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Ultrasonographic examination of the small intestine, large intestine and greater omentum in 30 Saanen goats

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ABSTRACT

The small and large intestine of 30 healthy Saanen goats were examined ultrasonographically using a 5.0 MHz-linear transducer. The goats were examined on the right side, from the eighth rib to the caudal aspect of the flank. The small and large intestine could be easily differentiated. The descending duodenum could be imaged in 19 goats, and the jejunum and ileum seen in all goats. The jejunum and ileum were most often seen in cross-section and rarely in longitudinal section in the ventral region of the right flank. The intestinal contents were usually homogenously echoic, and active motility was observed in all the goats. The diameter of the small intestine was 0.8–2.7 cm (1.6 [0.33] cm). The spiral ansa of the colon was imaged in all the goats, and in 21 the caecum was also seen. Both these sections of large intestine were most commonly seen in the dorsal region of the right flank. The spiral ansa of the colon was easily identified by its spiral arrangement of centripetal and centrifugal gyri, which had a garland-like appearance. Because of intraluminal gas, only the wall of the colon closest to the transducer could be imaged. The diameter of the spiral colon ranged from 0.8 to 2.0 cm (1.1 [0.24] cm). Usually only the wall of the caecum closest to the transducer could be imaged and it appeared as a thick, echoic, slightly undulating line. The greater omentum could be seen in all the goats.

Introduction

In cattle, ultrasonographic examination of the small intestine (Marmier, 1993; Braun and Marmier, 1995) and large intestine (Amrein-Schneider, 1999; Braun and Amrein, 2001) has been described in healthy cows and in cows with ileus of the duodenum, ileum and jejunum (Braun et al., 1995, 2010; Braun, 2003, 2005; Nuss et al., 2006; Streeter and Step, 2007; Lejeune and Lorenz, 2008) and caecal dilatation (Braun et al., 2002). Evaluation of the contents of the small intestine in cattle is usually straightforward. Because there is generally no gas, the intestinal wall closest to the transducer as well as the intestinal contents and the wall furthest from the transducer can be visualised. The different parts of the small intestine can be clearly differentiated. The cranial part of the duodenum is easily identified because it starts at the abomasum and is in close contact with the liver and gallbladder. The descending duodenum can almost always be imaged and is identified as a horizontal structure running caudally between the two serosal layers of the greater omentum immediately adjacent to the abdominal wall. The jejunum and ileum cannot be differentiated ultrasonographically and represent the longest part of the small intestine. In most healthy cows, using a 3.5 MHz-linear transducer with a penetration depth of 17 cm, more than 10 loops of small intestine are seen, usually in cross-section but sometimes in longitudinal section, in the flank and 9th–12th intercostal spaces.

Intraluminal gas is usually a differentiating feature of the large intestine (Amrein-Schneider, 1999; Braun and Amrein, 2001). Because of the gas, often only the wall of the large intestine closest to the transducer can be imaged and it appears as a thick echoic line. Parts of the proximal ansa, caecum and spiral ansa of the colon can usually be seen. The proximal ansa and caecum appear as a thick echoic continuous and slightly curved line. The spiral ansa of the colon looks like an echoic garland because of the concentric arrangement of the loops of intestine. To the authors' knowledge, there is no information on the ultrasonographic appearance of the intestinal tract in goats. Reasons for this most likely are economic; the value of individual goats is generally low and ultrasound equipment is expensive. However, because ultrasound machines are widely available in general veterinary practice, and because owners of sick pet goats or expensive show animals are often willing to pay for an extensive diagnostic work-up, it is expected that the use of ultrasonography in goats, as in other small ruminants, will become more widespread. Ileus and caecal dilatation attributable to various causes occur frequently in cattle and to a lesser extent in goats. Transrectal palpation can be used to detect dilated loops of intestine or a dilated caecum in many bovine

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patients but this is not possible in goats for anatomical reasons. Instead, a tentative diagnosis of ileus or caecal dilatation may be based on the absence of faeces in the rectum or the presence of blood, mucus or fibrin in the faeces. Failure to diagnose either of these conditions may result in conservative rather than surgical treatment, which results in prolongation of the disorder and perhaps irreparable lesions. Abdominal ultrasonography appears to be a promising tool for rapid diagnosis of ileus or caecal dilatation in goats. However, diagnosis of these conditions requires a thorough knowledge of the ultrasonographic appearance of the normal large and small intestines in goats. Thus, the goal of the present study was to document the ultrasonographic findings of the small and large intestines in 30 healthy Saanen goats.

Materials and methods

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

Animals

Thirty, clinically healthy, non-lactating, female, Saanen goats, which were 2.0–6.5 year (mean [sd] 4.9 [1.10] years) old and weighed 42–86 kg (61.8 [9.95] kg), were used. The goats were not pregnant. They originated from two farms and had been sold for slaughter. 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).

