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Ultrasonographic Findings of the Liver in Lori Breed Sheep

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Abstract

Objective: The aim of this study was ultrasonographic findings and technique of the liver in the Lori breed sheep.
Design: Descriptive study.
Animals: 10 clinically healthy, female sheep.
Procedures: Ultrasound examination of liver performed from the caudal aspect of 13th rib to the 7th intercostals spaces (ICS). The possibility of liver imaging from each ICS, distance between the position of liver in each view from the dorsal midline while expiration, echogenicity of liver, depth of liver, depth and diameter of portal vein and caudal vena cava, position and size of gall bladder were surveyed.
Results: The liver tissue was completely accessible from 7th to 12th ICS. The liver parenchyma was echogenic, homogeneous and medium level of echogenicity. The parenchymal pattern of liver consists of numerous weak echoes homogenously distributed over the entire liver. Anechoic round and tubular vascular structures were seen within hepatic tissues, representing hepatic and portal veins. The caudal vena cava was consistently positioned dorsal and medial to the portal vein and completely accessible between the 9th to 12th ICS. The portal vein was usually visualized in the 9th to 12th ICS. It was round or slightly oval in shape. The diameter was decreasing toward the cranial while the depth was increasing. The gall bladder was visualized in most of sheep.
Conclusion: Results of this study provide reference values for ultrasonographic examination of the liver of another breed of sheep.
Key words: liver, ultrasonography, Lori breed sheep, gall bladder

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Introduction

Ultrasonography is one of the best modality for diagnosis of liver diseases in human and animals[1]. Ultrasonographic examination of the liver were well documented in the dogs, cats and horses but there are a few references in the literature concerning ultrasound evaluation of liver in small ruminants[1,2,3]. A number of studies concerning ultrasonographic examination of the liver in cattle, sheep and goat have been reported[4,5,6,7]. Detailed description of the ultrasonographic appearance of the liver, caudal vena cava, portal vein, and gallbladder was reported in ruminant[4,5,6,7]. In addition, reliability of the methods was assessed, using the interassay coefficients of variation[4,5,6]. A number of authors have reported ultrasonographic findings in cows, heifers and buffalos with liver abscesses and hydatid cyst[8,9,10,11]. Ultrasonographic findings in cows with diffuse changes in the liver parenchyma and percutaneous ultrasound-guided catheterization of the portal vein also have been described[12]. Other authors described percutaneous ultrasound-guided cholecystocentesis and aspiration of bile[13]. They determined that microscopic examination of aspirated bile was an excellent method of demonstrating *Fasciola hepatica* and *Dicrocoelium dendriticum* eggs[13]. In addition, concentration of bile acids can be determined for diagnosis of liver disease[9,14]. Other reports concerning ultrasonographic examination of the liver include findings in a cow with thrombosis of the caudal vena cava and dilatation of the bile ducts [9].
Until now, the reference values that have been used for sheep were determined in only White Alpine sheep by Braun and Hausammann in 1992[6]. However, other breeds of sheep are often referred for examination. It is not known whether breed of sheep influences the position and size of the liver and its vasculature. The purpose of the present study was to gain detailed information about ultrasonographic features and approaches of liver and its portal veins, caudal vena cava and the gallbladder of the Lori breed sheep. Liver size and thickness, diameter and depth of vessels in each intercostals space were also investigated.

Materials and Methods

Animals

Ultrasonographic examinations were performed on 10 adult female, clinically normal Lori breed sheep. The half abdominal circumference of the sheep was between 52.5 ± 3.20 cm at the 12th intercostal space (ICS) and 49.0 ± 3.05 cm at the 7th ICS. Sheep were between 3-5 years old (mean 3.7 years) and weight between 45 and 53 kg (mean 49.6 kg).

Ultrasonographic examination

Ultrasonographic examinations were performed according to the technique described to evaluate normal hepatic structure in ruminant [4,5,6,7]. Examinations were performed with a 5 MHz linear transducer for deeper structures and a 7.5 MHz linear transducer for superficial imaging of the liver while the sheep was standing. Their right sides from 5th rib to a handbreadth behind the last rib and from transverse processes of vertebrae up to the ventral aspect of the abdomen were sheaved. After

application of transmission gel, each ICS was scanned, beginning dorsad and progressing ventrad with the transducer held parallel to the ribs. Initially, echotexture of the liver, hepatic and portal veins, and visceral and diaphragmatic surfaces of the liver were examined. The echogenicity of the liver was compared with that of the renal cortex.

