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Field Guide to Abdominal Ultrasonography of Adult Healthy Arabian Mares

[1]Noha, A. Beder and [2]M.S. Fadel

[1]Department of Animal Medicine, Faculty of Veterinary Medicine,
Damanhour City, Damanhour University, Egypt
[2]Animal Reproduction Research Institution, Cairo, Egypt

Abstract: Eighteen Arabian mares, 3-5 years old were examined ultrasonographically on the abdomen as a first study about normal abdominal ultrasound in Arabian breed of horses. The stomach was scanned from the left side between the 8th and 13th inter-costal spaces (ICS) and appeared as a smooth curved hyper-echoic line deep to the spleen. The spleen was identified immediately adjacent to the body wall, from the left ventral 8th intercostal space to the para-lumbar fossa with finely mottled pattern parenchyma. The left kidney found medial to the spleen. The small colon was imaged in the left para-lumbar fossa medial to the spleen with short, sharply curving, hyper-echoic lines. The ventral colon was sacculated while the dorsal one was not sacculated. The liver was imaged on the right side of the abdomen between the diaphragm and the right dorsal colon. It was recognizable by homogeneous echogenicity and its anechoic branching vasculture. The duodenum was imaged at area from the right 12th-15th inter-costal spaces while the jejunum was imaged at left inguinal area. The right kidney was imaged at right 16th inter-costal space to rostral para-lumbar fossa. The cecum was identified by motile sacculated wall extending from right para-lumbar fossa to ventral mid-line. It was concluded that there are no differences between Arabian horses and Thoroughbred horses in their normal abdominal ultrasonography.

Key words: Ultrasound · Abdomen · Arabian horses

INTRODUCTION

Veterinary ultrasound has grown in the late 1970 to the service at university hospitals and many private veterinary practices. It is a useful tool in veterinary gynecology, ophthalmology, cardiology, gastroenterology and nephrology [1]. Ultrasonography is a non-invasive real-time imaging modality, with minimal potential complication. Now, there are many potential applications in horses, including abdominal ultrasonography. The large sizes of abdominal structures are relatively in accessible to other diagnostic techniques, such as radiology and endoscopy. Laparoscopy is valuable diagnostic tool, but the expertise and equipment required restrict its availability to specialist centers [2].

Arabian horse historically has maintained a reputation as the horse of beauty, intelligence, endurance and romance. It is gentle and familiar, almost to the point of being troublesome [3]. It has five lumbar vertebrae and 17 pairs of ribs instead of six and 18 in other breeds [4]. Abdominal ultrasonography in the mature horse is extremely useful in the investigation of acute intestinal problems, recurrent colic and weight loss, as well as the imaging of abdominal organs such as liver, spleen and uro-genital system [5]. On the right side of the horse, ultrasound can visualize the cecum, right kidney, right liver lobe and right dorsal colon. On the left side, ultrasound can evaluate the spleen, left kidney, stomach and left liver lobe. The small intestine and large colon can be seen throughout the abdomen and can be evaluated based on size, motility and bowl wall thickness [6].

The present study aimed to establish the normal ultrasound appearances of abdominal viscera in synchronize with their topographical anatomy and encourage the use of ultrasound as a routine procedure in examination of the abdominal organs in Arabian mares.

Corresponding Author: Noha A. Beder, Department of Animal Medicine, Faculty of Veterinary Medicine, Damanhour City, Damanhour University, Egypt.
Tel.: +20453627042, P.O. Box: 22599, E-mail: abdnour_2009@yahoo.com.

MATERIALS AND METHODS

Animals: Eighteen Arabian mares of 3-5 years old were selected from the animals submitted to Animal Reproduction Research Institute, Egypt for examination from March 2013-May 2014. The feed was withheld for 10 hours and water for 2 hours before the examination ad. Each mare had a wide set of observation including a complete history and thorough clinical examination; Body temperature, Respiratory and pulse rates, conjunctival mucous membranes, superficial lymph nodes and auscultation of intestinal sound [7].

