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THE ULTRASONOGRAPHIC FINDINGS OF THE GASTROINTESTINAL TRACT AND SPLEEN IN HEALTHY EGYPTIAN BUFFALOES *(BUBALUS BUBALIS)*

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ABSTRACT

This study aimed to describe the normal ultrasonographic image of the gastrointestinal tract and spleen in Egyptian buffaloes *(Bubalus bubalis)*. The obtained results were compared to the normal reference values that had been previously established in cattle. This study was carried out on thirty healthy buffalo. Complete clinical examination, hematological pictures profiling, blood biochemical analysis of different parameters such as total blood serum proteins, albumins, globulins, aspartate aminotransferase, alkaline phosphatase, gamma-glutamyl transferase, triglycerides and cholesterol, radiography and ultrasonographic examination were done. The clinical findings, blood pictures and blood biochemical levels agreed with the previously reported reference values of healthy buffaloes. Radiography of the healthy buffaloes showed free reticulum, normal heart and well-identified diaphragm. The heart appeared as radio-opaque structure. This study could detect the suitable site for visualization of reticulum, omasum, abomasums, rumen, small intestine and large intestine. It also described the normal ultrasonographic patterns of these organs. It was very essential to establish these ultrasonographic findings to improve the diagnostic efficacy of ultrasonography for evaluation of different gastrointestinal organs in healthy buffaloes that will be very useful in the future detection of the abnormal findings associated with gastrointestinal diseases.

Keywords: *Buffaloes, ultrasonography, gastrointestinal, haematological, radiography.*

INTRODUCTION

Preliminary, diagnosis of digestive disorders in ruminants could be achieved by ordinary diagnostic procedures such as visual inspection, palpation, percussion and auscultation, still as usual as basic methods (Rosenberger, 1979; Kelly, 1984; Radostits *et al.*, 1994).

Ultrasound examinations are now a routine work of small animal and equine diagnostic tools with cardiac, thoracic, abdominal, reproductive, ocular and musculoskeletal applications all being well documented and many literatures being available (Green, 1996; Reef, 1998; Nyland and Mattoon, 2002). Braun, 2003 said that ultrasounds are a very important in diagnosis of different digestive system disorders in cattle. Other diagnostic applications of ultrasound were reported in cow include heart diseases (Schweizer *et al.*, 2003). Abdominal affections as traumatic reticuloperitonotis, liver diseases such as liver abscess, intestinal diseases such as ileus of small intestine and abomasal diseases such as abomasal displacement (Hassel *et al.*, 1995; Kim *et al.*, 1996; Pusterla and Braun, 1997; Braun *et al.*, 1997a, b; Braun *et al.*, 1998a, b) and musculoskeletal examinations (Kofler, 1996).

Several studies were conducted and reported full description of the normal ultrasonographic findings of the digestive system organs in cows such as reticulum, rumen, omasum and abomasum by Braun *et al.* (1993b and 1997a); Sena *et al.* (2003), spleen by Braun and Sicher (2006), small intestine by Braun and Marmier (1995) and large intestine by Braun and Amrein (2001).

The literatures about the ultrasonographic findings of gastrointestinal tract and spleen in healthy Egyptian buffaloes were not widely published and because of the great importance of buffaloes as well as cows in the national economy of Egypt and because of Cattle and buffaloes submitted to veterinary medical teaching hospital represent about 90 % from total cases of our patients (El-sebaie, 2008), we aimed in this study to establish the normal ultrasonographic findings of the gastrointestinal organs and spleen in

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healthy buffaloes and we hope that our study will be very helpful for further investigations about the importance of ultrasonography for diagnosis of digestive system diseases in buffaloes.

MATERIALS and METHODS

Animals: A total number of thirty animals were included in this study. All buffaloes were treated in accordance with guidelines established by the Faculty of Veterinary Medicine, Assiut University Committee on Animal Care. These female; non-pregnant buffaloes were selected from healthy buffaloes belonging to both of the herd of veterinary teaching hospital which kept for teaching purpose and from the neighboring villages around Assiut city. This group includes twenty buffaloes aged 5 to 7 years and ten heifers between 1 to 2.5 years.

