remains a major issue in practice. However, both afterload and preload are altered during the disease course. This represents a limitation of conventional techniques to accurately assess myocardial function, as most corresponding variables are load-dependent. Recent ultrasound techniques including tissue Doppler imaging, strain and strain rate imaging, and speckle tracking echocardiography, provide new parameters to assess regional and global myocardial performance (e.g., myocardial velocities and gradients, deformation and rate of deformation, and mechanical synchrony). As illustration,

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the authors present new data obtained from a population of 91 dogs (74 MVD dogs, 17 age-matched controls) using strain imaging, and showing a significant longitudinal systolic alteration at the latest MVD heart failure stage.

Abbreviations

ARJ/LAA	regurgitant jet area signal to left atrium area
CT	chordae tendineae
CTR	chordae tendineae rupture
EF%	ejection fraction
ESVI	end-systolic volume index
FS%	fractional shortening
IVRT	isovolumic relaxation time
LA	left atrium
LA/Ao	left atrium to aorta ratio
LV	left ventricle
MR	mitral regurgitation
MVD	mitral valve disease
NT-proBNP	N-terminal pro-B-type natriuretic peptide
PAH	pulmonary arterial hypertension
PISA	proximal isovelocity surface area
RF	regurgitant fraction
STE	speckle tracking echocardiography
TDI	tissue Doppler imaging

Introduction

Degenerative mitral valve disease (MVD) is the most common acquired canine heart disease.[1,2] Its prevalence can attain 14%—40% in small-sized dogs depending on the breed, and even reaches higher values in geriatric canine populations.[3—5] Large breed dogs such as German Shepherds can also be affected by the disease.[6,7] Whichever the canine breed considered, MVD is characterized by chronic myxomatous mitral valve degeneration resulting in thickening and incomplete apposition of the valve leaflets during systole with secondary mitral valve regurgitation (MR),[8—10] the severity of which is a major determinant of the natural disease progression. Although most dogs with MVD remain asymptomatic for years and even for life,[11—15] severe complications can occur concomitantly with MR worsening, including left- and then right-sided congestive heart failure secondary to pulmonary arterial hypertension (PAH).[16—20] This ultimately leads to death or euthanasia due to unresponsive symptoms.

Because of the potential deleterious consequences and high prevalence of MVD, its accurate diagnosis and the monitoring of its progression over time are critical clinical concerns for predicting the risk of decompensation, guiding prognosis and adapting medical prescription.

The standard transthoracic echocardiographic examination is currently considered as the non-invasive diagnostic method of choice for early detection of the mitral valve lesions, evaluation of MR severity, and lastly, for assessing its impact on cardiac remodeling, myocardial function, left ventricular (LV) filling pressures as well as pulmonary arterial pressure.[18—23] However, owing to volume overload and complex hemodynamic changes associated with disease progression, the detection of myocardial dysfunction in the setting of chronic MR still remains challenging.[22—28] Nevertheless, more recent advances in ultrasound technology, together with the introduction of other imaging modalities such as tissue Doppler imaging (TDI), strain and strain rate imaging, and two-dimensional (2D) speckle tracking echocardiography (STE), currently offer new opportunities for assessing and monitoring global and regional myocardial function over time.[29]

The present article provides a review of the conventional echocardiographic alterations associated with canine MVD, including a critical approach to the assessment of LV contractile performance, followed by an outline of the more recent ultrasound techniques and their impact on the understanding of MVD-associated myocardial dysfunction.

Identification of mitral valve lesions

Macroscopically mitral valve lesions associated with MVD are firstly characterized by small, smooth nodules on the leaflet tips (Fig. 1) and thickened chordae tendineae (CT), which may be identified by 2D and M-mode echocardiography (Fig. 2). These nodular deformations are usually greater for the anterior leaflet (Fig. 2A and C) and become thicker and more irregular during disease progression.[2,21] Abnormal systolic flattening of one or both mitral valve leaflets and then mitral valve