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Gastrointestinal effects of general anaesthesia in horses undergoing non abdominal surgery: focus on the clinical parameters and ultrasonographic images

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Abstract

The ultrasonographic images of the gastrointestinal tract in horses can be influenced by fasting and sedation but the proper effect of general anaesthesia (GA) on them has not been determined yet. This study aimed to evaluate the effects of GA on ultrasonographic images of the gastrointestinal tract in horses and to compare these effects with a clinical evaluation. Twenty horses undergoing non-abdominal surgeries were evaluated by ultrasonography before and 4 times within 24h after GA. Each ultrasonographic exam focused on the stomach, the duodenum and on 5 locations on the jejunum. The four-quadrant auscultation and the postoperative faecal output were also recorded. Pre and post anaesthetic values were compared using linear mixed effects models. None of the horses presented colic signs or reduced faecal output. During the first 2 post anaesthetic evaluations, the gut sounds were significantly decreased and, when taking all jejunal locations together, the jejunal diameter and visualisation frequency significantly increased. No intestinal loop appeared thickened and most of their diameters remained within the normal range. Our results suggest that the effects

of GA on the ultrasonographic images of the small intestine are mild and of short duration and can therefore be differentiated from a pathological process.

Introduction

Transabdominal ultrasonography is increasingly used in equine acute abdominal disease as well as in the follow-up of surgical colic patients. It is a non-invasive procedure that is well tolerated by the animals, requires minimal preparation (Kirberger et al., 1995) and it can help to determine if a surgical intervention is needed, to give a prognosis and to monitor the response to the treatment, especially in cases of postoperative colic or ileus (Reef et al., 2004) because it is more sensitive than rectal palpation for the detection of small intestinal abnormalities (Klohnen et al., 1996).

However, the ultrasonographic images of the small intestine can be influenced by several conditions including fasting and xylazine sedation (Kirberger et al., 1995). Epstein and co-workers (2008b) found that hypocontractile segments of jejunum were most frequently identified on day 1 after exploratory celiotomy in normal ponies, suggesting a mild functional ileus after bowel handling.

Nevertheless, several molecules commonly used in equine general anaesthesia (GA) such as α2 adrenoceptors agonists (eg xylazine, detomidine, romifidine) and opioid agonists (eg morphine,…) (Muir, 2009) are known to decrease the intestinal motility. The type of volatile agent used in gaseous anaesthesia also seems to influence the recovery of the equine gastrointestinal function, with halothane having a longer lasting depressive effect than isoflurane (Durongphongtorn et al., 2006). The negative influence of GA may lead to clinical signs of colic, even after elective non-abdominal procedures (Andersen et al., 2006; Little et al., 2001; Senior et al., 2006). Consequently, when abnormal ultrasonographic images of the

small intestine are observed after GA, it is not straightforward to determine if they could be related to a transitional effect of GA or to the precursor signs of a pathological process.

To answer to this question, this study aimed to evaluate the effects of general anaesthesia and their duration on ultrasonographic images of the small intestine and the stomach taken serially in horses preoperatively and within 24 hours after non-abdominal surgeries and to compare these effects with a clinical evaluation of the digestive system.

Material and methods

Animals

Twenty horses (8 mares, 7 stallions and 5 geldings) hospitalised in the Equine Clinic of the University of Liège- Belgium were included in the study. Horses presented during the clinical rotation of the principal investigator (A.G.), aged over one year, weighing 250 to 700 kg and undergoing routine non-abdominal surgery under inhalation anaesthesia were the inclusion criteria. The horses'age ranged from 1 to 19 years (median 4 years) and weight varied from 280 to 635 kg (median 475kg). There were 10 Warmbloods, 4 Arabians or Cross Arabians, 2 Quarter Horses, 1 Trotter, 1 Hispanic Horse, 1 Frisian Horse and 1 Appaloosa. The horses underwent the following surgeries: 9 orthopaedic surgeries (7 arthroscopies, 1 keratoma removal by complete hoof wall resection and 1 splint bone ostectomy), 4 ophthalmic surgeries (3 enucleations and 1 conjunctival graft), 3 inguinal castrations, 1 tooth repulsion, 1 tie-forward, 1 facial reconstruction and 1 modified Forsell procedure. All horses were admitted in the Clinic at least the day before the surgery and they remained in the hospital for a minimum of 48h after the surgery. The experimental protocol did not interfere with the usual management of hospitalised horses. However, owners signed an informed consent sheet and allowed the Clinic to use the data acquired from their horses.