Samples*:* Whole blood samples were collected on EDTA and stored at 4 Ċ until analysis. Non hemolysed blood serum samples were collected on plain vaccutiner tubes and stored at -20 Ċ until analysis according to Coles, (1986).

Clinical Examination: Clinical examination of the animals using clinical chart was done according to Rosenberger (1990).

Haematological parameters were determined using automated blood cell counter machine, Medonic CA620 Vet hematology analyzer –Sweden, was used to determine various hematological parameters. Differential leukocytic count (DLC) was determined using four field meander method (Kelly, 1984).

Biochemical assays: Spectrophotometric method using Phillips Pye Unicam spectrophotometer (U.V. Visible Mod. 800) was adopted to determine serum levels of AST (U/L) (Sherwin, 1984), GGT (U/L) (Shaw *et al.*, 1983), AP (U/L) (Moss, 1982), Total protein (g/L) (Tietz, 1994), albumin (g/L) (Tietz, 1990), globulin by subtraction of albumin from total protein, albumin/globulin ratio, cholesterol (mmol/L) (Ellefson and Caraway, 1976) and triglycerides (mmol/L) (Stein, 1987) by using commercial kits. All kits and reagents were obtained from Spectrum Reagents (Egyptian Company for Biotechnology, Egypt).

Radiographical examination**:** The cranial abdominal region and caudal thorax were examined radiographically according to Nägeli (1991); Braun *et al.* (1993a) using fixed ceiling X-ray apparatus (40-60 Kv and 45-55 mA/s). The following criteria were recorded upon radiographical examination: nature and location of foreign body (reticular, diaphragmatic, pericardial position), status of diaphragm (intact versus broken) and visualization of the cardiac area (good versus bad line of demarcation).

Ultrasonographical examination: Ultrasonographic Examination of reticulum, rumen, abomasums, omasum, spleen and intestine in each animals according to Braun and Götz (1994); Braun and Marmier (1995); Wild (1995); Braun and Amrein (2001); Braun and Sicher (2006) by using a 3.5 MHz Sector transducer of apparatus (FF Sonic, Model UF-4000, Tokyo, Japan). It was performed on standing non-sedated buffaloes after the application of transmission gel. The hair is clipped from the area where the transducer is using to be applied; for optimal transmission of ultrasound waves, remaining hair may be removed by a razor or depilatory cream.

Statistical analysis: Data were analyzed using statistical software program (Spsswin, 1997). All data were presented as mean ± standard deviation (SD).

RESULTS

Clinical findings*:*
The range of body temperature, respiration; heart rate and ruminal motility were 38.2±0.64 Ċ, 15±3 R.C/min, 67±10 beat/min and 3±1 R. cycle/2min, respectively.

The examined buffaloes also had good appetite, normal gait, normal mucous membrane, absence of any signs of dehydration, anemia, congestion of mucous membranes and engorgement of episcleral capillaries. Absence of abnormal heart and lung sounds. The abdomen was not tensed and not distended whereas the pain test was negative.

Blood picture indices:
Mean values of total red blood corpuscles count, packed cell volume, haemoglobin concentration and total leukocytic count were 7.54±2.98 (T/L), 38±3.24 (%), 118±4.5 (g/L) and 6.71±1.63 (G/L), respectively. Mean values of differential leukocytic count for neutrophils, lymphocytes, monocytes, eosinophils and band cells were 26.4±9.13 (%) 60.80±7.73 (%), 7.80±4.63 (%), 3.60±2.07 (%) and 1.40±0.52 (%), respectively.

Serum biochemical analysis:
Mean values of serum total protein, Albumin, globulin and A/G ratio were 94.7±10.7 (g/L), 55±8.4 (g/L), 45.7±4.6 (g/L) and 1.38±0.59, respectively. Meanwhile the mean values of serum levels of GGT, AP and AST were 14.95±1.23 (U/L), 36.11±4.40 (U/L), 32.92±4.77 (U/L), respectively. Mean values of serum levels of cholesterol and triglycerides were 106.77±10.96 (mmol/L) and 3.62±0.2 (mmol/L), respectively.

Radiographic findings:
Radiographic finding of reticulum in healthy non-pregnant buffaloes showed that the reticulum was free from any metal objects. The reticulum was imaged as

radio-opaque. The diaphragm was imaged as a clear black line between two radio-opaque structures; reticulum and heart. There were no evidences of adhesions between diaphragm and reticulum or between diaphragm and heart. The heart had clear margins, normal size and a characteristic shape. Heart appeared as radio-opaque (Fig. 1).