Ultrasonographic examination of the small intestine and large intestine

A real-time ultrasound machine (EUB 8500, Hitachi Medical Systems) with a 5.0 MHz-linear transducer with a penetration depth of 9 cm (EUP-L53 Linear) was used to examine the standing, non-sedated goats. The right side of each goat, from the dorsal midline of the back to the linea alba and from the eighth rib to the caudal aspect of the flank, was clipped. The 8th–12th intercostal spaces were examined from dorsal to ventral with the transducer held parallel to the ribs. The right flank was examined from dorsal to the linea alba with the transducer held perpendicular to the longitudinal axis of the body. For optimal localisation of the various parts of the intestine, the flank was divided into four quadrants using a vertical line at the level of the fifth lumbar vertebra and a horizontal line at the level of the patella (Fig. 1a).

Small intestine

Ultrasonographic evaluation of the small intestine was carried out as described for cattle (Marmier, 1993; Braun and Marmier, 1995; Braun, 2003) and goats (Steininger, 2009). The appearance, contents and intestinal motility were subjectively assessed. The diameter and the thickness of the intestinal wall were determined using the in-built cursor system once the image was frozen. Visualisation of the cranial, descending and ascending parts of the duodenum was then attempted (Fig. 1b). The jejunum and ileum were evaluated in the 9th–12th intercostal spaces on the right flank. No attempt was made to differentiate between the jejunum and the ileum, as such a differentiation is not possible in cattle (Braun and Marmier, 1995; Braun, 2003). The intercostal space and abdominal quadrant in which loops of intestine could be visualised were determined. Then at each location, the number of loops seen in cross and longitudinal section, the intestinal diameter and the appearance of the intestinal contents were recorded.

Large intestine

Ultrasonographic examination of the large intestine was carried out as described for cattle (Amrein-Schneider, 1999; Braun and Amrein, 2001; Braun, 2003) and goats (Steininger, 2009). The size of the large intestine was determined in the 10th–12th intercostal spaces and in the flank (Fig. 1). Attempts were made to differentiate the proximal loop of the colon, the spiral loop of the colon and the caecum. The contents, thickness and various layers of the wall and motility of the large intestine were evaluated. The diameter of the spiral loop of the colon and the caecum were also determined.

Ultrasonographic examination of the greater omentum

The greater omentum was evaluated in the 8th–12th intercostal spaces and in the right flank. The thickness of the omentum was measured electronically using the two cursors.

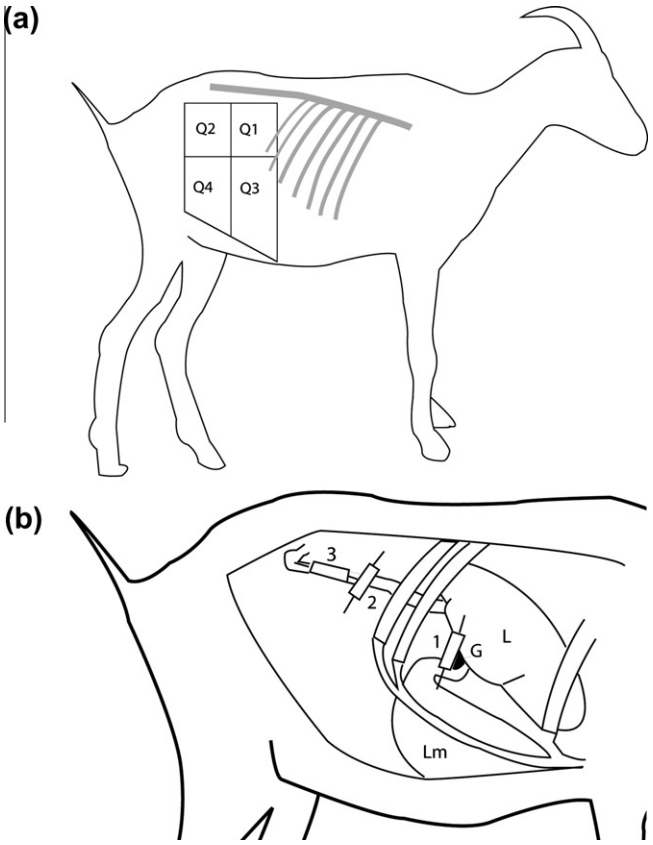

Fig. 1. (a) Division of the flank region into four quadrants for localisation of intestine during ultrasonographic examination. Q1 – Craniodorsal quadrant, Q2 – Caudodorsal quadrant, Q3 – Cranioventral quadrant, Q4 – Caudoventral quadrant. (b) Position of the linear transducer for the ultrasonographic examination of the various parts of the duodenum. 1 – Position for the examination of the cranial part of the duodenum, 2 – Position for examination of the descending part of the duodenum in cross-section, 3 – Position for the examination of the duodenum in longitudinal section, L – Liver, G – Gall bladder (black area), Lm – Abomasum.

Postmortem examination

After examination, the goats were slaughtered (n = 14) or euthanased (n = 16). A macroscopic postmortem examination of the intestines 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 intestine was examined on these sections.

Statistical analysis

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

Results

Duodenum

The cranial part of the duodenum could not be visualised in any of the goats because it was hidden by the liver (see also Fig. 1b), and the ascending part of the duodenum could not be seen because its distance from the abdominal wall exceeded the depth of penetration of the transducer. The descending duodenum could be distinctly differentiated from other parts of the small and large intestine in 19 goats. Similar to cattle (Braun and Marmier, 1995), the descending duodenum was recognised because of its location immediately adjacent to the abdominal wall and between the two serosal layers of the greater omentum (Fig. 2). Its contents