ORIGINAL ARTICLE

Veterinary Research Forum. 2025; 16 (7): 387 - 390
doi: 10.30466/vrf.2025.2026001.4230
Journal Homepage: vrf.iranjournals.ir

Veterinary Research Forum

Radiological examination of thorax in Awassi sheep

Ali Koçyiğit[1]*, İsmail Demircioğlu[2], Gülşah Güngören[3], Funda Aksünger Karaavci[4]

[1] Laboratory and Veterinary Health Vocational School, Harran University, Şanlurfa, Türkiye; [2] Department of Anatomy, Faculty of Veterinary Medicine, Harran University, Şanlıurfa, Türkiye; [3] Department of Animal Science, Faculty of Veterinary Medicine, Kastamonu University, Kastamonu, Türkiye; [4] Department of Anatomy, Faculty of Veterinary Medicine, Bingöl University, Bingöl, Türkiye.

Article Info

Article history:

Received: 29 September 2024
Accepted: 22 April 2025
Available online: 15 July 2025

Keywords:

Heart
Radiology
Sheep
Thorax
Vertebral heart score

Abstract

Medical imaging methods (magnetic resonance imaging, computed tomography, X-ray, and ultrasound) are used to guide physicians when diagnosing diseases and planning their treatment. Thorax radiography is frequently preferred for the detection of diseases related to the respiratory system and the heart. When the thorax anatomy is known, this facilitates the detection of diseases in these regions. The vertebral heart score (VHS) is a parameter used for the detection of cardiac anomalies. In cases such as cardiomyopathy and chronic pneumonia, the heart silhouette changes and cardiac enlargement is ensued. Knowing the normal VHS parameter is important in the detection of anomalies. In the present study, 15 male and 30 female adult Awassi sheep were used. The thorax region was imaged with an X-ray device in the right lateral position. Each animal was measured for nine parameters in the region. In the measurements, the female and male VHS scores were found to be 9.77 ± 0.48 and 9.69 ± 0.52, respectively, using one method and 10.11 ± 1.64 and 9.96 ± 0.73, respectively, using the other method. No statistical difference was found between the two methods. The cardiodiaphragmatic contact parameter was observed to be statistically significant between males and females. No statistical difference was found in other parameters. Consequently, this study was carried out to determine the VHS values in Awassi sheep, and the thorax measurements were evaluated. This study is considered to contribute to veterinary surgeons and the field of veterinary surgery.

Introduction

Radiography, an affordable and easy-to-access technique, is preferred to detect anomalies in the thorax in different animal species.[1] Thorax radiography is used to examine the shape, position and size of the heart and its vessels. Thorax radiography provides data not only on the heart but also on the lungs and the position of the heart.[2] It is necessary to identify the normal radiographic appearance of the heart in order to detect the disease in the heart.[3] Many studies have been conducted to indicate the normal appearance of the thorax. Thorax radiographs are used in the detection of diseases such as pneumonia, diaphragmatic hernia and megaesophagus.[4,5] In instances where there is concomitant cardiac involvement and pneumonia, the use of vertebral heart score (VHS) can facilitate the detection of cardiac enlargement. In the event of a combination of pneumonia and congestive heart failure, there may be a change in the heart silhouette.[6,7]

The Awassi breed is one of the most common sheep breeds raised in the eastern Mediterranean. It is frequently reared in countries like Turkey, Syria, and Jordan. Awassi sheep are preferred due to their advantages, such as high milk yield, resistance to diseases and parasites, and good tolerance to high temperatures.[8] This study aimed to radiographically examine the thorax of Awassi ewes and determine whether there is a difference between the sexes.

Materials and Methods

Adult male (n = 15) and female (n = 30) healthy sheep were used in the study. This study was approved by Harran University Animal Experiments Local Ethics Committee (Decision No. 2023/007/05). The animals used in the study were not anaesthetised. The radiographic images obtained were taken by following the full inspiration time as much as possible. The sheep were kept standing, immobilised, and imaged in the right lateral position.

