



Right ventricular outflow tract fractional shortening: an echocardiographic index of right ventricular systolic function in dogs with pulmonary hypertension[☆]

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Abstract Objectives: To create reference intervals for right ventricular outflow tract fractional shortening (RVOT-FS) in healthy dogs and examine diagnostic performance of this index in dogs with pulmonary hypertension (PH). In addition, we examine the impact of myxomatous mitral valve disease (MMVD) without PH on RVOT-FS.

Animals, materials and methods: The study population included 52 healthy adult dogs, 51 dogs with MMVD but without PH, and 51 dogs with PH. This is a prospective study. Complete echocardiographic evaluations were performed on all dogs. Right ventricular outflow tract fractional shortening was obtained by two-dimensional guided M-mode recordings from the right parasternal short axis view. Right ventricular outflow tract fractional shortening was evaluated in healthy dogs of various

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breeds, and reference intervals were generated. We examined the effect of PH on RVOT-FS with receiver operating characteristic analysis and evaluated the effect of MMVD on RVOT-FS in dogs without PH. Intraobserver and interobserver reproducibility was calculated.

Results: Healthy dogs had RVOT-FS > 44%. Right ventricular outflow tract fractional shortening values of healthy dogs and MMVD dogs without PH did not differ ($p=0.84$). In dogs with PH, RVOT-FS decreased with increasing tricuspid regurgitation velocity ($p<0.0001$). Pimobendan use in dogs with PH increased RVOT-FS as PH worsened. Right ventricular outflow tract fractional shortening was acquired with clinically acceptable intraobserver and interobserver reproducibility.

Conclusions: Right ventricular outflow tract fractional shortening is a novel, easy applicable, and repeatable index for evaluating RV systolic function. Studies comparing this index with common echocardiographic indices used to assess RV function in dogs are needed.

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Abbreviations

ACVIM	American College of Veterinary Internal Medicine
LA	left atrium/left atrial
LA:Ao	left-atrial-to-aortic ratio
MMVD	myxomatous mitral valve disease
PH	pulmonary hypertension
RV	right ventricle/right ventricular
RVOTED	right ventricular outflow tract dimension in end diastole
RVOTES	right ventricular outflow tract dimension in end systole
RVOT-FS	right ventricular outflow tract fractional shortening
TAPSE	tricuspid annular plane systolic excursion
TR	tricuspid regurgitation

Introduction

Evaluation of the right ventricle (RV) has recently garnered attention of veterinary cardiologists [1–8]. Improvements in cardiac imaging now allow more detailed qualitative and quantitative evaluation of the RV. In humans, analysis of RV morphology and function can help predict clinical status and survival in primary right heart diseases [9] and in secondary pathological processes, including pulmonary hypertension (PH) [10,11] and left heart disorders [12–14].

Assessment of RV function is more difficult than that of left ventricular function because of its complex (nonelliptical) geometry, which defies simple mathematical modeling. The RV appears to

be triangular in the longitudinal plane and crescent-shaped in transverse plane; it is anatomically subdivided into the inflow tract, infundibulum (outflow tract), and apex [15,16]. The endocardial surface has prominent trabeculae that complicate the geometry. Furthermore, marked load dependence of most indices of RV function pose substantial limits in the assessment of function [17].

Echocardiography represents the most practical, noninvasive, and readily available diagnostic tool for assessing RV morphology and function. Most of the proposed echocardiographic indices of RV function in the dog assess the RV inflow and apical regions and exclude assessment of the RV outflow tract (RVOT). In humans, some studies have described RVOT fractional shortening (RVOT-FS) as a noninvasive and easily applicable echocardiographic index of RV systolic function [18–22]. This echocardiographic index has been shown to correlate with PH more than tricuspid annular plane systolic excursion (TAPSE) [22].

Investigators have reported the reference intervals and repeatability of echo-derived indices of RV function in conscious healthy dogs [5,7]. Several indices of RV function have been investigated in dogs with PH and arrhythmogenic RV cardiomyopathy [8,23–26]. Echocardiographic indices of RV function include TAPSE, fractional area change, tissue Doppler imaging–derived systolic myocardial velocity of the lateral tricuspid annulus and RV longitudinal strain and strain rate. Recently, investigators demonstrated that RV function in dogs with myxomatous mitral valve disease (MMVD) differs between stages of MMVD [1–3]. Furthermore, investigators have proposed the RV Tei index as a predictive index of cardiac-related death in dogs with advanced MMVD [27].

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