Fecal Examination: 20 g fecal samples were collected from each mare for physical and parasitical examinations. The samples were obtained from the rectum or at time of defecation in a clean container and examined as soon as possible [8].

Blood Samples: Two blood samples were obtained from all animals by jugular vein puncture. The 1st blood samples were collected in centrifuge tubes, left to clot for serum separation, centrifuged at 3500 r. p. m. for 10 minutes and the clear non-hemolysed sera were used for determination of liver enzymatic activities of aspartate aminotransferase (AST), gamma glutamyletranspeptidase (GGT) [9] Also, blood urea nitrogen (BUN)and creatinine levels were determined as kidney function tests [10]. The 2nd blood samples were collected in screw capped tubes containing EDTA as an anticoagulant for determination of total erythrocytic count (TEC), packed cell volume (PCV%) and hemoglobin concentration (HB)[11].

Both fecal and blood analysis were carried out to test and confirm that those animals are healthy.

Ultrasonography: Sonography was performed in each side of the abdomen from the 7th intercostal space (ICS) and directed caudally. Isopropyl alcohol was applied on the skin without clipping the hair and acoustic coupling gel was applied over the transducer which was then covered by thin latex sheath to protect its surface from alcohol. Trans-abdominal ultrasonography of each mare was performed with 3.5-5 MHZ micro-convex probe using Exagyne®, ECM Company, France,ultrasound machine while 6-8 MHZ lubricated sleeved linear array probe used for trans-rectal ultrasonography of urinary bladder (U.B) after removal of all fecal content[12-14]. Ultrasonography is often performed with the footprint of the transducer in an intercostal space. Most imaging of the abdomen is performed with the transducer oriented in a slightly oblique transverse plane initiated dorsally and directed ventrally and when the greater curvature of the stomach wall was visualized, the image captured. All images were captured during expiration to avoid lung interference. The stomach was scanned medial to the spleen and mid portion of left side of the abdomen in the area at 8th or 9th – 12th or 13th ICS [15].The spleen was scanned along the left side of the abdomen from the left ventral eighth ICS to the para-lumbar fossa in a dorsal, sagittal and transverse plane [16] The left kidney was scanned deep to the last rib and ventrally to the first three lumbar vertebrae in both sagittal and transverse planes [17].The small colon was scanned in the left para-lumbar fossa medial or ventral to the spleen and also dorsal to the urinary bladder from the ventral abdomen if the bladder is full and adjacent to body wall[16]. Large colon was examined throughout the majority of the abdomen along both body walls and along the ventral abdomen according to Jones *et al.* [18].

The liver was scanned ventral to the ventral margins of the lungs, along the right side of the abdomen from the 6th-14th ICS [19]. The duodenum was examined ventral to right kidney at 15th and 16th ICS on the right flank and the area between the liver and the right dorsal colon at the 12th-15th ICS [20]. Scanning of the right kidney was performed at the right16th ICS to rostral para-lumbar fossa[17].Cecum was imaged along the body wall in the dorso-caudal portion of right abdomen [16]. The urinary bladder was imaged trans-rectally in a transverse and sagittal planes [21]. Also, trans-abdominal ultrasonography from the ventral abdominal window is performed, if distended.

Statistical Analysis: Data were expressed as means ± standard error (M ± SE).

RESULTS AND DISCUSSION

Clinical Findings: Normal clinical findings were recorded in examined Arabian mares; body temperature was 37.50±0.11 °C, respiratory and pulse rates were 12.90±0.69/minute and 32.30±1.1b/minute respectively as reported previously by Shety [22]. Conjunctival mucous membrane, eye capillaries, intestinal sound and rectal finding were normal as observed by Kelly [23] and Merritt *et al.*[24]. Negative results of fecal examination were recorded regarding parasites, sand and blood.

Blood Analysis: Normal mean values of packed cell volume (PCV), total erythrocytic count (TEC) and hemoglobin (HB) were recorded (39.0±2.71%, 6.43 ± 0.50 million/ mm^3 and 14.90±0.50gm/dl) respectively. These results coincided with those obtained by Smith [25] and Radostits *et al*. [26].

