FLASC – Fast Localized Abdominal Scan in Cattle

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Abstract

Rapid ultrasound examination has been used in human emergency medicine and adapted to small animal (FAST) and equine medicine (FLASH) for assessment of trauma or colic. Fast Localized Abdominal Scan in Cattle (FLASC) is a focused assessment using the ultrasound that I have adapted to assist with all of my examinations when I do not have a clear idea what is causing clinical signs. This exam is tailored toward the most common things I find in beef cattle, but can be useful with all classes of cattle to assist in diagnosis.

Key words: bovine, imaging, FLASC, diagnostics, ultrasound

The FLASC technique for bovine abdominal exam

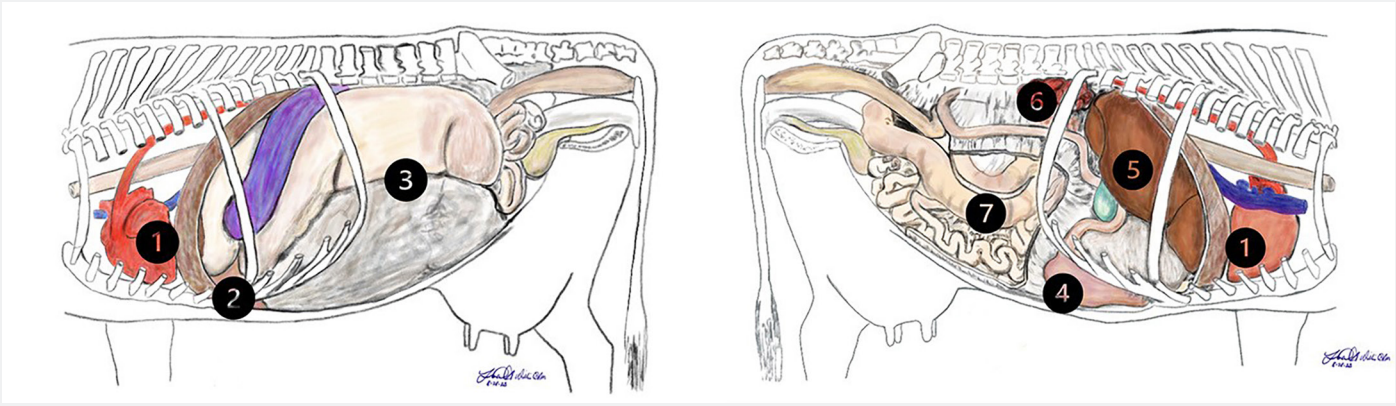
There are many indications for performing transabdominal ultrasonography in cattle, including acute or chronic abdominal pain, weight loss, inappetence and fever of unknown origin. You may be using transabdominal ultrasonography because there are specific clinical signs or physical findings that are directing your attention to a particular organ or area (i.e. reticulum, liver or kidney) that you would like more information on, or it may be that the signs are nonspecific, and the entire abdomen is being scanned. Reviewing all abnormalities of the bovine abdomen is beyond the scope of this review. However, since cattle can present with non-specific signs, this review will focus on the use of transabdominal ultrasonography as a guide to focus diagnostics and treatments. The limitations of ultrasound are that only structures adjacent to the body wall are visible and most abdominal organs are not entirely visible. The rectal probes (5-10 MHz) that most bovine practitioners have for reproductive use can be used to assess the surface of the lungs, look for peritonitis in the ventral abdomen, assess the liver and kidneys, as well as other soft tissue structures of the body including the eye and retrobulbar area. An excellent resource for ultrasonography is the *Veterinary Clinics of North America Food Animal Practice Series,* Bovine Ultrasound.[1,2,3]

Transabdominal ultrasonography of the cattle abdomen is an ancillary diagnostic aide that must always be interpreted in conjunction with the signalment, history, clinical signs and other diagnostic findings. FLASC is the acronym for Fast Localized Abdominal Sonography of Cattle and basically involves sonography of 7 to 8 key regions of the abdomen (Figure 1). Each of those regions will be reviewed below. An abdominal probe (2-3 MHz) is used to get the most useful images, but rectal probes (5-10 MHz) that most bovine practitioners have for reproductive use can be used. With a little practice, the FLASC method should be able to be completed in less than 10 minutes.

