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Research Article

Normal echocardiographic findings in Lori-Bakhtiari sheep

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Abstract. Aim: The assessment of heart parameters in healthy animals for evaluation of heart structure, function and cardiovascular disease are necessary and important. Material and method: In this study 20 healthy Lori-Bakhtiari sheep (ten males and ten females) of one year age and weights 42±3 kg were selected. The echocardiography was done in 4th and 5th intercostal spaces in the longitudinal and transverse views. Results: The values obtained are: the left ventricular internal diameter at end systole and end diastole was 1.50 and 2.70 cm, respectively; left ventricular free wall at end systole and end diastole was 1.69 and 0.93 cm, respectively; inter ventricular septum at end systole and end diastole was 1.45 and 0.92 cm, respectively; the right ventricular at end systole and end diastole was 1.28 and 2.94 cm, respectively; the aortic root was 2.03 cm; left atrial was 1.58 cm; the gap between mitral valve to septal ventricular end-diastole was 0.68 cm; the stroke volume was 27.24 mL, and fractional shortening of heart was 56.29%. In addition, relationship between genders with any of the measured parameters was statistically evaluated and calculated. Significant difference was observed between gender and size of the right ventricular at end systole, size of the left ventricle at end systole, size of the left ventricular free wall at end diastole, size of the left atrial and volume of right ventricular at end diastole was observed in males and females ($p \leq 0.05$). Conclusion: The data collected in this study provide reference values for the evaluation of Lori-Bakhtiari sheep

Key Words: heart structure, gender, heart, cardiovascular disease.

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Introduction

Echocardiography or cardiac ultrasonography is currently considered an important non-invasive diagnostic technique for evaluating structural and functional values of the cardio-vascular system, heart chamber size, wall thickness and motion, anatomy and movement of the valves, great vessels and pericardium, being a useful technique for diagnosing cardiovascular disease in animals (Amory et al 1991). This harmless technique is particularly suitable when is repeated and frequent measurements are required for research or clinical purposes (Amory et al 1992; Crippa et al 1992; Yadegari et al 2013).

The Lori-Bakhtiari sheep is one of the most common native breeds and the largest fat-tail size among all the Iranian fat-tailed breeds in Iran (Talebi et al 2007; Vatankhah 2013). Due to the long history diversity of this breed and few information about echocardiography in sheep (Talebi et al 2007), it is important to studying and research (on different paraclinical parameters) on this breed.

For longitudinal studies to be undertaken and individual cases to be evaluated by different clinicians, knowledge of the reliability of these measurements is required. To the authors' knowledge, no studies have been undertaken evaluating technique and measurement reliability of echocardiographic parameters in Lori-Bakhtiari sheep. There are no studies reporting a full set of cardiac dimensions and time indices in Lori-Bakhtiari sheep, although one study has reported in adult sheep (Hallowell et al 2012).

The aim of the study was to establish normal reference echocardiographic value in the Lori-Bakhtiari sheep. Methods for obtaining echocardiograms based on external anatomical landmarks have been described (Bonagura et al 1985; Carlsten 1987) and adapted for obtaining quantitative measurements based upon internal land marks by other authors (Reef 1990; Long et al 1992) in horses previously.

These guidelines have been used in this study in order to ensure consistent images and thus measurements are obtained.

Material and method

In this study, 20 healthy Lori-Bakhtiari sheep (ten males and ten females) at one year of age and weights 42±3 kg were selected. After the reduction of environmental stress (sheep's were not sedated or anesthetized at the time of the study), echocardiographic examinations were performed with an EX8000 Medison ultrasound system, using a 2-4 MHz Phased array transducer. All echocardiographic examinations were performed in the standing unsedated animal. Echocardiography was prepared from the 4th and 5th intercostals spaces in the longitudinal and transverse views and on the left and right chest. The left ventricle was evaluated by B-mode and M-mode systems.

