Ultrasonographic examination of caecum and colon of normal Adult Spiti horses and Himalayan Hill mules of India

Ulase Bin Farooq*, Adarsh Kumar and Rajni Chaudhary

Department of Surgery and Radiology, College of Veterinary and Animal Sciences, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 061, Himachal Pradesh, India.

Received: 10-12-2016 Accepted: 09-03-2017

ABSTRACT

The objective of this study was to develop baseline topographical data of landmarks for locating and generating sonographic calliper measurements along with dynamic parameters of caecum and colon in 50 native adult healthy unsedated Spiti horses and Himalayan Hill mules of either sex. The wall thickness, contractility, character and echo-architecture of caecum and colon were recorded. Caecum was found from 15th to 17th inter costal space (ICS). Right dorsal colon (RDC), right ventral colon (RVC), left ventral colon (LVC) and left dorsal colon (LDC) were found from 6th to 14th, 9th to 17th, 9th to 14th and 6th to 15th ICS, respectively. Descending colon was found in the left paralumbar fossa upto tuber-coxae in both horses as well as mules. The corresponding values of horses and mules for wall thickness (in mm) was 2.1±0.05 and 1.4±0.05 for the caecum, 2.16±0.05 and 1.32±0.02 for the right dorsal colon, 2.1±0.03 and 1.32 ±0.02 for the right ventral colon, 2.12±0.03 and 1.32±0.02 for the left dorsal colon, 2.1±0.03 and 1.32±0.02 for the left dorsal colon and 2.04±0.02 for the descending colon. Prominent sacculations were observed on ventral colon and absent on dorsal colon. Detailed ultrasonographic examination of caecum and colon generated baseline data, which will be useful for management of the affections of caecum and colon.

Key words: Caecum, Colon, Horse, Mule, Ultrasonography.

INTRODUCTION

India has second largest population of equines in world. Simultaneously, the incidences of equine abdominal emergencies are very common. There are numerous factors responsible for these abdominal emergencies and lastly it becomes a challenge for the veterinarian to diagnose the exact etiology as there are very few diagnostic techniques available which mainly include radiography and rectal examination. However, these techniques have their own limitations, hence diagnostic abdominal ultrasonography is increasingly used in veterinary practice and has an important role in decision making in equines with abdominal disorders (Freeman 2002).

Sonographic assessment of abdominal organs in different equine breeds has already been described (Reef, 1998; Freeman, 2002; Hendrickson et. al., 2007; Epstein et. al., 2008; Barton, 2011), but no such study has been conducted on native breeds of India. Hence, it is envisaged to perform the detailed ultrasonographic examination of caecum and colon and to compile baseline data of Spiti horses and Himalayan hill mules.

MATERIAL AND METHODS

The present study was carried out on 50 clinically healthy adult native animals of either sex (25 Spiti horses and 25 Himalayan hill mules). The horses were between 8-17 years of age and weighed between 120-165 kg, whereas mules were between 8-15 years of age and weighed between 90-110 kg. The normal equine abdomen was subjected to ultrasonographic examination for standardizing the technique and machine settings. Trans-abdominal ultrasonography was performed to scan and document images of caecum and colon, to delineate their topographical anatomy in different planes, to define their echotexture and to determine their thickness and site for placement of the transducer at various locations. Ultrasonography was carried out using Siemens Acuson X300 ultrasound system, premium edition, a grey scale B + M-mode and 4D scanners. The standing animals were restrained in a crate without any sedation and were kept for 15 minutes so that their heart rate becomes normal. All animals were fasted for 12 hours prior to ultrasonography and in some animals fasting was extended to 24 hours to determine decrease in contraction rate at different time intervals but drinking water was kept available all the time. The topographic regions of all animals were shaved and cleaned with tap water. Contact gel was applied and animals were examined using two different transducers: i) 5.3-10 MHz linear transducer with a maximum depth of field of 13 cm and ii) 2-5 MHz volumetric (4D) transducer with a maximum depth of field of 30 cm. Care was taken to record

*Corresponding author’s e-mail: farooquiase@gmail.com
1Division of Animal Genetics and Breeding, ICAR Indian Veterinary Research Institue, Izatnagar, Bareilly, India
ultrasonograms at the peak of inspirations. The organ echotexture, motility pattern, wall thickness, size, optimal topographical locations as well as associated structures were studied with photographic recordings.