General anaesthesia

All horses underwent a clinical examination and a blood analysis (haematological and biochemical) the day before the anaesthesia and none of them presented any gastrointestinal abnormality . Every horse entered into I, II or III American Society of Anaesthesiologists' classification. All horses had *ad libitum* access to water at all times. Hay/ silage and cereals were withheld eight to ten hours prior to premedication for GA and horses were starved thereafter for approximately 3 hours after the recovery from anaesthesia. All horses except 3 were premedicated with acepromazine (Placivet[1]) (0.1 mg/kg, IM) administered 45 minutes before induction. All received xylazine (Proxylaz 2%[2]) (0.6 mg/kg, IV) five minutes before induction. Anaesthesia was induced with ketamine (Anesketin[3]) (2.2 mg/kg, IV) and midazolam (Dormicum[4]) (0.06 mg/kg, IV). Orotracheal intubation was performed and anaesthesia maintained by isoflurane (Isoflo[5]) in an oxygen/air mixture and a constant rate infusion of midazolam (0.02 mg/kg/h) and ketamine (1 mg/kg/h). Intermittent positive pressure ventilation was installed in order to maintain normocarbia. Intra-anaesthetic parameters consisting of heart rate, respiratory rate, peak inspiratory pressure, tidal volume, end-tidal CO2 pressure, end-tidal isoflurane concentration, oxygen saturation of haemoglobin, and invasive mean arterial pressure were constantly monitored and recorded every five minutes. Arterial blood gas analyses were performed every 15-30 minutes. Lactated Ringer's solution (Ringer Lactate Solution[6]) was administered intravenously at a rate of 10 ml/kg/h throughout the whole procedure. Dobutamine (Dobutrexmylan[7]) was administered intravenously if needed to maintain mean arterial blood pressure $\geq$ 70 mmHg. At the end of the procedures, horses were returned to spontaneous respiration, and recovered in a padded recovery box. As required, xylazine was administered at a dose of 0.2 mg/kg IV during the recovery period. For pre/post-operative medication, flunixin meglumine (Emdofluxin 50[8]) (1.1 mg/kg, IV) and antibiotics were administered depending on pathology and evolution of their condition.

Timing of the experiment

Horses were evaluated at several time points, which were defined as follow: T0 (the day before GA, when horses were fed normally and had not received any form of sedation during the 24 preceding hours), Tr (at the end of the recovery from GA, as soon as the horse is standing stable), Tr+2 (2-4 hours after the recovery from GA), Tr+12 (12-18 hours after the recovery from GA) and Tr+24 (24 hours after the recovery from GA).

Clinical evaluation of the digestive system

At each T time, digestive auscultation was performed with a stethoscope (Littmann Classic II[10]). Four abdominal quadrants (upper and lower, left and right) were assessed by one observer to determine the number of borborygmi heard over one minute. Then, a mean of the 4 quadrants measurements was calculated. For each horse, the number of defecations (evaluated by the number of piles of faeces, which were immediately removed to avoid double counts) within 24 hours post anaesthesia was also counted. Then, this number was compared to the physiologic number of defecation of a normal horse (6-12 defecations per day, depending on the diet) (Bradley, 1981; Fraser, 1992).

