

Ultrasonographic examination of the spleen in 30 goats

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Summary

The ultrasonographic appearance, location and size of the spleen in 30 healthy female Saanen goats are described. The intercostal spaces of the left thoracic wall were scanned with a 5.0 MHz linear transducer in standing goats. The appearance of the splenic parenchyma, the position of the ultrasonographically visible dorsal and ventral margins of the spleen and the distance between them, the thickness of the spleen and the diameter of the splenic vessels were determined. The spleen could be visualised in at least one examination position and it always lay between the rumen and abdominal wall. The spleen bordered the lung dorsally and was located adjacent to the left abdominal wall in the last intercostal space and area immediately caudal to the last rib. The spleen had an echogenic capsule, and its parenchyma showed a homogenous fine echotexture / echo pattern throughout the whole visible part of the spleen. The splenic vessels were seen within the parenchyma. The visible dorsal margin of the spleen ran from cranioventral to caudodorsal. The distance from the dorsal margin of the spleen to the midline of the back was greatest in the 8th intercostal space (19.7 ± 4.19 cm) and smallest in the region immediately caudal to the last rib (7.0 ± 1.07 cm). The size of the spleen was smallest in the 8th intercostal space (3.1 ± 1.24 cm) and greatest in the 11th intercostal space (8.7 ± 2.78 cm). The thickness of the spleen ranged from 2.2 ± 1.14 cm caudal to the last rib to 6.4 ± 1.78 cm in the 11th intercostal space.

Keywords: goat, spleen, ultrasonography, normal findings

Sonographische Untersuchung der Milz bei 30 Saanenziegen

In der vorliegenden Arbeit wird die Ultraschalluntersuchung der Milz von 30 weiblichen, klinisch gesunden Saanenziegen beschrieben. Die Untersuchungen wurden am stehenden Tier mit einem 5.0 MHz-Linearschallkopf in den Interkostalräumen der linken Brustwand durchgeführt. Zuerst wurde die Milz subjektiv beurteilt. Um Aufschluss über die Grösse und Ausdehnung der Milz zu erhalten, wurden die obere und untere Milzgrenze sowie die Ausdehnung der Milz bestimmt. Ebenfalls bestimmt wurden die Milzdicke und der Durchmesser der Milzgefässe. Die Milz konnte bei allen Ziegen an mindestens einer Untersuchungsstelle dargestellt werden. Sie lag immer zwischen Pansen und Bauchwand. Nach dorsal grenzte die Milz an die Lunge, im letzten Interkostalraum und kaudal der letzten Rippe auch an die Bauchwand. Die Milz war von einer echogenen Kapsel umgeben. Die Milzpulpa bestand aus zahlreichen feinen Echos, welche die Milzkontur ausfüllten. In die Milzpulpa eingebettet waren die Milzgefässe. Die dorsale Milzgrenze verlief von cranioventral nach caudodorsal. Im 8. Interkostalraum war sie mit 19.7 ± 4.19 cm am weitesten und im Bereich kaudal der letzten Rippe mit 7.0 ± 1.07 cm am wenigsten weit von der Mittellinie des Rückens entfernt. Die Ausdehnung der Milz war im 8. Interkostalraum mit 3.1 ± 1.24 cm am kleinsten und im 11. Interkostalraum mit 8.7 ± 2.78 cm am grössten. Die Dicke des Milzparenchyms lag zwischen 2.2 ± 1.14 cm kaudal der letzten Rippe und 6.4 ± 1.78 cm im 11. Interkostalraum.

Schlüsselwörter: Ziege, Milz, Sonographie, Normalbefunde

Introduction

In goats, the spleen is located dorsally in the region of the 10th to 13th intercostal spaces in the left dorsal abdominal quadrant (Frewein et al., 2004). Approximately half of the parietal surface of the spleen is related to the region where the craniodorsal blind sac of the rumen and the dia-

phragm are adherent, which fixes the spleen in a relatively immovable position. The spleen serves to recognize and eliminate abnormal blood cells and blood parasites and produce haematopoietic cells as well as lymphocytes and specific antibodies in response to systemic diseases; the spleen is moderately enlarged in many infectious diseases reflecting an increase in function (Radostits et al., 2007).