Liver and kidney function tests were within normal levels; AST activity (118.0±9.20 u/l), GGT activity (15.50±1.18 u/l), BUN (20.90±1.64 mg/dl) and creatinine (1.20±0.04 mg/dl) that agreed with Radostits *et al*. [26] and Katiuska *et al.* [27]. Those results of clinical findings and blood analysis approved that the examined animals were healthy before ultrasonographic examination

Ultrasonography: Imaging of the stomach is started on the left rostral side of the abdomen, between the 8^{th}or $9^{th}$and 12^{th}or13^{th}ICSapproximately at the level of the shoulder. The images were captured when the greater curvature of the stomach wall was identified as a smooth curved hyper-echoic line deep to the spleen. It is characterized by hyper-echoic shadwing gas originating from the gastric mucosa (Fig.1). This coincided with those observed by Colin *et al.* [28] and Valeria *et al*.[29].

The spleen was identified immediately adjacent to the body wall, from the left ventral 8^{th} intercostal space to the para-lumbar fossa, its parenchyma appeared moderately echogenic with a finely mottled pattern and surrounded by hyper- echogenic capsule. The splenic vein appeared in its medium in longitudinal and cross- section views (Fig.1,2,3).The echogenicity of the spleen is greater than that of the liver or kidneys. These findings agreed with Valeria *et al.* [29] and Reef [16].

The fibrous capsule of the kidney appeared as hyper-echoic line. The cortex imaged as homogeneous area of fine echoes, less echogenic than the adjacent retro-peritoneal and splenic tissue, approximately 2cm thickness while the medulla is a hypo- echoic to anechoic region subsequent to the cortex with a distinct demarcation between them. The renal pelvis visualized as a bright echogenic line in the center of the kidney (Fig.5). Branches of renal arteries were evident in the medulla and renal pelvis deep to the cortex as anechoic, pulsatile structures. Inter-lobar vessels appeared as small circular or linear structures with anechoic centers and echogenic wall. These results coincided with Douglas and Fairfield [30]. The left kidney found deep to the last rib and ventrally to the first three lumbar vertebrae, medial to the spleen. Gas in the small colon or left colon or lung may preclude trans-abdominal viewing of the left kidney. The ureters could not be imaged. These findings agreed with the results of Michelle [1]. The small colon was imagedin the left para-lumbar fossa medial to the spleen. Only small sections of the surfaces are visible because of its small diameter, sacculations and packed serpentine loops that suspend from the dorsal mesocolon. It appeared as short, sharply curving, hyper-echoic lines (Fig.2). This coincided with those observed by Freeman [12].

The large colon is identified as a mobile structure outlined by a curvilinear, hypo-echoic line overlying a hyper-echoic gas shadow. The luminal contents and opposite wall were not visualized due to the acoustic gas shadow. The left ventral colon was located ventro-medial to the spleen, delineated by curved lines of different length (sacculation) (Fig.3). Precise measurement of the colonic wall can be difficult because of the indistinct mucosal-luminal interface; however, the wall of the colon should measure less than 4 mm. The left dorsal colon was imaged dorsal, lateral, medial and ventral to the left ventral colon without sacculation. However, Gas in the left ventral colon often precludes distinct identification of the left dorsal colon when it lies medial or dorsal to the left ventral colon. This result was in accordance with that stated by Mitchell *et al*.[31] and Eli *et al*. [32].

Liver was imaged on the right side of the abdomen, below the right lung margin. It was located from the 6^{th} to the 14^{th} intercostal spaces between the diaphragm and the right dorsal colon. It was recognizable by homogeneous echogenicity and its anechoic branching vasculture with portal and hepatic veins. The portal veins have more connective tissue in their walls and thus appeared more echogenic walls than the hepatic veins. Shorter segments of smaller portal veins appeared as hyper-echoic parallel lines (Fig.4). The common bile duct and its branches are not normally visible. This result coincided with that of Scharner *et al*. [15]. Gas in the lung or the right dorsal colon can obscure identification of the liver dorsally and ventrally.

