Indian Journal of Animal Sciences **82** (5): 486–488, May 2012

Ultrasonographic imaging of the small intestine in healthy Indian crossbred cows

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Received: 30 August 2011; Accepted: 19 October 2011

Key words: Cows, Small intestine, Ultrasonography

In cattle, the intestinal tract is displaced to the right half of the abdominal cavity due to large size of the rumen. Most of the intestines, attached by the mesentery, lie in the supra-omental recess. The jejunum overreaches the greater omentum caudally and passes into the straight ileum just ventral to the caecum (Budras *et al.* 2003). Ultrasonography has been proposed as a noninvasive and helpful method for subjective assessment of the small intestine in healthy cows (Braun and Marmier, 1995) and in cows with intestinal ileus (Braun *et al.* 1995 and Imran *et al.* 2011). The purpose of the present study was to describe observations based on ultrasonographic examination of the small intestine in healthy Indian Jersey/Red Sindhi crossbred cows.

Examinations were performed on 10 adult, non-pregnant, healthy Indian Jersey/Red Sindhi crossbred cows. The cows were declared to be clinically healthy based on routine physical examination and complete blood count. The cows were between 4–12 years old and weighed approximately 300–450 kg. The area extending from tuber-coxae to sixth intercostal space (ICS) and from dorsal midline to linea alba on right side was shaved. Animals were secured in standing position in a cattle crate without any chemical restraint. The small intestine and its contiguous organs were examined with a 3.5 MHz curvilinear transducer. An imaginary line was drawn from the distal third of the femur up to eighth ICS, parallel to longitudinal axis of the cow (Fig.1). The jejunum and ileum were scanned ventral to this imaginary line up to the linea alba. The descending duodenum was imaged in the lower third of the 12th ICS (transverse image) and along an imaginary oblique line (transverse and longitudinal images) drawn from the point of intersection at the lower third of the last rib up to the tuber coxae (Fig. 2). These demarcations were based on the topographical anatomy described by several authors (Popesko 1979, Budras *et al.* 2003). Further, the small intestine was also imaged from 12th–8th ICS by placing the transducer parallel to ribs. The diameters of various segments of small intestine were measured electronically on the frozen ultrasonograms by means of the 2 cursors.

The duodenum was identified as a double- walled round structure, in transverse section, adjacent to the right abdominal wall. This double-walled 'target like' appearance

Figs 1-2. **1.** Topographical areas for ultrasonographic examination of the small (1) and the large intestines (2) in a Jersey crossbred cow. **2.** Topographical imaginary line for ultrasonographic examination of the descending duodenum in a cow.

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was due to hyperechogenic omentum enveloping the duodenum. The cranial duodenum could be seen from 10th to 9th ICS near costo-chondral junction and the adjacent ventral-paracostal region (Fig. 3). The diameter of the cranial

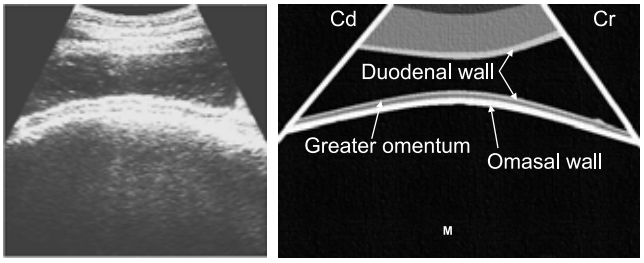

Fig. 3. Ultrasonogram of the cranial duodenum and omasum in a clinically healthy cow, obtained by placing the transducer just ventral to the costal arch of the 8th to 9th intercostal spaces and parallel to the longitudinal axis of the cow. Cr, cranial; Cd, caudal; M, medial.

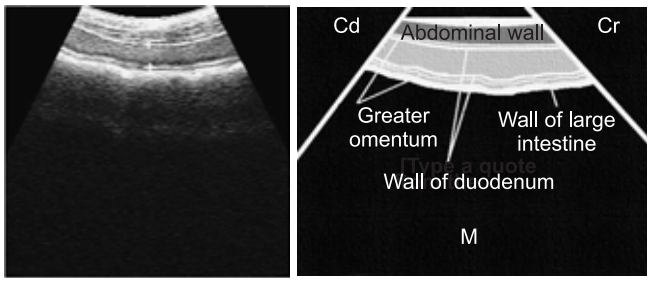

Fig. 4. Ultrasonogram of the descending duodenum in longitudinal section imaged from mid-flank by placing the transducer parallel to the imaginary line as depicted in Fig. 2. Cr,cranial; Cd, caudal; M, medial.