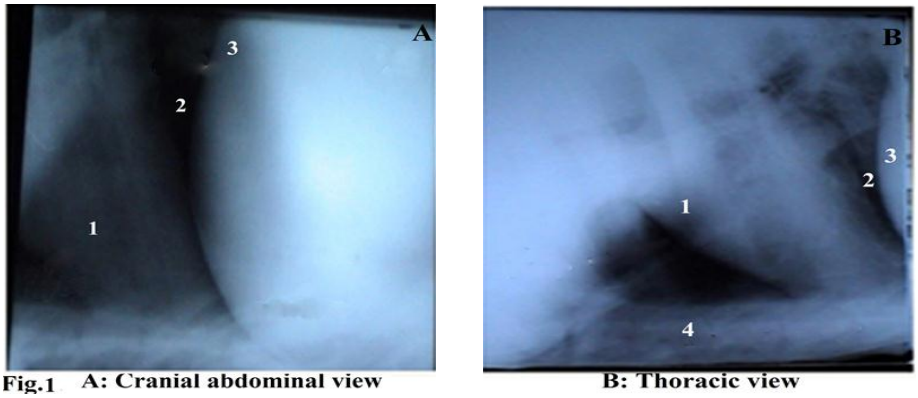


Fig.1 A: Cranial abdominal view B: Thoracic view

1: Heart. 2: Diaphragm. 3: Reticulum. 4: Sternum

Fig. 1: Lateral radiographic view of the cranial abdomen **(a)** and the thorax **(b)** of a 3 years non-pregnant female buffaloes showed normal radiographic appearance of reticulum, heart and diaphragm.

Ultrasonographic findings:

The reticulum was imaged from the left ventral aspect of the thorax; from the left and right side of the sternum as well as thoracic wall just up to elbow level. The sonographic image of the reticulum included its even contour with half-moon shaped structure. It immediately situated adjacent to the ventral abdominal wall and diaphragm (At a distance 0.5-1.4 cm) and contracted at regular intervals with characteristic biphasic reticular contractions which were 3/3mins (one biphasic contraction/min). The reticulum was situated adjacent to the ventral abdominal wall (echogenic band), musclophrenic vein (anechoic band), and sternal part of the diaphragm (echogenic band). It had a thin echogenic reticular serosa (Fig. 2.A and B). The site of probe in case of ultrasonography of the reticulum was not restricted to the left ventral aspect of the thorax but it also was imaged from the left paramedian and right paramedian.

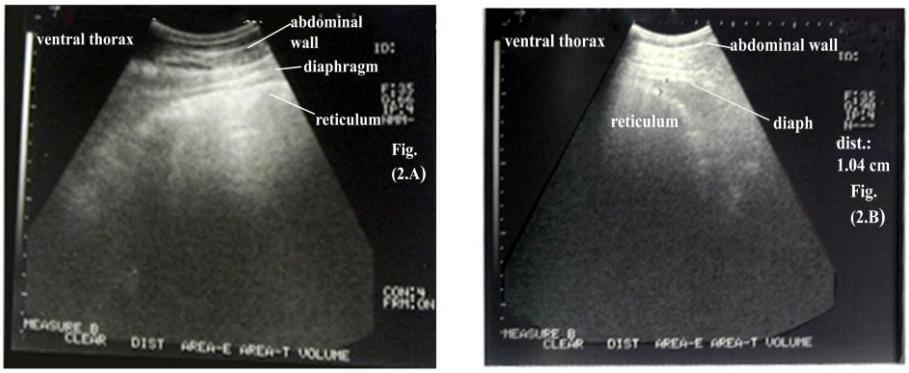
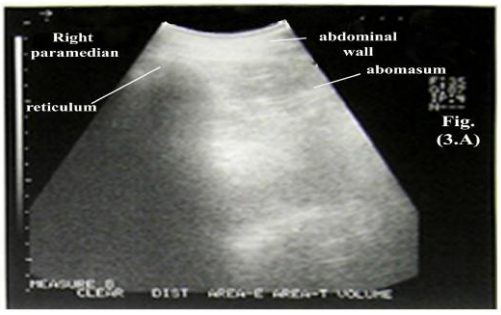


Fig. 2. A and B: Ultrasonogram in a buffalo imaged from the left ventral thorax. It showed reticulum with its half- moon shaped structure and its even contour. It has thin distinct echogenic wall. It immediately situated adjacent to the ventral abdominal wall and the diaphragm at a distance about 1.04 cm.

