EVALUATION OF CARDIAC OUTPUT BY USING MODIFIED SIMSON (2D) *VERSUS* TEICHOLZ (M-mode) ECHOCARDIOGRAPHY METHODS IN DOGS

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INTRODUCTION: An accurate assessment of left ventricular (LV) systolic function is of central importance to the diagnosis and management of heart disease. Currently two echocardiography methods are most often used for the assessment of ventricular function in veterinary medicine – Teicholz and modified Simpson's method of discs (SMOD). Teicholz method uses M-mode echocardiographic measurements for calculation of left ventricular volumes and cardiac output. The Teicholz formulas for systolic and diastolic volumes are widely used, as they calculate LV volume using only LV dimension, but its accuracy depends on the accuracy of geometric assumptions about LV shape that may assess geometric changes occurring in diseases such as Dilated Cardiomyopathy (DCM) less accurately. Accordingly, the American Society of Echocardiography (ASE) recommends not to use linear measurements to calculate LV volumes and EF for clinic practice. The most commonly used 2D measurement for volume measurements in human beings is the biplane Simpson's method of discs (SMOD), currently the recommended method of choice according to the ASE. Using SMOD heart volume is measured as the summation of parallel cylinders, whose diameters are derived from endocardial border tracing performed on 1 or 2 orthogonal LV apical views. The objective of this study is to compare technical aspects of these two methods on dogs of different breeds and varying body sizes.

MATERIALS AND METHODS: 10 clinically healthy adult dogs of different breeds and sizes were examined. Echocardiography was performed on manually restrained dogs in right lateral positions using Phillips HD11 ultrasound system equipped with 5.0/8.0 and 2.0/4.0 MHz probes with simultaneous ECG recording by the ultrasound machine. All valves were examined by color-Doppler and velocities over the aortic and pulmonary valves were measured by continuous wave Doppler examinations to exclude congenital or acquired cardiac disease. For Teicholz method, M-mode measurements were obtained from the right parasternal short-axis view from the left LV short-axis slice just basal to the papillary muscle tips at end-diastole and end-systole. SMOD measurements were done on the right parasternal long-axis 4-chamber view. Frame-by-frame analysis was performed, with selection of end diastolic frames (corresponding to onset of QRS, i.e., at the time of mitral valve closure) and end-systolic frames (corresponding to the last frame before mitral valve opening). The LV area was measured by tracing the endocardial border on each selected image. All measurements were repeated three times and mean values were calculated. LV volumes and CO (l/min) were then automatically calculated by the ultrasound machine. SMOD and Teicholz derived CO volumes were indexed to BW (l/min/kg). Statistical analysis was performed using SPSS 20.0 computer software.

RESULTS: The present study showed that there was no significant difference between the measurement of cardiac output (CO) obtained by SMOD and Teicholz ($P>0.05$). SMOD is a more time consuming method than Teicholz. For 2D LV volume measurements it is important to optimize the right parasternal long-axis 4 chamber view in order to include the anatomical LV apex, which occasionally might be technically challenging. There are two main factors

that can influence image quality – the experience of echocardiographer and the conformation of the canine thorax. M-mode measurements for Teicholz method are technically less demanding even for a less experienced echocardiographer on dogs of varying breeds and sizes.

CONCLUSIONS: This study shows that both methods - SMOD and Teicholz can be used for noninvasive measurement of cardiac output in dogs. Teicholz method for evaluation of this parameter is more convenient and easier to perform in practice.