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Radiographic Measurement of Cardiac Size in 27 Rabbits

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ABSTRACT. Right lateral position (RL) chest radiograms were obtained from 27 heart disease-free rabbits, and cardiac sizes were compared according to body weight (<1.6 vs. ≥1.6 kg) and gender (female vs. male). Significant differences (P<0.05) were observed in RL-long axis (RL-LA) and RL-vertebral heart size (RL-VHS). RL-LA was 4.22 ± 0.25 and 4.48 ± 0.3 cm, and RL-VHS was 7.55 ± 0.38 and 7.99 ± 0.58, in the <1.6 kg (n=12) and ≥1.6 kg (n=15) groups, respectively. These values should prove useful as new diagnostic indices for cardiac disease in rabbits.

KEY WORDS: heart, rabbit, radiography.


Cardiac diseases are highly emergent events among exotic animals, not only in the ferret, which is prone to such diseases, but also in the rabbit (Ocyctolagus cuniculus). Imaging studies for definitive diagnosis before treatment are therefore important [4]. Chest radiography is easier to perform than echocardiography. Cardiac size is evaluated primarily using vertebral heart size (VHS) as reported by Buchanan et al. [1]. However, while some reports have described the evaluation of cardiac size using VHS in ferrets [3, 5], none have provided similar information for rabbits. We therefore attempted to determine standard cardiac dimensions in the rabbit using VHS.

This study used 27 heart disease-free rabbits (no duplications) that were brought to Onuma Animal Hospital for the purpose of consultation or health examination between August 2008 and July 2009. In all rabbits, chest radiography (no sedation/on inhalation) was performed using a KXO-12 diagnostic x-ray apparatus (Toshiba, Tokyo, Japan). Imaging conditions were 60 kVp and 100 mA. Cardiac size was then measured on X-ray films. In addition to cardiac size, data concerning age, gender, body weight, and breed of the rabbits used for the study were collected.

Since ventrodorsal position (VD) was difficult to measure in many animals, only right lateral position (RL) dimensions of the heart were evaluated in this study. Long axis (RL-LA), short axis (RL-SA), and VHS (RL-VHS) were measured and compared according to body weight and gender (female vs. male). Animals were divided into 2 groups (<1.6 vs. ≥1.6 kg) by body weight based on the median weight (1.6 kg) of all animals. VHS (n) was expressed as the number of vertebrae corresponding to the length of the LA (cm) and SA (cm) from the cephalic margin of the 4th thoracic vertebra, as described by Buchanan et al. [1] (Fig 1).

Fig. 1. Right lateral position (RL) radiographic view of a normal rabbit thorax. Radiographic view indicates measurement axes for the cardiac silhouette. LA, long axis; SA, short axis. Vertebral heart size (n) = LA (n) + SA (n).

Fig. 2. Schematic diagram of the measurement of vertebral heart size (n).

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Table 1: Characterization of the rabbits (n).

Mean age was 4.83 years (range, 0.67–9 years; SD, 2.52 years) in females and 5.25 years (range, 0.75–9 years; SD, 2.87 years) in males. Mean body weight was 1.74 kg (range, 1.2–2.7 kg; SD, 0.42 kg) in females and 1.5 kg (range, 1–2.3 kg; SD, 0.37 kg) in males (Table 1).

Table 2 shows values obtained from radiographic measurement items and classified by gender (16 females; 11 males), and subdivided by body weight (<1.6 kg vs. ≥1.6 kg). In addition, each value of radiographic measurement items is classified by body weight (<1.6 kg vs. ≥1.6 kg) or gender in Table 3.

For female animals, mean RL-LA (n) was 4.23 ± 0.31
For male animals, mean RL-LA (n) was 4.68 ± 0.13 (n=4; range, 4.5–4.8), RL-SA (n) was 3.63 ± 0.1 (n=4; range, 3.5–3.7), and RL-VHS (n) was 8.3 ± 0.22 (n=4; range, 8–8.5) in the ≥1.6 kg group, showing significant differences (all; *P<0.01)(Table 2).

According to body weight, mean RL-LA (n) was 4.22 ± 0.25 (n=12; range, 3.7–4.6) in the <1.6 kg group and 4.48 ± 0.3 (n=15; range, 4.8–4.8) in the ≥1.6 kg group, showing a significant difference (*P=0.05).

All data counted thoracic vertebrae corresponding to the length of the fourth thoracic vertebra on the cephalic side. RL, right-lateral position; LA, long axis; SA, short axis; VHS, vertebral heart size; SD, standard deviation; Max, maximum; Min, minimum. Significance between radiographic measurements and body weight (<1.6 kg vs. ≥1.6 kg) in each group (*P<0.05).

