Iranian Journal of Veterinary Surgery

ORIGINAL ARTICLE

Examination of Cardiac Structures by Echocardiography in Healthy Shin Bash Sheep

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ARTICLE INFO

Article History:

Received: 19 August 2023
Revised: 16 December 2023
Accepted: 16 December 2023

Keywords:

Echocardiography
Heart
Shin Bash sheep

ABSTRACT

In this study, the heart structures of this sheep breed were examined in a healthy state and the desired structures were measured. This study was carried out on 8 healthy sheep of the Shin Bash breed in a standing position without the use of sedation. Then the desired investigations were done on the valves, arteries, and veins of the heart. The results of pulsed wave Doppler echocardiography in healthy sheep showed that the blood flow in the aorta and pulmonary vessels in the right sternal view and the blood flow in the mitral valve and the tricuspid valve in the left sternal view are evaluated in the best way. The obtained values were reported as a reference for healthy adult Shin Bash sheep. Tricuspid and pulmonary flows were best evaluated on the right side whereas mitral and aortic flows were best obtained on the left side and reference values are reported for healthy adult Shin Bash sheep. Pulsed wave Doppler echocardiography allows the measurement of intracardiac blood flow indices in goats. The reference values establishment will help interpret these indices of cardiac function in clinical cardiac cases and develop animal models for human cardiology research.

Introduction

Shin Bash sheep are bred in the south of West Azerbaijan province, Iran, especially in the cities of Mahabad and Piranshahr, and its population is about 200,000. It seems that the Shin Bash is of great economic importance for local breeders due to its large size in terms of milk and meat production, but due to the unknown production performance and also mixing with other breeds in the region, its population is decreasing. Shin Bash in Kurdish means blue, white forehead, so the color of this breed is dark blue and has a white forehead. Because this mountainous region has very cold winters, this breed is resistant to cold weather and has hands and The feet are suitable for walking in mountainous areas.[1]

Echocardiography is a non-invasive method for assessment of the ovine and caprine heart. However, it is a technique that has been utilized more frequently in the assessment of clinical disease in small animals and horses for evaluation of changes in wall thickness, chamber size and valvular appearance and function. For measurements to be accurate and reliable, images must be taken from correctly orientated imaging planes in relation to internal landmarks.[2] Sheep and goats are infrequently clinically diagnosed with structural cardiac abnormalities. This may be due to these species being relatively resistant to cardiac disease or because these animals are rarely presented for detailed medical evaluation. Descriptions of endocarditis in small ruminants have not been reported.[3]

Considering that the Shin Bash sheep breed is one of the unknown sheep breeds in Iran and no study has been done on it, the heart structures of Shin Bash sheep were studied in this research.

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https://doi.org/10.30500/ivsa.2023.412379.1365

Materials and Methods

This study was conducted on 8 sheep (male and female) of the Shin Bash breed. The average age and weight of these animals were 25 months and 74 kg, respectively. All animals received a routine clinical examination and a base-apex electrocardiogram (ECG) was recorded at rest. The animals were only included in the study if they were reported to have been in good health in the previous four weeks prior to echocardiographic examination. Before imaging, the hair was shaved on both sides, from the 3th to the 5th right intercostal space just caudal to the triceps muscle mass, from 3 to 5 cm below the right olecranon to 5 to 10 cm above it. The shaved areas were then copiously rinsed with water and acoustic coupling was obtained using ultrasound gel. A 5 MHz phased-array transducer attached to ultrasound machine was used to acquire the images. Echocardiography was prepared from the 4th and 5th intercostal spaces in the longitudinal and transverse views and on the left and right the measured parameters, the ratio of pre-ejection period to ejection time (PEP/ET) was calculated and the stroke volume (SV) and the cardiac output (CO) were obtained using the following standard formulae (Figure 1). Then, mean ± standard deviation (SD) of measurements was calculated for each of the parameters and the analysis between indicators in all sheep was conducted by ANOVA test.

Results

By performing echocardiography examinations of sheep, it was found that the average heart rate (HR) during the echocardiographic examination was 90. 50 ± 10.25 beats/minute and ranged from 82 to 125 beats/minute. The image quality and the Doppler spectra were good in all sheep, except for the quality of the tricuspid flow and the right side aortic flow which were often poor.

