Ultrasonographic examination of liver and spleen of normal adult spiti horses and Himalayan Hill mules of India

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ABSTRACT
The main objective of this study was to develop baseline topographical data of landmarks for locating liver and spleen and to generate sonographic caliper measurements along with dynamic parameters of these organs. Abdominal ultrasonography was performed on 50 native adult (Spiti horses and Himalayan hill mules) healthy unsedated equines of either sex. The thickness, character and echo-architecture of liver and spleen were recorded. In horses, the right lobe of liver was found from 8th to 15th intercostal space (ICS) and left lobe from 6th to 11th (±1) ICS, while in mules the right liver lobe was found between 6th to 15th (±1) ICS and left lobe between 6th to 9th (±1) ICS. The liver was recognized by its branching vasculature and architecture was found relatively homogenous. In addition ventral edges were distinctly sharp. Spleen was found from 8th to 17th ICS both in horses as well as in mules. The splenic parenchyma was homogenously granular in appearance with few blood vessels and most echogenic organ in the abdominal cavity of equines. The only measurement that was reliably obtained was the central thickness or depth of the spleen, which varied from 41.4 to 68.4 mm (Mean±SE= 50.84±4.61 mm) in horses and 37.9 to 51.6 mm (Mean±SE = 42.76±2.34 mm) in mules. Therefore detailed ultrasonographic examination of liver and spleen helped us to compile baseline data, which will be helpful in management of the affections of liver and spleen in future.

Key words: Horses, Liver, Mules, Spleen, Ultrasonography.

INTRODUCTION
Soft tissue organs like Liver and spleen are not easily accessible for clinical examination by palpation or percussion because of their topographic location under costal part of the abdominal wall. It can neither be examined by rectal palpation nor radiographed, thus making the diagnosis of related disease conditions very difficult. Usually exploratory laparotomy confirms the diagnosis of disease conditions of liver and spleen, although its invasiveness may not be suitable in already compromised patients. Veterinary laboratory diagnosis is also a nonspecific indicator of the splenic diseases. Similarly, clinical diagnosis of the liver diseases is difficult in equines, since even severe diseases may not always be accompanied by specific signs. The common laboratory tests for liver function also usually fail to reveal a disorder as long as one-third of the liver parenchyma is still functioning. In these circumstances ultrasonography a non invasive procedure can be used to diagnose the affections.

Sonographic assessment of abdominal organs in different equine breeds has already been described (Reef, 1998; Freeman, 2002; Freeman, 2003; Desrocher, 2005; 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 liver and spleen and to compile baseline data of Spiti horses and Himalayan hill mules. This will be useful in future to delineate normal and abnormal conditions and will provide an important diagnostic lead in management of affections of liver and spleen.

MATERIALS AND METHODS
Standardization 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 liver and spleen, 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. The topographic regions of all animals were shaved and cleaned

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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 ultrasonograms at the peak of inspirations. The organ echotexture, size, optimal topographical locations as well as associated structures were studied with photographic recordings.

RESULTS AND DISCUSSION

Liver: In horses, the right lobe of liver was found between eighth to fifteenth intercostal space (ICS) caudal to diaphragm, cranial to right kidney and descending duodenum, dorsal to right dorsal colon and caecum. The left lobe of liver was found between sixth to eleventh (±1) ICS caudal to diaphragm, cranial to stomach and was smaller than the right lobe. While in mules the right and left liver lobes were found between sixth to fifteenth (±1) ICS and sixth to ninth (±1) ICS respectively. As only a small portion of liver could be imaged from both the sides of abdomen, it was difficult to estimate the actual size of liver. Hence the estimates of the size rely on its expanse across intercostal spaces. Liver was recognized by its branching vasculature. The portal veins having more connective tissue in their walls appeared more echogenic than hepatic veins (Fig-1.1[a, b]). Blood in hepatic veins appeared anechoic or small moving echos were imaged as the ultrasound beam reflects off the moving cells and other blood components. The general echogenicity of liver was less than spleen but more echogenic than the adjacent kidney (Fig-1.2[a, b]). The common bile duct and its branches within the normal liver were not visible and atrophy of the right lobe of liver was also observed in some.