Ultrasonographic evaluation of the digestive system

The serial ultrasonographic evaluations of the digestive system were performed in all horses and at each time point by the same operator (A.G.) using a 5 MHz linear transducer (Honda electronics, HS-2000[9]). The horses were not clipped for the ultrasonographic examination but alcohol was applied to the skin of the abdomen to provide appropriate contact of the probe. A systematic approach was used to assess the stomach, duodenum and jejunum. The stomach was imaged as a large semi-circular structure medial to the spleen in the cranial and mid portion of the abdomen's left middle third (dorso-ventrally) (Rantanen, 1986). For each T time, the number of intercostal spaces where the stomach was visualised was recorded and the

gastric wall thickness was obtained by calculating the mean of 3 consecutive measurements. The duodenum was examined in the dorsal part of the middle third (dorso-ventrally) of the abdomen in the fourteenth or fifteenth right intercostal spaces, between the liver and the right dorsal colon, as described by Busoni and co-workers (2011). Measurements were taken where the visualisation was the clearest depending on the horse's morphological factors. For the rest of the small intestine that can be imaged by transabdominal ultrasonography, ie the jejunum and the proximal part of the ileum (later named in this text as 'jejunum'), 5 locations were chosen arbitrarily: on the ventral midline caudally to xiphoid cartilage (location 1), on the right (location 2) and the left (location 4) cranial ventral part of the abdomen, and caudally on right (location 3) and left side (location 5) of the ventral midline, close to the inguinal regions (later called 'inguinal regions' in this text). On each site, the presence or absence of jejunum was recorded. For each T time and each location, the number of contractions of the duodenum and -if visualised- of the jejunum over a 1-minute-period was recorded twice with a 10-minute interval and the mean was calculated. For both types of small intestine, the cross sectional diameter from serosa to serosa during the maximum distension phase was obtained by calculating the mean of 3 consecutive measurements for each T time and each location. The small intestinal wall thickness was not measured but was recorded as subjectively thickened / oedematous or normal. Organ identification was performed by anatomic location and ultrasonographic appearance.

Statistical analysis

The level of significance was set at $p < 0.05$. Data were presented as mean ± standard deviation (SD). All computations were done with RStudio[12]. First, Pearson correlations were computed between all explanatory variables. Only a set of independent variables was kept. Linear mixed effects models were built and included time, demographic data (age, sex, breed and weight) and anaesthetic data (duration of anaesthesia, premedication with acepromazine

or not, duration of the recovery phase and dosage of xylazine administered during the recovery phase) as fixed effects and the random effect of horse. For continuous outcome variables, the "lme" function from the "nlme" package was used. The model assumptions (residuals homoscedacity and normal distribution) were verified a posteriori. If the assumptions were violated, a Welch test was used instead. For binary outcome variables, we relied on the glmer function from the "lme4" package. Finally, for ordinal outcome variables, we chose the clmm2 function from the package "ordinal". Missing values were omitted from the computation.

Results

The mean duration (± SD) of the GA was 127.6 ± 35.5 minutes and the mean duration of the recovery was 42.3 ± 13.9 minutes. Neither demographic data nor anaesthesia-related data were found to have a significant effect on the outcome variables.

Clinical evaluation of the digestive system

None of the horses presented any signs of colic or lack of appetite during the experiment or later during the hospitalization.

The number of defecations during the first 24 postoperative hours ranged from 5 to 15 (mean: 8.94), which is assumed to follow the distribution of the reported physiologic 6-12 defecations per day.

The gut sounds were significantly decreased at Tr and Tr+2 when compared to T0. The mean gut sounds heard per minute were 7.57 ± 0.51 for T0, 2.76 ± 0.64 for Tr, 4.97 ± 0.64 for Tr+2, 7.39 ± 0.70 for Tr+12 and 7.64 ± 0.74 for Tr+24.

Ultrasonographic evaluation of the stomach

There was no statistically significant difference in the visualization of the stomach by ultrasonography between times. The size of the stomach was significantly smaller at the recovery (Tr) compared to T0. The stomach was visualised over 3.12 ± 1.12 intercostal spaces at the recovery and it was visualised over 4.6 ± 1.68 intercostal spaces at T0. The gastric wall thickness did not differ significantly between time points.

Ultrasonographic evaluation of the duodenum

There was no significant difference between the pre- and post-anaesthetic values when considering the duodenal cross sectional diameter and the number of contractions of the duodenum per minute. Taking all horses and all time points together, we observed 3.43 ± 1.34 contractions per minute and the mean maximum duodenal cross sectional diameter was 32.74 ± 7.91 mm. All maximal diameters were inferior to 50 mm except 2 (one at Tr+2 and one at Tr+12).

