Ultrasonography of the gastrointestinal tract in healthy and diseased camels (*Camelus dromedarius*)

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Abstract

The aim of this mini review was set to describe ultrasonography of the normal appearance, size, shape, and position of various gastrointestinal organs in dromedary camels including the rumen, reticulum, omasum, abomasum and small and large intestines. First part of this review will deals with technique of ultrasonography of the GIT in healthy camels. The rumen and its glandular sacs were visualized occupying the major portion of the abdominal cavity, filling most of the left side of the abdomen. It was best seen in the left paralumbar fossa. In the later region, the large caudodorsal ruminal sac was visualized close to the spleen and left kidney. The cranial glandular sacs were seen deep in the right and left 5th intercostal spaces in 20 (91%) camels. The ventral part of the reticulum was best imaged in 17 (77%) camels from the left and right paramedian region just behind the sternal pad. The omasum was best imaged through the right 6th to 8th intercostal spaces in 18 (82%) camels. The abomasum could be best visualised from the right 9th and 8th intercostal spaces in 14 (64%) camels. Small intestinal structures were best seen low in the right paralumbar fossa. The large intestine was usually easy to differentiate from the small intestine based on its marked gas content and relatively large diameter. Second part of this review article deals with ultrasonography of the gastrointestinal disorders in particular intestinal obstruction and chronic enteritis caused by paratuberculosis.

Key words:
Camels, Gastrointestinal, Intestinal obstruction, Paratuberculosis, Ultrasonography.

1. Introduction

Diseases of the gastrointestinal tract (GIT) of the camel are of great importance including impaction, bloat, ulceration and swallowed foreign bodies, enteritis, constipation, abomasal and intestinal obstruction, peritonitis, as well as abdominal hemorrhage, ascites and neoplasia [1-6]. Many of these diseases can be effectively treated in their early stages, but efforts to recognize them or their severity are hampered by camel stoic nature and vague clinical signs [3]. Due to large-sized abdomen of camels, even experienced clinicians may not be able to pinpoint the organ affected and diagnose the gastrointestinal disease. In addition, transrectal palpation in camels gives access only to the caudal viscera [1,2]. Exploratory laparotomy is usually performed in cases of camels with unexplained gastrointestinal illness [2]. Most owners consent to this invasive procedure only when the prognosis is good, and when there is a reasonable chance that the animal can be cured. Exploratory laparotomy should be avoided in camels with a poor prognosis because it may inflict additional pain, it can be considered as an expansive diagnostic test and the
animal cannot be slaughtered for human consumption waiting for withdrawal times [3].

Recent data on the use of ultrasound in scanning of the normal gastrointestinal tract in camels (Camelus dromedarius) has been reported [7]. In addition, data on the use of ultrasound in medical and surgical affections of many abdominal disorders has been published [5,6,8,9]. This mini review article emphasizes the ultrasonography of the normal appearance, size, shape, and position of various gastrointestinal organs in dromedary camels. In addition, it reviews the ultrasonographic findings in camels with GIT disorders.

Ultrasonography of the rumen and glandular sacs

The rumen and its glandular sacs were visualized occupying the major portion of the abdominal cavity, filling most of the left side of the abdomen. It was best seen in the left paralumbar fossa. In the later region, the large caudodorsal ruminal sac was visualized close to the spleen and left kidney. The rumen wall was smooth and echogenic with an average wall thickness of 0.3±0.11cm. Reverberation artifacts running parallel to the ruminal wall were seen in the region of the dorsal gas cap. In all examined camels, the contents of the rumen could not be seen. Motility of the rumen 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 rumen, it was not possible to measure the size of the rumen. The cranial glandular sacs were seen deep in the right and left 5th intercostal spaces in 20 (91%) camels. In the other 2 (9%) cases, these glandular sacs were visualized deep in the 6th intercostal spaces to the right and left of the thorax. The caudal glandular sacs were imaged in the 9th intercostal space just ventral to the abomasum and liver in 18 (82%) animals. The ventral parts of the caudal glandular sacs in these 18 camels could be imaged lying against the paramedian region 10 cm to the right of the umbilicus. In the other 4 (18%) cases, these glandular sacs could not be imaged at all. The contents of glandular sacs appeared echogenic with gaseous inclusions, and hypoechoogenic fluid. The cranial and caudal glandular sacs had a wall thickness of 0.6±0.22 cm. Both of them could be seen as series of hyperechoic, semicircular protrusions, curving away from the ventral body wall [7] (Figure 1A).