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In cattle with traumatic reticuloperitonitis, suppurative splenitis or abscessation of the spleen often results when a reticular foreign body penetrates the spleen (Nuss et al., 2009). This disease is uncommon in goats because the spleen is not situated directly adjacent to the reticulum and goats rarely ingest sharp foreign bodies. However, the caprine spleen may be affected by tumours such as malignant lymphoma, or septic and suppurative processes via haematogenous spread of infection. There are no characteristic signs of splenic disease and there are no specific methods for examination of this organ in goats. It cannot be palpated externally and there are no specific laboratory parameters for determining splenic disease. Radiography is not useful for assessing the spleen in goats, but computed tomography has proven to be an excellent diagnostic tool (Irmer, 2009). Ultrasonography has been well described and is used routinely to evaluate the spleen in dogs (Nyland et al., 2002), horses (Reef, 1998) and cattle (Sicher, 1995; Braun and Sicher, 2006), but not in goats. The goal of the present study was to describe the ultrasonographic appearance, size and localisation of the spleen and associated blood vessels in 30 healthy goats.

Animals, Material and Methods

Animals

Thirty clinically healthy, female Saanen goats, which were 2.0 to 6.5 years (mean \pm sd = 4.9 \pm 1.10 years) old and weighed 42 to 86 kg (61.8 \pm 9.95 kg), were used. After purchase, all of the goats were deemed healthy based on the results of a thorough clinical examination, a complete blood cell count, biochemical profile, urinalysis, and examination of rumen juice and faeces. The results of these examinations have been described in detail (Becker-Birck, 2009). The goats originated from two farms and had been sold for slaughter.

Ultrasonographic examination of the spleen

A real-time ultrasound machine (EUB 8500, Hitachi Medical Systems, Zug, Switzerland) with a 5.0 MHz linear transducer was used to examine the spleen of standing, non-sedated goats using the method described for cattle (Sicher, 1995; Braun and Sicher, 2006) and goats (Steininger, 2009). The left thoracic wall was clipped from the caudal border of the shoulder to just caudal to the last rib and from the dorsal midline to the linea alba. Each intercostal space and the region caudal to the last rib were examined from dorsal to ventral with the transducer held parallel to the ribs.

First the appearance of the splenic capsule and parenchyma were assessed subjectively. The size and location of the spleen were then calculated using the values determined for the position of the dorsal and ventral margins of the spleen. Figure 1 shows how the measurements were made

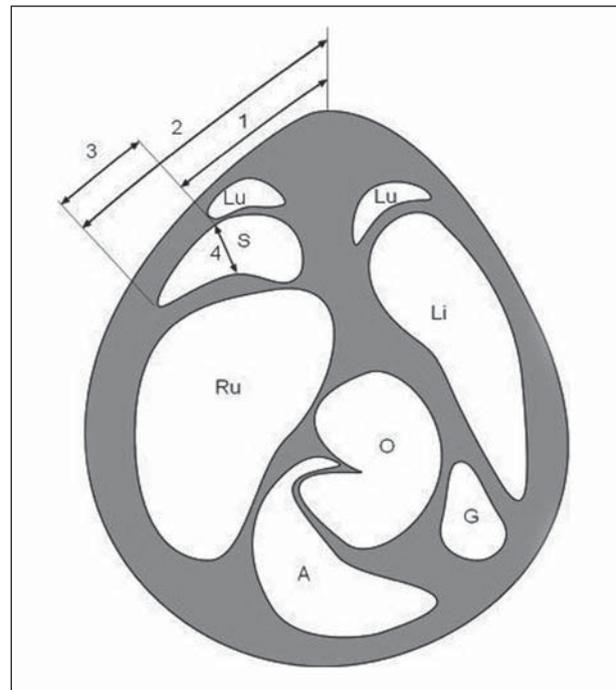


Figure 1 : Schematic representation of determination of the position and size of the spleen in goats on a cross section in the 11th intercostal space. Lu Lung, Li Liver, G Gallbladder, S Spleen, Ru Rumen, O Omasum, A Abomasum, 1 Distance between dorsal midline and dorsal margin of the spleen, 2 Distance between dorsal midline and ventral margin of spleen, 3 Size of spleen, 4 Thickness of spleen.

in each intercostal space. They included determination of the dorsal visible and ventral margins, size and maximal visible thickness of the spleen. Measurements were made at maximum inspiration. The positions of the dorsal visible and ventral margins of the spleen were determined relative to the midline of the back. The size of the spleen was calculated by subtracting the value for the dorsal visible margin of the spleen from that for the ventral margin. The diameter of blood vessels in the spleen was measured electronically using the two calipers.