The least square mean value and the standard error to the mean of each blood flow measurements obtained on day 1, day 2 and day 3 and the multivariable ANOVA test were calculated to evaluate the repeatability of these measurements. Concerning the aortic flow, significant between days differences were observed for maximal velocity (V_{max}), velocity time integral (VTI), cardiac output (CO) and cardiac index (CI). Almost all measurements of the pulmonary flow were significantly different between days except PEP and the ratio of PEP/ET. Early (E) and late (A) mitral and tricuspid flow velocities (E_{max}, E_{mean}, A_{max}, A_{mean}, E_{max}/A_{max}) and E_{peak} and A_{peak} of mitral and tricuspid VTI were significantly different between days (Figure 2).

Comparisons of the pulsed wave Doppler echocardiographic measurements of the aortic and mitral flows obtained from the right and from the left side are shown in Tables 1 and 2 respectively. For the aortic flow, only PEP and PEP/ET were not significantly different whilst all other parameters were significantly different from the right and the left side. Most of the parameters, especially V_{max} and V_{mean}, were significantly higher when they were obtained from the left side than from the right side. For mitral flow, all parameters of A_{peak} except ET of E_{peak} were not significantly different from both sides. A color ET of E_{peak} were not significantly different from both sides. The mitral E_{max}, E_{mean} and VTI of E_{peak} were higher when obtained from the left side than when obtained from the right side. The results of the measurements of the aortic, mitral, pulmonary and tricuspid flows are shown in Tables 1-4, respectively. Most of the parameters had low to moderate variability excepted for thrombotic thrombocytopenic purpura (TTP) of the aortic flow, acceleration (Acc) slope of the aortic and pulmonary flows, and deceleration time and deceleration slope of the mitral and tricuspid E_{peaks} that showed a high variability. For all flows, within-day variability was clearly lower than between-day variability.

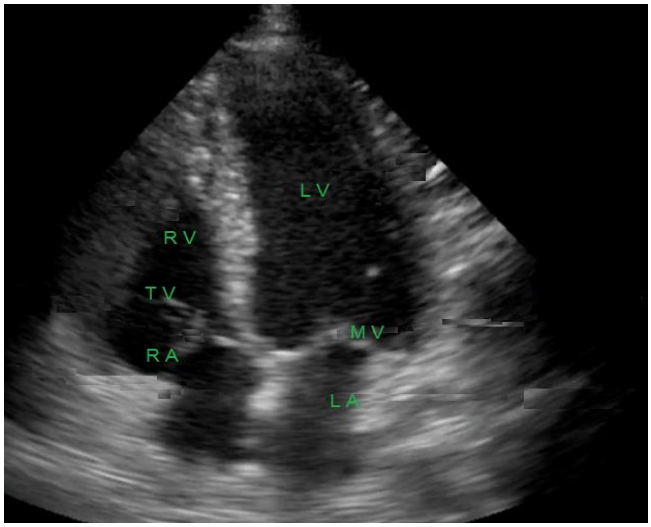

Figure 1. 2D image of the heart. LA: Left atrium, LV: Left ventricle, MV: Mitral Valve, RA: Right atrium, RV: Right ventricle, TV: Tricuspid valve

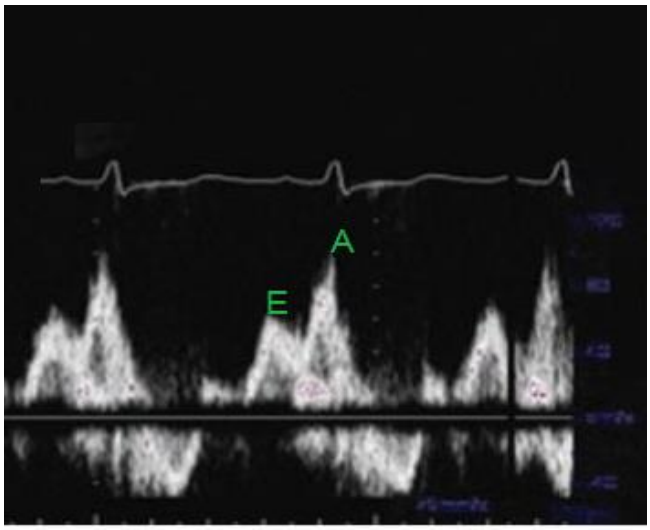

Figure 2. Pulsed wave Doppler of mitral inflow velocity.

Table 1. Pulsed wave Doppler echocardiographic parameters of the aortic flow.