Ultrasonography of the reticulum

The ventral part of the reticulum was best imaged in 17 (77%) camels from the left and right paramedian region just behind the sternal pad, about 33±9 cm cranial to the umbilicus. In the other 5 (23%) camels, the reticulum could not be imaged from this position. In these animals, the reticulum could not be imaged as it is not possible to perform ultrasonography in the standing animal. The reticulum had a thick wall (1.17±0.3 cm) that appeared as a half-moon-shaped structure with an even contour (Figure 1B). The reticulum had a biphasic contraction, and the period between 2 successive biphasic contractions was 50±13 seconds in camels in which reticulum could be imaged. 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 reticulum could not be seen on the monitor. An interval of complete relaxation follows, in which the reticulum returned to its initial position [7].

Ultrasonography of the omasum

The omasum was best imaged through the right 6th to 8th intercostal spaces in 18 (82%) camels. In the remaining 4 (18%) camels, it was visualised through four consecutive intercostal spaces (right 6th to 9th). The omasum 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. Only the wall of the organ closest to the transducer was visible; its wall appeared as a thick echogenic line. It had a wall thickness of 1.1±0.7cm and a transverse diameter of 8.74±3.4cm. The content of the omasum could not be seen probably because of its content. The organ appeared largest in the 7th intercostal space and decreased in size cranially and caudally from this point (Figure 1C). The distance between the dorsal limit of the omasum and the midline of the back was 66±14, 76±16 and 84±15cm at the right 8th, 7th and 6th intercostal spaces, respectively. In the 6th intercostal space, the cranioventral ruminal sac was visible ventral to the omasum. Similar to the reticulum, an active motility was visualized in the omasum, but in a shorter duration (23±14 seconds) [7].

Ultrasonography of the abomasum

The abomasum could be best visualised from the right 9th and 8th intercostal spaces in 14
(64%) camels, while in 3 (14%) animals it could be observed in the 9th intercostal space and in 5 (22%) camels in the 8th and 7th intercostal space. Its diameter was largest in the 8th intercostal space (9.1±1.1cm), followed by the 9th (7±1.6cm) and the 7th (5.4±0.45cm) intercostal spaces (Figure 1D). At postmortem examination, the abomasum was differentiated from the duodenum by its large diameter. Duodenum at necropsy had a diameter of 3.8±0.32 cm. The abomasum had a wall thickness of 0.76±0.46cm. In the 9th intercostal space, the abomasum lies between the glandular sacs of the caudodorsal ruminal sac and the hepatic parenchyma. The abomasal wall appeared as a narrow echogenic line and the contents appeared as a heterogeneous, moderately echogenic structure with echogenic stippling. Abomasal contractions were not observed in any of the examined camels, but movement of the abomasum contents was seen. In none of the 22 examined animals the pylorus was identified and imaged [7].

**Ultrasonography of the intestines**

Small intestinal structures were best seen low in the right paralumbar fossa. It had had a wall thickness of 0.43±0.14cm and a mean diameter of 2.62±0.47cm. Its contents were almost very 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. More than 10 loops of small intestine were imaged adjacent to one another from the lower right flank and lateral abdominal wall and from the 9th to 11th intercostal spaces [7] (Figure 2A).

