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ULTRASONOGRAPHY OF THE DIGESTIVE TRACT IN YOUNG CAMEL CALVES UNTIL THE AGE OF 100 DAYS

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ABSTRACT

This study was designed to obtain the normal imaging pictures of the gastrointestinal tract (GIT) including the gastric compartments and small and large intestines in camel calves until the age of first 100 days of life. The GIT was examined at day 1, day 20, day 40, day 80 and day 100 by ultrasound in 15 clinically healthy camel calves (from 1 day until 100 days of age) and the normal imaging patterns were recorded and analysed. The results of ultrasonography as well as the imaging of the gastric compartments and small and large intestines are summarised. Ultrasonography could be used as a noninvasive diagnostic tool in order to detect GIT diseases in the camel calves.

Key words: Abdomen, camel calves, digestive, gastrointestinal, ultrasonography

The ultrasonographic picture of the gastrointestinal tract (GIT) including the gastric compartments and small and large intestines has been reported for adult dromedaries (Tharwat *et al,* 2012a). In diseased camels, on the other side, diagnostic ultrasonography has been applied for the evaluation and determining the prognosis of camels with gastrointestinal disorders such as abdominal distension (Tharwat *et al,* 2012b), paratuberculosis (Tharwat *et al,* 2012c), abdominal disorders (Tharwat and Al-Sobayil, 2016), gastrointestinal tumours (Tharwat *et al,* 2018) and chronic peritonitis (Tharwat, 2019).

In cow calves, ultrasonography of the reticulum, rumen, omasum and abomasum has been reported (Braun *et al,* 2013; Braun and Gautschi, 2013). In growing camel calves, however, the ultrasonographic picture of the dramatically changed GIT during the first 100 days of age has not been reported. The purpose of this study was therefore designed to periodically examine the GIT including the gastric compartments and small and large intestines in camel calves until the age of 100 days to gain detailed information about normal ultrasonographic imaging patterns of the GIT. It is believed that knowledge of the ultrasonographic appearance of the normal GIT in camel calves will provide a reference for the interpretation of the GIT in camel calves with suspected digestive abnormalities.

Materials and Methods

Animals and physical examination:

For obtaining the normal imaging patterns of GIT, 15 clinically healthy camel calves were used (from day 1 until 100 days of age). Calves were kept in the Veterinary Teaching Hospital, Qassim University, Saudi Arabia. Camel calves underwent a thorough physical examination including general behaviour and condition, auscultation of the heart, lungs, stomach and intestine, detection of heart and respiratory rates and rectal temperature (Köhler-Rollefson *et al,* 2001). All camel calves were considered clinically healthy based on physical and laboratory evaluation (complete cell blood count and chemistry panel), and they had full access to feed and water before and after examination.

Ultrasonographic examination

Ultrasonographic examination of the GIT was carried out in the camel calves at day 1, day 20, day 40, day 80 and day 100. Ultrasonography of the GIT was carried out in camel calves as described for adult camels (Tharwat *et al,* 2012b) in sternal recumbency. Ultrasonographic examination was carried out using a 3.5 to 5.0 MHz sector transducer (SSD-500, Aloka, Tokyo, Japan). After the application of transmission gel to the transducer, the animals were examined beginning at the caudal abdomen and extending

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forward to the level of the sternal pad. The gastric compartments, i.e. (first compartment (C1), second compartment (C2) and third compartment (C3) and small and large intestines were scanned and images were stored.

Results

At day 1 of age, the contents of C1 were anechoic and it was best seen in the left caudal paralumbar fossa. In the later region, the large caudodorsal sac was visualised close to the spleen and left kidney. The wall of C1 was smooth and echogenic. Reverberation artifacts running were seen in the region of the dorsal gas cap. Because of its gaseous nature, the contents of C1 could not be seen at that time (Fig 1).