RESULTS AND DISCUSSION

Caecum: The caecum was found between 15th to 17th intercostal space (ICS) in the right flank caudal to the liver, ventral to the right kidney, descending duodenum (Figure-1.1[a, b]) and right ventral colon (RVC) up to linea alba in both horses as well as mules. The contents of the caecum varied from solid to liquid or mixed but usually highly echogenic, causing strong acoustic shadowing and masking the details of the underlying structures. Only the caecal wall and caecal contents up to a few centimeter (cm) depths could be imaged (Figure-1.2[a, b]). Sacculations were prominent and motility was assessed from the movement of the wall, underlying hyperechoic shadow and by motion induced changes in the sacculations of the caecum. Our observations were in line with Freeman (2002) who reported that caecum could be visualized as a sacculated and motile organ extending from the right paralumbar fossa to the ventral midline. In the present study, the frequency of caecal contractions per minute was recorded as 2-6 contractions in fed animals and 2-4 contractions when animals were fasted for 12 hrs without holding water, but when animals were fasted upto 24 hours, caecal contraction rate was decreased to 1-3 contractions/minute with presence of a lot of gas. The caecal wall thickness varied from 2.0 to 2.3 mm (Mean ± SE= 2.1 ± 0.05 mm) (Figure-1.3[a, b]) and in mules, varied from 1.3 to 1.6 mm (Mean ± SE= 1.4 ± 0.05 mm). All the muscle layers of the caecal wall were appreciable (Figure-1.1[a, b]). The finding of the present study were similar to previous reports (Reef, 1998; Freeman, 2002; Reef et al., 2004; and Barton, 2011).

However, the wall thickness variations obtained in the current study were lower than that of previous study (Barton, 2011) where wall thickness of caecum was reported to be 4mm. The difference regarding the ultrasonographic imaging of wall thickness in local horses may be possibly attributed to the variations in the body weight/size or breed type. But in mules, the present findings revealed the caecal wall thickness was in agreement with Epstein et. al., (2008) who reported that caecal wall thickness in ponies was 0.179±0.03 cm.

Right dorsal colon (RDC) and Left dorsal colon (LDC): RDC was found between 6th to 14th ICS in slightly oblique transverse plane, dorsal to the RVC, ventral to the liver, caudal to the diaphragm and cranial to the caecum whereas, LDC was found between 6th to 15th ICS ventro-medial to spleen, in the lower flank, dorsal to LVC, ventral to stomach, liver and jejunum both in horses as well as mules (Figure-2.1[a, b]). RDC consistently appeared as a hyperechoic curved line adjacent to the liver (Figure-2.2[a, b]) whereas LDC appeared as a hyperechoic line adjacent to the spleen and jejunum. In both RDC and LDC no sacculations were observed. Freeman (2002) also reported that RDC and LDC lack sacculations and this allows the distinction between the dorsal and the ventral colon. In both RDC and LDC, a peculiar gas pattern was observed in fed animals which typically generated a hyperechoic appearing wall with an indistinct luminal border and intra-luminal acoustic shadowing that precluded the identification of the contents and the medial wall (Figure-2.3[a, b]), but in fasted animals a fluid pattern containing multiple echoic specks and occasional free gas caps were imaged. Only wall and the contents upto a depth of few centimeters could be imaged. The motility was assessed from the movement of the wall

Fig-1.1[a, b]: Ultrasoundgram of Caecum (Horse) at 16th ICS showing various muscle layers of wall of caecum. The image was obtained with linear transducer at 10 MHz at a depth of 6.5 cm. (DD= descending duodenum, ICM= intercostal muscle)
and separation of the wall from the adjacent organs (Figure-2.4[a, b]). In both RDC and LDC, frequency of contractions was recorded as 2-6 contractions/minute in fed animals, 2-4 contractions/minute when animals were fasted for 12 hrs without holding water and 1-2 contractions/minute when animals were fasted for 24 hours. All the five layers of the LDC and LVC (i.e., Serosa, Muscularis, Sub-mucosa, Mucosa and Mucosal gas interface) were identified (Figure-2.5[a, b]). In horses, wall thickness of RDC varied from 2.0 to 2.3 mm (Mean ± SE= 2.16 ± 0.05 mm) whereas, wall thickness of LDC varied from 2.0 to 2.2 (Mean ± SE= 2.12 ± 0.03 mm). However, in mules wall thickness of RDC as well as LDC varied from 1.3 to 1.4mm (Mean ± SE= 1.32 ± 0.02mm) and all the muscle layers of wall were appreciable (Figure-2.6[a, b]).

