Reliability of ultrasonographic examination of the large intestine in healthy cows

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ABSTRACT: The aim of this study was to assess the usefulness of ultrasonographic examination of the large intestine in 10 clinically healthy Jersey/Red Sindhi crossbred cows. The area extending from the tuber coxae to the 6^{th} intercostal space (ICS) and from the lumbar transverse processes to the linea alba on the right side was shaved. An imaginary line was drawn from the distal third of the femur up to the 8^{th} ICS parallel to the longitudinal axis of the cow. The large intestine was scanned dorsal to this imaginary line. Only the near wall of the large intestine adjacent to the abdominal wall could be imaged ultrasonographically. Based on the topographical anatomy, the ultrasonographic images of the caecum and the proximal loop of the ascending colon (PLAC), resembling the 'arc of a circle', were observed in the mid to dorsal right paralumbar fossa and the 12^{th} ICS; however, the caecum and the PLAC could not be differentiated with certainty using ultrasonography. Similarly, the ultrasonographic images of the spiral loop of the ascending colon (SLAC), resembling a 'cycloid', could be imaged through the 12^{th} to 11^{th} ICSs and in the dorsal right paralumbar fossa; yet, ultrasonographically, it was difficult to differentiate the SLAC from the descending loop of the ascending colon, transverse colon, and descending colon, respectively. The differences (qualitative and quantitative) in the degrees of curvatures of various ultrasonographic images of parts of the large intestine were also not helpful. In conclusion, ultrasonographic imaging of various parts of the bovine large intestine should be interpreted with caution.

Keywords: ultrasonography; large intestine; caecum; colon; cows

List of abreviations

DC = descending colon, **DLAC** = descending loop of the ascending colon, **ICS** = intercostal space, **PLAC** = proximal loop of the ascending colon, **SC** = sigmoid colon, **SLAC** = spiral loop of the ascending colon, **TC** = transverse colon

Knowledge of the topographic relations of the large intestine (caecum and colon) to the body wall is essential to the veterinary surgeon for its clinical examination, which includes the techniques of transrectal palpation, laparoscopy, ultrasonography, and diagnostic laparotomy. The caecum lies in the dorsal part of the right abdominal cavity and extends from the middle of the lumbar region to the pelvic inlet with a free, rounded blind apex which projects caudally from the supraomental recess. The colon consists of the ascending colon, transverse colon, and descending colon. The ascending colon, the longest part of the large intestine, has three parts/loops (proximal, spiral, and distal). The proximal loop of the ascending colon (PLAC) runs cranially for a short distance to the plane of the right kidney, where it doubles back dorsal to the first part and the caecum. It then turns mediodorsally around the caudal border of the mesentery and runs cranially on the left side of the mesentery. Ventral to the descending duodenum, in the supraomental recess of the greater omentum, are the PLAC and the caecum. Near the left kidney, the PLAC becomes narrower and turns ventrally into the elliptical coil formed by the spiral loop of the ascending colon (SLAC). This is variable, but usually consists of 1.5–2 centripetal gyri, the central flexure, and the same number of centrifugal gyri. The last (outer) centrifugal gyrus passes into the narrow distal loop of the ascending colon (DLAC) at the plane of the first lumbar vertebra. The DLAC runs first dorsocaudally on the left side of the mesentery, ventral to the ascending duodenum and dorsal to the PLAC. At the plane of the 5th lumbar vertebra, the DLAC turns sharply around the caudal border of the mesentery and runs forward on the right to the short transverse colon (TC). The TC turns around the cranial mesenteric artery from right to left and becomes the descending colon (DC) that runs caudally ventral to the vertebral column. The DC is dorsal to the ascending duodenum and adherent to it. Its fat-filled mesocolon lengthens at the last lumbar vertebra, and the sigmoid colon (SC) forms at the pelvic inlet. The rectum begins at the pelvic inlet with a shortened mesorectum, but no structural transition (Simoens et al. 2003). Examination of the intestines includes external observation and palpation, swinging/percussion auscultation, abdominocentesis, laparoscopy and radiography, but all of these are of minor importance compared with rectal exploration and, occasionally, diagnostic laparotomy (Dirksen 1979). Gross examination of faeces provides valuable information to the veterinary surgeon, and it should always be performed if there is suspicion of intestinal disease. Other aids include the examination of faeces for pH, toxins of biological and/or chemical origin, parasites, bacteria and viruses, and serological tests for antibodies to pathogens causing intestinal disease (Dirksen 1979). Ultrasonographic examination of the intestines may prove useful in certain cases where other diagnostic modalities remain uncertain. Ultrasonography has been proposed as a non-invasive and helpful method for the assessment of the contour of the large intestine in healthy cows (Braun and Amrein 2001), and also for the diagnosis of caecal disorders in cows (Braun et al. 2002). However, there is a lack of literature on the reliability of identifying various parts of the large intestine ultrasonographically in healthy cows and on the usefulness of ultrasonography in the differential diagnosis of bovine large intestinal disorders. This study describes the reliability of ultrasonography in visualising various parts of the large intestine in healthy Jersey/Red Sindhi crossbred cows.