The morphometric parameter used in the study were based on works of Abdelhakiem *et al.* and Makungu as shown in Figure 1: [9,10] 1) Thoracic inlet diameter (TID), 2) Trachea diameter, 3) Fourth thoracic vertebral maximum

***Correspondence:**

Ali Koçyiğit. DVM, PhD
Laboratory and Veterinary Health Vocational School, Harran University, Şanlurfa, Türkiye
E-mail: akocyigit@harran.edu.tr

height, 4) Fourth thoracic vertebral length, 5) Thoracic depth (THD; Distance between the ventral surface of the thoracic vertebrae and the dorsal surface of the sternum), 6) Cardiac silhouette short axis measurement, (Measurement of the short axis boundaries of the widest outline of the heart silhouette), 7) Cardiac silhouette long axis measurement, (Measurement of the long axis boundaries of the widest outline of the heart silhouette), 8) Cardiodiaphragmatic contact, and 9) Cardiosternal contact.

First method. To measure the VHS, they were first measured using the technique developed by Buchanan and Bücheler. The long axis and short axis of the heart were measured in mm and recorded separately. The measurement value was continued from the cranial end of the 4th vertebra to the caudal. The number of vertebrae passed was measured separately in the long and short axis at a value of 0.01 vertebral unit (v). The VHS was determined by adding the values obtained.[11]

Second method. The long axis and short axis of the heart were measured perpendicular to each other. The measurements were divided by the length of the 4th vertebral body. The obtained results were summed and the VHS value was calculated.[12]

Statistical analysis. Statistical evaluation of data was performed using SPSS Software (version 13.0; SPSS Inc., Chicago, USA). Levene's test was run to check normal distribution of data. The independent *t*-test was run to check the statistical difference between sexes. The paired *t*-test was run for the difference between the two methods.

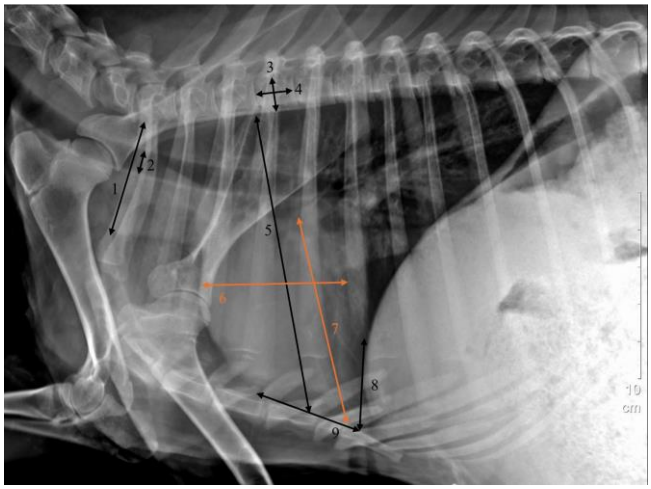

Fig. 1. Lateral view of thoracic radiograph. 1: Thoracic inlet diameter, 2: Trachea diameter, 3: Fourth thoracic vertebral height, 4: Fourth thoracic vertebral length, 5: Thoracic depth, 6: Cardiac silhouette short axis measurement, 7: Cardiac silhouette long axis measurement, 8: Cardiodiaphragmatic contact, and 9: Cardiosternal contact (CSC).

Results

The data obtained from radiological images taken from sheep are shown in Table 1. It shows the findings from radiography images in this study. Thirteen vertebrae in thoracicae were observed. The parameter of the VHS was 10.50 ± 0.48 in females and 10.80 ± 0.52 in males.

Table 1. Morphometric measurements obtained from radiological images.

Parameters	Gender	No.	Minimum	Maximum	Mean	SD	*p*-value
TID (mm)	Female	30	69.80	117.70	98.43	10.95	0.551
	Male	15	79.80	131.60	96.23	12.90	
TD (mm)	Female	30	11.70	21.60	16.54	2.78	0.214
	Male	15	11.30	23.20	15.30	3.68	
FTH (mm)	Female	30	12.40	29.80	19.87	4.310	0.889
	Male	15	12. 20	24.30	20.05	3.70	
FTL (mm)	Female	30	15.40	32.40	25.11	4.06	0.421
	Male	15	19.60	31.60	24.14	3.13	
THD (mm)	Female	30	136.60	242.20	209.10	24.48	0.768
	Male	15	178.80	247.70	207.00	17.10	
CSLA (mm)	Female	30	126.60	170.00	150.40	13.35	0.055
	Male	15	129.60	171.70	142.55	10.91	
CSSA (mm)	Female	30	76.50	115.10	98.21	11.81	0.551
	Male	15	80.00	108.40	96.14	8.66	
VHS	Female	30	9.00	10.50	9.79	0.48	0.525
	Male	15	8.70	10.80	9.69	0.52	
VHS (Formulas)	Female	30	8.11	15.53	10.11	1.64	0.160#
	Male	15	8.86	11.36	9.96	0.73	
CDC (mm)	Female	30	34.50	65.90	52.22	6.80	0.018*
	Male	15	42.10	69.30	57.89	8.15	
CSC (mm)	Female	30	48.60	89.30	69.60	9.47	0.661
	Male	15	43.60	97.80	71.05	15.94	