Area 1: The left and right thorax

The majority of practitioners do not have access to a radiographic machine that can penetrate the adult thorax and the required chute systems with beef cattle can make radiographic imaging difficult. Ultrasound is limited to the pleural surfaces of the lungs and thorax, the heart and pericardium. The cattle lung field is much smaller than the horse, so care must be taken to insure you are far enough cranial to see the entire lung. The area between the 5th and 12th intercostal spaces can be shaved for superior images, although I do not usually clip during my FLASC exams due to the limited time and nature of my assessments. The lung field is in the shape of a triangle that spans the caudal edge of the thoracic limb, the transverse vertebral processes, and a line stretching from the elbow to the dorsal corner of the 13th rib and following the diaphragm.[1] Depth can be increased to visualize the lung through the triceps muscle, as well. Normal lung will appear as a bright white (hyperechogenic) pleural line in which the parietal pleura is indistinguishable from the visceral pleura during a static image but can be

Figure 1: Proposed target areas for ultrasound of the left (a) and right (b) abdomen of cattle to facilitate diagnosis in animals presenting for acute abdomen or with non-specific clinical signs.



ascertained during real time examination with the gliding sign, which is the sliding movement of the lung during respiration.[4,5]

Abnormalities such as pneumothorax, pleural fluid, abscesses, pericarditis and pulmonary edema can be visualized with practice.[5,6,7] Placing your probe on as many normal animals as you can will facilitate recognition of an abnormal scan.

Area 2: The rumen reticulum window

The rumen reticulum window in the left parasternal area can be checked to help rule out or confirm a suspicion of reticuloperitonitis, vagal indigestion and ascites.[8] The transducer is placed ventral and lateral to the sternum and lateral thorax up to the elbow. The normal reticulum appears as a half-moon-shaped structure with an even contour. It contracts at regular intervals and when relaxed, it is situated immediately adjacent to the diaphragm and ventral portion of the abdominal wall. The different layers of the reticular wall usually cannot be imaged, and the honeycomb-like structure of the mucosa is not often seen clearly. In cattle with ascites, the tunica serosa of the reticulum appears as a narrow echogenic line, the tunica muscularis is seen as a hypoechogenic line, and the tunica mucosa is seen as a wider echogenic line. Contents of the reticulum cannot be normally imaged because of their partly gaseous composition.[2]

The craniodorsal blind sac of the rumen and the transition to the ventral sac of the rumen can be seen caudal to the reticulum. For assessment of reticular motility, the transducer is placed on the left ventral thoracic region. The reticulum is located and observed for 3 minutes without moving the transducer. The reticulum normally contracts once per minute in a biphasic manner, in which the first contraction is incomplete. Thus, in the 3-minute observation period, the reticulum has 3 biphasic contractions. Contraction of the craniodorsal blind sac of the rumen is seen immediately after the second reticular contraction. Rumination is associated with an additional ruminal contraction, which occurs immediately before the biphasic contraction.[2,8]

Once you become familiar with the different images of normal in this area, you will be able to detect dorsal displacement secondary to fluid and/or adhesions, and will be able to assess changes in contractility. I have occasionally seen liver or spleen cranial to reticulum and abomasum in the area between reticulum and rumen depending on my probe placement and rumen shrinkage, which can be confused with echogenic material or fluid in the area, and monitoring for complete contractions is helpful in confirming what you are visualizing.

Area 3: The ruminal groove

The left longitudinal sulcus of the rumen is one of the areas I check on all FLASC exams due to the relative ease of locating the landmarks on normal animals and that it can identify ascites/generalized peritonitis, a left displaced abomasum and omental bursitis.[2] The last 3 intercostal spaces on the left side are examined ventrally to dorsally with the transducer held parallel to the ribs. Normally, the rumen is immediately adjacent to the left abdominal wall. On ultrasonograms, the ruminal wall is medial to the abdominal wall and from ventral to dorsal appears as a smooth, thick, echogenic line, which is indented at the left longitudinal sulcus. With left displacement of the abomasum, the wall of the rumen often is still immediately adjacent to the abdominal wall in the ventral region. When the transducer is moved dorsally, it becomes apparent that the wall of the rumen is pushed medially and then can no longer be imaged ultrasonographically. Instead, the abomasum is seen—located between the abdominal wall and rumen. Moving the transducer further dorsally, the abomasum disappears and the rumen reappears on the screen.

The abomasal contents do not appear uniform because ventrally there are fluid ingesta and dorsally there is a gas cap that varies in extent. The ingesta visible ventrally in the abomasum appear hypoechogenic. Occasionally, the abomasal folds are visible among the ingesta and appear as elongated, echogenic, sickle-shaped structures. The ruminal wall often can be seen medial to the ingesta. The abomasal gas cap, seen further dorsally, is characterized by reverberation artifacts similar to those observed during the ultrasonographic examination of lung.[2]

Omental bursitis can be visualized by an increase in the fluid between the rumen and omentum, and it is distinguishable on the ventral area of sulcus from the rumen dorsally due to the omental attachment.[8]

Ascites or peritonitis can be visualized in this area as it will displace the rumen medially. In areas where I am unsure if I am looking at organ contents versus intraperitoneal, I will decrease the depth and see if I can locate the serosal or muscularis regions and also look for contractions or movements to assist with identification.