Ultrasonographic evaluation of the jejunum

The frequency of visualisation of the jejunum for each time point and for each of the 5 locations is displayed in Table 1. The next results concerning the jejunal visualisation and diameters are expressed with respect to T0.

On the ventral midline caudally to the xiphoid cartilage (location 1), the visualisation of the jejunum was significantly increased at recovery ($p=0.008$) and had a tendency to be increased at Tr+2 ($p= 0.06$).

On the right cranial ventral part of the abdomen (location 2), the visualisation of the jejunum was not significantly different between time-points. However, the jejunum was usually better visualised at Tr ($p= 0.06$).

On the right 'inguinal' region (location 3), the visualisation of the jejunum was significantly increased at recovery ($p=0.002$) and at Tr+2 ($p= 0.03$).

On the left cranial ventral part of the abdomen (location 4), the visualisation of the jejunum was significantly increased at recovery ($p = 0.018$).

On the left 'inguinal' region (location 5), the visualisation of the jejunum was increased at recovery ($p= 0.001$).

Taking all time periods together, the visualisation frequency of the jejunum was significantly smaller ($p<10^{-5}$) at location 2 compared to other locations. Although not statistically significant, the visualisation frequency of the jejunum seemed to be higher at the 'inguinal' locations (locations 3 and 5, see Table 1).

Taking all locations together, the jejunum visualisation frequency was significantly increased at Tr ($p < 10^{-5}$) and at Tr+2 ($p = 0.008$).

A significant negative correlation ($r = -0.48$, $p<1e-5$) was found between the gut sounds and the visualisation of the jejunum at all times. We observed that the smaller heard gut sounds number the higher the jejunum visualisation frequency. This effect is obviously more noticeable at Tr and Tr+2.

Table 2 displays the mean jejunal maximal diameter ± SD and the number of observations for each location and each time period.

For the locations 1, 2, 3 and 5, the jejunal diameter was not significantly different between time points. However, the diameter of the jejunum was increased ($p= 0.004$) at recovery at location 4.

Taking all locations together, the jejunal diameter was significantly increased at Tr ($p< 10^{-5}$) and Tr+2 ($p= 0.01$).

All maximal diameters were inferior to 50 mm except 6 which were all measured at recovery.

For each location, it was rarely possible to image with certainty the same intestinal loop during a sufficient period of time to count the contractions. Therefore it was impossible to evaluate objectively the jejunal motility.

No small intestinal loops appeared grossly oedematous or thickened.

Discussion

Numerous studies have shown that sedation and general anaesthesia have a negative influence on the equine gastrointestinal motility (Durongphongtorn et al., 2006; Freeman and England, 2001; Merritt et al., 1998; Singh et al., 1997). The prevalence of postoperative colic in horses undergoing non-abdominal surgeries has been reported to range from 5.2 to 12% (Andersen et al., 2006; Little et al., 2001; Senior et al., 2006). However, in the present study, even if a depressive effect of the general anaesthesia on the intestinal motility was observed as a decrease of the gut sounds was recorded during the first 2 post anaesthetic evaluations (within 2-4 hours post recovery), none of the horses showed signs of abdominal discomfort. This is particularly interesting as 65% of our horses (13/20) were operated for orthopaedic (n=9) or ophthalmic (n=4) diseases, which are frequently considered as the pathologies presenting an increased risk of colic (Patipa et al., 2012; Senior et al., 2006). Furthermore, the number of postoperative defecations of our horses was not significantly different from the physiologic values. This is in contrast with the results of Little and coworkers (2001) who reported that 37 on 85 horses undergoing non abdominal surgery presented a reduced postoperative faecal

output, defined as ≤ 3 defecations per 24-hour period after surgery. The anaesthetic protocol and perioperative treatments used in the present study might explain the shorter depression of gastrointestinal motility and the absence of postoperative colic in the horses. In particular, none of the patients received opioids before and during the study and only one horse was treated with perioperative topical atropine. Both molecules have been recognized to negatively affect gut motility (Muir, 2009; Williams et al., 2000). The use of isoflurane (vs halothane) might also have contributed to reduce the depressive effect of GA on the gastrointestinal motility (Durongphongtorn et al., 2006).

