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COMPARATIVE ECHOCARDIOGRAPHIC STUDIES OF DOGS WITH MIXOMATOUS DEGENERATION OF THE MITRAL VALVE, DEPENDENT ON THE PRESENCE OR ABSENCE OF PULMONARY EDEMA, CONSECUTIVELY INDEXED BY THE LINEAR AND WEIGHT IDEALIZING AORTIC SIZE

Atanas Pankov

University of Forestry, Faculty of Veterinary Medicine, Sofia, Bulgaria
E-mail: pannkov@abv.bg

ABSTRACT

Echocardiographic dimensions of 20 dogs with myxomatous degeneration of the mitral valve were compared in this paper. The patients were decided into two groups depending on the presence or absence of pulmonary edema. ERIs were obtained after consecutive indexing of Aom and Aow. In the indexing of Aom we received significant differences for aLA***, aLVODd** and aΔA**. In the indexing of Aow we received significant differences for more ERIs (wLA***, wLVODd**, wLVODs*, wΔA** and wWAd*).

Key words: dogs, mitral, mixomatous, degeneration, echocardiographic.

Introduction

Many authors consider the mitral valve disease (MVD) the most common heart disease in small dog breeds (5, 6, 7). This disease is also the most common cause of heart failure in this species (4).

Echocardiography is the primary method in the diagnosis of cardiac disorders. The problem with this method of testing is the different size of the animals in the dog population and the different size of the cardiac structures. In this connection, in 2003 a new method for quantitative echocardiographic interpretation based on the calculation of the ratios, where each unprocessed measurement in M-mode is divided by the size of the aortic root (Ao) was introduced. "Aortic based" indices are calculated using the aortic root (Aom) as a standard for length. Furthermore, the authors offer "weight based" indices, representing an idealized assessment of the aortic size (Aow), where Aow = KxW1/3. The use of these indexes bypasses the unwanted statistical characteristics typical for the linear regression of the echocardiographic measurements compared to the body weight and, to a lesser extent, to the body surface (2). Compared to the regressions, the ratios led to a significant improvement of the predictable range for any M-mode measurements in dogs, particularly with reducing the body size.

The same authors in 2005, carried out a comparative study on M-mode echocardiographic indices (ERIs) in dogs with mitral regurgitation due to chronic valvular disease (CVD / MR), about the ability of these ratios to discriminate and quantitatively connect echocardiographic changes. They determined that one M-Mode ERI index (WΔA), designed to express by weight the normalized short-axised impact area, is sensitive (90%) and specific (98%) in establishing a difference between normal and CVD / MR dogs. Predicting the left-sided heart failure within the group of CVD / MR is more problematic, but the ERI expressed size of the left atrium (WLA) showed 76% sensitivity and 81% specificity in this regard. Their study of echocardiographic models of pathology associated with CVD / MR determined as ERI, are sensitive and specific for CVD / MR and LSHF. Based on the results they claim that ERI normalizes the echocardiographic data regarding body size in dogs and are suitable for quantitative description and analysis (1).

There is considerable debate on the existence of a linear relationship between echocardiographic measurements and body size. In M-mode and 2D images, the size of the LA is often indexed to the aortic diameter at the level of the aortic cusps because of the lightness of the image and the assumption that in the cases of the most common heart diseases the aortic size does not change significantly, which determines this ratio as a relatively independent internal index which is a better reflector of the body frame (skeleton) compared to the body weight (3). The aortic diameter is less likely to change over time in comparison to the body weight, which makes the ratios based on it, probably, more accurate at tracing the development of heart disease in the individual animals over an extended period of time.

Purpose of the study

To make a comparison between the weight indexed and linearly indexed M-mode echocardiographic indices (ERIs) in dogs with mitral regurgitation due to chronic valvular disease (CVD / MR), regarding the ability of these ratios to identify and quantitatively bind echocardiographic changes with cardiac decompensation.

Material and methods

To achieve the objective the dogs with leftward apical systolic murmur had X-rays and ultrasound done. Based on the results obtained, they were divided into two groups. First group - dogs with MVD without pulmonary edema, and the second group – MVD dogs with pulmonary edema.

The ultrasonographic examination was performed with the apparatus My Lab 70 vet XV (the most modern veterinary Doppler apparatus of the Italian company Esaote – one of the leaders in the design and manufacture of ultrasonic systems and software for veterinary medicine in Europe). The patients were examined with specialized cardiac phasometric transducers PA023E (at a frequency of 4-11MHz) and PA122E (with a frequency of 3–7 MHz) suitable for small dog breed cardiac patients in a right-sided parasternal position. The patients were examined in the right-sided parasternal sections - longitudinal (long axis) and transverse (short axis).