The small intestine has the most visible motility of any part of the gastrointestinal tract, with peristaltic waves producing frequent rhythmic contractions. Fluid luminal contents typically enable accurate measurement of the wall (<3 mm) and visualization of the far wall. These findings coincided with those reported by Reef *et al.* [33].

The position of the duodenum is fixed by its suspending meso-duodenum; it was found descending the right middle abdomen between the liver and the right

Fig. 1: Ultrasonographic view of ventral part of Rostoral left abdomen showing stomach, spleen (s), splenic vein (s. v) and left dorsal colon (LDC). Dorsal (dr).

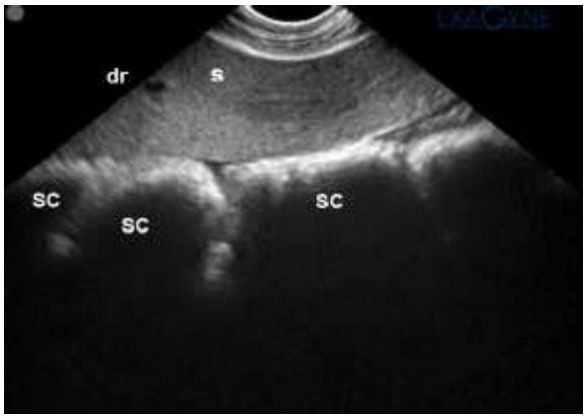

Fig. 2: Ultrasonographic view of ventral part of caudal left abdomen showing spleen (s) and individual loops of small colon (sc). Dorsal (dr).

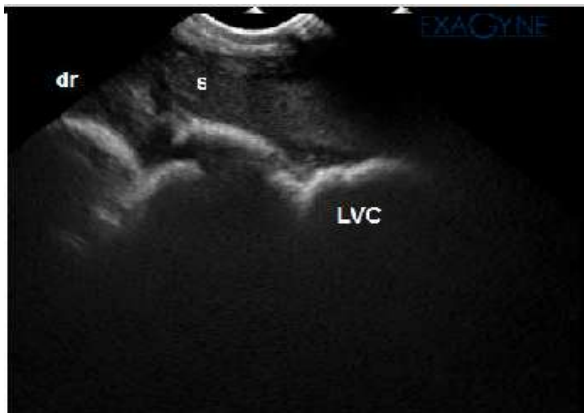

Fig. 3: Ultrasonographic view of caudal left Abdomen showing spleen (S) and left ventral colon (LVC) with its hyper- echoic sacculated wall. Dorsal (dr).

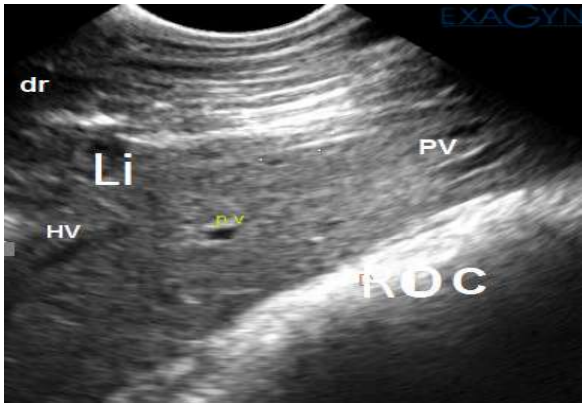

Fig. 4: Ultrasonographic view of middle right abdomen showing liver (Li), portal vein with hyper-echoic wall (PV), hepatic vein (HV) and right dorsal colon(RDC) without sacculations. Dorsal (dr).