The position of the dorsal and ventral liver margins, caudal vena cava, portal vein, and dorsal margin of the gallbladder were measured in relation to the midline of the dorsum. For example, the dorsal margin of the liver was determined by measuring the distance between the dorsal margin of the liver and the midline of the dorsum. The visible size of the liver in a given ICS was determined by subtracting the distance between the dorsal margin of the liver and the midline of the dorsum from the distance between the ventral margin of the liver and the midline of the dorsum. Diameter of the caudal vena cava and portal vein was measured. The largest dimension of the caudal vena cava was used to determine its diameter.

Thickness of the liver, and depth and diameter of caudal vena cava and portal vein were measured. All examinations, except those of the gallbladder, were carried out in the 12^{th}, to 7^{th} ICS. Ability to visualize the gallbladder in the various ICS was noted, and the longitudinal and transverse diameters of the structure were measured. The length and width of the gallbladder were determined only in the position which the gallbladder has been appeared the largest form of it. Extrahepatic bile ducts (cystic, hepatic, and common bile ducts) were noted if seen. Ultrasonographic images were electronically stored at maximal expiration of the sheep; and, measurements were then made electronically on the ultrasonogram by use of 2 cursors. After ultrasonographic examination, sheep were slaughtered and the livers were inspected.

Statistical analysis

The normal range of a variable was defined as mean ± SD. Statistical calculations were performed by means of SPSS program.

Results

The liver parenchyma

The normal hepatic liver parenchyma was echogenic, homogeneous and had a uniform, medium level of echogenicity. Anechoic round and tubular vascular structures were seen within hepatic tissues, representing hepatic and portal veins (Fig. 1). Portal and hepatic veins diameter increased toward the portal vein and the caudal vena cava. The lumen of these vessels was anechoic and, therefore, appeared black. In contrast to the hepatic vein, the wall of the portal vein was characterized by an echogenic border, which made it easier to recognize. The hepatic artery and intrahepatic bile ducts were not visible. At the same scanning depth and instrument gain settings, echogenicity of the liver was equal to that of the cortex of the right kidney, or the liver was slightly more echogenic.