(n=5; range, 3.7–4.6), RL-SA (n) was 3.52 ± 0.2 (n=5; range, 3.2–3.8), and RL-VHS (n) was 7.75 ± 0.46 (n=5; range, 6.9–8.1) in the <1.6 kg group and mean RL-LA (n) was 4.4 ± 0.32 (n=11; range, 4–4.8), RL-SA (n) was 3.46 ± 0.35 (n=11; range, 3–4), and RL-VHS(n) was 7.86 ± 0.64 (n=11; range, 7–8.8) in the ≥1.6 kg group, showing no significant difference (P=0.33, 0.72, 0.72).

For male animals, mean RL-LA (n) was 4.2 ± 0.22 (n=7; range, 4–4.5), RL-SA (n) was 3.17 ± 0.13 (n=7; range, 3–3.4), and RL-VHS (n) was 7.37 ± 0.2 (n=7; range, 7.2–7.7) in the <1.6 kg group and mean RL-LA (n) was 4.68 ± 0.13 (n=4; range, 4.5–4.8), RL-SA (n) was 3.63 ± 0.1 (n=4; range, 3.5–3.7), and RL-VHS (n) was 8.3 ± 0.22 (n=4; range, 8–8.5) in the ≥1.6 kg group, showing significant differences (all; *P<0.01)(Table 2).

According to body weight, mean RL-LA (n) was 4.22 ± 0.25 (n=12; range, 3.7–4.6) in the <1.6 kg group and 4.48 ± 0.3 (n=15; range, 4.8–4.8) in the ≥1.6 kg group, showing a significant difference (*P=0.05). Mean RL-SA (n) was 3.33 ± 0.24 (n=12; range, 3–3.8) in the <1.6 kg group and 3.51 ±
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0.3 (n=16; range, 3–4) in the ≥1.6 kg group, showing no significant difference (P=0.107). Mean RL-VHS (n) was 7.55 ± 0.38 (n=12; range, 6.9–8.1) in the <1.6 kg group and 7.99 ± 0.58 (n=16; range, 7–8.8) in the ≥1.6 kg group, showing significant difference (P=0.029).

According to gender, mean RL-LA (n) was 4.34 ± 0.32 (n=16; range, 3.7–4.8) in females and 4.37 ± 0.3 (n=11; range, 4–4.8) in males, showing no significant difference (P=0.776). Mean RL-SA (n) was 3.48 ± 0.29 (n=16; range, 3–4) in females and 3.34 ± 0.25 (n=11; range, 3–3.7) in males, again with no significant difference (P=0.197). Mean RL-VHS (n) was 7.82 ± 0.56 (n=16; range, 6.9–8.8) in females and 7.71 ± 0.51 (n=11; range, 7.2–8.5) in males, with no significant difference (P=0.609) (Table 3).

Significant differences (P<0.05) were observed in males according to body weight (<1.6 kg vs. ≥1.6 kg) and RL-LA and RL-VHS according to body weight. The reference of RL-VHS was compared with body weight to confirm whether a significant difference was apparent, but no correlation was found (Fig. 2).

Various reports have described cardiomyopathy, valvulopathy, endocarditis, and ventricular septal defect among cardiac diseases in rabbits, and these diseases have been evaluated by auscultation of heart murmurs, echocardiography, or electrocardiography [2, 4]. Since the rabbit has a narrow thoracic cavity compared with other mammals and a large heart relative to the thoracic cavity even in a normal state, special evaluation criteria are necessary. In particular, chest radiography provides important information concerning cardiac dilation. In rabbits, however, evaluation criteria based on VHS as a common index of cardiac dilation have yet to determined, enhancing the clinical significance of this study.

In this study, 27 rabbits without diseases affecting the heart were examined by chest radiography. Since measurement was difficult in more than half of the animals in the VD because of soft tissue shadows on the cephalic side of the heart (residual thymus or intrapleural fat), evaluation was made only using the RL, and the results were compared according to body weight (<1.6 vs. ≥1.6 kg) and gender (female vs. male). While no significant differences were noted in RL-SA according to body weight or in any item of measurement according to gender, significant differences (P<0.05) were observed in RL-LA and RL-VHS according to body weight. Our results in females appeared inconsistent with this classification, as significant differences with body weight (<1.6 kg vs. ≥1.6 kg) were only observed in males. RL-LA of 4.22 ± 0.25 in the <1.6 kg group and 4.48 ± 0.3 in the ≥1.6 kg group and an RL-VHS of 7.55 ± 0.38 in the <1.6 kg group and 7.99 ± 0.58 in the ≥1.6 kg group were thus suggested as useful evaluation criteria for cardiac dilation.

As observed above, among the items that showed significant differences, RL-VHS in particular should be added as a new item of measurement for predicting cardiac function in rabbits, as well as in dogs and ferrets. We will accumulate more cases of cardiac disease and evaluate the criteria derived from this study.

REFERENCES