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 furthest from the transducer could not be imaged. The cecum was imaged chiefly in the caudal right flank. It was thin-walled (0.37±0.05 cm), had a diameter of 13.8±1.6cm. Its lateral wall appeared as a thick echoic, crescent-shaped line. Owing to the presence of gas, the content of the cecum could not be imaged in any of the camels (Figure 2B). The tip of the cecum could also not be imaged because of its caudal position. Segments of ascending colon could be seen in the right paralumbar fossa. The proximal loop of the large colon appeared as thick, echogenic, continuous and slightly curved lines. It was thin-walled (0.51±0.08 cm) and had a diameter of 3.5±0.8cm. The spiral colon was confined in all camels 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 [7].

**Figure 1.** Gastric ultrasonography in dromedary camels. Image A shows the caudal glandular sacs. It was taken in the right ventral abdomen 10 cm to the right of the umbilicus. Image B shows reticulum. It was taken in the right paramedian region just behind to the sternal pad. Image C shows the omasum. It was taken in the right 6th intercostal space. Image D shows the abomasum. It was taken in the right 8th intercostal space. 1 = liver; 2 = caudal glandular sacs; D = diaphragm; F = free peritoneal fluid; PV = portal vein; HV = hepatic vein; DS = dorsal; VT = ventral.
Figure 2. Ultrasonogram of the Intestines in dromedary camels. Image A shows jejunum. It was taken low in the right paralumbar fossa. Image B shows cecum. J = jejunum; DS = dorsal; VT = ventral.

Practical application of ultrasonography in GIT disorders in camels

Intestinal obstruction

Intestinal obstruction is relatively rare in camels. It may be partial or complete. Massive intestinal parasite infestation, plastic foreign bodies and enlarged mesenteric lymph nodes may all cause intestinal obstruction [2]. Camels suffering from pica usually eat hair, leading to the formation of phytozoos and trichobezoars that may reach the intestine causing obstruction. Other causes of intestinal obstruction include impaction of the spiral colon, dilatation and torsion of the caecum and strangulation of the intestine in inguinal hernia [10]. Ultrasonographic findings, such as changes in luminal diameter, motility and intestinal wall thickness, have been used to diagnose intestinal problems in other ruminant species. In a study reported recently [8], ultrasonographic findings in camels with either partial or complete intestinal obstruction included dilation of the small intestine with a marked reduction or absence of intestinal motility. Fluid was seen between loops of intestine. Accumulation of ingesta in the omasum/abomasum chamber was detected, some of which also had accumulation of ingesta in the rumen. These findings when taken together are indicative of ileus as found in cattle. Clinical manifestations include depression, reduced gastrointestinal motility, abdominal distension, dehydration, recumbency and vomition.

In camels with partial obstruction, rectal examination reveals the presence of very hard, spiny fecal particles and distended viscera. In animals with complete obstruction, rectal findings show a small amount of black feces stained with mucus or no feces at all. Case history may inform swallowing foreign bodies such as plastic bags and ropes. In these cases, rectal examination reveals the presence of small amounts of hard feces and distended rumen. Rumenotomy, if performed, shows presence of plastic bags, ropes, glass, hairballs, wires and nails. Ultrasonographic findings includes distended small intestinal loops with markedly reduced or absent motility. The foreign body obstructing the intestinal lumen may be visualized as a hyperechoic material. Hypoechoic fluid with or without fibrin may also be seen among the intestinal loops [8] (Figure 3). Necropsy findings may include presence of constricted intestines around enteroliths, paralytic ileus and mesenteric torsion.

Ultrasoundography of chronic enteritis caused by paratuberculosis (Johne’s disease)

Johne’s disease or paratuberculosis is characterized by persistent and progressive diarrhea, weight loss, debilitation and eventually death. The disease occurs worldwide and affects cattle, sheep, goats, farmed deer, and other domestic and wild ruminants [11]. In dromedary camels, paratuberculosis is a chronic wasting and fatal disease manifested clinically by persistent diarrhea that terminates in death [12]. In tropical areas with intensive camel farming, paratuberculosis presents a serious economic problem due to culling of clinical cases, reduced milk production and the costs of laboratory testing and control measures [3]. Although the organisms can be shed in milk, the fecal-oral route is the primary mechanism for transmission of Mycobacterium avium subsp. paratuberculosis (MAP) and this is
reflected in disease control recommendations. These are similar in most countries and are mainly based on removal of clinical cases, identification of subclinical cases by clinical tests, and hygienic neonate-rearing through feeding MAP-free colostrum and milk. Definitive diagnosis of Johne’s disease is based on culture and identification of MAP from feces or tissue. Unfortunately, the organism is slow growing (four to sixteen weeks, and it requires special enhanced media). Other diagnostic tests used to screen herds and make a diagnosis in individual livestock species include AGID, complement fixation, competitive ELISA, histologic pattern of a granulomatous reaction, Ziehl-Neelsen staining (acid - fast) of tissue and feces, polymerase chain reaction (PCR) and DNA probes [3].