In the equine literature, the evaluation of the gastrointestinal motility has been described using various methods, ranging from very simple to highly sophisticated: four-quadrant auscultation (Singh et al., 1996; Singh et al., 1997), count of defecations (Little et al., 2001), transit time of chromium oxide administrated through a nasogastric tube (Durongphongtorn et al., 2006), transabdominal ultrasonography (Epstein et al., 2008a, b; Hendrickson et al., 2007), transabdominal Doppler ultrasonography (Mitchell et al., 2005), transrectal ultrasonography (Freeman and England, 2001), electrointestinography (Sasaki et al., 2004) and evaluation of the manometric activity by means of pressure sensors introduced via a gastric cannula or recording of the intestinal myoelectric activity using electrodes previously surgically placed on the intestinal serosa (Merritt et al., 1998). Although electrointestinography proved to be more objective and provided more details than auscultation and ultrasonography for the evaluation of intestinal motility after jejunocecostomy in horses (Sasaki et al., 2008), this method is not frequently used under field conditions. Also, our aim was not to determine the best method to evaluate the gastrointestinal motility but to determine until which extent GA influences the ultrasonographic images of the stomach and the small intestine, as ultrasonography is frequently used when examining a colic horse. To be close to an emergency situation with a horse with colic, we did not perform an

in-depth transabdominal ultrasonography at each time point, which is time-consuming but we evaluated in approximately 15 minutes seven predetermined topographical locations like in the FLASH (fast localized abdominal sonography of horses) protocol described by Busoni and co-workers (2011), but we used different locations. We evaluated essentially the ventral part of the abdomen because this was the location where loops of small intestine were more frequently visualised after fasting, supposedly caused by an emptying of the large intestine (Mitchell et al., 2005) or during a pathological process causing the loops to be distended and oedematous and therefore weightier (Reef, 1998).

Although not statistically significant, the stomach was less frequently visualised just after the recovery from anaesthesia. This can be explained by the poor quality images obtained on some horses because of profuse sweating. At recovery, the stomach appeared to be smaller, probably because of the preoperative fasting period. However, another study using fasted horses (Mitchell et al., 2005) did not describe a reduction of the stomach size but a ventral displacement of the stomach.

As the duodenum can almost always be visualised using the same ultrasonographic window, the influence of the anaesthesia on the duodenal visualisation was not evaluated in this study. But this repeatability allowed us to evaluate the number of contractions, which were not significantly reduced after fasting/ anaesthesia in our study, as after 36h starvation in another article (Kirberger et al., 1995).

As previously reported (Epstein et al., 2008a), the jejunum was more frequently visualised in the left and right caudal parts of the abdomen, near the inguinal regions, particularly at recovery, although this was not statistically significant in our study. Therefore, it could be hypothesised that in case of a pathological process involving a large part of the small intestine, the abnormally distended loops of the latter could be observed first in these

locations. On the other hand, taken all time points together, the jejunum was significantly less frequently visualised in the right cranial ventral part of the abdomen. Thus, if an increased number of small intestinal loops are visualised in this particular region in a horse showing signs of abdominal discomfort, it might be reasonable to suspect a pathological process like an entrapment in the epiploic foramen rather than a simple effect of GA. Indeed, distended or oedematous loops of small intestine identified by ultrasonography in the right cranial region of the abdomen might be suggestive of an epiploic foramen entrapment (Freeman, 2002; Vachon and Fischer, 1995).

In our study, the GA decreased the gut sounds and increased the visualisation and the diameter of the jejunum (negative correlation between the number of gut sounds and the ultrasonographic images of the small intestine). This effect was particularly statistically significant when all locations were mixed considered. However, this effect was short-lived as all the results obtained during the 3rd post anaesthetic evaluation (Tr +12-18h) were not significantly different from the pre anaesthetic values. This finding may be considered as a limited physiologic post-anaesthetic ileus without significant repercussions on the horses' health as none of our patients presented clinical signs of discomfort and can therefore be considered as clinically sound. In addition, with the exception of 6 measurements, all the small intestinal diameters were inferior to 50 mm, and therefore could not be considered as abnormally distended (Freeman, 2002). Furthermore, an increased size of the stomach would be expected in case of an ileus with clinical repercussions, contrarily to the decreased gastric size we observed at recovery. A decrease of the small intestinal contractions would also have been expected. This was not the case here for the duodenum. Unfortunately, because of the intestinal movements, we were not able to count sufficient jejunal contractions to perform a statistical analysis. The issue of the inconsistent visualisation of the jejunum by transabdominal ultrasonography (Reef, 1998; Scharner et al., 2002) and the difficulty to

evaluate the contraction rate with Doppler ultrasonography (Mitchell et al., 2005) have been previously reported.