The abomasums usually visualized from the cranial part of the right paramedian region, 12 cm caudal to xiphoid process of sternum and 10 cm to the right from the ventral midline, and sometimes form the left paramedian region. The abomasums had characteristic contents which appeared as heterogenous moderately echogenic contents with echogenic stippling structures with invisulization of the abomasal folds (Fig. 3.A and B). It was imaged between the ventral abdominal wall and diaphragm and caudally to the reticulum.



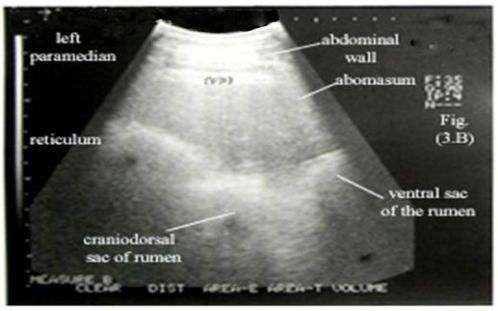
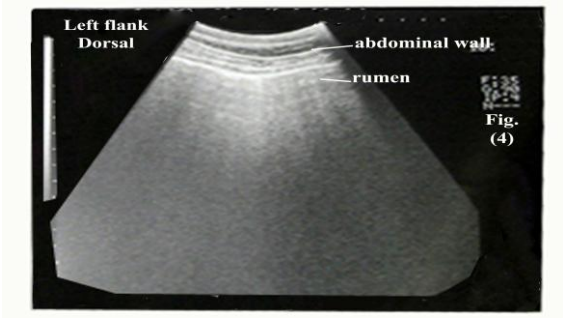


Fig. 3. A and B: Ultrasonogram in a buffalo imaged from 12 cm caudal to the xiphoid process and 10 cm to the right from the ventral midline (cranial part of the right paramedian region) and from the left paramedian region. It showed the abomasums situated immediately between craniodorsal sac and ventral sac of the rumen and the ventral abdominal wall and caudal to the reticulum. It has thin fine echogenic serosa with imaging of its characteristic contents as heterogenous moderately echogenic contents and echogenic stippling. The abomasal folds could not be imaged.

The best site for imaging the rumen was from the left lateral abdominal wall. It was imaged immediately adjacent to the left abdominal wall as thick echogenic line with invisualization of its contents due to its gaseous contents (Fig. 4). It also was imaged from the left paramedian with imaging reticulum, craniodorsal sac, ventral sac of the rumen and sometimes spleen.

In case of ultrasonographic examination of the omasum, the probe was placed in the cranial part of the right paramedian region and the omasum was imaged as thick circular echogenic wall with invisualization of its contents (Fig. 5).



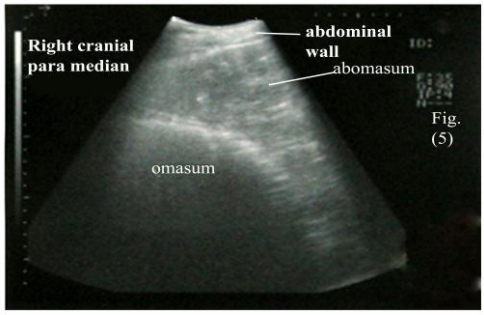
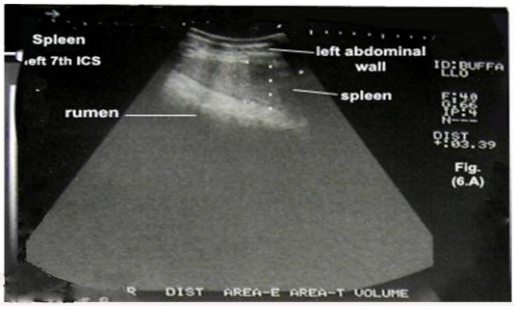


Fig. 4: Ultrasonogram in a buffalo imaged from the dorsal and ventral parts of the left flank region. It showed rumen with its thick echogenic wall that immediately situated medially to the left flank region. Invisualization of the ruminal contents due to its gaseous contents.