Postmortem examination

The goats were slaughtered (n = 14) or euthanased (n = 16). A macroscopic postmortem examination of the spleen was carried out in the slaughtered goats. The euthanased goats, which were also used in other studies (Becker-Birck, 2009; Irmer, 2009), were frozen and cut into 1.0 to 1.5 cm-thick transverse sections. The spleen was examined on these sections.

Statistics

The statistical software program StatView 5.1 (SAS Institute, Wangen) was used for analysis of the data. Frequencies, means and standard deviations were calculated.

Approval of the study by an ethical committee

The study was approved by an ethical committee of the canton of Zurich, Switzerland.

Results

The spleen could be visualised via ultrasonography in at least one intercostal space in all goats and was seen in the 8th, 9th, 10th, 11th and 12th intercostal spaces in 12, 24, 29, 30 and 29 goats, respectively, and immediately caudal to the last rib in 14 goats (Tab. 1). It was located between the rumen and left abdominal wall in all goats. Dorsally, the parietal surface of the spleen was in contact with the lung and the most dorsal part was partially covered, and in the last intercostal space and region immediately caudal to the last rib, it lay against the left abdominal wall. There was movement of the spleen relative to the peritoneum in synchrony with respiration. The spleen had an echoic capsule, and the parenchymal pattern consisted of numerous

weak echoes distributed homogenously over the entire visible area of the spleen (Fig. 2). Compared with the liver, the spleen was sonographically hyperechoic in 17 goats, isoechoic in nine and hypoechoic in four. The vessels of the spleen were embedded in the parenchyma of the organ and appeared as anechoic circular to oval or elongated structures. They had a diameter of 0.07 to 0.57 cm. The dorsal margin of the visible part of the spleen ran from cranioventral to caudodorsal (Fig. 3). The distance between the dorsal margin of the spleen and the midline of the back was greatest in the 8th intercostal space (19.7 ± 4.19 cm; Table 1). This distance decreased caudally and was only 7.0 ± 1.07 cm in the region immediately caudal to the last rib. The ventral margin of the spleen had a similar course; it was greatest in the 9th intercostal space (22.9 ± 2.80 cm) and shortest in the region immediately caudal to the last rib (10.9 ± 2.58 cm). The size of the spleen was smallest in the 8th intercostal space (3.1 ± 1.24 cm) and largest in the 11th intercostal space (8.7 ± 2.78 cm). The thickness of the spleen ranged from 2.2 ± 1.14 cm caudal to the last rib to 6.4 ± 1.78 cm in the 11th intercostal space.

Table 1: Results of ultrasonographic examination of the spleen in 30 Saanen goats (mean \pm sd, ranges are in brackets).

Variable	Localisation					
	8th intercostal space	9th intercostal space	10th intercostal space	11th intercostal space	12th intercostal space	Caudal to last rib
Number of goats	12	24	29	30	29	14
Dorsal margin of spleen (cm)	19.7 ± 4.19 (10.0 – 25.0)	17.4 ± 2.76 (12.0 – 22.0)	13.9 ± 2.75 (9.0 – 18.5)	9.6 ± 2.36 (6.0 – 13.0)	7.7 ± 1.61 (5.0 – 11.0)	7.0 ± 1.07 (5.5 – 9.0)
Ventral margin of spleen (cm)	22.8 ± 4.34 (13.0 – 28.0)	22.9 ± 2.80 (16.0 – 28.0)	21.4 ± 2.67 (16.0 – 27.0)	18.3 ± 2.92 (12.0 – 23.0)	15.1 ± 2.79 (10.0 – 21.0)	10.9 ± 2.58 (7.0 – 17.0)
Size of spleen (cm)	3.1 ± 1.24 (2.0 – 5.0)	5.5 ± 2.08 (2.0 – 9.5)	7.5 ± 2.82 (3.0 – 13.0)	8.7 ± 2.78 (3.5 – 15.0)	7.4 ± 2.71 (1.5 – 12.0)	3.9 ± 1.97 (1.0 – 8.0)
Thickness of spleen (cm)	3.5 ± 1.40 (1.4 – 6.5)	4.5 ± 2.0 (0.5 – 8.6)	6.1 ± 1.76 (1.2 – 9.7)	6.4 ± 1.78 (1.5 – 9.3)	5.0 ± 1.88 (1.2 – 7.9)	2.2 ± 1.14 (0.4 – 5.1)