Motility of the C1 was seen as shifting, retreating, and eventual replacement of portions of the wall during gastric contraction cycles. Because of the lack of penetration and large volume of the C1, it was not possible to measure the size of the C1. At day 20, C1 was imaged from left and right sides of the abdomen and the contents of the C1 were seen with disappearance of the reverberation artifacts. The contents of the C1 were visible as hyperechoic echoes interrupted with hypoechoic contents (Fig 2).

At day 40, the contents of the C1 were anechoic with appearance of the longitudinal groove splitting the C1 compartment into dorsal and ventral sacs (Fig 3).

From day 40, the water sacs were visualised in all camel calves and it appeared as series of hyperechoic, semicircular protrusions, curving away from the ventral body wall (Fig 4).

At imaging the C1 at day 80, it was found occupying the entire left abdomen. Imaging of the C2 was seen in only three of the calves at day 40 with weak biphasic contractions. At day 80 and 100, the C2 contractions were stronger and longer. The first contraction was incomplete and was followed by an interval of incomplete relaxation; this was followed immediately by a second complete contraction where the C2 could not be seen on the ultrasound monitor. An interval of complete relaxation follows, in which the C2 returned to its initial position. The wall of C2 is thick and appeared as a half-moon-shaped structure with an even contour (Fig 5).

The C3 was imaged in 3, 5 and 8 calves at day 1, 20 and 40, respectively. At day 80 and 100, it was imaged in all calves through the 6^{th} to 8^{th} intercostal spaces on the right side. It was visible as a tubular structure extending between these intercostal spaces and coursing along the body wall approximately parallel to the long axis of the camel. The contents of the first part of C3 were moderately imaged. It appeared largest in the 7^{th} intercostal space and decreased in size cranially and caudally from this point. An active motility was visualised in the first part of C3, but in a shorter duration than what has noticed in the C2. The most important imaging pattern of the first part of C3 was the fine mucosal folds that appeared as a fine hyperechogenic folds protruded from the mucosa (Fig 6). The folds of the last part of C3 appeared coarse and elongated when compared with that of the first part of C3 (Fig 7).

Small intestinal structures were best seen low in the right paralumbar fossa. Its contents were almost hypoechoic, heterogeneous and it contracted every few seconds. Boluses of hypoechoic fluid ingesta could be seen, but were rarely present more than those few seconds before the intestine contracted. Individual segments of intestine were difficult to discern in areas of collapsed intestine because of the lack of contrast between wall and lumen; gas shadowing was not seen. Because of the absence of the gallbladder in camels, it was very difficult to identify and image the duodenum in any of the examined cases. Therefore, the duodenum, jejunum and ileum could not be differentiated from one another ultrasonographically. Several loops of small intestine were imaged adjacent to one another from the lower right flank and lateral abdominal wall and from the 9^{th} to 11^{th} intercostal spaces (Fig 8).

The large intestine was usually easy to differentiate from the small intestine based on its marked gas content and relatively large diameter. Because of the gas, only the wall of the large intestine close to the transducer was imaged where it appeared as a thick echogenic line. The wall of the large intestine could not be imaged. The cecum was imaged chiefly in the caudal right flank. The tip of the cecum could also not be imaged because of its caudal position. Owing to the presence of gas, the content of the cecum could not be imaged in any of the camel calves (Fig 9).

Segments of ascending colon could be seen in the right paralumbar fossa. The spiral colon was confined in all calves to the caudal ventral half of the abdomen. It appeared as structures with thick echoic lateral walls with a number of echogenic arched lines next to each other (Fig 10).