Left ventricular end-diastolic and end-systolic, left ventricular free wall at end systole and end diastole, inter ventricular septum at end systole and end diastole, right ventricular at end systole and end diastole, the aortic root, left atrial, the gap between mitral valve to septal ventricular end-diastolie, the stroke

volume and fractional shortening measurements were taken, respectively (Fig. 1 & Fig. 2). Then, mean ± standard deviation (SD) of measurements was calculated (for each of the parameters) and the analysis between indicators in male and female sheep was conducted by SAS SAS 8.2 statistical software (SAS, 1999) using Duncan method.

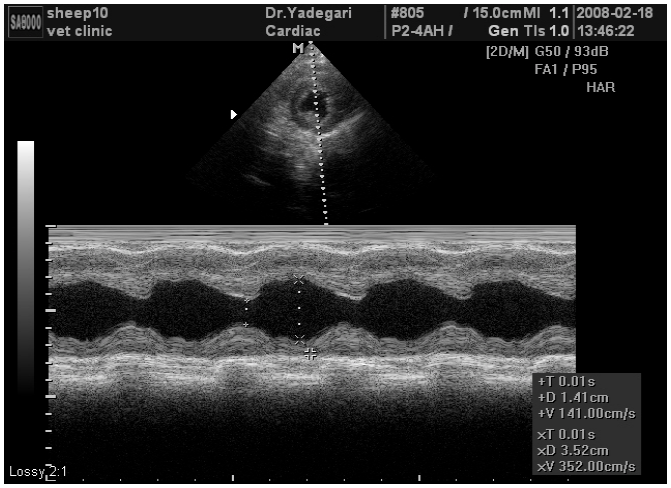

Figure 1. Left ventricular diameter end-diastolic and end-systolic

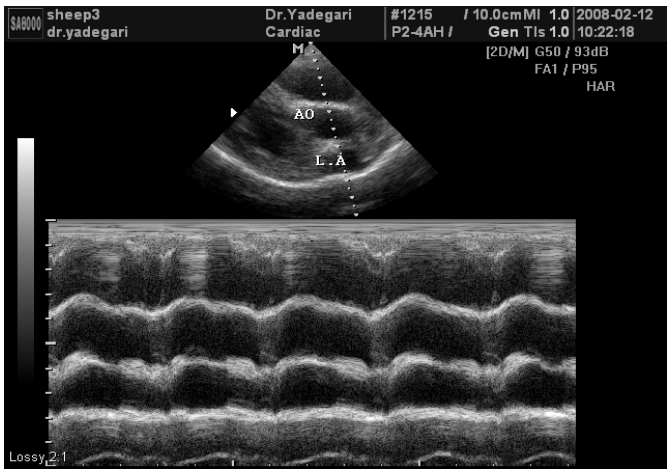

Figure 2. The aortic diameter and left atrial diameter measurements

Results

The sheep in this study had no history or evidence of cardiac dysfunction. No abnormalities were detected on clinical examination of the cardiothoracic systems of any of the animal and no murmurs or dysrhythmia were detected by cardiac auscultation. The mean and standard deviation of each parameter were summarized in Table1 and the mean and standard deviation of two groups (female and male sheep) parameters were summarized in Table 2.

The overall, means of echocardiographic value in the Lori-Bakhtiari sheep (except for fractional shortening of left ventricle) in males group was significantly higher than in females group. Significant difference was observed between gender and size of the right ventricular at end systole, size of the left ventricle at end systole, size of the left ventricular free wall at end diastole, size of the left atrial at end systole and volume of left ventricular at end diastole was observed in males was significantly higher than in females (significant differences: $p \leq 0.05$) (Table 2).

Table 1. Mean and SD of the total echocardiographic parameters calculated for Lori-Bakhtiari sheep

Parameters	±S.D.	Mean
Weight (kg)	4.36	40.6
RVIDd (cm) [1]	0.05	1.44
RVIDs (cm) [2]	0.05	0.38
IVSd (cm) [3]	0.11	0.92
IVSs (cm) [4]	0.16	1.45
LVIDd (cm) [5]	0.18	2.94
LVIDs (cm) [6]	0.11	1.28
LVFWd (cm) [7]	0.09	0.93
LVFWs (cm) [8]	0.1	1.69
FS% [9]	2.68	56.29
EF % [10]	3.26	61.81
SEP (cm) [11]	0.06	0.68
Aod (cm) [12]	0.09	2.03
Las (cm)[13]	0.36	1.58
LVVd (cm^3)[14]	3.44	43.94
LVVs (cm^3)[15]	1.1	16.7
SV(cm^3) [16]	3.28	27.24
HR (bpm) [17]	3.83	87.9
LV OUT PUT (cm^3/min) [18]	304.54	2394.39