MATERIAL AND METHODS

The transabdominal ultrasonographic examinations were performed on 10 non-pregnant clinically healthy Jersey/Red Sindhi crossbred cows that had been kept off feed for a period of 12 h, using a 3.5 MHz curvilinear transducer (BPL US 9101 Ultrasound Scanner, BPL Health Management Solutions Limited, Bangalore, India). The cows were 4–12 years old and weighed approximately 300–450 kg. The animals were secured in standing position in a cattle crate without any chemical restraint. The cows were considered to be clinically healthy based on the results of routine physical examination, complete blood count, observation of spontaneous defecation, swinging/percussion auscultation, faecal parasitological examination, and faecal occult blood test (Dirksen 1979). The area extending from the tuber coxae to the 6th ICS and from the lumbar transverse processes to the linea alba on the right side was shaved. An imaginary line was drawn from the distal third of the femur up to the 8th ICS parallel to the longitudinal axis of the cow. The large intestine was scanned dorsal to this imaginary line. These demarcations were based on the topographical anatomy described elsewhere (Simoens et al. 2003). The widths (sizes) of various segments of the large intestine were obtained using calipers and measurement software on the ultrasound machine.

RESULTS

Only the near wall of the large intestine adjacent to the abdominal wall could be imaged ultrasonographically. However, reverberation artifacts reflecting from the tissue-gas interphase superimposed on the image of the wall of the large intestine and obscured the lumen and its contents. Moreover, the distal acoustic shadowing caused by the presence of the gas in the intestinal lumen masked the underlying structural details. Based on the topographical anatomy, the ultrasonographic images of the caecum and the PLAC, resembling the ‘arc of a circle’, were observed in the mid to dorsal right paralumbar fossa and the 12th ICS (Figure 1); however, the caecum and the PLAC could not be differentiated with certainty using ultrasonography. Similarly, the ultrasonographic images of the SLAC, resembling a ‘cycloid’, could be imaged through the 12th to 11th ICSs and in the dorsal right paralumbar fossa; yet, ultrasonographically, it was difficult to differentiate the SLAC from the DLAC, TC, and DC, respectively (Figures 2 and 3). The differences (qualitative and quantitative) in the degrees of curvatures of various ultrasonographic images of parts

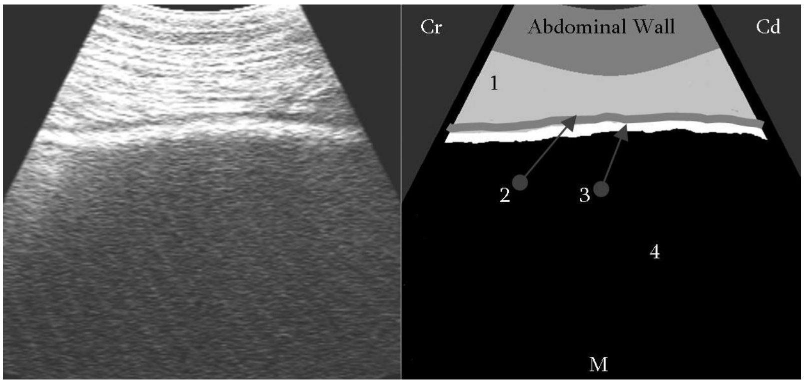

Figure 1. Ultrasonographic image of the caecum or the PLAC imaged in the dorsal plane at the right midflank by placing the transducer parallel to the longitudinal axis of the cow. 1 = greater omentum, 2 = hypoechoic line representing the wall of the caecum or the PLAC, 3 = hyperechoic line (internal reverberation artifact) reflecting from the tissue-gas interphase superimposed on the image of the wall of the caecum or the PLAC, 4 = lumen of the caecum or the PLAC is invisible due to internal reverberation artifacts originating from the intraluminal intestinal gas; Cr = cranial, Cd = caudal, M = medial

of the large intestine were also not helpful. The measured widths (segmental sizes) of the caecum and/or the PLAC varied from 5.4 to 6.2 cm (mean ± SE (standard error) = 5.7 ± 1.4 cm), and that of the colon (SLAC, DLAC, TC, and DC) varied from 2.2 to 4.4 cm (mean ± SE = 3.2 ± 1.2 cm). Other organs seen contiguous with various parts of the colon included loops of the jejunum, descending duodenum, pancreas, and liver (Figures 3 and 4).