Introducing ultrasonography for examining camels with Johne’s disease can be helpful in screening cases waiting for confirmation by definitive tests (culture, ELISA or PCR). The procedure is especially valuable in determining macroscopic intestinal lesions as well as enlargement of the mesenteric lymph nodes that reflect the severity of the inflammatory changes, which were confirmed at postmortem examination (Tharwat et al., 2011; Tharwat et al., 2012). In camels with paratuberculosis, history includes progressive weakness, loss of body condition, and chronic intermittent diarrhea. A rectal smear stained with Ziehl-Neelsen stain showed acid-fast bacilli. DNA extracted from feces, rectal samples and lymph nodes resulted in amplification of 229-bp PCR product, which is the specific product of Mycobacterium avium subsp. paratuberculosis-IS900. Transabdominal ultrasonography showed thickening and corrugation of the small intestinal wall. At postmortem examination, diffuse thickening and corrugations of the small intestine was seen. The mucus membrane was increased in size forming folds. The mesenteric and hepatic lymph nodes were highly swollen [12] (Figure 4 A).

Figure 3. Ultrasonographic findings in camels with intestinal obstruction. Ultrasonographic findings included distended intestinal loops with markedly reduced or absent motility (A, B, C). Image D shows a hypoechoic fluid with fibrin (white arrow) between intestinal loops; black arrow points to the intestinal wall. In one camel with partial obstruction, the intestinal lumen contained localized hyperechoic material consistent with foreign body (E). Corrugated ruminal wall was scanned in one camel with intestinal obstruction (F). IL = intestinal loops; FB = foreign body; F = fluid; DS = dorsal; VT = ventral.

Figure 4. Ultrasonographic finding in camel with Johne’s disease. Image A was taken from ventral abdomen on the right side where corrugated intestinal wall was seen. A clear folded intestinal mucosa is imaged (B, stars). Image C shows the intestinal edema and peritoneal effusions where anechoic fluid (F) was seen. Image D shows five (1-5) mesenteric lymph nodes are imaged enlarged with anechoic capsule and echogenic contents. Left image shows clumps of echogenic tissue interspersed with fluid pockets are imaged between the intestinal loops.
In another camel with confirmed Johne’s disease, transabdominal ultrasonography showed thickening and corrugation of the small intestinal wall and intestinal edema with peritoneal effusion (Figure 4B). At postmortem examination, diffuse thickening and corrugations of the small intestine was seen. The mucus membrane was increased in size forming folds. Intestinal edema with anechoic abdominal effusions was also imaged. In another camel with confirmed Johne’s disease, transabdominal ultrasonography showed thickening and corrugation of the small intestinal wall. The most outstanding sonographic findings were the visible enlargement of mesenteric lymph nodes that was confirmed at necropsy. Enlarged lymph nodes had anechoic capsule and with echogenic contents. Clumps of echogenic tissue interspersed with fluid pockets were imaged between the intestinal loops (Figure 4C). Pericardial and pleural effusions were imaged as an anechoic fluid. At postmortem examination, diffuse thickening and corrugations of the small intestine was seen. The mucus membrane was increased in size forming folds. Fluid was found in the pericardium and in the pleura [12] (Figure 4D).

In conclusion, ultrasonographic examination of the GIT of camels can be helpful in determining its disorders. Confirmation of such disorders is still required through laboratory and postmortem examinations.

References