[1] Right ventricular internal diameter at end-diastole; [2] Right ventricular internal diameters at end-systole; [3] Interventricular septal thickness at end-diastole; [4] Inter ventricular septal thickness at end-systole; [5] Left ventricular internal diameter at end-diastole; [6] Left ventricular internal diameter at end-systole; [7]Left ventricular posterior wall thickness at end-diastole; [8] Left ventricular posterior wall thickness at end-systole; [9] Fractional shortening; [10] Ejection Fraction; [11] Septum E Point; [12] Aortic sinus diameter; [13] Left atrium in systole; [14] Left Ventricular End Diastolic volume; [15] Left Ventricular End Systolic volume; [16] Stroke Volume; [17] Heart rate; [18] Left ventricular OUT PUT.

Discussion

Echocardiography is considered as noninvasive, most sensitive and specific diagnostic approach and valuable method for evaluating structural and functional values of the cardiovascular system (Tharwat et al 2012). Importance of the heart and its location in the chest area indicates that the echocardiography could be a better technique for the diagnosis various types of heart disorders. It is a technique that has been utilized frequently in many animals and birds for evaluation of changes in wall thickness, chamber size and valvular appearance and function (Jacobs & Knight 1985; Patteson et al 1995; Hallowell et al 2007; Mojca & Aleksandra 2007; Karimi et al 2008; Tharwat et al 2012; Yadegari et al 2013).

Echocardiography allows investigation of the morphology and function of cardiac structures and measurement of cardiac dimensions. In cattle, dogs, ostrich and horses, measurement of cardiac chamber dimensions is considered one of the most important tools for assessing heart disease severity and prognosis (Reef 1990; Crippa et al 1992; Buczinski 2009; Dehghan et al 2011; Tharwat et al 2012; Yadegari et al 2013).

Table 2. Mean and standard deviation (S.D.) of the total echocardiographic parameters calculated for male and female Lori-Bakhtiari sheep

Parameters	±SD	Mean		P value
		Male (n=10)	Female (n=10)	
RVIDd (cm) [1]	0.022	1.441	1.441	0.994
RVIDs (cm) [2]	0.013	0.423	0.349	0.001
IVSd (cm) [3]	0.034	0.966	0.882	0.11
IVSs (cm) [4]	0.04	1.497	1.404	0.13
LVIDd (cm) [5]	0.057	2.96	2.927	0.663
LVIDs (cm) [6]	0.02	1.324	1.251	0.028
LVFWd (cm) [7]	0.025	0.988	0.889	0.01
LVFWs (cm) [8]	0.027	1.72	1.66	0.17
FS% [9]	0.635	55.26	57.32	0.04
EF % [10]	0.852	63.7	59.9	0.74
SEP (cm) [11]	0.019	0.703	0.665	0.17
Aod (cm) [12]	0.032	2.042	2.02	0.63
Las (cm)[13]	0.090	1.74	1.43	0.02
LVVd (cm^3)[14]	0.924	45.874	42.02	0.011
LVVs (cm^3)[15]	0.381	16.79	16.61	0.74
SV(cm^3) [16]	0.815	29.263	25.22	0.67
HR (bpm) [17]	1.29	88.9	86.89	0.3
LV OUT PUT (cm^3/min) [18]	72.65	2598.2	2190.5	0.25

[1] Right ventricular internal diameter at end-diastole; [2] Right ventricular internal diameters at end-systole; [3] Interventricular septal thickness at end-diastole; [4] Inter ventricular septal thickness at end-systole; [5] Left ventricular internal diameter at end-diastole; [6] Left ventricular internal diameter at end-systole; [7]Left ventricular posterior wall thickness at end-diastole; [8] Left ventricular posterior wall thickness at end-systole; [9] Fractional shortening; [10] Ejection Fraction; [11] Septum E Point; [12] Aortic sinus diameter; [13] Left atrium in systole; [14] Left Ventricular End Diastolic volume; [15] Left Ventricular End Systolic volume; [16] Stroke Volume; [17] Heart rate; [18] Left ventricular OUT PUT.

