Evaluation of left atrium in two-dimensional and M-mode echocardiography in Brazilian boxer dogs

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Abstract

The Boxer dogs have high predisposition to show dilated cardiomyopathy (DC). Consequently the evaluation of the left atrium size is important to the assessment of the severity of this disease. In the present study, the aortic root (AO) and left atrium (LA) dimensions were evaluated using two-dimensional (2D) and M mode (M) echocardiography in 36 healthy Boxer dogs. There were used 18 males and 18 females, ranging from 1.5 to 6 years old. A statistically significant difference between the sexes was observed for AO-M, AO-2D, LA-M and LA-2D. A linear regression with body surface area was obtained for AO-M, AO-2D, LA-M and LA-2D. The LA/AO-2D ratio was 1.17 ± 0.11 (n=36) and the LA/AO-M ratio was 1.10 ± 0.11(n=36). The ratios evaluated in two-dimensional and M mode also didn’t differ between sexes in healthy Boxer dogs.

Key-words: Dogs, Boxer, echocardiography, Left atrium.

Introduction

The left atrium (LA) can become enlarged in size and mass attributable to both pressure and volume overload in various cardiac disease (Hansson et al., 2002). So, to identify and classify the degree heart disease is important to evaluate LA size (Haendcchen et al., 1982, Hansson et al., 2002, Muzzi et al., 2006).

Left atrial size can be determined using linear dimensions (Boon et al., 2002).
1983, Gonçalves et al., 2002) or various circumference, area or volume calculations (Rishniw and Erb, 2000). The dimensions of LA and the aorta root (AO) have been used to calculate an LA/AO ratio, producing an index for LA size. The application of this ratio is better than using LA dimensions normalized to body weight or body surface area, because the AO is an internal reference and was not likely to become enlarged as a result of common forms of cardiac disease (Brown et al., 1974, Boon et al., 1983).

The determination of reference values for each breed is crucial in improving the accuracy of echocardiographic diagnosis and breed specific data are needed to obtain the more narrow reference ranges (Crippa et al., 1992, Dukes-McEwan et al., 2002). The Boxers dogs were predisposed to present dilated cardiomyopathy (Tidholm et al., 1997), aortic stenosis and pulmonary stenosis (Boon, 1998). In the present study, the LA/AO index was evaluated using the two dimensional and M modes in males and females healthy Boxer dogs.

Materials and Methods

A total of 36 Boxer dogs (18 males and 18 females) were used in the study. The dogs were clinically healthy, with ages ranging from one and a half to six years old, and mean weights of 27.18 kg ± 4.28. Body weight (Wt; grams) was recorded, and the body surface area (BSA; metres²) calculated from the following formula: BSA=10.1xWt0.667x10^-4. The experimental protocol had the approval of the Institutional Ethical Committee at the Federal University of Minas Gerais.

Each dog was submitted to physical and electrocardiographic (ECG) examinations, non-invasive blood pressure (BP) evaluation and routine echocardiographic exams using a 5Mhz probe¹. At the level of left distal tibia, the systolic, the diastolic and the mean BP were measured using an oscillometric blood pressure monitor². ECG examinations were performed according to standard techniques (Kittleson, 1998, Tilley, 2000).

The LA and AO were measured in M-mode (LA-M, AO-M) using a short axis view at the aortic valve level. The AO diameter was measured on the time of electrocardiography Q wave and the LA size was measured on the time of electrocardiography T wave (Lombard, 1984). Afterwards the LA/AO-M ratio was calculated (Figure 1A).

In two-dimensional (2D), the diameters of LA and AO were measured similarly to previous study (Rishniw and Erb, 2000). It was measured the internal short-axis diameter of aorta (AO-2D) along the commissure between

¹ Toshiba SSH-140, Toshiba Corporation, Tokyo, Japan.
² DX 2010, Dixtal biomédica, Manaus, Amazonas, Brazil.
the noncoronary and right coronary aortic valve cusps on the time of electrocardiography Q wave. The measuring of internal short-axis diameter of the left atrium (LA-2D) in a line extending from the commissure between the noncoronary and left coronary aortic valve cusps to the distant margin of the left atrium on the time of electrocardiography T wave. In images where a pulmonary vein was seen entering the left atrium at this caudolateral location, the edge of the LA was approximated by extending the visible edges of the left atrium in a curved fashion (Figure 1B). Afterwards the LA/AO-2D ratio was calculated.