The ultrasonographic visualisation of the small intestine was increased after GA in the present study. An increased jejunal visualisation has also been reported in horses after 24h fasting (Norman et al., 2010) and after 8h fasting and xylazine sedation (Mitchell et al., 2005). Therefore, as our horses were also fasted during 8-10 hours before surgery, we cannot be sure if this increased jejunal visualisation was caused by fasting, by GA or by both as fasting and GA are confounding factors here. However, the fasting period before the surgery was not strict, as horses were not muzzled and the access to water and to the straw of their bedding was not restricted. Even if it would have been interesting to evaluate the effect of GA in horses without fasting period, we did nottest it here as our horses were client-owned and current general recommendation before general anaesthesia includes a food withdrawal for at least 6 hours (Robertson and Scicluna, 2009) although controversy still remains regarding the respiratory and gastrointestinal benefits and disadvantages of pre-anaesthetic fasting (Mama, 2019).

Like every clinical study, our protocol has its limitations. The clinical nature of this study means that horses were not totally acclimatized to their environment prior to the first ultrasound measurement. The stress of being in a new environment may have altered motility prior to surgery, and this time point may therefore not completely be normal. The confounding effect between GA and fasting was previously discussed. The absence of control group fasting 8-10 hours without GA and of a group undergoing GA without surgery has to be cited among the limitations of the study, as well as the subjective evaluation (vs objective measurements) of the small intestinal wall thickness. . Although not evaluated in the study, the type of surgery performed and the postoperative pain level may also have influenced the intestinal motility, since unaddressed pain and inflammation are known to result in poor

gastrointestinal motility (Fogle, 2019). Finally, although low-frequency (2-5 MHz) curvilinear transducers are the transducers of choice for equine transcutaneous ultrasonography (Le Jeune and Whitcomb, 2014), we used a 5 MHz linear rectal transducer because it was the transducer used to evaluate (transabdominally and transrectally) colic horses admitted in our clinic. Because of its maximal scanning depth of 10-12 cm, the visibility with a transrectal transducer is limited to structures close to the skin surface (Le Jeune and Whitcomb, 2014), which can be considered as a significant limitation. Having used a 2-3 MHz curvilinear transducer might have allowed us to visualise deeper jejunal loops and thus increase the number of jejunal visualisations and obtain more values to count the jejunal contractions. The frequency of transducer used has to be kept in mind if comparisons with other clinical settings are made.

In conclusion, as none of the horses of this study presented any pathological clinical signs, the effects of GA on the ultrasonographic images of the small intestine observed here can be considered as 'normal'. These effects essentially consisted in a transient (less than 12 hours) increased jejunal visualisation and diameter (but in remaining in the normal range for the majority of the observations) without grossly thickening of the intestinal wall. These observations were correlated to a decrease of the gut sounds, suggesting a mild physiologic and not pathologic ileus.

Manufacturers' addresses

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2. Prodivet Pharmaceuticals, Eynatten, Belgium.

3. Eurovet, Heusden-Zolder, Belgium.

4. Roche, Bruxelles, Belgium.

5. Abbott, Bershire, UK.

6. Baxter, Zurich, Switzerland.

7. Mylan, Hoeilaart, Belgium.

8. Ecuphar, Oostkamp, Belgium.

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Tables and figure legends

Table 1: Proportion (and percent) of jejunum visualisation for each time period and each location.