The chest radiographs were made with a direct digital radiography (DR X-ray system) in LLR (left lateral), and VD (ventro-dorsal) projections.

The patients were divided into two groups depending on the presence or absence of a radiographically established pulmonary effusion.

M-mode echocardiographic indices (ERIs) of the dogs were obtained from the raw echocardiographic measurements. They were calculated by the formulas of Brown D.J. et al., (2003), in which in order to allow the comparison of patients with different sizes, they are indexed first by the aortic size (AOm), and then in terms of the weight idealized aortic size (AOw).

The statistical processing was carried out with the program StatMost.

Results

Standardized, statistically summarized, linearly indexed by Aom data from Table 1 of dogs with MVD without pulmonary edema were compared to dogs with MVD with pulmonary edema. In the table the mean values and the standard deviation of the studied ratios are shown. Then the same was done in regard to the echocardiographic M-mode measurements, but indexed to the weight idealized aortic size (Table 2), and, finally, the values from the two different types of indexing were compared.

Table 1: Statistics – linearly based (Aom) derivatives

Indicator	Without pulmonary edema n = 9		With pulmonary edema n = 11		Accuracy
	mean	SD	mean	SD	
aLA	1.4209	0.3100	2.1054	0.3554	0.0003***
aLVODd	2.9112	0.4602	3.4815	0.3038	0.0037**
aWTd	1.0024	0.1505	0.9993	0.2003	0.9691
aLVODs	2.6216	0.4323	2.8437	0.2823	0.1829
aWTs	1.6529	0.5313	1.5488	0.2415	0.5673
aΔA	2.8678	1.0590	4.5446	1.4493	0.0097**
aWAd	5.0997	1.2979	5.8778	0.8374	0.1220
aWAs	5.6990	1.6060	6.3771	1.2489	0.3017

a – Aorta-Based; aLA – Index of left atrial dimension; aLVODd – Index of left ventricular outer dimension, diastole; aWTd – Index of combined septal and left ventricular wall thickness, diastole; aLVODs - Index of left ventricular outer dimension, systole aWTs - Index of combined septal and left ventricular wall thickness, systole; aΔA – Index of change in left ventricular internal area (ie, short-axis stroke area); aWAd – Index of left ventricular short-axis myocardial wall area, diastole; aWAs - Index of left ventricular short-axis myocardial wall area, systole (Brown D.J. et al., 2003).

Table 2: Statistics – weight based (Aow) derivatives

Indicator	Without pulmonary edema n = 9		With pulmonary edema n = 11		Accuracy
	mean	SD	mean	SD	
wLA	1.4273	0.2555	2.1237	0.2715	1.511E-005***
wLVODd	3.0237	0.3169	3.5308	0.2952	0.0016**
wWTd	1.0132	0.1399	1.0114	0.1971	0.9813
wLVODs	2.6284	0.2655	2.9327	0.2855	0.0250*
wWTs	1.5087	0.2224	1.5575	0.2212	0.6304
wΔA	2.8306	0.7971	4.7611	1.4701	0.0024**
wWAd	5.1100	0.9789	6.0173	0.6106	0.0206*
wWAs	5.6812	1.1607	6.5494	1.1332	0.1090

w – Weight-Based; wLA – Index of left atrial dimension; wLVODd – Index of left ventricular outer dimension, diastole; wWTd – Index of combined septal and left ventricular wall thickness, diastole; wLVODs – Index of left ventricular outer dimension, systole wWTs - Index of combined septal and left ventricular wall thickness, systole; wΔA – Index of change in left ventricular internal area (ie, short-axis stroke area); wWAd - Index of left ventricular short-axis myocardial wall area, diastole; wWAs - Index of left ventricular short-axis myocardial wall area, systole (Brown D.J. et al., 2003).