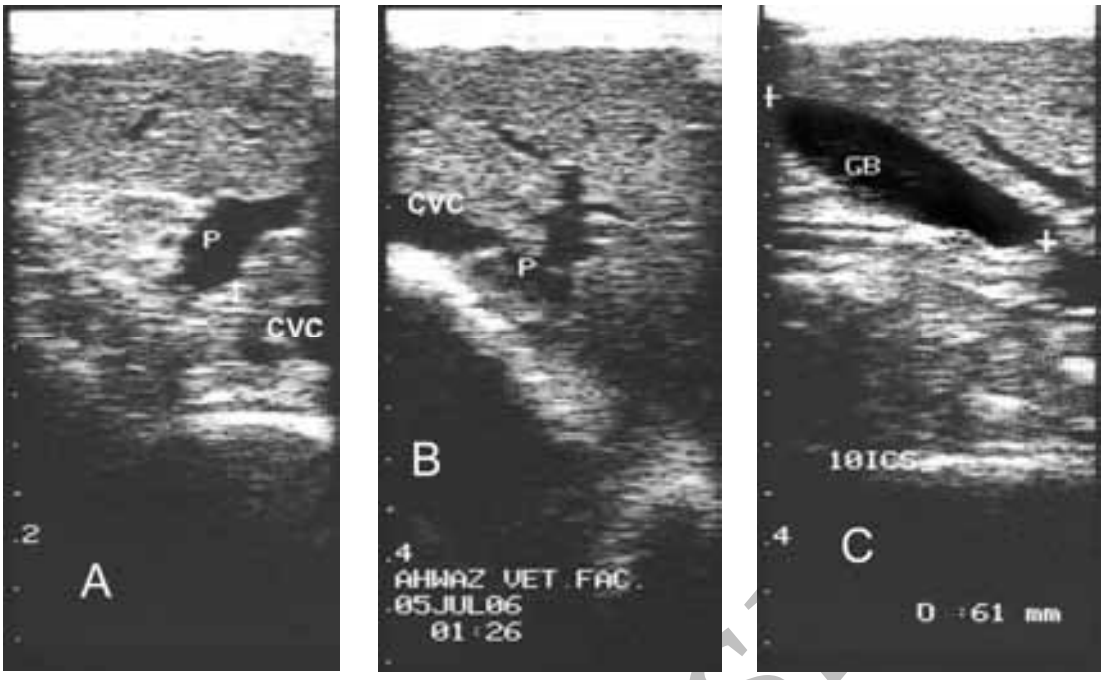

Fig.1: Ultrasonogram of normal liver, portal vein (P), caudal vena cava (C) and gallbladder (GB) of the Lori breed sheep. A: Transducer was placed in the 10th ICS about 16 cm distal to the midline of the back. B: Transducer was placed in the 11th ICS about 8 cm distal to the midline of the back. C: Transducer was placed in the 10th ICS about 34 cm distal to the midline of the back.

The Liver dimension

Mean of variables was calculated (Table 1). The liver could be visualized ultrasonographically from the 7th to the 12th ICS in all sheep. The liver and part of the right kidney could be imaged in the area directly caudal the 13th rib in all sheep by slight tilting of the transducer.

The dorsal border of the liver that could be imaged ran caudodorsad to cranioventrad. The distance between the dorsal visible margin of the liver and the midline of the dorsum was the shortest in the 12th ICS (mean ± SD, 8.0 ± 1.93 cm) and became progressively longer craniad to the 7th ICS (28.5 ± 1.8 cm), as is shown in table 1. This line coincided with the acute margin of the lung, because parts of the liver were located beneath the lung and could not be visualized ultrasonographically. The ventral margin of the liver also had a cranioventral course. The distance between this margin and the midline of the dorsum also was the shortest in the 12th ICS (17.4. ± 2.84 cm) and increased craniad to the 7th ICS (37.5 ± 2.90 cm). Size of the liver was greatest in the 10th ICS (12.5 ± 3.1 cm) and gradually decreased cranial and caudal to this point. Size of the liver was the smallest in the 7th ICS (9.4 ± 3.1 cm) because of the lung situated over it. Thickness of the liver varied between 4.8 and 7.4 cm and mean thickness of the liver in all spaces was 5.6 to 6.6 cm. Thickness of the liver was decreased dorsally to ventrally in each ICS.

Table 1: Results of the ultrasonographic dimensions of the liver of 10 adult female Lori breed sheep.

Variable	ICS	Mean	SD	Normal range
Dorsal Margin of the liver	12	8*	1.93	7 to 10
	11	11.9*	2.1	10 to 14
	10	15.2*	2.3	12 to 17
	9	20.1*	1.8	16 to 22
	8	25.2*	2.5	21 to 28
	7	28.5*	2.4	24 to 30
Ventral margin of the liver	12	17.2*	3.4	16 to 21
	11	22.3*	3.2	19 to 25
	10	28.5*	2.8	26 to 33
	9	32.2*	3.4	30 to 37
	8	36.1*	2.4	34 to 40
	7	37.5*	3.3	36 to 41
Size of the liver (cm)	12	9.2	3.2	†
	11	10.6	2.9	†
	10	12.5	3.1	†
	9	12.1	3.2	†
	8	10.2	3.5	†
	7	9.4	3.1	†
Thickness of the liver (cm)	12	5.7	0.9	5.1 to 6.5
	11	6.1	1.1	5.5 to 6.8
	10	6.6	1.2	6.1 to 7.4
	9	5.9	1.3	5.6 to 6.3
	8	5.8	1.2	5.6 to 6.4
	7	5.6	0.8	4.8 to 5.9

* cm distal to the mid line of the back, †= Not applicable, ICS = Intercostal spaces.

The portal vein

The portal vein was visualized in the 10^{th} and 11^{th} ICS in all sheep and in the 9^{th} and 12^{th} ICS in sheep no. 8 and 6, respectively (table 2). In the 8^{th} ICS, it was visualized in only 2 sheep. The portal vein (Fig. 1A, B) was round or slightly oval. The course of the portal vein was parallel to that of the caudal vena cava, but its dorsal margin was situated 2.9 and 3.3 cm ventral to that of the caudal vena cava. The distance between the dorsal margin of the portal vein and the midline of the dorsum was 9.9 ± 2.1 cm in the 12^{th} ICS and increased continually to the 9^{th} ICS (17.5 ± 2.7 cm). Portal vein depth was less than that of the caudal vena cava. It was at a depth between 4.3 ± 1.02 cm in the 12^{th} ICS and 5.3 ± 1.07 cm in the 9^{th} ICS. The diameter of the portal vein was smaller than that of the caudal vena cava. It was greatest in the 12^{th} (1.8 ± 0.3 cm) and decreased continually to the 9^{th} ICS (1.3 ± 0.5 cm). The portal vein diameter decreased cranially. However, the wall of the portal vein was visible better than that of the caudal vena cava.

