

# How ultrasound has changed decision making in colic surgery

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Colic is common in horses and requires thorough examination to allow proper decision making for treatment. History, physical exam, blood examination, nasogastric intubation and rectal palpation are regarded as 'standard' procedures in almost every colic case. Nowadays, also ultrasound is often being implemented as routine because it is widely available, non-invasive and user-friendly.

Rectal, linear 5.0/7.5 MHz probes are available in virtually every equine practice. The relatively high frequency allows detailed imaging of bowel wall and content and different abdominal organs, such as kidney, spleen, adrenal glands, reproductive tract.

Transabdominal or transcutaneous ultrasound is routinely performed with a 1.7 - 5.0 MHz probe (5.0 - 10 MHz in foals). Especially probes with a small footprint allow examination without clipping, using ethanol alone. This approach reduces examination time -examination of areas of interest and even the whole abdomen generally takes around 10 minutes<sup>1</sup>- and avoids irritation of the owner. Probes with a larger footprint, for example a linear probe, produce a slightly better image quality and resolution, but generally require more patient preparation, such as clipping and use of ultrasound gel. Transabdominal examination is typically done starting in the caudal and dorsal flank moving the probe from dorsal to ventral. The examination starts caudal and moves gradually towards cranial thereby following the direction of the intercostal spaces. The left and right, as well as the ventral abdominal wall is examined. The caudoventral borders of the thorax are included in the exam.

## Decision making for surgery

### *Examination of specific, 'inaccessible' areas*

Only a small portion of the abdomen can be explored by rectal palpation. Transcutaneous ultrasound allows examination of a relatively large portion of the abdomen, also cranially, laterally and ventrally located structures that cannot be palpated per rectum. Especially in foals, young horses and ponies, where rectal palpation is impossible, the contribution of ultrasound becomes even more important for the evaluation of the colic patient. In addition, a relatively larger proportion of the abdomen can be visualised in the smaller sized animals<sup>2-5</sup>. Using rectal ultrasound, the field of view can be slightly

extended by using a sector or phased array probe whereby structures beyond those that can be palpated per rectum can be visualized.

### ***Assessment of intra-abdominal structures***

Gastro-intestinal wall thickness and structure, luminal content and contractile function are assessed and anatomical location of intestines is determined. Different organs are examined and presence of abdominal fluid or a mass is identified.

The stomach is found medial to the spleen, dorsal to the splenic vein, between the 8<sup>th</sup> to 13<sup>th</sup> intercostal space with a size of 3 – 4 intercostal spaces. Wall thickness is generally around 4 mm and should not exceed 7.5 mm<sup>4,5</sup>. An empty stomach may show a folded wall<sup>6</sup>. Normal gastric content is not visible because of an acoustic shadow. Wall thickening (usually hypoechoic) may result from ulceration or gastritis or from neoplasia<sup>7</sup>. Gastric tympany produces reverberation artefacts. Reflux appears as hypoechoic, heterogenous fluid in the ventral part of the stomach, separated from air dorsally by a horizontal hyperechoic line<sup>8</sup>. Mirror artefact is often present along this horizontal line. Gastric impaction can be accurately diagnosed on ultrasound: the stomach is dilated, there are generally no reverberation artefacts, there is no reflux and gastric intubation does not decrease gastric size (only in case of tympany)<sup>9</sup>. Ventral displacement of the stomach is often found during left dorsal displacement of the colon into the nefrosplenic space.

The duodenum can be identified on the right side, medial to the liver, running towards the caudal pole of the right kidney. Jejunum is often found in the left mid-flank region or in the inguinal area. Ileum can be imaged transrectally. Small intestines usually appear collapsed or show a small amount of echogenic fluid. Contractility is clearly seen. Wall thickness of duodenum and jejunum is 3 to 4 mm with 5 layers that can be identified when using high frequency probes<sup>10,11</sup>. Due to an additional layer, wall thickness of ileum is 4 to 5 mm with 7 layers. Fasting during 24 hours results in mild dilatation of small intestines, an increased contractility and improves image quality<sup>6</sup>. Due to stasis (ileus, obstruction, strangulation) intestinal content becomes progressively hypoechoic to anechoic with sedimentation. Wall thickening may result from inflammation such as proximal enteritis or enteritis in foals. Especially in foals, intramural hyperechoic spots and intraluminal shreds of mucosa may be identified. Hypo- as well as hypercontractility may be present. It is important to notice that duodenal thickening in proximal enteritis may be subtle in some cases. Strangulation or obstruction leads to hypocontractility, dilatation and wall thickening with a progressive increase in peritoneal fluid. Intussusception, with a typical 'bull's eye' pattern or 'multiple ring sign', results in ventral displacement due to gravity, except for very large

intussusceptions which may displace dorsally. Granulomatous or neoplastic cell infiltration or idiopathic muscular hypertrophy results in wall thickening, often without dilatation<sup>12-14</sup>.