The findings of the present study were in consonant with previous reports (Kiper et al., 1990; Hoffman et al., 1995; Kirkberger et al., 1995; Freeman, 2002; Freeman, 2003; Colin et al., 2005; Hendrickson et al., 2007 and Barton, 2011). However, Freeman (2002) reported that RDC had three taenial bands but in the present study no such bands could be identified. Keller and Horney (1985) reported that
**Fig-2.1[a, b]**: Ultrasonogram of LDC (Horse) at 10th ICS. The image was obtained with linear transducer at 5.3 MHz at a depth of 6.5 cm. (LDC= left dorsal colon, ICM= intercostal muscles)

**Fig-2.2[a, b]**: Ultrasonogram of right dorsal colon (Horse) at 7th ICS. The image was obtained with linear transducer at 10.0 MHz at a depth of 6.5 cm. (RDC= right dorsal colon, MGI= mucosal gas interface)

**Fig-2.3[a, b]**: Ultrasonogram of LDC (Horse) at 7th ICS. The image was obtained with linear transducer at 7.3 MHz at a depth of 6.5 cm. (LDC= left dorsal colon, ICM= intercostal muscles)
Fig-2.4[a, b]: Ultrasonogram of right dorsal colon (Horse) at 6th ICS, showing normal contraction of RDC in real time scanning. The image was obtained with linear transducer at 7.3MHz at a depth of 6.5 cm. (RDC= right dorsal colon)

Fig-2.5[a, b]: Ultrasonogram of LDC (Horse) at 13th ICS. The image was obtained with linear transducer at 7.3 MHz at a depth of 6.5 cm. (LDC= left dorsal colon, ICM= intercostal muscles)

Fig-2.6[a, b]: Ultrasonogram of right dorsal colon (Mule) at 9th ICS. The image was obtained with linear transducer at 5.3 MHz at a depth of 6.5 cm. (Zoom view)
diameter of RDC was 30-50 cm, but in present study diameter could not be recorded because only RDC wall and the contents upto few centimeters depth could be imaged. However, the wall thickness variation obtained in the current study was lower that of previous studies (Jones et al., 2003 and Barton, 2011) where wall thickness was reported upto 3mm and 4mm respectively. The difference regarding the ultrasonographic imaging of wall thickness in local horses may be possibly attributed to the variations in the body weight/size or breed type.

**Right ventral colon (RVC) and Left ventral colon (LVC):**
RVC was found between 9\(^{th}\) to 17\(^{th}\) ICS in slightly oblique transverse plane, cranial to the caecum and ventral to RDC upto linea alba whereas, LVC was found between 9\(^{th}\) to 14\(^{th}\) ICS in lower flank ventral to LDC upto linea alba in both horses as well as mules. Both RVC and LVC were identified by peculiar features i.e. presence of sacculations, sluggish motility and inability to scan entire circumference or diameter of wall. They appeared as bright hyperechoic lines on ultrasonography (Figure-3.1[a, b]). Both RVC and LVC, showed a typical gas pattern in fed horses casting a strong acoustic shadow masking the details (Figure-3.2[a, b]), but in fasted animals, a fluid pattern containing multiple echogenic specks, continuous movement of the ingesta and occasional free gas caps were imaged (Figure-3.3[a, b]). The motility was assessed from movement of wall, separation of

**Fig-3.1[a, b]:** Ultrasonogram of right ventral colon (horse) at 6\(^{th}\) ICS. The image was obtained with linear transducer at 7.3 MHz at a depth of 6.5 cm. (RVC= right ventral colon, PF= peritoneal fluid)