The caudal vena cava

The caudal vena cava was visualized in the 11^{th} and 10^{th} ICS in all sheep, (Table 3). Of 10 sheep, the caudal vena cava was imaged in the 12^{th} and 9^{th} ICS, in sheep no. 6 and 8, respectively, and it could not be visualized in the spaces cranial to this point owing to superimposition of the lung. The caudal vena cava was characteristically triangular or drop-like on cross-sectional view because it was embedded in the sulcus

venae cavae in the hepatic parenchyma. The caudal vena cava (Fig. 1A) was consistently positioned dorsal and medial to the portal vein. Similar to the dorsal margin of the liver, the course of the caudal vena cava was in a caudodorsal to cranioventral direction. The distance from the dorsal margin of the caudal vena cava to the midline of the dorsum was 6.8 ± 1.9 cm in the 12th ICS and was increasing cranially to the 9th ICS 14.2 ± 2.1 cm. It was at a depth between 5.2 ± 1.02 cm in the 12th ICS and 7.9 ± 0.87 cm in the 9th ICS. The diameters of the caudal vena cava increased cranially and mean diameter was between 1.7 ± 0.2 cm in the 12th ICS and 1.8 ± 0.2 cm in the 9th ICS with the greatest diameter measured as 2.2 cm, and the smallest as 1.5 cm.

Table 2: Results of the ultrasonographic examination of the portal veins of 10 adult female Lori breed sheep.

Variable	ICS (No. of sheep)	Mean	SD	Normal range
Dorsal Margin	12 (6)	9.9 *	2.1	8 to 11
	11 (10)	12.7*	2.3	11 to 14
	10 (10)	14.9*	2.4	13 to 17
	9 (8)	17.5 *	2.7	15 to 19
Depth (cm)	12 (6)	4.3	1.02	3.5 to 4.8
	11 (10)	4.8	0.9	3.7 to 5.0
	10 (10)	5.1	1.2	4.5 to 5.4
	9 (8)	5.3	1.07	4.9 to 5.6
Diameter (cm)	12 (6)	1.8	0.3	1.4 to 2.1
	11 (10)	1.7	0.4	1.4 to 1.9
	10 (10)	1.6	0.5	1.1 to 1.7
	9 (8)	1.3	0.5	1.1 to 1.6

* cm distal to the mid line of the back, ICS = Intercostal spaces.

Table 3: Results of the ultrasonographic examination of the caudal vena cava of 10 adult female Lori breed sheep.

Variable	ICS (No. of sheep)	Mean	SD	Normal range
Dorsal Margin	12 (6)	6.8*	1.9	5 to 8
	11 (10)	9.7*	1.7	7 to 12
	10 (10)	12.6*	1.6	10 to 15
	9 (8)	14.2*	2.1	12 to 16
Depth (cm)	12 (6)	5.2	1.02	4.8 to 5.8
	11 (10)	6.1	1.05	5.2 to 6.6
	10 (10)	6.9	0.9	6.1 to 7.2
	9 (8)	7.9	0.87	7.4 to 8.4
Diameter (cm)	12 (6)	1.7	0.2	1.5 to 2.0
	11 (10)	1.7	0.3	1.5 to 1.9
	10 (10)	1.8	0.2	1.6 to 2.2
	9 (8)	1.8	0.2	1.7 to 2.1

* cm distal to the mid line of the back, ICS = Intercostal spaces.

The gallbladder

The gallbladder was visualized in all sheep (Fig. 1C). In 2 sheep, it was visible in only 1 space (11th ICS), whereas in 7 sheep, it was observed in 2 spaces (10th and 11th

ICS) and in 1 sheep it was seen in 3 spaces (10^{th} to 12^{th} ICS). In all of the sheep, the gallbladder was situated in the 11^{th} ICS. Ultrasonographically, the gallbladder was easily recognized. It appeared as an anechoic region with an echogenic margin, immediately adjacent to the visceral surface of the liver. Its shape was mostly oval, often slim and oblong, sometimes pear-shape, and rarely round. The neck of the gallbladder was clearly visible. The size of the gallbladder varied greatly. Its length was between 4.3 and 6.2 cm (5.2 ± 0.9 cm) and its width varied from 1.4 to 2.1 cm (1.7 ± 2.2).