To the authors' knowledge, echocardiography of the normal Lori-Bakhtiari sheep heart and its internal dimensions has not previously been reported in the literature and there is limited information about echocardiographic measurements in sheep. However, in a study conducted by Moses & Ross (1987) was observed M-mode echocardiograms recorded from 20 ewes. Fifteen echocardiographic measurements were taken and compared with body weights or heart rates, using linear regression equations. Significant correlations (p less than 0.05) were found when body weight was compared with left ventricular internal dimensions in systole and diastole, septal thickness in systole and diastole, aortic root dimension and left atrial dimension (Moses & Ross 1987).

Hallowell et al in 2012, was report reliability of quantitative echocardiography in adult sheep and goats (Hallowell et al 2012). Studies of Locatelli et al in 2011, reference values for echocardiographic parameters and indexes of left ventricular function in healthy, young adult sheep and comparison with standardized values in humans was investigated.

In the pilot study, acute mitral valve regurgitation created in sheep using echocardiographic guidance (Kunzelman et al 1999). Aissi (2011) reported the anatomical structure of normal heart studied in vitro through ultrasonography of 27 healthy hearts of sheep collected following slaughter.

The objective of the study by Hallowell et al (2007) was to report normal ultrasonographic appearance and intra-cardiac dimensions in two dairy breeds (ten Jersey (J) and 12 Holstein Friesians (HF)) in the body weight range of 400 to 700 kg and to calculate cardiac output (CO) using echocardiography. Left and right ventricular dimensions, adjusted for body weight, were significantly larger in J cows when compared to HF cows.

Braun et al (2001), performed a study on 51 clinically healthy cows were examined echocardiography of the normal bovine heart from the third and fourth intercostal spaces on both sides of the thorax.

Amory et al (1992) studied, by means of echocardiography in vivo, the cardiac consequences of the double-muscled character selection in beef cattle. Morphologic and functional echocardiographic variables were regularly estimated in 17 Friesian and 8 Belgian White and Blue calves during their growth. Most of the diastolic measurements of the left ventricle were not significantly different between breeds when normalized for body weight. To the contrary, systolic measurements of left ventricular wall thickness and dimensions were significantly lower and greater, respectively, in Belgian White and Blue calves than in Friesian calves.

Olsson et al (2001) studied echocardiography and Doppler measurements were performed to investigate changes in heart dimensions and function during pregnancy, lactation and the non-pregnant, non-lactating (dry) period in dairy goats. Eight Swedish domestic goats (Capra hircus) were investigated. Cardiac dimensions did not differ between periods

Other study was performed by Kayar et al (2006) on M-mode echocardiographic measurements made on 50 healthy German shepherd dogs (30 males and 20 females). There was a significant relationship between gender and LVPW in systole and diastole and FS.

Crippa et al (1992) reported M-mode and two-dimensional echocardiographic measurements made from the right sternal border of 50 healthy Beagles (25 males and 25 females). A statistically significant difference between the sexes was only observed for LVWT in systole and diastole. A linear regression with body weight was obtained only for LVID in systole and in diastole.

Obtained data in this research demonstrates that it is possible to use a new simple and different approach for achieve suitable echocardiogram in Lori-Bakhtiari sheep. Normal echocardiographic values in the healthy Lori-Bakhtiari sheep may be used as early diagnostic and prognostic values in Lori-Bakhtiari sheep with cardiac diseases.

Conclusion

This study showed that it is possible to obtain good-quality echocardiograms in Lori-Bakhtiari sheep and provide normal cardiac dimensions. This study could be used as a reference for further studies concerning sheep with cardiac diseases.

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