TID: Thoracic inlet diameter, TD: Trachea diameter, FTH: Fourth thoracic vertebral height, FTL: Fourth thoracic vertebral length, THD: Thoracic depth, CSSA: Cardiac silhouette short axis measurement, CSLA: Cardiac silhouette long axis measurement, VHS: Vertebral heart score, CDC: Cardio diaphragmatic contact, and CSC: Cardio sternal contact.

* There is significant difference between the genders ($p < 0.05$). #: Paired *t*-test.

The cardiac silhouette long axis measurement parameter was found to be higher in females, however, no statistical difference was observed between the sexes ($p > 0.05$). No statistical difference was found between the first and the second VHS measuring methods ($p > 0.05$).

Discussion

Thorax radiography is one of the methods frequently used in the detection of cardiovascular and respiratory diseases. Many studies compared the measures taken from radiography images taken in the latero-lateral position across sexes to determine VHS.

A study conducted by Makungu and Paulo on sheep reported that 83.33% of the animals studied had 13 vertebrae thoracicae and 16.77% had 12 vertebrae thoracicae. A study conducted in East African goats revealed that there were 12 vertebrae thoracicae in one out of 10 goats and 13 vertebrae thoracicae in nine goats.[13]

It was reported that the VHS value in new-born lambs was 10.07 ± 0.10 in the first 24 hr and 9.42 ± 0.08 on the 35th day.[14] Olatunji-Akioye *et al.*[6] reported that the VHS value of African Dwarf Goats ranged between 8.50 and 10.00. In Muzaffarnagari sheep, VHS scores in two groups separated according to weight and age were reported as 8.40 ± 0.14 v and 8.23 ± 0.21 v, respectively.[15] In Zaraibi goats, VHS values were reported to range between 7.30 - 8.80.[16] The authors in the studies on dogs reported a VHS value of 9.42 ± 0.37 in Corgi breeds,[17] 9.78 ± 0.42 in dogs from Khorasan region,[18] 9.70 ± 0 .67 in Kangal dogs,[19] 7.50 ± 0.30 v in cats,[20] and 7.30 ± 0.55 v in stray cats.[21] Makungu *et al.*[22] reported a VHS value of 8.92±0.42 in ring-tailed lemurs. This study in Awassi Sheep revealed that the VHS value was 9.79 ± 0.48 in females and 9.69 ± 0.52 in males with first method, and 10.11 ± 1.64 in females and 9.96 ± 0.73 in males with second method. No statistical difference was found between the two methods.

In thorax morphometric measurements, the TID value in East African black-head sheep was stated as 9.17 ± 0.60 cm and the THD value was 17.48 ± 0.60 cm.[9] Makungu and Paulo[13] on East African goats, the THD parameter was reported as 15.29 ± 1.53 cm and the TID parameter was reported as 7.58 ± 0.65 cm. The TID parameter value in non-brachycephalic small breed dogs is 9.17 ± 0.60 cm.[21] In the study, the TID parameter was calculated to be 98.43 ± 10.95 mm in females and 96.23 ± 12.90 mm in males, and the THD parameter was calculated to be 209.10 ± 24.48 mm in females and 207 ± 17.10 mm in males. No statistical difference was observed between genders in both parameters ($p > 0.05$).

Thus, VHS values were determined in the radiographic examination of the thorax of Awassi sheep. In this study, the thorax parameters of healthy Awassi sheep were determined. These values should not be used only for the detection of diseases that develop on the heart and thorax but should be also used together with clinical examinations. This study is considered to contribute to the clinical field.

Acknowledgments

Not applicable.

Conflict of interests

There are no conflicts of interest to declare for any of the authors.