The mean value of the linearly indexed size of the left atrium (aLA) in the group without edema is (1.4209 ± 0.3100) which is statistically significantly (0.0003 ***) lower than the mean value in the group with edema (2.1054 ± 0.3554). When comparing the same dimentions but indexed by the weight idealized aortic size, very close mean values were obtained (1.4273 – in the group without edema and 2.1237 – group with edema), where the fact that the values of standard deviation are lower makes impression (0.2555 – in group without edema and 0.2715 – in the group with edema). Also, a higher accuracy (as an absolute value) between the group without edema and the group with edema indexed with this type of indexing (1.511E-005 ***) were obtained. The mean value of the diastolic linearly indexed left ventricular outer dimension (aLVODd) in the group without edema is (2.9112 ± 0.4602) which is statistically significantly (** 0.0037) lower than its mean value in the group with edema (3.4815 ± 0.3038). The mean value of the same dimensions, but weight indexed (wLVODd) in the group without edema is (3.0237 ± 0.3169) which is statistically significantly (** 0.0016) lower than the mean value in the group with edema (3.5308 ± 0.2952). As far as this indicator is concerned a higher accuracy was obtained, but only as an absolute value with the weight indexed dimensions in comparison to the linearly indexed dimensions. The mean value of the linearly indexed sum of the wall thicknesses of the septum and the left ventricle (aWTd) in the group without edema is (1.0024 ± 0.1505) which is statistically insignificantly (0.9691) higher compared to the mean value in the group with edema (0.9993 ± 0.2003). Similar values and lack of statistical significance (0.9691) were also obtained after the indexing of this dimension with the weight index.

The mean value of the systolic linearly indexed left ventricular outer dimension (aLVODs) in the group without edema is (2.6216 ± 0.4323) which is statistically insignificantly (0.1829) lower than the mean value in the group with edema (2.8437 ± 0.2823). The mean value of the same dimension, but weight indexed (wLVODs) in the group without edema is (2.6284 ± 0.2655) lower than the mean value in the group with edema (2.9327 ± 0.2855). For this indicator, in contrast with the linear indexing, there was a statistically significant difference (0.0250 *) when indexing the size by using the weight idealized aorta.

The mean systolic linearly indexed sum of the wall thicknesses of the septum and left ventricle (aWTs) in the group without edema is (1.6529 ± 0.5313) which is statistically insignificantly (0.5673) higher than the mean value in the group with edema (1.5488 ± 0.2415). Similar values and lack of statistical significance (0.6304) were obtained when indexing this dimension with the weight index as well. The mean value of linearly indexed short-axised impact area (aΔA) in the group without edema is (2.8678 ± 1.0590) which is statistically significantly (** 0.0097) lower in comparison to the mean value of the group with edema (4.5446 ± 1.4493). The mean value of the same size, but weight indexed was (2.8306 ± 0.7971) which is statistically significantly (** 0.0024) lower in comparison to the mean value of the group with edema (4.7611 ± 1.4701). For both types of indexing of the short-axised impact area (aΔA) results with similar values, standard deviation and statistical significance were obtained.

The mean value of the diastolic linearly indexed left ventricular myocardial short-axised wall area (aWAd) in the group without edema is (5.0997 ± 1.2979) which is statistically insignificantly (0.1220) lower than the mean value of the group with edema (5.8778 ± 0.8374). The mean value of the same dimension, but weight indexed (wWAd), in the group without edema is (5.1100 ± 0.9789) which is lower than the mean value in the group with edema (6.0173 ± 0.6106). For this indicator, in contrast with the linear indexing, there was a statistically significant difference (0.0206 *) when indexing the size with the weight idealized aorta.

The mean value of the systolic linearly indexed left ventricular short-axised myocardial wall area (aWAs) in the group without edema is (5.6990 ± 1.6060) which is statistically insignificantly (0.3017) lower than the mean value of the group with edema (6.3771 ± 1.2489). Similar values and lack of statistical significance (0.6304) were obtained with the indexing of this dimension with the weight idealized aorta.

Discussion

After concluding the results from both methods for indexing the M-mode echocardiographic measurements, it was found that the ratios measured based on the weight idealized aortic size are obtained with higher reliability in comparison to the results obtained with the indexing of the same dimensions with the linear aortic size. I suppose that the differences obtained in the two ways of compiling the ratios are due to the weight loss in patients, which is associated with the progression of the cardiac decompensation. Under these conditions the indexing of the raw echocardiographic dimensions and the lower body weight leads to higher values of the ratios and register of a higher reliability. The question that arises is – which is the more correct indexation? When developing a clean left-sided heart failure the isolated development of pulmonary edema cannot significantly affect the body weight. On the other hand, the real weight loss is another sign of the advancing heart disease and as such it should not be excluded when reporting the progression of the process.

Conclusions

1. Upon the indexing of the raw M-mode echocardiographic measurements with the weight idealized measured aortic size, the results obtained are with a higher reliability in comparison with the indexing of the same dimensions with the linear aortic size

2. Based on the reasoning in the discussion of the results, I believe that as far as the mixomatous valvular disease is concerned, the indexing of M-mode echocardiographic measurements with weight aortic size is more suitable in comparison to the indexing with the linear aortic size, where in the case of this indexing the weight loss with progression of the heart failure is also noted.

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