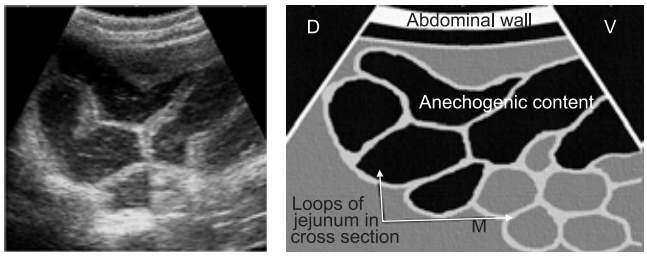

Fig. 5. Ultrasonogram of the loops of jejunum in cross-sections obtained from right ventral flank by placing the transducer perpendicular or parallel to the imaginary line as depicted in Fig. 1. D, dorsal; V, ventral; M, medial.

part of the duodenum varied from 2.0 to 5.0 cm (mean±SE, 3.78±0.51 cm). The diameter of the descending duodenum ranged from 1.0 to 2.7 cm (mean±SE, 1.91±0.15 cm) (Fig. 4). The diameter of cranial duodenum was always greater than the descending portion. The ascending duodenum could not be visualized due to attenuation of the ultrasound waves while traversing the deep abdomen and internal reverberation caused by the gas filled large intestine. The jejunal/ileal loops could be seen easily and differentiated from the duodenum, because of lack of 'target like' appearance in the former. The wall thickness of cranial duodenum was greater and ranged from 4 to 5 mm, whereas the thickness of walls of descending duodenum and jejunum/ileum varied from 2 to 3 mm. The micro-anatomical wall layering pattern of the small intestine could not be observed in any of the cows. The fatty mesentery of the jejunum and ileum was observed as hyperechogenic bands in between the intestinal loops. The parts of jejunum/ileum were observed in cross-section, sagittal-section, and sometimes longitudinally (Fig. 5). In the lower flank and the 12th ICS, the number of intestinal loops ranged from 10 to 12 in an imaging frame at a depth of 12 cm, whereas the number of the intestinal loops always decreased as the transducer was moved cranially up to the 9th ICS. The diameter of the jejunum/ileum ranged from 2.1 to 3.6 cm (mean±SE, 2.65±0.15 cm). Ultrasonographically, it was impossible to differentiate between jejunum and ileum.

The micro-anatomical layering of the wall of small intestine could not be discerned perhaps due to thinness of its wall and attenuation of the ultrasound waves while traversing the greater depth of the bovine abdomen. However, the duodenum could be easily differentiated from jejunum/ileum due to enveloping hyperechogenic greater omentum of the duodenum. The cranial and descending parts of the duodenum were differentiated on the basis of greater diameter of the former part.

The findings obtained in the current study were more or less consistent with that of Braun and Marmier (1995). They reported greater mean diameters of the descending duodenum (2.4±0.6 cm) and the jejunum/ileum (3.2±0.4 cm) in Swiss Braunvieh, Simmental, and Holstein cows. They observed that the number of intestinal loops decreased cranially when viewed from the successive intercostal spaces. In 94% of the cows, more than 10 loops of intestine could be visualized from the flank, whereas, from 12th, 11th, 10th and the 9th ICS the % of cows where more than 10 loops of intestine were visible were 96, 82, 48 and 4% respectively. From other intercostal spaces, less than 10 or no loops of intestine were visualized. In majority of cases, the intestines contained mucus or feed which appeared hyperechogenic, but in some cows, the intestinal lumen appeared hypoechogenic due to fluid content. The wall of cranial part of the duodenum, was thicker (~5 mm) than rest of the small intestinal wall (~ 3 mm). The observations made at 1, 6, 12 and 24 h after feeding did not differ significantly ($P<0.05$). The number of intestinal contractions recoded by them ranged from 0.5 to 10/min with a mean of 4.7±2.7. They also reported that in 3 out of 50 healthy cows, intestines were found to be non-motile during the 3 min observation period.

The quantitative results of our study were slightly lower than those obtained by Braun and Marmier (1995) for clinically healthy Swiss Braunvieh cows, likely due to breed and body weight based variation in the diameter, wall thickness and visibility of the intestinal loops in various intercostal spaces. Normalization of these parameters based on cow size would be a useful way to compare studies and develop criteria that could be applied to cows of different breeds and body weights.

SUMMARY

Healthy Jersey/Red Sindhi non-pregnant cows (10) were subjected to detailed abdominal ultrasonography to develop the baseline topographical data of the small intestine. Ultrasonography proved to be a useful tool for non-invasive examination of the small intestine. The duodenum was identified as a double-walled round structure, in transverse section, adjacent to the right abdominal wall. The jejunal/ileal loops could be seen easily and differentiated from the duodenum, because of lack of 'target like' appearance in former. The diameter of the cranial part of the duodenum varied from 2.0 to 5.0 cm and that of the descending duodenum ranged from 1.0 to 2.7 cm. The diameter of the jejunum/ileum ranged from 2.1 to 3.6 cm. Ultrasonographically, it was impossible to differentiate between jejunum and ileum. Our results were on a lower side, indicating breed and body weight based variation. Normalization of these parameters based on cow size would be a useful way to compare studies and develop criteria that could be applied to cows of different breeds and body weights.

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