	T0	Tr	Tr+2	Tr+12	Tr+24	Total
location 1	3/20 (15%)	11/19 (58%)**	8/19 (42%)	2/14 (14%)	4/13 (31%)	28/85 (33%)
location 2	2/20 (10%)	7/19 (37%)	2/19 (10%)	0/14 (0%)	0/13 (0%)	11/85 (13%)
location 3	4/20 (20%)	14/19 (74%)**	10/19 (53%)*	2/14 (14%)	5/13 (38%)	35/85 (41%)
location 4	4/20 (20%)	11/19 (58%)*	5/19 (26%)	5/14 (36%)	1/13 (8%)	26/85 (30%)
location 5	5/20 (25%)	16/19 (84%)***	8/19 (42%)	2/14 (14%)	1/13 (8%)	32/85 (38%)
Total	18/100 (18%)	59/95 (62%)***	33/95 (35%)**	11/70 (16%)	11/65 (17%)	

T0: before anaesthesia; Tr: at the recovery from anaesthesia; Tr+2: 2-4h after the recovery; Tr+12: 12-18h after the recovery; Tr+24: 24h after the recovery.

Location 1: ventral midline caudally to xiphoid cartilage; location 2: on the right cranial ventral part of the abdomen, location 3: caudally on right side of the ventral midline, close to the inguinal region; location 4: on the left cranial ventral part of the abdomen, location 5: caudally on left side of the ventral midline, close to the inguinal region.

The symbols '*' indicates the significance level with respect to the value at T0 < 0.05 (*), < 0.01 (**) and < 0.001 (***)

Table 2: Mean maximal jejunal diameter in mm ± SD (and number of observations) for each time period and each location (raw data).

	T0	Tr	Tr+2	Tr+12	Tr+24	Total
location 1	29.7 ± 12.8 (n= 3)	36.0 ± 10.8 (n= 11)	37.7 ± 7.2 (n= 8)	26.2 ± 1.7 (n= 2)	34.0 ± 5.8 (n= 4)	34.8 ± 9.2 (n= 28)
location 2	25.1 ± 7.8 (n= 2)	41.0 ± 10.4 (n= 7)	28.5 ± 4.9 (n= 2)	/ (n= 0)	/ (n= 0)	35.9 ± 11.2 (n=11)
location 3	28.6 ± 7.8 (n=4)	37.5 ± 8.8 (n= 14)	32.6 ± 7.1 (n= 10)	31.3 ± 8.9 (n= 2)	29.9 ± 11.0 (n= 5)	33.7 ± 8.8 (n= 35)
location 4	25.0 ± 1.8 (n= 4)	36.4 ± 10.1*** (n= 11)	29.6 ± 3.3 (n= 5)	25.0 ± 1.6 (n= 5)	25.0 ± 0 (n= 1)	30.7 ± 8.4 (n= 26)
location 5	30.4 ± 10.4 (n= 5)	34.1 ± 9.1 (n= 16)	34.0 ± 6.6 (n= 8)	33.8 ± 12.4 (n= 2)	30.0 ± 0 (n= 1)	33.4 ± 8.4 (n=32)
Total	28.1 ± 8.0 (n= 18)	36.5 ± 9.6*** (n= 59)	33.5 ± 6.8** (n=33)	28.0 ± 6.1 (n= 11)	30.9 ± 8.1 (n= 11)	

T0: before anaesthesia; Tr: at the recovery from anaesthesia; Tr+2: 2-4h after the recovery; Tr+12: 12-18h after the recovery; Tr+24: 24h after the recovery.

Location 1: ventral midline caudally to xiphoid cartilage; location 2: on the right cranial ventral part of the abdomen, location 3: caudally on right side of the ventral midline, close to the inguinal region; location 4: on the left cranial ventral part of the abdomen, location 5: caudally on left side of the ventral midline, close to the inguinal region.

The symbols '*' indicates the significance level with respect to the value at T0 < 0.05 (*), < 0.01 (**) and < 0.001 (***)

Highlights

Jejunal visualisation and diameter were increased within 2-4 hours after anaesthesia

Almost all maximal diameter of small intestine were within normal limits

No small intestinal loops appeared thickened after anaesthesia

The gut sounds were significantly reduced within 2-4 hours after general anaesthesia

No horse showed reduced fecal output or colic signs after anaesthesia