Area 4: The abomasal window

The abomasum can be visualized approximately 10 cm caudal to the xyphoid process from the left and right paramedian regions and from the ventral midline. The bulk of the abomasum is situated to the right of the ventral midline. The abomasum is frequently seen immediately caudal to the reticulum between the craniodorsal blind sac of the rumen, or the rumen, and the ventral abdominal wall. The wall of the abomasum appears as a thin echogenic line. Parts of the abomasal folds occasionally can be seen as echogenic structures within the content of the abomasum. Passive and slow movements of the abomasal contents are frequently seen.[2]

The window I use during my FLASC exam is to locate the pylorus on the ventral right abdomen by following the subcutaneous abdominal vein and placing the probe cranially to where the vein protrudes into the abdomen.[8] This gives me an idea of whether the abomasum is in its normal location and the pylorus can be monitored for normal contractions and dilatation which could be present secondary to pathology.

Area 5: The liver

The liver is scanned on the right side by starting caudal to the last rib and then following the liver cranially and ventrally along the intercostal spaces. The caudal edge of the liver is normally distinctly sharp and may appear rounded with hepatomegaly. Liver abscesses appear as circular masses within the liver parenchyma or can present as one solid mass. The gall bladder is easy to identify as it is filled with anechoic fluid and can be visualized between the 9th and 11th ribs. The liver will can be obscured with a right displacement of the abomasum.[2]

Area 6: The right kidney

The right kidney is visualized next at the caudal ventral edge of the liver over the right paralumbar fossa and the last intercostal space. It can be relatively easy to locate the kidney, but difficult to image the parenchyma well in obese or dark-skinned beef cattle. It is an area I will still routinely check due to the

proximity of the right kidney to the liver, pancreas, cecum and ascending colon, and to familiarize myself with normal. When I am suspicious of renal disease, I will also image the left kidney rectally. The lobulation of the kidney is obvious on ultrasound. The renal capsule is not distinctly visible. The renal cortex is hypoechoic compared to the liver and is slightly mottled. The medullary pyramids are less echogenic than the renal cortex. The cortex and the medullary pyramids cannot always be differentiated depending on body condition (subcutaneous fat) and ultrasound probe available. The entire right kidney cannot be visualized percutaneously due to its orientation in the body, but measurements taken from Swiss Braunvieh non-gravid cows will be listed as a reference point (Table 1) and with the increased utilization of ultrasound in cattle, there will be more data available that can be used as reference parameters. Acoustic shadowing deep to a bright white (hyperechogenic) area would indicate nephroliths.[10]

The pancreas can be visualized in the triangle formed by the liver cranially, the kidney caudoventrally, and the portal vein ventrally in intercostal spaces 10-12. The pancreas is difficult to distinguish from hepatic parenchyma, although it is slightly hyperechoic in comparison.[9]

Area 7: The intestines

The last area I typically examine in my FLASC exam is the right caudal abdominal wall. A quick scan of the area can indicate peritoneal fluid and motility of the small intestines (Table 2). A more detailed exam can be performed in this area if indicated by physical exam or FLASC findings. A diagnosis by clinical examination alone may not be possible, but ultrasonography of this area allows the differentiation of right displacement of the abomasum, ileus of the small intestine and cecal dilatation. Peritonitis should be suspected if there is increased volume or echogenicity of peritoneal fluid. In some cases, free-floating or adherent fibrin or fibrous tags may be visible. When ileus of the small intestine is suspected, an ultrasonographic examination should evaluate the diameter, motility and anatomic arrangement of the small intestine, evidence of peritonitis, and the possible cause of the ileus. In cattle with ileus, the small intestine is dilated in at least one area, and has a diameter of more than 3.5 cm. The motility of the small intestine is usually reduced or absent. Sometimes, hypoechogenic fluid, which is attributable to transudation, is visible between the dilated loops of intestine. Independent of the localization of ileus and its cause, the loops of small intestine are most commonly imaged in cross-section, often in cross-section and longitudinally but rarely only longitudinally.[2,4]

The site of ileus markedly affects the number of dilated loops of intestine seen in cross-section and longitudinally from either the flank or each intercostal space. When interpreting the diameter of the intestine, it is important to remember that in healthy cows, in which the intestine is full of ingesta, all parts of the intestine have a similar diameter (Table 3). By contrast, in animals with ileus, in addition to the extremely dilated loops of intestine proximal to the ileus, there are usually empty loops of intestine distal to the ileus. The intestinal lumen of a healthy cow is constantly changing, whereas the increased intestinal diameter of a cow with ileus remains unchanged because the intestinal motility is markedly reduced or absent.[8]

Ileus also can be caused by generalized peritonitis with fibrinous adhesions involving the small intestine. In such cases, thickening of the intestinal wall, fibrinous deposits and accumulation of intra-abdominal fluid are usually seen. Intussusceptions of the small intestine will have a characteristic "bullseye" or target lesion appearance when imaged across the short axis of the small intestine.[4]

Failure of ingesta to pass through the small intestine results in delayed passage of ingesta through the abomasum, omasum and rumen which consequently become dilated.