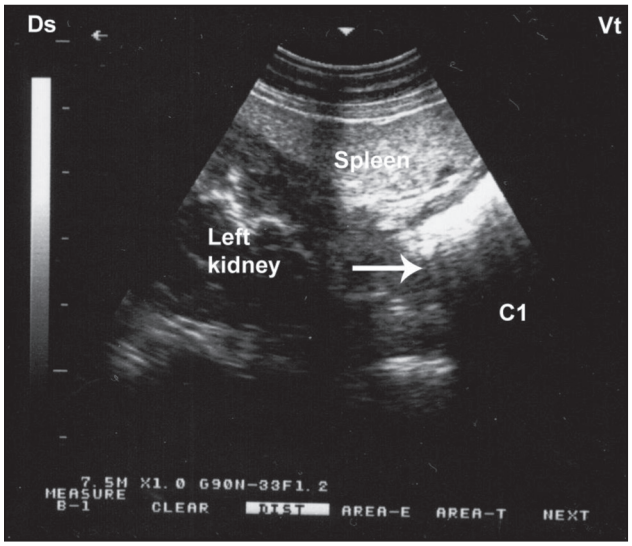

Fig 1. Ultrasonography of the C1, spleen and left kidney in a 1-day-old camel calf. Image was taken from the caudal left paralumbar fossa. The contents of the C1 could not be seen. Reverberation artifacts running parallel to the C1 wall were seen in the region of the dorsal gas cap (arrow). C1, first gastric compartment; Ds, dorsal; Vt, ventral.

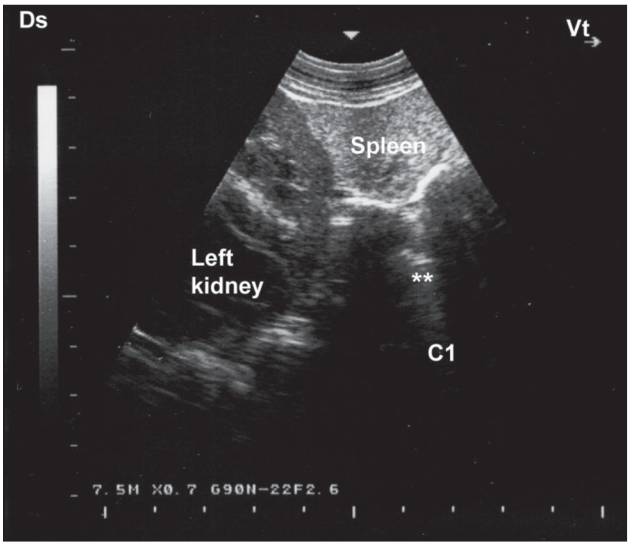

Fig 3. Ultrasonography of the C1, spleen and left kidney in a 40-day-old camel calf. Image was taken from the caudal left flank. The contents of the C1 were anechoic. The longitudinal groove (**) were imaged as a mucosal fold dividing the C1 into dorsal and ventral sacs. C1, first gastric compartment; Ds, dorsal; Vt, ventral.

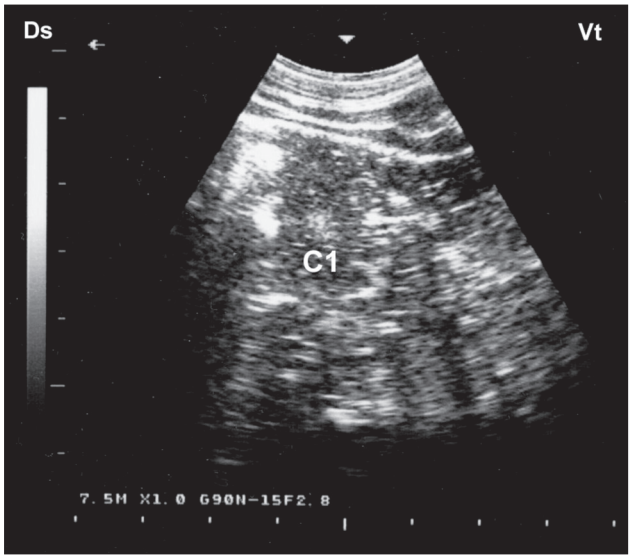

Fig 2. Ultrasonography of the C1 in a 20-day-old camel calf. Image was taken from the lower left abdomen. The contents of the C1 were visible as hyperechoic echoes interrupted with hypoechoic contents. C1, first gastric compartment; Ds, dorsal; Vt, ventral.