The peristaltic activity (motility) of the large intestine could not be ascertained ultrasonographically, even after placing the transducer at the same position for five minutes. Moreover, the microanatomical wall layering of various segments of the large intestine could also not be identified using ultrasonography.

DISCUSSION

Various segments as well as the peristaltic activity of the large intestine could not be precisely identified using ultrasonography in this study; however, the technique is still valuable in examining the abdomen in its entirety as gross abnormalities of the large intestine, regardless of the ability to specifically identify the exact segment, might lead the clinician toward exploratory laparotomy or laparoscopy. The limitations encountered here could be attributed to the following: (i) incessantly changing positions due to loose mesenteric attachments and respiratory movements of the body wall constrained the ultrasonographic differences be-

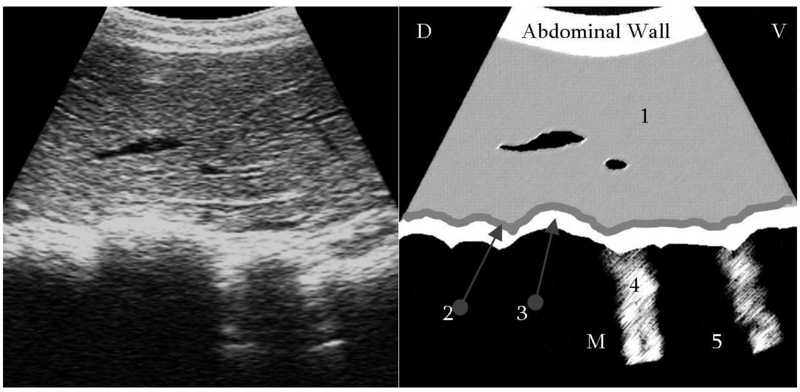

Figure 2. Ultrasonographic image of the colon imaged at the 12^{th} ICS by placing the transducer parallel to the ribs. 1 = liver, 2 = hypoechoic cycloid representing the wall of the colon, 3 = hyperechoic cycloid (internal reverberation artifact) reflecting from the tissue-gas interphase superimposed on the image of the wall of the colon, 4 = comet-tail artifact represented by a narrow beam of closely spaced, discrete, hyperechoic lines, 5 = lumen of the colon is invisible due to internal reverberation artifacts originating from the intraluminal intestinal gas; D = dorsal, V = ventral, M = medial

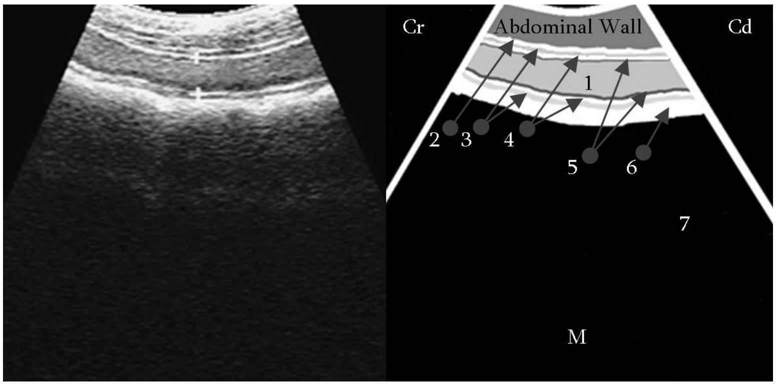

Figure 3. Ultrasonographic image of the colon and descending duodenum, in longitudinal section, imaged from the flank by placing the transducer along an imaginary oblique line drawn from the point of intersection at the lower third of the last rib up to the tuber coxae. 1 = echoic content of the duodenal lumen, 2 = serosal surface of the wall of the descending duodenum enveloped with the greater omentum, 3 = hypoechoic line representing the tunica muscularis of the descending duodenum, 4 = hyperechoic line representing the submucosal layer of the descending duodenum, 5 = hypoechoic line representing the tunica mucosa of the descending duodenum, 6 = hyperechoic line representing the serosal surface of the descending duodenum enveloped with the greater omentum, and the hyperechoic line (internal reverberation artifact) reflecting from the tissue-gas interphase superimposed on the image of the wall of the colon are lying adjacent to each other and cannot be distinguished; furthermore, the hypoechoic wall of the colon is not visualised as a separate entity on this image, 7 = lumen of the colon is invisible due to internal reverberation artifacts originating from the intraluminal intestinal gas; Cr = cranial, Cd = caudal, M = medial