Caecum and colon are found along the largest part of the left and right and ventral abdominal wall. The large size, sacculated appearance and acoustic shadowing make them easy to differentiate from the small intestines<sup>15</sup>. Normal wall thickness is 3 to 5 mm. Caecum intussusception can be accurately diagnosed on ultrasound<sup>16</sup>. Generally, caecum in caecum intussusception appears as an irregular, difficult to identify oedematous structure in the right flank. Caecum in colon on the other hand, appears as a typical 'multiple ring sign' with a central blood vessel, sometimes surrounded by liquid content from the colon, and with peritoneal fluid in the centre of the intussusceptum. The intussusceptum, 10-15 cm in diameter, is found in the low lateral flank or near the ventral abdominal wall. Colon or caecum impaction causes the sacculations to become more flattened and displace the intestine more closely against the peritoneal surface. In neonatal foals, meconium can be clearly visualised and measured and appears relatively echogenic in the rectum or hypoechoic to echogenic in the descending colon. Gas accumulation in caecum or colon flattens the wall and causes reverberation artefacts. Typhlitis and colitis result in wall oedema<sup>17</sup>, often with a liquid content, which may enable to visualise mucosal folds in the caecum. Large colon strangulation also results in marked wall oedema: associated signs usually allow clear differentiation between inflammatory (medical) and strangulating (surgical) cases<sup>18</sup>. It is difficult to differentiate certain parts of large intestine and caecum from each other because of their similar appearance on ultrasound. Therefore, assessment of colon displacement may be difficult. Except for a left dorsal displacement of the large colon in which colon, in the right dorsal flank, displaces the dorsal border of the spleen to medial and prevents the left kidney to be imaged transabdominally. Typically, this results in a small triangle of anechoic fluid between abdominal wall, displaced colon and spleen. False positive (gas-filled colon outside the nefrosplenic space) as well as false negative (collapsed colon, without content into the nefrosplenic space) images may be found.

Small amounts of anechoic peritoneal fluid is found, even in healthy horses. It is important to realise that in the 'vacuum' peritoneum, fluid is not always found ventrally: it might be displaced dorsally by an impacted colon. Peritoneal effusion may be anechoic, hypoechoic or echogenic depending on the cellularity and protein content (transudate, modified transudate, exudate). Peritonitis and bowel rupture result in hyperechoic spots in the echogenic fluid. Fibrin strands or a fibrin layer on the peritoneal surface may be found. Haemoperitoneum appears as 'smoke' or as echogenic fluid with a swirling motion. Organisation results in heterogenic, echogenic 'clots' ventrally, with more hypoechoic fluid dorsally. Urine appears anechoic to mildly echogenic. Due to peritoneal fluid accumulation, abdominal structures start floating and mesenterium, omentum,... are easily seen. An

abdominal abscess may have a fluid or more solid content, with almost any kind of pattern and echogenicity. Hyperechoic spots are typical for necrosis and gas bubbles. Neoplastic masses may be hypoechoic to echogenic and homogenic to heterogenic. In certain cases, colour flow Doppler may help to differentiate between neoplasia and abscess.

Apart from identifying the origin of colic, ultrasound is an important tool to formulate a prognosis, which might be important in case of financial constraints. Owners may decline surgical intervention when costs are too high and chances are too low.

### ***Decision making for surgery approach***

In selected cases ultrasound will result in another approach to surgery. Umbilical or inguinal herniation should be examined to determine the presence of small intestine, caecum or large intestine, and fluid or abscess formation, prior to the surgical intervention. The surgical site may be changed in case of a local mass, abscess or adhesion of intestines to the abdominal wall, or one might elect laparoscopy instead of laparotomy.

### **'False colic'**

A wide variety of diseases may be associated with colic signs such as pawing, flank watching, laying down, tachycardia. Thorough history taking, physical and rectal examination often need to be accompanied by additional tests, such as blood exam, because clinical signs may be non-specific. Rectal as well as transcutaneous ultrasound of abdomen en thorax are an important tool for diagnosis of 'false colic'. Oesophageal, hepatic, splenic, cardio-respiratory, neurological, urogenital and musculoskeletal diseases can all result in 'false colic' signs whereby history, breed, gender, environmental factors need to be taken into account. For example, aortopulmonary fistulation in Friesian horses may typically result in colic and tachycardia<sup>19</sup>. Finally, it is important to realise that non-intestinal causes of colic can induce gastro-intestinal problems that may complicate the clinical picture. For example impactions of the left colon can be a consequence of reduced intestinal motility caused by painful processes such as pleuritis or rhabdomyolysis

### **Conclusion**

Diagnosis and decision making in the colic patient might be challenging. The practitioner should gather all necessary information to get a full picture of the disease. In some cases, physical exam, rectal palpation and nasogastric intubation are sufficient. However, often, ultrasound provides key information for proper diagnosis, prognosis and decision making. For this reason, in many practices and equine clinics, echography is included in the standard examination of the equine colic patient.

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