Fig. 5: Ultrasonogram in a buffalo imaged from the cranial part of the right paramedian region. It showed the omasum with its thick circular echogenic wall and invisualization of its contents. The omasum was related to the ventral abdominal wall and abomasums.

Spleen was imaged from the distal part of the left 6th and 7th ICSs (between caudal point of scapula and caudal point of the elbow). It was a 3.5 cm (2.87 to 4.10 cm) thick structure. It was situated between the reticulum and/or craniodorsal sac of the rumen and the abdominal wall. It was tappered off ventrally. The medial and lateral surfaces were merged. Its capsule was imaged as an echogenic line. Splenic pulp in cross section was appeared as numerous weak echoes evenly distributed within it (Fig. 6.A and B).



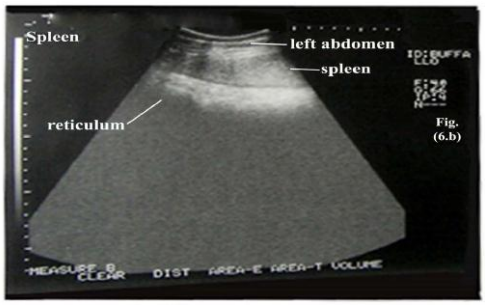


Fig. 6. A and B: Ultrasonogram in a buffalo imaged from the left 7th ICS between the caudal point of the scapula and elbow point. It showed a 3.39 cm thick structure with echogenic capsule. It tappered off ventrally. It situated between the abdominal wall and the craniodorsal blind sac of the rumen.

Ultrasonographic examination of the intestine in the healthy buffaloes was made through scanning of the right flank region.

The small intestine included duodenum, jejunum and ileum. The descending part of the duodenum was imaged from the dorsal area of the right flank region between the right abdominal wall and the loops of small intestine. It had an echogenic envelop with diameter 1.7- 4 cm. It also was imaged from the ventral part of the last right three intercostals spaces (Fig.7.A and B). The cranial part of the duodenum was imaged from the ventral part of the right 10th and 11th ICSs and ventromedially to the liver and gall bladder. The loops of jejunum and ileum were imaged from the ventral part of the last right three intercostals spaces and from the right flank region medial to descending duodenum. They were imaged in cross section as loops with two echogenic wall and with echoic or hypoechoic contents. Their diameters ranged between 2.5-4.2 cm (Fig. 8.A and B). The peristaltic movement of the small intestine was clearly observed. The contents of small intestine were usually imaged in cross section echoic due to their mucus or feed contents from and sometimes imaged hypoechoic due to its contents of fluid. Their longitudinal sections were imaged as hypoechoic contents.

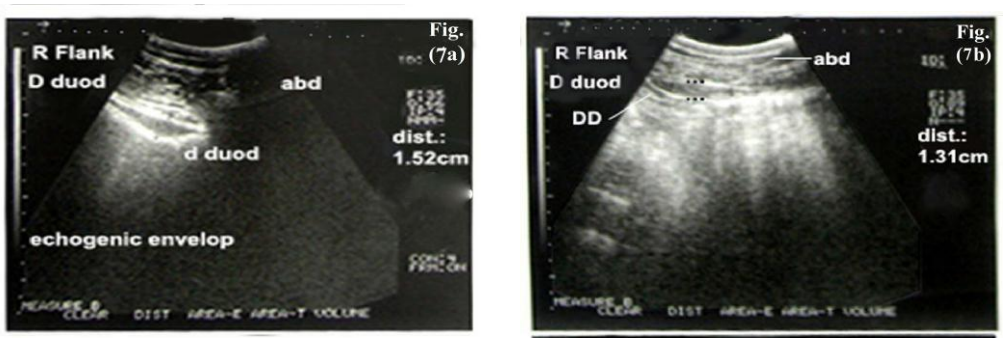


Fig. 7. A and B: Ultrasonogram in a buffalo imaged from the dorsal part of the right flank region. It showed CS in the descending part of the duodenum. The descending part of the duodenum had an echogenic envelop and its diameter was about 1.31 or 1.52 cm. It was immediately situated medially to the right flank region and laterally to the large intestine with visualization of its hypoechoic contents and two echogenic walls (the closest and the furthest walls).