**Figure 1:** The measurement of aortic root (between yellow arrows) and left atrium (between green arrows) made from M-mode echocardiography (A) and two-dimensional echocardiography (B) in the right parasternal short axis view is showed. Note the measured structures values inside the correspondent color ellipses. See text for details.

The ECG examinations were monitored and all results were recorded on VHS tapes for retrospective analyses.

Linear regression analyses (F-test) were calculated with the sexes, both combined and separated between all echocardiographic parameters and BSA. When the regression was found to be statistically significant at the 5% level, the equation of linear regression of BSA on the echocardiographic parameter was calculated. The Student’s t-test was used to compare the mean values between males and female and to set the significant level (5%). Hence, the data was described as the mean ± standard deviation (S.D.).
Results

Means values as well as all echocardiographic parameters and BSA, separately for males and females, are compiled in Table 1.

**Table 1.** Boxer Dogs Echocardiographic Measurements and Body Surface area with Regard to Gender.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>LA-2D (mm)</td>
<td>23.3 ± 2.3</td>
<td>20.6 ± 2.5</td>
</tr>
<tr>
<td>AO-2D (mm)</td>
<td>19.8 ± 1.6</td>
<td>17.6 ± 1.3</td>
</tr>
<tr>
<td>LA/AO-2D</td>
<td>1.18 ± 0.10</td>
<td>1.17 ± 0.13</td>
</tr>
<tr>
<td>LA-M (mm)</td>
<td>26.3 ± 2.06</td>
<td>23.4 ± 1.54</td>
</tr>
<tr>
<td>AO-M (mm)</td>
<td>23.8 ± 2.51</td>
<td>21.6 ± 1.56</td>
</tr>
<tr>
<td>LA/AO-M</td>
<td>1.11 ± 0.12</td>
<td>1.09 ± 0.11</td>
</tr>
<tr>
<td>BSA (m²)</td>
<td>0.97 ± 0.08</td>
<td>0.85 ± 0.07</td>
</tr>
</tbody>
</table>

*Different capital letters to same column represent difference (P<0.05). LA-2D, left atrium measured on a two-dimensional image; AO-2D, aorta measured on a two-dimensional image; LA/AO-2D, ratio between left atrium and aorta measured on a two-dimensional image expressed as an index; LA-M, left atrium measured in M-mode; AO-M, aorta measured in M-mode; LA/AO-M, ratio between left atrium and aorta measured in M-mode expressed as an index; BSA, body surface area in m²; S.D., standard deviation.

The linear regressions between echocardiographic indices and BSA are illustrated in Table 2.

**Table 2.** Effect of body surface area on echocardiographic parameters.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Regression equation</th>
<th>R²</th>
<th>Adjusted R²</th>
</tr>
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<tbody>
<tr>
<td>LA-M</td>
<td>13.225 + 12.812 x BSA</td>
<td>0.28**</td>
<td>0.26**</td>
</tr>
<tr>
<td>AO-M</td>
<td>11.560 + 12.209 x BSA</td>
<td>0.25**</td>
<td>0.23**</td>
</tr>
<tr>
<td>LA-2D</td>
<td>9.722 + 13.456 x BSA</td>
<td>0.23**</td>
<td>0.20**</td>
</tr>
<tr>
<td>AO-2D</td>
<td>11.125 + 8.359 x BSA</td>
<td>0.19**</td>
<td>0.16**</td>
</tr>
</tbody>
</table>

*Different capital letters to same column represent difference (P<0.05). LA-2D, left atrium measured on a two-dimensional image; AO-2D, aorta measured on a two-dimensional image; LA-M, left atrium measured in M-mode; AO-M, aorta measured in M-mode; LA/AO-2D, ratio between left atrium and aorta measured on a two-dimensional image; LA/AO-M, ratio between left atrium and aorta measured in M-mode.