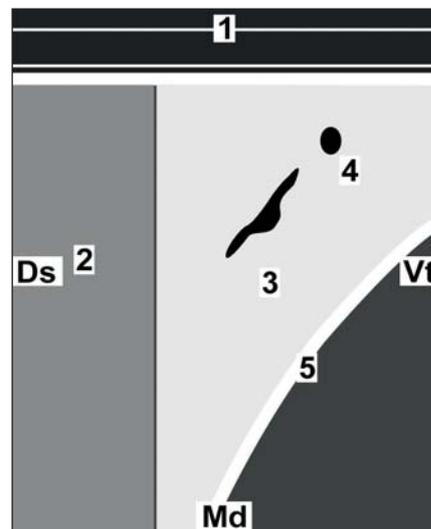
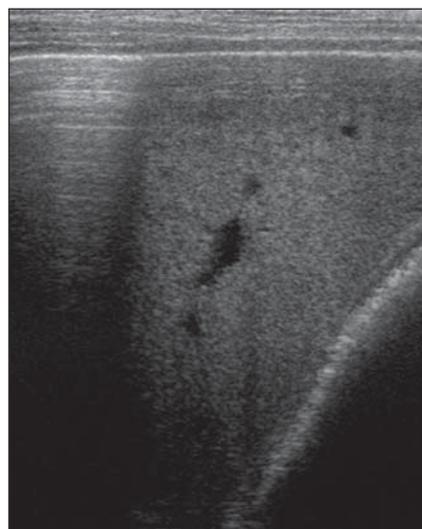


Figure 2: Ultrasonogram and schematic representation of the splenic parenchyma of a 3.5-year-old Saanen goat viewed from the 11th intercostal space. 1 Lateral abdominal wall, 2 Lung, 3 Splenic parenchyma, 4 Spleen vessels, 5 Rumen, Ds Dorsal, Vt Ventral, Md Medial.

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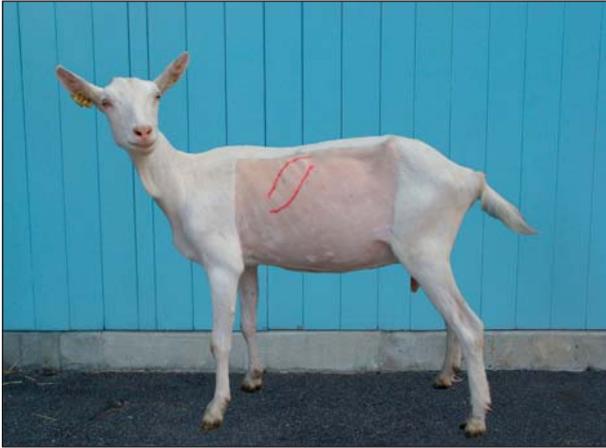


Figure 3 : The dorsal and ventral margins of the spleen have been drawn from the 8th intercostal space to just caudal to the last rib on a Saanen goat. The outline corresponds to the mean positions of the dorsal margins of the spleen and ventral margins of the spleen in 30 goats.

Discussion

Ultrasonographic examination of the spleen was straightforward. Because it was located adjacent to the costal part of the left abdominal wall, the spleen could be clearly visualised in all the goats from the 8th intercostal space to the region immediately caudal to the last rib. The splenic parenchyma was best evaluated in the 10th to 12th intercostal spaces because the organ was seen in almost all goats in this area. In goats, the spleen is limited to the

dorsolateral region of the costal part of the left abdominal wall, whereas in cattle, the spleen extends toward the ventral region and contacts the reticulum (Sicher, 1995; Braun and Sicher, 2006). Because of its location, the caprine spleen is not predisposed to disease caused by penetrating reticular foreign bodies as in cattle (Braun, 2003). The ultrasonographic appearance of the splenic parenchyma was similar to that reported for small animals (Nyland et al., 2002), horses (Reef, 1998) and cattle (Sicher, 1995; Braun and Sicher, 2006). It consisted of numerous small echoes homogeneously distributed over the entire area of the organ. The ultrasonographic appearance of the splenic parenchyma resembled that of the liver parenchyma; similar findings have been reported in horses, small animals and cattle (Braun, 1990). However, the two organs can be easily differentiated because of their different anatomical locations. Moreover, the liver is easily recognised by the triangular-shaped caudal vena cava and star-shaped branching of the portal vein (Steininger, 2009; Braun and Steininger, 2009). The hilus of the spleen is not visible on ultrasonograms because it is superimposed by lung.

