Study on right ventricular morphology and function evaluated by right heart catheterization and echocardiography in dogs

Abstract of Doctoral Thesis

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With recent academic and technological advances in veterinary medicine, many veterinarians have increased opportunities to diagnose pulmonary hypertension (PH), a life-threatening disease that induces right ventricular (RV) pressure overload. Therefore, the evaluation of the right heart system has received increased attention. Currently, echocardiography is the most common modality to evaluate the right heart system. However, few studies have compared RV morphological and functional indices obtained by echocardiography and right heart catheterization in dogs, although right heart catheterization is a gold standard for evaluating RV function. Therefore, this study aimed to evaluate RV morphology and function obtained using right heart catheterization and echocardiography in dogs under varying loading conditions.

First, we observed the changes in various echocardiographic RV indices associated with the increase in pulmonary arterial pressure in dogs experimentally induced chronic embolic PH. In this study, two-dimensional speckle tracking echocardiography (2D-STE)-derived RV longitudinal strain and strain rate (RV-SL and RV-SrL, respectively) could reflect the RV adaptation mechanism against RV afterload, which conventional RV functional indices could not detect.

Second, we investigated the influence of changes in venous return, respiration, and heart rate on RV morphological and functional indices obtained by right heart catheterization and echocardiography in anesthetized healthy dogs. In these studies, some dissociations were observed between RV pressure-volume loop-derived RV functional variables and conventional echocardiographic variables including tricuspid annular plane systolic excursion (TAPSE). Whereas, 2D-STE- and three-dimensional echocardiography-derived RV functional variables showed significant association with end-systolic elastance (Ees), an indicator of load-independent myocardial contractility, and the ratio of Ees to effective arterial elastance (Ees/Ea), an indicator of ventricular-arterial coupling.

Finally, we evaluated the RV myocardial function using 2D-STE and investigated the clinical utility of TAPSE normalized by RV size indicators and pulmonary vascular resistance estimated by echocardiography in dogs with myxomatous mitral valve disease, the most common cardiac disease and the most common cause of

PH. In these studies, 2D-STE-derived RV-SL and RV-SrL revealed that RV function, not only systolic function but also diastolic function, was activated to adapt the mild to moderate PH, but was impaired in severe PH due to the maladaptation to severe and chronic RV pressure overload. Additionally, TAPSE normalized by RV size indicators and PVRecho might be additional tools to evaluate RV function considering RV loading conditions.

Consequently, loading conditions changed by venous return, respiration, and heart rate might complicate the evaluation of RV morphology and function assessed by echocardiography. Whereas, 2D-STE-derived RV-SL and RV-SrL, real-time three-dimensional echocardiographic variables, TAPSE normalized by RV size indicators, and PVRecho might be useful indicators that reflect RV myocardial contractility (Ees) and RV‐pulmonary arterial coupling (Ees/Ea) non-invasively.