Fig 1.1[a, b] Ultrasonogram of right lobe of liver (Mule) at 13th ICS. The image was obtained with linear transducer at 5.3 MHz at a depth of 6.5 cm. (MGI= mucosal gas interface, RDC= right dorsal colon, D= dorsal, V= ventral, M= medial).

Fig 1. 2[a, b]: Ultrasonogram of right lobe of liver (Horse) at 11th ICS. The image was obtained with linear transducer at 7.3 MHz at a depth of 6.5 cm. (ICS= intercostal space, MGI= mucosal gas interface, RDC= right dorsal colon).
older horses. The architecture of liver was found relatively homogenous and the ventral edges of the normal liver were distinctly sharp (Fig-1.3[a, b]). The findings of this study were similar to those of (Rantanen, 1986; Aleman et al., 2002; McAuliffe, 2004; Reef et al., 2004 and Barton, 2011). According to Barton (2011) liver could be located from the 6th to 14th ICS between the diaphragm and RDC. Reef (1998) reported that liver could be seldom seen beyond the 15th ICS or in the same transverse plane as the kidney, except at the most rostral aspect of the kidney. However, the topographic anatomic variation regarding the expanse of right liver lobe across intercostal spaces in mules was slightly higher. This difference regarding the topographic anatomic variation in mules may be possibly attributed to the variations in the body weight/size, breed type, and/or hybrid (interspecies variation) nature of mules. 

Spleen: The spleen was found between eighth to seventeenth ICS and just caudal to the last rib in left paralumbar fossa, in slightly oblique transverse plane anteriorly, caudal to stomach, dorsal to jejunum, laterally caudal and medial to left kidney both in horses as well as in mules(Fig-2.1[a, b]). The splenic parenchyma appeared homogenously granular with few blood vessels and was most echogenic organ in the abdominal cavity of equines (Fig-2.2[a, b]). Spleen was found encapsulated with an echogenic capsule and splenic vein was easily located as an anechoic tubular structure medial to spleen around tenth ICS (Fig-2.3[a, b]). The location of spleen varied depending on gastric distention and size of the adjacent organs like liver. However in one animal (mule) it was found extended beyond the ventral midline towards the right hemi abdomen. Rantanen (1986) and Barton (2011)

Fig 1.3[a, b]: Ultrasonogram of left lobe of liver (Male) at 6th ICS. The image was obtained with linear transducer at 10 MHz at a depth of 9.5 cm. (ICM= intercostal muscles, LDC= left dorsal colon, D= dorsal, V= ventral, M= medial).

Fig 2.1[a, b]: Ultrasonogram of spleen (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, D= dorsal, V= ventral, M= medial).
also reported that the size and the location of spleen was highly variable and was identifiable immediately adjacent to the body wall, from the left ventral eighth ICS extending up to paralumbar fossa and it may remain to the left of the midline, or extend slightly beyond the right of ventral midline. In present study the only measurement that was reliably obtained was central thickness or depth of the spleen, which varied from 41.4 to 68.4 mm (Mean ± SE = 50.84 ± 4.61 mm) in horses and in mules it varied from 37.9 to 51.6 mm (Mean ± SE = 42.76 ± 2.34 mm).

The findings of present study were in consonant with previous reports (Rantanen, 1986; Reef, 1991; Porter and Ramirez 2005; Reef, 1998; Freeman, 2002, Freeman, 2003 and Barton, 2011), except for central thickness of the spleen which highly varied from published values of Rantanen (1986) and Barton (2011) who reported that central thickness of the spleen is usually less than fifteen cm. These differences regarding central thickness of the spleen in local horses and mules may be possibly attributed to variations in body weight/size, breed type, and/or hybrid (interspecies variation) nature of mules.

CONCLUSION

Based on the sonographic evaluation of liver and spleen, the surgeon/clinician may be able to diagnose different affections of these organs for e.g. differentiation between true and false colic. This will help in accurate diagnosis as well as formulation of a precise and efficient therapeutic plan.

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