**Fig-3.2[a, b]:** Ultrasonogram of LVC (Mule) at 13\(^{th}\) ICS. The image was obtained with linear transducer at 10.0 MHz at a depth of 6.5 cm.
the wall from the adjacent abdominal muscles and typical change in pattern of sacculations. Barton (2011) also reported that gas in the colon typically generates a hyperechoic appearing wall with an indistinct luminal border and intraluminal acoustic shadowing that precludes identification of the contents and the medial walls (Figure-3.4[a, b]). He also reported that LVC was sacculated with sluggish motility and wall thickness measured less than 4 mm. In the present study, frequency of contractions was recorded as 2-6 contractions/minute in fed animals, 2-4 contractions/minute when animals were fasted for 12 hrs without holding water and 1-2 contractions/minute when animals were fasted for 24 hours. The wall thickness in RVC and LVC varied from 2.0 to 2.2 mm (Mean ± SE= 2.1 ± 0.03 mm) (Figure-3.5[a, b]). However, in mules wall thickness varied from 1.3 to 1.4 (Mean ± SE= 1.32 ± 0.02 mm) and all the muscle layers of wall were appreciable in both horses and mules (Figure-3.6[a, b]).

The findings of present study were in agreement with previous reports (Kirkberger et al., 1995; Reef, 1998; Freeman, 2002; Colin et al., 2005; Hendrickson et al., 2007.

---

**Fig-3.3[a, b]:** Ultrasonogram of LVC (Horse) at 9th ICS. The image was obtained with linear transducer at 10.0 MHz at a depth of 6.5 cm. (LVC= left ventral colon, ICM= intercostal muscles)

**Fig-3.4[a, b]:** Ultrasonogram of LVC (Horse) at lower ventral abdomen. The image was obtained with linear transducer at 10.0 MHz at a depth of 7 cm
and Barton, 2011). However, Freeman (2002) reported that the RVC had four taenial bands but in the present study no such bands could be identified. Colin et al. (2005) reported that the frequency of contractions decreased on fasting and diameter of RVC and LVC could not be assessed on ultrasonography due to the acoustic shadowing. Hendrickson et al. (2007) also found that the range of mean values for wall thickness of large colon was 1.6 to 2.7 mm which was less than reported normal values i.e., 2.0 to 3.75 mm (Freeman et al., 2000). On the other hand, the wall thickness variation obtained in the current study was lower that of previous study (Barton, 2011) where wall thickness was reported upto 4mm. The difference regarding the ultrasonographic imaging of wall thickness in local horses may be possibly attributed to the variations in the body weight/size or breed type. Freeman (2002) has also reported that size of animal could potentially be alter wall thickness.

**Descending colon (DC):** DC was found in left paralumbar fossa, behind the last rib upto tuber-coxae, caudal to the spleen, dorsal to the jejunum and LDC and ventral to the lumbar transverse processes. It was identified by its small diameter, sacculations and packed serpentine loops. It was observed that small sections of surface of the loops were visible as short sharply curving hyperechoic lines and when faecal balls were present in the DC these hyperechoic lines casted a strong acoustic shadowing (Figure-4.1[a, b]). The motility of DC was sluggish with 1 to 3 contractions per minute and luminal gas prevented visualization of the contents and distal wall. The wall thickness was observed...
same in horses as well as mules and it varied from 2 to 2.1 mm (Mean ± SE = 2.04 ± 0.02 mm) (Figure-4.2[a, b]). Reef (1998) reported that small colon can be imaged from ventral abdomen only through a distended urinary bladder which is used as an acoustic window. However in the present study urinary bladder could not be found through ventral abdomen. It may be either due to the gas present in ventral colon or bladder might not be fully distended at the time of sonography. Therefore, small colon was not visualized through ventral abdomen in the present study. Freeman (2002) reported that small colon can be located more easily using transrectal ultrasonography, however in the present study only transcutaneous ultrasonography was used. Keller and Horney (1985) reported that small colon is small in size with diameter of 7 to 10 cm, but in present study, the diameter of the small colon could not be assessed due to strong acoustic shadowing by faecal balls present in the small colon which masked the details of the medial wall (Figure-4.1[a, b]). Rest of the findings were in agreement with previous studies (Keller and Horney 1985; Reef, 1998; Freeman, 2002 and Barton, 2011).

CONCLUSIONS

Based on the sonographic evaluation of the abdomen of equids, the surgeon/clinician can be able to differentiate the true and false colic, which will help in accurate diagnosis and formulation of a precise and efficient therapeutic plan.
ACKNOWLEDGEMENTS

The authors would like to thank faculty members and support staff of the department of veterinary surgery and radiology, college of veterinary and animal sciences CSKHPKV Palampur for their suggestions and cooperation.

REFERENCES