The BSA of male dogs (0.97 ± 0.08) was higher than for female dogs (0.85 ± 0.07), this difference was statistically significant (P<0.05).

The LA/AO-2D and LA/AO-M indexes were similar in males and females. The linear regression analysis also no indicated a significant correlation between LA/AO-2D or LA/AO-M indexes and BSA.

The LA-2D, LA-M, AO-2D and AO-M were higher in males than in females (P<0.05) and the regression analysis indicated a significant positive correlation between these parameters and BSA. Adjusted correlation coefficient values ranged from 0.16 to 0.26.
Discussion

Evaluation of left-heart disease always includes assessment of the size of the left atrium (Boon et al., 1983), and this evaluation can be determined using 2D or M-mode by echocardiography (Rishniw and Erb, 2000, Hansson et al., 2002).

The most important difference between the 2D and the M-mode method is that the M-mode cursor often transects the left auricle (rather than the body of the left atrium) in dogs because of different positioning of the heart compared to humans. Thus, previous investigators might sometimes have inadvertently compared the size of the left auricle and not the left atrium to the aorta (Figure 2); In normal dogs, the LA/AO-M would be expected to be smaller than LA/AO-2D (Hansson et al., 2002).

Figure 2: The measurement of aortic root and left atrium made from M-mode echocardiography. The standard M-mode cursor position (yellow line) for measuring aortic root diameter usually transects the left atrium (LA) near its auricle, therefore underestimating true LA size.

In our study, 100% of the dogs had LA/AO-2D < 1.4 (Table 1), and the mean LA/AO-2D was 1.17. It was apparently lower than others studies in different breeds (Rishniw and Erb, 2000), normal English Bull Terriers
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Most of the echocardiographic study (Rishniw and Erb, 2000, Hansson et al., 2002) measured the LA-2D and AO-2D on the 1st frame rate after aortic valve closure. In the present study, we do the measurements of LA-2D (at systole) and AO-2D (at diastole) with electrocardiographic parameters. The measurements in this study were similar to another work (Rishniw and Erb, 2000), which evaluated different breeds of dogs and obtained mean LA/AO-2D to 1.31.

In another study (Hansson et al., 2002), it was compared the LA/AO-2D ratio and LA/AO-M in 56 normal dogs and 110 dogs with mitral regurgitation. No difference was seen between M-mode and 2D derived LA/AO indices in normal dogs (1.01±0.13 and 1.03±0.09). However, in dogs with mitral regurgitation, the LA/AO-2D (1.61±0.57) was significantly greater than the LA/AO-M (1.42±0.51), so the 2D index is more sensitive to LA enlargement than the M-mode index.

In the present study, the dogs had LA/AO-M of 1.10±0.11, within the expect range of 0.8-1.3 (Bonagura, 1983, Lombard, 1984), but are slightly larger than cavalier King Charles spaniels (1.01±0.13) (Hansson et al., 2002), German Shepherd dogs (0.9±0.08) (Kayar et al., 2006); (0.97±0.09) (Muzzi et al., 2006), and in studies with different breeds (Lombard, 1984).

In our study the echocardiographic measurements were little significantly correlated with BSA (Table 2), in agreement with a previous work (Crippa et al., 1992), but frequently this correlation varies (Gonçalves et al., 2002, Kayar et al., 2006). These results suggest the existence of cardiac morphological and functional homogeneity for this breed and age without any precise relation with body weight.

In agreement with this study, previous investigators (Lombard, 1984, Rishniw and Erb, 2000) demonstrated that no correlation occurred between LA/AO ratio and bodyweight, suggesting that this measurement is independent of body weight.

In conclusion, the male dogs in the present study had BSA, LA-M, LA-2D, AO-M and AO-2D larger than females, and the LA/AO-M and LA/AO-2D wasn’t influenced by gender.
Acknowledgment
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References