Parameters	Mean ± SD
V_{max} (m/s)	1.25 ± 0.20
V_{mean} (m/s)	0.70 ± 0.010
ET (ms	277.20 ± 14.5
VTI (cm)	19.25 ± 2.5
PEP (ms)	50.10 ± 4.85
TTP (ms)	92.5 ± 17.5
SV (ml)	66.5 ± 8.5
CO (l/min)	5.10 ± 0.3
PEP/ET	0.16 ± 0.03

Table 2. Pulsed wave Doppler echocardiographic parameters of the mitral flow.

E_{peak} Parameters	Mean ± SD
V_{max} (m/s)	0.79 ± 0.05
V_{mean} (m/s)	0.50 ± 0.01
ET (ms)	9.10 ± 0.55
VTI (cm)	225.05 ± 18.75
A_{peak} Parameters	
A_{max} (m/s)	0.71 ± 0.06
A_{mean} (m/s)	0.45 ± 0.05
ET (ms	117.25 ± 16.10
VTI (cm)	4.15 ± 0.50
E_{max}/A_{max}	1.15 ± 0.15

Table 3. Pulsed wave Doppler echocardiographic measurements of the pulmonary artery.

Parameters	Mean ± SD
V_{max} (m/s)	0.89 ± 0.18
V_{mean} (m/s	0.85 ± 0.5
ET (ms)	269.5 ± 20.4
VTI (cm)	19.70 ± 1.65
PEP (ms)	44.3 ± 4.5
TTP (ms)	118.5 ± 11.5
SV (ml)	81.25 ± 16.05
CO (l/min)	8.25 ± 1.60
PEP/ET	0.16 ± 0.03

Table 4. Pulsed wave Doppler echocardiographic measurements of the tricuspid flow.

E_{peak} Parameters	Mean ± SD
E_{max} (m/s)	0.75 ± 0.15
E_{mean} (m/s)	0.56 ± 0.18
VTI (cm)	10.90 ± 2.40
ET (ms)	241 ± 41.5
A_{peak} Parameters	
A_{max} (m/s)	0.63 ± 0.15
A_{mean} (m/s	0.52 ± 0.20
VTI (cm)	5.35 ± 1.45
ET (ms)	120.4 ± 13.5
E_{max}/A_{max}	1.35 ± 0.04

Discussion

In the present study, E_{max} and E_{mean} were lower when the measurements were performed from the right side than from the left side, which suggests that in sheep, the mitral flow should be interrogated from the left rather than from the right hemi thorax. The mean values of the mitral velocity spectrum obtained from a tilted left parasternal long axis four chamber view were significantly different from those obtained from a tilted right parasternal long axis four chamber view, except for all parameters of the A_{peak} and for ET of the E_{peak}. By Saadi *et al*. In 2018, heart parameters in breed of Markhoz were measured. The results were consistent with the results of the present study and there is no significant difference between the results.[4] The E_{max}/A_{max} ratio is a parameter often used to evaluate the left ventricular diastolic function in man.[5-7] Independently of the side from which it is measured, the E_{max}/A_{max} ratio of the mitral flow was rather similar to the tricuspid flow E_{max}/A_{max}. The same was observed in 8 of 40 investigated healthy horses and was explained as a more accurate alignment of the transducer with the A wave of atrial contraction than with the E wave of the early rapid ventricular filling.[8,9] Measurements of E_{peak} and A_{peak} seemed also to depend on HR. In goats as in sheep, it has been reported than the A_{peak} is closer to the E_{peak} with increasing HR, and when HR was more than 120 beats/min, fusion of the two peak can occur.[4] Measurements of aortic velocity spectrum are very interesting because they allow assessing left ventricular SV and CO.[5] In 2021, a research was conducted by Sadi on Nagdi goats, and considering that both goats and sheep are small ruminants, the results of this researches are close to the results of the current research.[10] In this study, except for PEP and PEP/ET, the aortic velocity spectrum measurements obtained from the tilted left parasternal long axis five chambers view were significantly higher than those obtained from a tilted right parasternal long axis five chambers view. This is in agreement with the results obtained in horses. In 2023, echocardiography studies were done on Kurdish sheep by Saadi, and the results of this research showed a great agreement with the current study, which could be due to the closeness of the body weight and body structure of these two sheep breeds.[11]

By performing this study, the parameters of healthy heart echocardiography were obtained in the Shin Bash sheep's that can be used as a reference values in sheep. Meanwhile, heart disease in sheep is diagnosed by comparing these reference values with the obtained from the echocardiography.

Conflict of Interest

None to declare.

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