Discussion

The description of the ultrasonographic appearance of liver of clinically normal Lori breed sheep represents a reference for use of diagnostic ultrasonography in sheep with suspected hepatic disease.

In ruminants, there are many indications for ultrasonographic examination of the liver, because other diagnostic imaging techniques for detecting liver diseases are not appropriate. Radiology could not be use in ruminants because of large soft tissue effect of the rumen. Computed tomography and magnetic resonance imaging are not applicable in ruminant and scintigraphy is expensive, has radiobiological problem and not applicable in the field. So that ultrasonography will be the modality of choice in ruminants not only for the liver but also for the abdominal organs. In ruminants, hepatic enzyme tests are not specific for diagnosis of liver diseases. Metabolic disorders lead to diffuse changes in liver, whereas abscesses and tumors usually induce focal changes [15]. Hepatic enzyme tests are generally unable to distinguish these diseases [15]. In this study, we determined quantitatively the normal anatomic characteristics of liver of another breed of sheep. Braun and Hausammann in 1992 reported that liver of sheep could be examined from the 7^{th} ICS to just caudal the costal arch and intercostal spaces of 11 through 7 were the best for examination [6]. This is in accordance with our results. However, it is important to examine the liver in all spaces. In our study and in Braun and Hausammann in 1992 the liver was seen dorsally up to the margin of the lung, but ventral hepatic margin sometimes covered a few centimeters of the costal arch [6]. Braun and Hausammann in 1992 believed that an increase in liver size may be suspected when the liver extends over 25 cm in one ICS or is over 8.5 cm thick but our finings were a little different from this range. We found in Lori breed sheep when the diameter of the caudal vena cava in the 10^{th} ICS is more than 2.2 cm and the diameter of the portal vein is over 2.0 cm, dilatation from congestion may be suspected. While Braun and Hausammann in 1992 suggested 2.7 cm and 2 cm for the diameter of the caudal vena cava the portal vein respectively. In Braun and Hausammann report in 1992 the gallbladder circumference changed daily, thus it is difficult to decide whether the size is normal or increased on the basis of 1 examination [6]. From the results of current examination, the length of the gallbladder should not exceed 7 cm. In questionable cases, the gallbladder should be reexamined the next day, or the animal should be fed before examination to stimulate gallbladder emptying.

There were good agreement between results of our study and those described earlier when White Alpine sheep were examined, particularly for technique and position of the liver. But there were also some differences between thickness and size of the liver in our study and previous report in sheep that emphasize of the influence of the breed

of sheep on the quantitative ultrasonic assessment of liver size [6]. This is in contrast to the Braun and Gerber report that breed and age of the cow did not influence the ultrasonographic appearance of the liver [5]. Results of this study provide reference values for ultrasonographic examination of the liver of another breed of sheep. It is important to remember that subjective assessment of the liver, hepatic vasculature and gallbladder also is important. To optimize the diagnostic potential of ultrasonographic examination of the liver, it is crucial to combine results of objective measurement and subjective assessment.