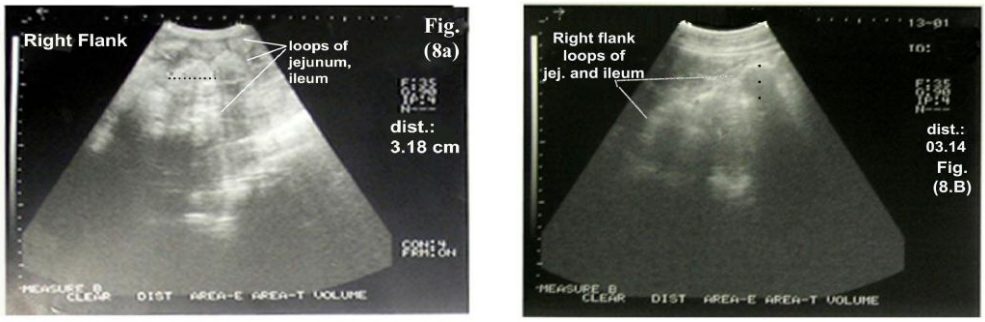


Fig. 8. A, B and C: Ultrasonogram in a buffalo imaged from the right flank region more ventrally. It showed CS in loops of jejunum and ileum with diameters of 3.14, 3.18 or 3.65 cm. The loops of jejunum and ileum had echogenic, hypoechoic and isoechoic contents and visualization of their two walls (the closest and the furthest walls) as echogenic line. The peristaltic movement of the small intestine was clearly observed.

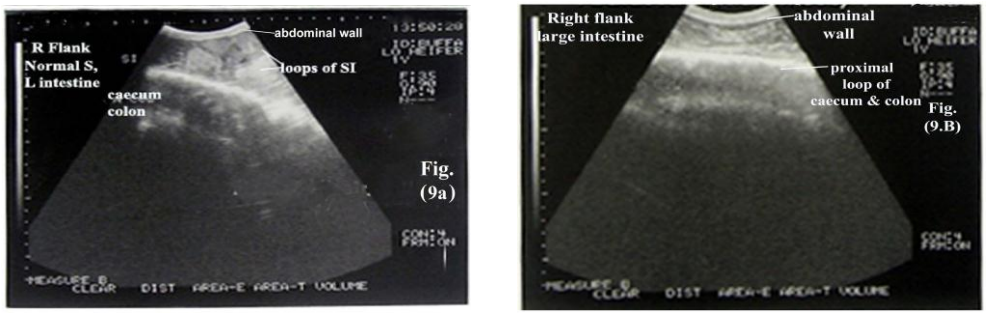


Fig. 9. A and B: Ultrasonogram in a buffalo imaged from the right flank region. It showed CS in the caecum and proximal loop of colon. The closest wall of the colon or caecum to the transducer is imaged as thin continuous echogenic line [9a] or slightly curved [9b], meanwhile the furthest wall from the transducer and the contents of the colon could not be imaged due to the gases reverbration artifacts at the soft tissue- air interface.

The large intestine was imaged from the right flank regions. The proximal loop of the colon and caecum were clearly imaged from the right flank region, mainly its caudodorsal and caudoventral parts. The closest wall of the proximal loop of colon and caecum was imaged in cross section as continuous echogenic line or slightly curved (Fig. 9.A and B) meanwhile in case of the spiral colon, its closest wall appeared as gar-land like appearance (Fig. 10). The furthest wall and contents of proximal loop of the colon and caecum could not be imaged. It was difficult to differentiate between caecum and proximal loop of colon by using ultrasonography with a 3.5 MHz sector array transducer. The movement of large intestine was not as segmental and vigorous as that of small intestine.