References

1. Mattoon JS. Digital radiography. Vet Comp Orthop Traumatol 2006; 19(3): 123-132.
2. Guglielmini C, Diana A. Thoracic radiography in the cat: identification of cardiomegaly and congestive heart failure. J Vet Cardiol 2015; 17(Suppl 1): S87-S101.
3. Bustos A, Pertusa A, Salinas JM, et al. PadChest: a large chest x-ray image dataset with multi-label annotated reports. Med Image Anal 2020; 66: 101797. doi: 10.1016/j.media.2020.101797.
4. Lakhani P, Sundaram B. Deep learning at chest radiography: automated classification of pulmonary tuberculosis by using convolutional neural networks. Radiology 2017; 284(2): 574-582.
5. Hyun C. Radiographic diagnosis of diaphragmatic hernia: review of 60 cases in dogs and cats. J Vet Sci 2004; 5(2): 157-162.
6. Olatunji-Akioye AO, Bolaji-Alabi FB, Oni Z. Thoracic radiographic anatomy as a diagnostic tool for pneumonia in West African Dwarf goats. Anim Res Int 2020; 17(1): 3536-3540.
7. Timperman L, Habing G, Green E. The vertebral heart scale on CT is correlated to radiographs in dogs. Vet Radiol Ultrasound 2021; 62(5): 519-524.
8. Ertuğrul M, Dellal G, Soysal İ, et al. Protection of native sheep breeds in Türkiye [Turkish]. Bursa Uludağ Üniv Ziraat Fak Derg 2009; 23(2): 97-119
9. Abdelhakiem MA, Khalphallah A, Al-lethie ALA. Radiographic appearance and measurements of thoracic structures using four radiographic projections in goats. Alex J Vet Sci 2020; 64(1): 34-46.
10. Makungu M. Thoracic radiographic anatomy in sheep. Tanz Vet J 2017; 34: 129-135.
11. Buchanan JW, Bücheler J. Vertebral scale system to measure canine heart size in radiographs. J Am Vet Med Assoc 1995; 206(2): 194-199.
12. Spasojević-Kosić L, Krstić N, Trailović RD. Comparison of three methods of measuring vertebral heart size in German shepherd dogs. Acta Vet (Beograd) 2007; 57(2-3): 133-141.
13. Makungu M, Paulo P. Thoracic radiographic anatomy in goats. Tanz Vet J 2014; 29(2): 73-80.

14. Ulian CMV, Lourenço MLG, Inamassu LR, et al. Echocardiographic parameters and vertebral heart size (VHS) in lambs during the neonatal period. Pesqui Vet Bras 2018; 38(9): 1869-1877.
15. Singh A, Pandey RP, Purohit S, et al. Measurement and comparison of vertebral heart size (VHS) in Muzaffarnagari sheep using two different methods. J Entomol Zool Stud 2020; 8(3): 834-837.
16. Abdelgalil AI, Hassan EA, Torad FA. Objective radiographic evaluation of cardiac size in clinically normal Zaraibi goats. Indian J Anim Res 2023; 57(9): 1232-1235.
17. Tangpakornsak T, Saisawart P, Sutthigran S, et al. Thoracic vertebral length-to-height ratio, a promising parameter to predict the vertebral heart score in normal Welsh Corgi Pembroke dogs. Vet Sci 2023; 10(2): 168. doi: 10.3390/vetsci10020168.
18. Zahabpour F, Rajabioun M, Salari Sedigh H, et al. Radiographic evaluation of normal heart size in native dog of Khorasan province using VHS method. Iran J Vet Surg 2017; 11(2): 39-42.
19. Gülanber EG, Gönenci R, Kaya Ü, et al. Vertebral scale system to measure heart size in thoracic radiographs of Turkish shepherd (Kangal) dogs. Turk J Vet Anim Sci 2005; 29: 723-726.
20. Litster AL, Buchanan JW. Vertebral scale system to measure heart size in radiographs of cats. J Am Vet Med Assoc 2000; 216(2): 210-214.
21. Ghadiri A, Avizeh R, Rasekh A, et al. Radiographic measurement of vertebral heart size in healthy stray cats. J Feline Med Surg 2008; 10(1): 61-65.
22. Makungu M, du Plessis WM, Barrows M, et al. Radiographic thoracic anatomy of the ring-tailed lemur (*Lemur catta*). J Med Primatol 2014; 43(3): 144-152.