tween various parts of the large intestine, (ii) inability to image the large intestine in its entirety due to internal reverberation artifacts originating from the intraluminal intestinal gas (these artifacts were characterised by the formation of several hyperechoic lines that were equally spaced and gradually attenuated (Blond and Buczinski 2009), and (iii) deeper location of some segments of the large intestine such as DLAC, TC, DC, and SC from the right abdominal wall preventing their imaging due to ultrasonic attenuation.

Ultrasonographically, there were no characteristic differences between the caecum and the PLAC. The body of the caecum is attached by the common mesentery to the proximal and distal loops of the colon, and is continuous with the colon, with no change in the lumen at the caecocolic orifice (Simoens et al. 2003). It has been reported that

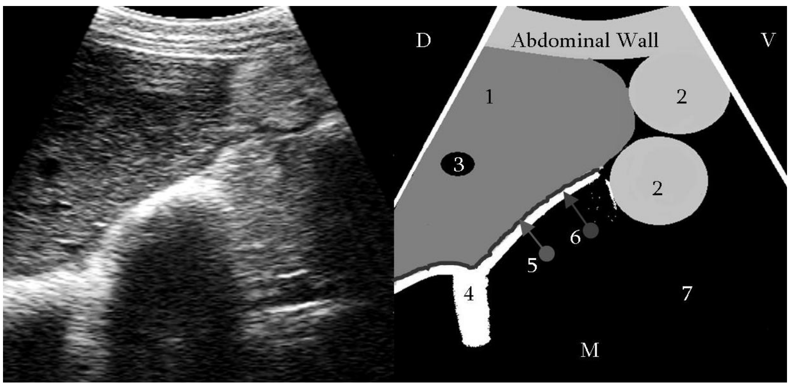

Figure 4. Ultrasonographic image of the colon imaged at the 12th ICS by placing the transducer parallel to the ribs. 1 = liver, 2 = echoic loops of the jejunum in cross-section, 3 = hepatic vein, 4 = comet-tail artifact represented by a narrow beam of closely spaced, discrete, hyperechoic lines, 5 = hypoechoic arc representing the wall of the colon, 6 = hyperechoic arc (internal reverberation artifact) reflecting from the tissue-gas interphase superimposed on the image of the wall of the colon, 7 = lumen of the colon is invisible due to internal reverberation artifacts originating from the intraluminal intestinal gas; D = dorsal, V = ventral, M = medial

the caecum and the proximal ansa of colon could be differentiated on the basis of the smaller diameter (width/segmental size) of the latter; however, the given diametrical range of these structures in healthy animals was also wide (Braun and Amrein 2001). The diameters of the caecum and that of the proximal ansa of the colon ranged from 7.0 to 18.0 cm and 5.0 to 15.0 cm, respectively. In our opinion, given the variability in the relation between parts of the large intestine and various abdominal organs, ultrasonographic difference between the caecum and the PLAC merely on the basis of segmental size cannot be relied upon as a consistent feature. Furthermore, Braun and Amrein (2001) also reported that the SLAC was identified ventral to the descending colon and dorsal to the caecum with its diameter (width) ranging from 2.1 to 5.0 cm. Its wall appeared as thick echoic lines and, in a contracted state, resembled a garland; however, characteristic criteria for differentiating the SLAC from the DLAC, TC, and DC have not been described.

Ultrasonography allows some assessment to be made of small intestinal activity and lumen contents. In contrast to the small intestine, which has vigorous peristaltic activity and segmental contractions, few contractions are observed in the large intestine (Braun 2009). However, true peristaltic activity has not been easily or widely determined, because differentiating peristaltic activity from oscillatory activity using B-mode ultrasonography has not been possible (Mitchell et al. 2005).

In conclusion, ultrasonography could not be used to identify various segments of the large intestine in healthy cows. Therefore, ultrasonographic imaging of various parts of the bovine large intestine should be interpreted with caution. Abnormal ultrasonographic findings of the large intestine, regardless of the segment, warrant further exploration.

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