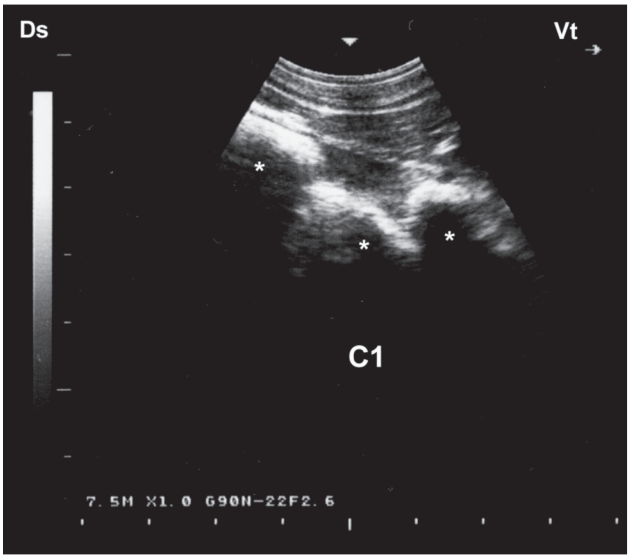

Fig 4. Ultrasonography of the water sacs in a 100-day-old camel calf. Image was taken from the left abdomen at the level of the 10th intercostal space. Water sacs appeared as series of hyperechoic, semicircular protrusions, curving away from the ventral body wall (stars). C1, first gastric compartment; Ds, dorsal; Vt, ventral.

Discussion

To the best of the author's knowledge, this is the first report describing the imaging patterns of the GIT of camel calves until the age of 100 days. In cow calves, ultrasonography of the GIT has been carried out in milk-fed calves from birth to 20 days of age (Jung, 2002) and in 90-day-old hay-fed calves (Gautschi, 2010). When the ultrasonographic findings of the two studies were compared, great differences were detected. The reason why such differences were recorded is that the GIT change dramatically during the first few months of life when milk is replaced by hay, which leads to an increase in the size of the rumen (Braun *et al,* 2013).

In this study, the size of the C1 was considerably smaller during the first 40 days of life. When examined at day 80, the C1 was imaged

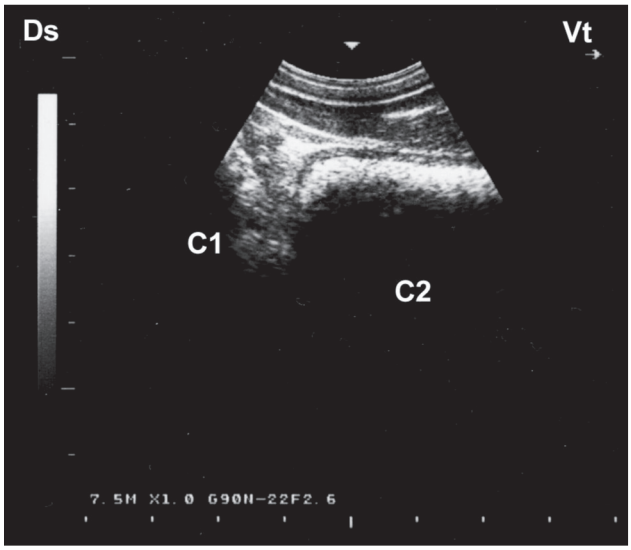

Fig 5. Ultrasonography of the C2 in a 40-day-old camel calf. Image was taken from the ventral left abdomen at the level of the 6th intercostal space. The C2 wall was thick that appeared as a half-moon-shaped structure with an even contour. C1, first gastric compartment; C2, second gastric compartment, Ds, dorsal; Vt, ventral.