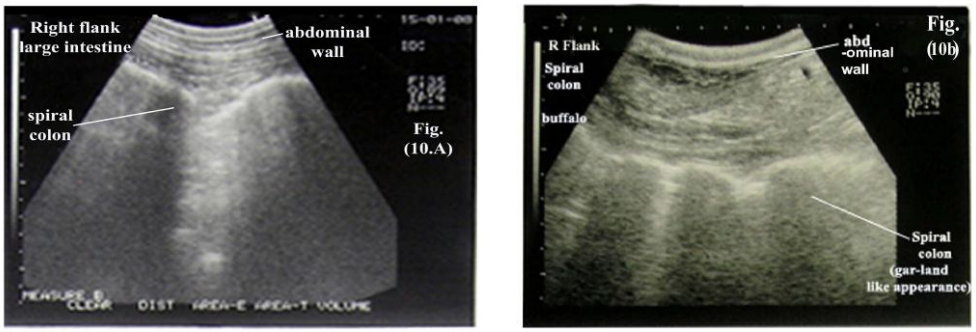


Fig. 10: Ultrasonogram in a buffalo imaged from the right flank region more ventrally. It showed CS in the spiral colon. The closest wall of the colon appeared as gar-land like appearance. The furthest wall from the transducer and the contents of the colon could not be imaged due to the gases reverbration artifacts at the soft tissue-air interface.

DISCUSSION

Bovine medicine including diagnosis and therapy is considered the most important field in veterinary medicine in Egypt, because cattle constitute the major sector in animal population if compared with other animal species. Cattle and buffaloes submitted to veterinary medical teaching hospital represent about 90 % from total cases of our patients (El-sebaie, 2008).

The clinical findings in healthy buffaloes including temperature, pulse, respiration, rumen motility, appetite, mucous membranes, dehydrations, pain test, abdominal tension and animal gait similar to the results reported by Smith (1990); Radostits *et al.* (1994). The blood pictures in healthy buffaloes coincided with the normal reference values stated by Rosenberger (1990); Sedik (1992); Abd Ellah (1998), meanwhile their blood biochemical levels agreed with that reported by Green *et al.* (1982); Rosenberger (1990) for total proteins Sedik (1992); Abd Ellah (1998) for albumins, by Abd Ellah (1998); Salem *et al.* (2003) for globulins, Abd Ellah (1998) for A/G ratio, Sedik (1992) for AST, Rosenberger (1990) for GGT, AP and cholesterol, Sedik (1992) for triglycerides.

Radiography of the healthy buffaloes showed free reticulum, normal heart and well-identified diaphragm. The heart appeared as radio-opaque structure. Braun *et al.* (1993a) explained the importance of radiography as an aid in the diagnosis of traumatic reticuloperitonitis in cattle while (Braun and Götz, 1994) stated a comparison between ultrasonographic and radiographic findings in cows with traumatic reticuloperitonitis.

This study reported that the site and image of the reticulum in healthy buffaloes agreed with what was described by Braun *et al.* (1993b); Braun and Götz (1994); Sena *et al.* (2003) in cattle as it was imaged from the left ventral aspect of the thorax; from the left and right side of the sternum as well as thorathic wall up to elbow level. It had an even contour with half-moon shaped structure. It immediately situated adjacent to the ventral abdominal wall and diaphragm (At a distance 0.5-1.4 cm) and contracted at regular intervals with characteristic biphasic reticular contractions that were 3/3mins (one biphasic contraction/min).

The current results revealed that the omasum was imaged from the cranial part of the right paramedian region and had a thick circular echogenic wall with invisualization of its contents. This finding was supported by the results mentioned by Braun *et al.* (1993b).

The rumen was imaged from the left lateral abdominal wall as thick echogenic line with invisualization of its contents due to its gaseous contents. When it was imaged from the left paramedian, the reticulum, craniodorsal sac, ventral sac of the rumen and some times spleen were also visualized. These findings coincided with what stated by Braun and Götz (1994); Kaske *et al.* (1994); Braun (1997) in cows.

This study described the best site for imaging the abomasum which was the cranial part of the right paramedian region, 12 cm caudal to xiphoid process of sternum and 10 cm to the right from the ventral midline. Sometimes, the abomasums was examined form the left paramedian region. It had a characteristic appearance of its contents which appeared as heterogenous moderately echogenic contents with echogenic stippling structures and invisulalization of the abomasal folds. Invisulalization of the abomasal folds due to the hetergenous nature of the abomasums which absorb the waves before reaching the abomasal folds and the undulating shape of these folds that make it very difficult to be imaged with our 2-dimensions system probe. This image was supported by the findings reported by Braun *et al.* (1997a). Poor visualization of the abomasal wall was mainly due to very thin tela-submucosa (0.1 mm) and was partially attributable to the heterogeneous abomasal contents (Wild, 1995).