The large intestine is always visible from the flank and is situated medial to the descending duodenum, whereby the colon is more dorsal and the proximal loop of the colon and cecum are more ventral. The large intestine is usually easy to differentiate

Table 1: Measurements of kidney's via ultrasound scans made on Swiss Braunvieh cows as reported by research from Ueli Braun.[10]

Ultrasound measurements kidney	Left (cm)	Right (cm)
Renal cortex and medulla thickness	1.5 – 2.0	
Vertical diameter	4.5 – 7.5	4.0 – 7.0
Circumference of largest medullary pyramid	4.1 – 5.8	3.6 – 5.9
Difference between body surface and right kidney (at R paralumbar fossa)	1.2 – 2.9	

Table 2: Reference measurements for imaging of the small intestine - Normal

SI wall thickness	2 – 3 mm	
SI luminal diameter	2 – 4 cm	
Cranial duodenum	Medial or ventral to gallbladder ICS 10 – 11	0.9 – 0.5 cm
Descending duodenum	ICS 10, 11, 12 Dorsal right flank	1.5 – 3.5 cm
Jejunum and ileum	ICS 9 – 12, Lateral wall, flank	2 – 4 cm

Table 3: Reference measurements for imaging of the small intestine – Ileus/Obstruction

Duodenum	< 5 dilated loops	6.5 – 9.9 cm
Jejunum	> 5 dilated loops	3.5 – 9.8 cm
Ileum	> 5 dilated loops	4.4 – 5.5 cm

from the small intestine based on its marked gas content. Because of the gas, only the wall of the large intestine closest to the transducer can be imaged and appears as a thick echogenic line. Reverberation artifacts that originate from the tissue-gas interphase may become superimposed on the image of the wall and obscure it, however. The wall of the large intestine furthest from the transducer cannot be imaged. Usually, the proximal loop of the large colon, the cecum and the colon can be visualized. The proximal loop of the large colon and the cecum appears as thick, echogenic, continuous and slightly curved lines. The spiral loop of the colon has the appearance of a garland with several echogenic arched lines next to each other. In contrast to the small intestine, which has vigorous peristaltic activity and segmental contractions, few contractions are observed in the large intestine.[2,8]

Diagnosis of cecal dilatation usually is straightforward but may be difficult when the dilatation is complicated by retroflexion of the cecum. In that case, either no abnormal transrectal findings can be palpated or a distended viscus can be palpated only with the tips of the fingers. The differential diagnoses must include ileus of the small intestine and right displacement of the abomasum, respectively. A dilated cecum always can be imaged from the lateral abdominal wall; in some cases, it may be seen from the 12th, 11th and 10th intercostal spaces. The dilated cecum and the proximal loop of the colon are almost always immediately adjacent to the abdominal wall. Because of the gaseous contents, only the wall of the dilated cecum and proximal loop of the colon closest to the transducer are seen ultrasonographically.[2]

Additional comments

The spleen can be imaged from the left side on the rumen between intercostal spaces 7-12. It can be as far forward as the elbow and may be confused as consolidated lung for those used to scanning equine chests due to the small nature of the cattle lung field. I have previously found a solitary abscess in the spleen in an adult bucking bull, but do not routinely scan here during a FLASC. If suspicion of traumatic reticuloperitonitis is present, I will usually scan the spleen, as well.

Abscesses and neoplasia would be 2 differential diagnoses for intra-abdominal masses and they can be just about anywhere in the peritoneal cavity, in or attached to bowel or other intra-abdominal viscera (i.e. spleen, kidney, liver). The basic concept is that there are soft tissue densities of variable shapes and acoustic properties that distort normal sonographic architecture. Although a definitive etiology of an intra-abdominal mass is often not discernable ultrasonographically, a "classic" abscess appears loculated with mixed echogenicity and a cobweb-like appearance. A hematoma may appear similar to an abscess. An abscess or hematoma more commonly is isolated to a single location, whereas metastatic neoplasia should be considered if variable masses are present in multiple locations. Although the ultrasonographic appearance of a mass may not be distinguishing to etiology, ultrasonography may be a helpful guide to biopsy or aspiration of an intra-abdominal mass.[4]

Superior images can be obtained with proper preparation of the skin including clipping and degreasing and by having an abdominal convex probe available, but a rectal probe can be used successfully in quick assessments and assist tremendously with diagnosis.

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