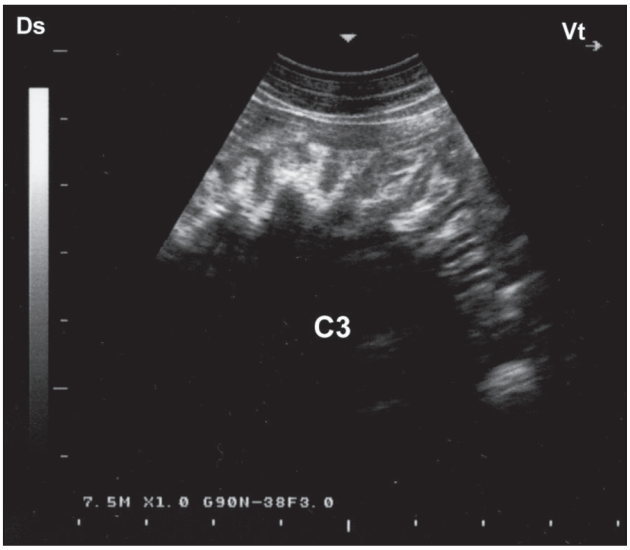

Fig 7. Ultrasonography of the last part of C3 in a 100-day-old camel calf. Image was taken before feeding at the level of the 8th intercostal space on the right side. The folds appeared coarse, hyperechoic and elongated and protruding from its mucosa. C3, third gastric compartment; Ds, dorsal; Vt, ventral.

Fig 6. Transverse section in the first part of C3 in an 80-day-old camel calf. Image was taken at the level of the 7th intercostal space on the right side. Note the hyperechoic fine folds protruded from its mucosa. C3, third gastric compartment; Ds, dorsal; Vt, ventral.

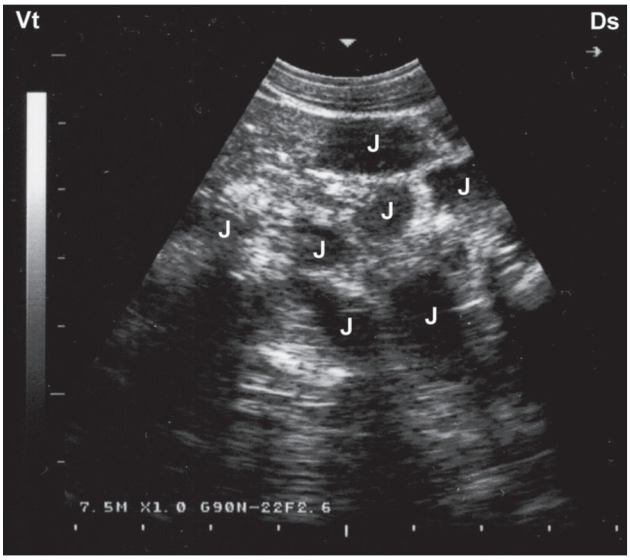

Fig 8. Transverse section showing several loops of jejunum (J) adjacent to one another in an 80-day-old camel calf. Image was taken from the lower paralumbar fossa at the level of the 10th intercostal space on the right side. Ds, dorsal; Vt, ventral.

occupying the entire left abdomen. The C2 contractions were only noticed in 3 of the 15 calves at day 40 (20%) and the contractions were weak and short. At day 80 and 100, on the other hand, C2 contractions were recorded in all camel calves and were stronger and longer. The nature of feeding hay at this age may be the cause of these stronger and longer contractions. Similar findings were reported in cow calves (Jung, 2002; Gautschi, 2010; Braun *et al*, 2013). In a study of Braun *et al* (2013), the reticulum was identified in only one of the newborn cow calves; thereafter it was visible in all calves and had typical biphasic contractions.

The C3 was imaged in 3, 5 and 8 calves at day 1, 20 and 40, respectively. At day 80 and 100, it was imaged in all camel calves through the 6th to 8th intercostal spaces on the right side. In an ultrasonographic study of 10 cow calves several