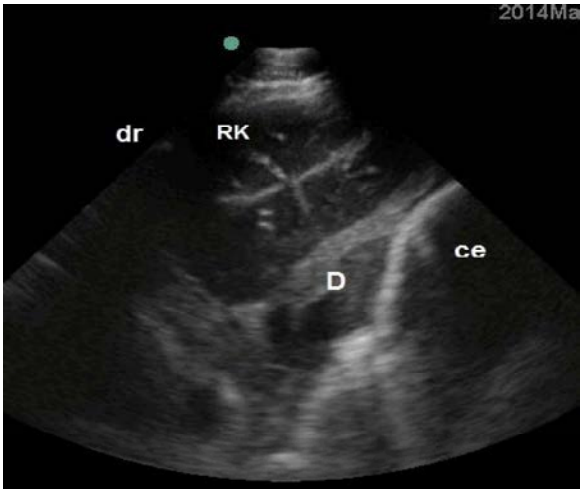

Fig. 5: Ultrasonographic view ofcaudal right abdomen showing right kidney (RK), duodenum (D) and ceacum with sacculated hyper-echoic wall (ce).Dorsal (dr).

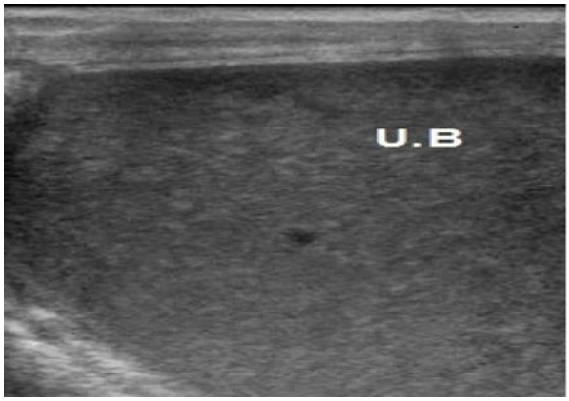

Fig. 6: Trans- rectal ultrasonographic view of Urinary bladder (U. B) with hyper- echoic particles.

dorsal colon at area from the 12th-15th intercostal spaces. It was also imaged ventral to the caudal pole of right kidney in the right flank. It appeared as a hyper-echoic flattened line changed to oval or rounded shape during peristaltic propulsion of ingesta (Fig.5). The duodenal wall and its content were easily distinguishable. This result coincided with results of David *et al*. [20] and Valeria *et al*. [29]. The jejunum is most consistently found in the left inguinal area, medial to the spleen and the left ventral colon. It appeared as flat or triangular hyper-echoic structure with very sparse contents. The medial location of the ileum precludes distinct identification by trans-cutaneous ultrasonography. These results agreed with those reported by Mitchell *et al*. [31] and Worth [34] who stated that Jejunum and Ileum could not be usually imaged in the adult horse owing to the interposed large colon.

The right kidney was imaged at rostral right para-lumbar fossa to 16th ICS as have been observed by Mitchell *et al*. [31]. Gas in the cecum, right dorsal colon or lungs sometimes obscures visualization of the right kidney. The right dorsal colon could most reliably be imaged at 11th, 12th and 13th ICS. It appeared as hyper- echoic curved line caudal to the liver and duodenum, has no sacculations (Fig.4) while, the right ventral colon was identified by its sacculations just ventral to the right dorsal colon. Similar findings were described by Abutarbush [13] and Reef *et al*. [33].

The cecum identified by a sacculated wall that extends from the right para-lumbar fossa to ventral mid-line and its motility. The contractions of the cecum oriented vertically as opposed to horizontally in the large colon. Its content appeared highly echogenic with a coustic shadowing (Fig.5). Similar findings were described by Freeman [12]. The urinary bladder was scanned trans-rectally, its wall was uniformly echogenic and appeared thinner when the bladder distended. Its content varied from anechoic with hyper-echoic particles to a homogeneous pattern similar to that of the spleen (Fig.6). These particles representing calcium carbonate crystals and proteineceous materials.. The urethra was evident when filled with urine. This result was in accordance with that stated by Reef *et al*. [33].

CONCLUSION

Ultrasound is an easy method of abdominal examination of Arabian horses, we can depend on it in distinguishing normal from abnormal conditions. Both Arabian and Thoroughbred horses were similar in their normal ultrasonography of abdominal organs either appearance or sites of examination

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