Ultrasonography is a useful, straightforward and non-invasive method for evaluation of the spleen in goats. The appearance and size of the spleen in healthy goats serves as reference values for the diagnosis of splenic lesions. To date, splenic lesions diagnosed via ultrasonography in cattle have been associated with traumatic reticuloperitonitis (Braun, 2003). In dogs, other lesions including tumours, atrophy, hypertrophy, haematoma and torsion of the spleen have been diagnosed using ultrasonography (Nyland et al., 2002).

Examen échographique de la rate chez 30 chèvres de Gessenay

On décrit dans le présent travail l'examen échographique de la rate chez 30 chèvres de Gessenay cliniquement saines. Les examens ont été effectués sur l'animal debout par les espaces intercostaux de la paroi gauche du thorax au moyen d'une sonde linéaire de 5.0 MHz. Tout d'abord la rate a été jugée de façon subjective. Afin de définir la taille et l'étendue de la rate, ses limites supérieures et inférieures ainsi que son extension ont été déterminées. On a également mesuré son épaisseur et le diamètre des vaisseaux spléniques. Chez toutes les chèvres, la rate a pu être visualisée à au moins un emplacement d'examen. Elle se trouvait toujours entre la paroi abdominale et la panse. Dorsalement, elle atteignait les poumons et, dans le dernier espace intercostal et en arrière de la dernière côte, la paroi abdominale. La rate était entourée d'une capsule échogène. La pulpe se composait de multiples petits échos qui remplissaient le contour splénique. Les vais-

Esami sonografici della milza in 30 capre di Saanen

Nello studio qui riportato viene descritto l'esame a ultrasuoni sulla milza di 30 capre di Saanen femmine clinicamente sane. L'esame veniva effettuato sull'animale in piedi con una sonda a ultrasuoni lineare di 5.0 MHz nello spazio intercostale della parete toracica sinistra. Dapprima la milza è stata valutata soggettivamente. Per ottenere un pronostico sulla dimensione e l'estensione della milza è stato definito il limite superiore e inferiore della milza e la sua estensione. Inoltre sono stati misurati lo spessore della milza e il diametro dei suoi vasi. La milza si è potuta visualizzare in tutte le capre almeno in una zona esaminata. Si trovava sempre tra rumine e parete addominale. Dorsalmente la milza era sui bordi dei polmoni, e anche nella parete addominale nell'ultimo spazio intercostale e caudale dell'ultima costola. La milza era circondata da una capsula ecogena. La polpa della milza era composta da numerose sottili eco che riempivano il suo contorno.

seaux spléniques étaient inclus dans la pulpe. Le bord dorsal s'étendait de cranioventral en direction caudodorsale. Dans le 8^e espace intercostal, elle était le plus éloigné de la ligne médiane du dos avec 19.7 ± 4.19 cm et dans la région la plus rapprochée avec 7.0 ± 1.07 . L'extension de la rate était la plus petite dans le 8^e espace intercostal avec 3.1 ± 1.24 cm et la plus grande dans le 11^e espace intercostal avec 8.7 ± 2.78 cm. L'épaisseur du parenchyme splénique variait entre 2.2 ± 1.14 cm caudalement de la dernière côte et 6.4 ± 1.78 cm dans le 11^e espace intercostal.

La polpa della milza inglobava i vasi della milza. I limiti dorsali correvano da cranioventrale a caudodorsale. Nell'ottavo spazio intercostale era distanziata dalla linea centrale della schiena di 19.7 ± 4.19 cm al massimo e nell'area caudale dell'ultima costola di 7.0 ± 1.07 cm al minimo. L'estensione della milza era nell'ottavo spazio intercostale di 3.1 ± 1.24 cm al minimo e di 8.7 ± 2.78 cm al massimo. Lo spessore del parenchima si situava tra 2.2 ± 1.14 cm caudale dell'ultima costola e di 6.4 ± 1.78 cm nello spazio intercostale.

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