Spleen was imaged as a 3.5 cm (2.87 to 4.10 cm) thick structure between the reticulum and/or craniodorsal sac of the rumen and the abdominal wall. It tappered off ventrally. Braun and Sicher (2006) reported the same findings of spleen in cattle.

Ultrasonographic examination of the intestine in the healthy buffaloes was made through scanning of the right flank region and this was coincided with Braun and Marmier (1995) for small intestine and Braun and Amrein (2001) for large intestine.

The present study reported that the descending part of the duodenum was imaged from the dorsal area of the right flank region between the right abdominal wall and the loops of jejunum and ileum and also imaged from the ventral part of the last right three intercostals spaces It had an echogenic envelop with diameter 1.7-4 cm. The cranial part of the duodenum was imaged from the ventral part of the right 10^{th} and 11^{th} ICSs and ventromedially to the liver and gall bladder. The loops of jejunum and ileum were imaged from the ventral part of the last right three intercostals spaces and from the right flank region medial to descending duodenum. They were imaged in cross section as loops with two echogenic wall and with echoic or hypoechoic contents. Their diameters ranged from 2.5-4.2 cm. The peristaltic movement of the small intestine was clearly observed. These findings matched with the results obtained by with Braun and Marmier (1995) that described the normal ultrasonographic findings of small intestine in bovine animals.

The reported ultrasonographic findings of the large intestine were similar to what were described by Braun and Amrein (2001) where it showed the closest wall (To the transducer) of the proximal loop of colon and caecum in cross section as continuous echogenic line or slightly curved meanwhile in case of the spiral colon, the closest wall appeared as gar-land like appearance. The furthest wall and contents of caecum and colon were not imaged because of the gaseous contents of the large intestine that caused reverbration artifacts at the soft tissue-air interface that prevented visualization of the furthest wall and contents of the colon and caecum. It was difficult to differentiate between caecum and proximal loop of colon by using ultrasonography with a 3.5 MHz sector array transducer.

ABBREVIATIONS

A/G ratio: albumin/Globulin ratio, AST: aspartate aminotransferase, AP: alkaline phosphatase, CS: cross section, duod: duodenum, GGT: gamma-glutamyl transferase, ICS: intercostal space, jej: jejunum, L: left, LI: large intestine, R: right, SI: small intestine.

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الشواهد المرئية بإستخدام الموجات فوق الصوتية للقناة الهضمية والطحال في الجاموس المصري السليم

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تهدف الدراسة الحالية الي وصف القناة الهضمية والطحال في الجاموس المصري في الحالات السليمة الغير مريضة باستخدام الاشعة التليفزيونية (الموجات فوق الصوتية). أجريت الدراسة علي ثلاثين جاموسة. هذه الحيوانات تم عمل فحص سريري شامل لها مع اجراء صورة دم كاملة وقياس بعض مكونات مصل الدم. فحصت هذه الحالات ايضا بإستخدام كل من الاشعة السينية والموجات فوق الصوتية. الفحص السريري، صورة الدم الكاملة والفحوصات البيوكيمائية لمصل الدم كانت متفقة مع القيم القياسية التي سبق وان سجلت في الجاموس. الاشعة السينية اوضحت بأن الشبكية خالية من أية أجسام غريبة، القلب طبيعي والحجاب الحاجز واضح المعالم ومميز عن القلب والشبكية. الفحص بالموجات الفوق الصوتية حدد المكان المناسب لرؤية كل من الشبكية، الكرش، التلافيف، الانفحة، الامعاء الدقيقة والامعاء الغليظة مع تقديم الصورة الواضحة لهذه الأعضاء. أهمية هذه الدراسة ترجع إلي وضع أسس لوصف هذه الأعضاء بإستخدام الموجات فوق الصوتية في الجاموس السليم مما يعظم من الدور المستقبلي لتلك الوسائل التشخيصية في وصف الصورة الغير طبيعية لهذه الأعضاء والمرتبطة بمختلف امراض القناة الهضمية في الجاموس.