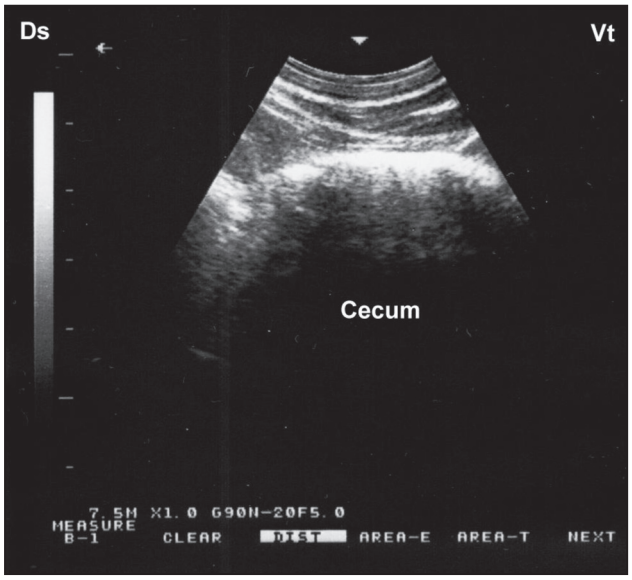

Fig 9. Ultrasonography of the cecum in an 80-day-old camel calf. Diameter of the cecum was large and its wall appeared thick and hyperechoic and the contents appeared anechoic. This image was captured at the caudal right flank. Ds, dorsal; Vt, ventral.

days after birth, the omasum was seen in only one 14-day-old calf (Jung, 2002). In cow calves that were an average of 20 days of age, the omasum was seen in 9 of 10, and by 90 days of age, the omasum could be seen in all 10 calves (Gautschi, 2010). In this study, the C3 appeared as a tubular structure and the contents were moderately imaged with an active motility. The most important imaging pattern of the C3 was the mucosal folds that appeared as hyperechogenic folds protruded from the mucosa. Jung (2002) was able to see the omasal leaves in their entirety in the cow calves, whereas Gautschi (2010) reported seeing only the base of the omasal leaves. The mucosal folds of the last part of C3 appeared in camel calves coarser and more elongated when compared with that of the first part of C3. In newborn cow calves, the abomasum extended caudally as well as to the left and right side of the abdomen with the volume of milk ingested (Wittek *et al,* 2005). Immediately after ingestion of milk, the contents of the C3 appeared echogenic in this study. The milk rapidly forms large echoic milk clot, which was broken down over the course of several hours resulting in liquefaction of the abomasal content (Miyazaki *et al,* 2009; Gautschi, 2010).

Ultrasonography of the GIT in camel calves was helpful in differentiating between the small and large intestine. The duodenum could not be imaged in any of the examined camels. In cattle, presence of the gallbladder facilitates the identification of the duodenum; however because of the absence of the

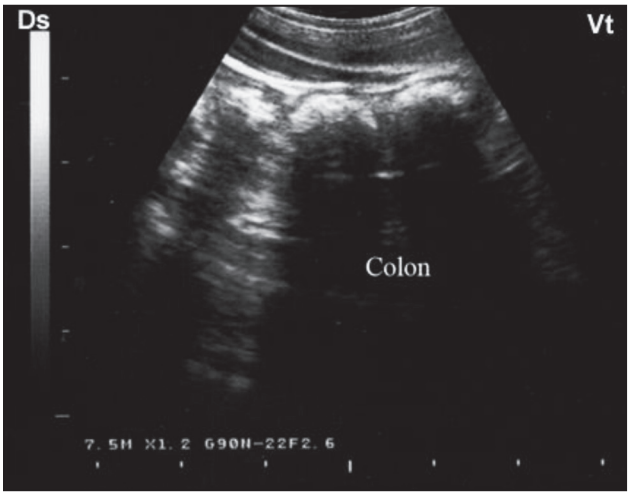

Fig 10. Ultrasonography of the colon in a 100-day-old camel calf. Image was taken in the right paralumbar fossa. Its wall appeared thick and hyperechoic and the contents appeared anechoic. Ds, dorsal; Vt, ventral.

gallbladder in camels, it was difficult to differentiate the duodenum from the jejunum and ileum. The jejunum and ileum were most often seen in the ventral region of the right flank. This is in contrast to cattle in which these were always seen in the 11th and 12th intercostal spaces (Braun and Marmier, 1995). Because of intraluminal gas, only the wall of the large intestine closest to the transducer could be imaged as a thick echoic line.