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References

1. Nyland TG and Matton JS. *Small animal diagnostic ultrasound*. 2nd ed. Pennsylvania:WB Saunders Co., 2002;93-128.
2. Godshalk CP, Badertscher RR, Rippy MK, et al. Quantitative ultrasonic assessment of liver size in the dog. *Vet Radiol* 1988;29:162-167.
3. Reef VB. *Equine diagnostic ultrasound*. 1st ed. Pennsylvania: WB Saunders Co, 1998; 277-281.
4. Braun U. Ultrasonographic examination of the liver of the cows. *Am J Vet Res* 1990;51:1522-1526.
5. Braun U, Gerber D. Influence of age, breed, and stage of pregnancy on hepatic ultrasonographic findings in cows. *Am J Vet Res* 1994;55:1201-1205.
6. Braun U, Hausammann K. Ultrasonographic examination of the liver in sheep. *Am J Vet Res* 1992;53:340-384.
7. Ghadiri AR, Haji Hahjikolaee MR, Mir A. Ultrasonographic examination of the liver in goat, in *Proceedings*. 38th Ann Sci Meet Exh Br Med Ultras Soci, Vet Sec 2006;31.
8. Braun U, Pusterla N, Wild K. Ultrasonographic examination of the liver and gallbladder in cows. Part 2. Abnormal findings. *Comp Cont Educ Pract Vet* 1996;18: 1255-1270.
9. Braun U, Pusterla N, Wild K. Ultrasonographic findings in 11 cows with a hepatic abscess. *Vet Rec* 1995;137:284-290.
10. Ghadiri AR, Esmaeil-zadeh S, Mohammadian B. Ultrasonographic study of hydatid cyst in some of livers of cattle and buffalos collected from slaughter house, in *Proceedings*. 2002 Eur Ass Vet Diag Imag Annual meeting. *Vet Radiol Ultras 2003;44*:251.
11. Lechtenberg, KF, Nagaraja TG. Hepatic ultrasonography and blood change in cattle with experimentally induced hepatic abscess, *Am J Vet Res* 1991;52:801-809.
12. Acorda A, Haruo Y, Ghamsari SM. Evaluation of fatty infiltration of the liver in dairy cattle thorough digital analysis of hepatic ultrasonogram, *Vet Radiol Ultras* 1994;35: 120-123.
13. Braun U, Pospischil A, Pusterla N, et al. Ultrasonographic findings in cows with cholestasis. *Vet Rec* 1995;137:537-543.
14. Braun U, Linggi T, Pospischil A. Ultrasonographic findings in three cows with chronic ragwort (Senecio alpinus) poisoning. *Vet Rec* 1999;144:122-126.

15. Pearson EG. Diseases of the hepatobiliary system. In: Smith BP ed. *Large Animal Internal Medicine*. 3rd ed. Missouri: Mosby, 2002;790-795

چکیده

یافته های اولتراسونوگرافی کبد در گوسفند نژاد لری

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هدف: تکنیک و یافته های اولتراسونوگرافی کبد گوسفند نژاد لری ایران
طرح: مطالعه توصیفی
حیوانات: ده راس گوسفند لری ماده سالم
روش کار: بدین منظور ۱۰راس گوسفند سالم انتخاب شدند. پشم های سمت راست از خلف کتف تا تهیگاه و از زائده عرضی مهره ها تا پایین شکم کاملا تراشیده و پوست تمیز و شسته شد. اولترا سونوگرافی برای جستجوی کبد از خلف دنده سیزده تا هفتمین فضای بین دنده ای و از سطح پشتی به شکمی انجام گرفت. یافته های اولترا سونوگرافی شامل امکان مشاهده کبد از هر فضای بین دنده ای و از میزان فاصله ای که از خط وسط پشتی در بازدم داشت، وضعیت اکوژنیسیته کبد ، عمق کبد، موقعیت ، قطر و عمق سیاهرگ های باب و میان خالی خلفی و موقعیت و اندازه کیسه صفرا بود، که مورد جستجو و ارزیابی اولترا سونوگرافی قرار گرفتند.
نتایج: اکوژنیسیته بافت کبد یکنواخت بود و درون آن سیاهرگ های کبدی و باب بخوبی قابل مشاهده بودند. بافت کبد از فضای بین دنده ای یازده تا هشت به آسانی قابل سونوگرافی بود. مقطع سیاهرگ باب ،گرد تا کمی بیضی شکل بود با دیواره کاملا واضح و اکوژنیک، که در فضای بین دنده ای دوازده تا نه بخوبی قابل اسکن بود. به سمت قدام ، قطر این سیاهرگ کمتر و عمق آن بیشتر می شد. سیاهرگ میان خالی خلفی ، قطره ای شکل بوده و در فضای بین دنده ای دوازده تا ده به خوبی اسکن شد و به سمت قدام ، قطر و عمق آن افزایش می یافت. کیسه صفرا، در اندازه های مختلف و به شکل یک فضای بدون اکو، بیضی و کشیده در مجاورت دیواره شکم دیده شد و اغلب در فضای بین دنده ای ده و یازده مشاهده می شد.
نتیجه گیری: نتایج این تحقیق مقادیر مرجع را برای آزمایش اولتراسونوگرافی کبد در نژاد دیگری از گوسفند را فراهم می نماید.
کلید واژگان: کبد، گوسفند لری، اولتراسونوگرافی، کیسه صفرا