In conclusion, this study provides the normal imaging pictures for the GIT in camel calves during the first 100 days of life. Results of this study demonstrated that the GIT in camel calves is easily accessible to ultrasonography. The C1 is best seen in the left flank; its contents are anechoic and its wall is smooth and echogenic. The C2 has biphasic contraptions; its wall is thick and appeared as a half-moon-shaped structure with an even contour. The C3 is visible as a tubular structure; its first and last parts have fine and coarse mucosal folds, respectively. Small intestinal structures are best seen low in the right flank, its contents are hypoechoic, heterogeneous and it contracted every few seconds. The large intestine is easy to differentiate from the small intestine based on its marked gas content and relatively large diameter. Finally, ultrasonography could be used as a noninvasive diagnostic tool in order to detect GIT diseases in the camel calves.

References

Braun U and Gautschi A (2013). Ultrasonographic examination of the forestomachs and the abomasum in ruminal drinker calves. Acta Veterinaria Scandinavica 55:1.

Braun U and Marmier O (1995). Ultrasonographic examination

of the small intestine of cows. Veterinary Record 136:239-244.

Braun U, Krüger S and Hässig M (2013). Ultrasonographic examination of the reticulum, rumen, omasum and abomasum during the first 100 days of life in calves. Research in Veterinary Science 95:326-333.

Gautschi A (2010). Sonographische Untersuchungen an Haube, Pansen, Psalter und Labmagen von 30 Kälbern. DrMedVet Thesis, Vetsuisse Faculty, University of Zurich.

Jung C (2002). Sonographie der Lunge und des Abdomens beim bovinen Neonaten unter besonderer Berücksichtigung pathologischer Veränderungen. DrMedVet Thesis, University of Giessen.

Köhler-Rollefson I, Mundy P and Mathias E (2001). Managing and treating camels. In: A Field Manual of Camel Diseases: Traditional and Modern Healthcare for the Dromedary. ITDG publishing, London pp 1-67.

Miyazaki T, Miyazaki M, Yasuda J and Okada K (2009). Ultrasonographic imaging of abomasal curd in preruminant calves. The Veterinary Journal 179:109-116.

Tharwat M, Al-Sobayil F, Ali A and Buczinski S (2012a). Transabdominal ultrasonographic appearance of the gastrointestinal viscera of healthy camels (*Camelus dromedarius*). Research in Veterinary Science 93:1015–1020.

Tharwat M, Al-Sobayil F, Ali A and Buczinski S (2012b). Ultrasonographic evaluation of abdominal distension in 52 camels (*Camelus dromedarius*). Research in Veterinary Science 93:448–456.

Tharwat M, Al-Sobayil F, Ali A, Hashad M and Buczinski S (2012c). Clinical, ultrasonographic, and pathologic findings in 70 camels (*Camelus dromedarius*) with Johne's disease. Canadian Veterinary Journal 53:543-548.

Tharwat M and Al-Sobayil F (2016). Ultrasonographic findings in camels (*Camelus dromedarius*) with abdominal disorders. Journal of Camel Practice and Research 23:291-299.

Tharwat M, El-Shafaey E, Sadan M, Ali A, Al-Sobayil F, Al-Hawas A (2018) Gastric adenocarcinoma in a female Arabian camel (*Camelus dromedarius*): clinical, hematobiochemical, ultrasonographic and pathologic findings. Journal of Applied Animal Research 46:1268-1271.

Tharwat M (2019). Chronic peritonitis in dromedary camels: clinical, hematobiochemical, ultrasonographic and pathologic findings. Journal of Camel Practice and Research 26:169-172.

Wittek T, Constable PD, Marshall TS and Crochik SS (2005). Ultrasonographic measurement of abomasal volume, location, and emptying rate in calves. American Journal of Veterinary Research 66:537-544.