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Gastric and large colon impactions combined with aggressive enteral fluid therapy may predispose to large colon volvulus: 4 cases

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Abstract

Background: To resolve large colon impactions, frequent enteral administration of large volumes of water (8-10 liters in a 500 kg horse) has been suggested. Furthermore, in large colon volvulus, the simultaneous presence of gastric impaction has been described as a possible predisposing factor .

Objectives: To describe the clinical and surgical features of horses with large colon volvulus associated with aggressive enteral fluid therapy performed to resolve an initial large colon impaction.

Methods: Records of horses that underwent exploratory laparotomy at the Veterinary Teaching Hospital of Turin between 2012-2019 were reviewed. Clinical and surgical features of cases initially diagnosed with large colon impaction that developed a large colon volvulus after enteral administration of large volumes of fluids were retrieved.

Results: Four horses met the criteria. In all horses an initial diagnosis of large colon impaction was made by the referring veterinarian. In all cases a sudden increase in pain was noticed shortly after enteral administration of large volumes (8-10 liters) of water. Administration of analgesic didn't resolve the pain in any of the horses that were then referred. A large colon volvulus was found during exploratory laparotomy in all cases. A moderate gastric impaction was also found intraoperatively, which was confirmed by gastroscopy postoperatively.

Conclusions: Nasogastric administration of large quantity of fluids with a pre-existing gastric and colon impaction, may reduce the available space in the abdominal cavity and potentially predispose the colon volvulus. More frequent enteral administration of smaller volumes of fluids might be preferred when treating large colon impactions.

Keywords: horse; colic; colon impaction; enteral fluid therapy; large colon volvulus

Large colon impaction is considered the second most common cause of colic in horses as well as the most common example of simple intestinal obstruction [1,2]. It has a multifactorial aetiology and is often associated with moderate pain; generally, it is treated medically with the administration of enteral and parenteral fluids [3,4]. In several studies, enteral fluid therapy was more effective than intravenous fluid therapy to resolve large colon impaction [5-8]. An experimental study demonstrated that the administration of up to 10 l of water in a 500-kg horse (20 ml/kg) via a nasogastric tube was safe and effective in hydrating faeces in the colon [7]. It is important to consider that the administration of excessive volumes of enteral water through gravity flow may be associated with a worsening of colic symptoms, following excessive distension of the gastric wall. This latter condition can, in fact, represent an important pain stimulus,

44 especially if gastric emptying is hindered and the contents flow slowly [8]. This
45 condition is also associated with an increase in intra-abdominal pressure, that could
46 predispose to large colon dislocation or volvulus (LCV) [9,10] alone or in combination
47 with other predisposing factors. The following report describes the clinical signs and
48 surgical characteristics of horses with large colon volvulus which developed after
49 aggressive enteral fluid therapy to resolve an initial large colon impaction. In all horses,
50 a moderate gastric impaction was also found intraoperatively, which was confirmed by
51 gastroscopy postoperatively.
52

53 ## 1. Materials and methods

54 ### *1.1 Case selection*

55 The study included horses hospitalised for acute abdomen and undergoing
56 exploratory laparotomy at the Veterinary Teaching Hospital of Turin from 2012 to
57 2019. All horses were diagnosed with colon impaction that developed a large colon
58 volvulus after enteral administration of large volumes of fluids.

59 ### *1.2 Case signalment*

60 Four horses met the criteria for the study; ages ranged from 16 to 19 years, with a
61 mean of 17.5 years, and mean weight was 563 kg (500–675). Two horses were
62 females, one was gelding, and one was entire male.

63 ## 2. Results

64 ***2.1 Case presentation*** We report the history and clinical findings of four horses
65 initially seen by four different referring veterinarians for inappetence and mild
66 colic symptoms. Horses had mild to moderate colic pain on the first visit; the

referring veterinarians carried out the clinical examination and rectal exploration and issued a diagnosis of large colon impaction. Treatment was initiated with spasmolytics and with the administration of intravenous fluid therapy. Approximately 8 to 10 litres of water were administered to each horse via a nasogastric tube, following which the patients began to show a worsening of the clinical signs, with an increase in heart rate and colic pain not respondent to analgesics.

2.1.1 Case 1 A 16-year-old 500-kg Warmblood mare was referredfor colic syndrome. The referring veterinarian had diagnosed a large colon impaction and treatment was initiated. Spasmolytics, analgesics and intravenous fluid therapy were administered. Approximately 10 litres of water (20 ml/kg) were also administered via a nasogastric tube, following which the patient began to show a worsening of the clinical signs with an increase in heart rate and severe colic pain not respondent to treatment with flunixin meglumine[1] (1.1 mg/kg IV) and detomidine hydrocloride[2] (0.2 ml/100 kg IV). The horse was then referred. Upon arrival, the horse was in severe pain and difficult to handle and explore. A dose of xylazine[3] (1 mg /kg IV) and butorphanol[4] (0.01 mg/kg IV) was administered to perform a quick preoperative examination and then used for anaesthesia premedication. At physical examination, increased heart rate (70 beats/min), absent gut sounds, increased values of PCV (45%) and TP (7 g/dl) were found. A severe large colon impaction was palpated on abdominal examination *per rectum*. Passage of a nasogastric tube did not reveal any net reflux. Because of the unrelentless pain, ultrasonography was not performed. Based on clinical findings, surgical

treatment was advised. After induction of general anaesthesia and aseptical preparation of the operating field, a ventral midline laparotomy was performed. This revealed a 360° counterclockwise colon volvulus, which was then corrected by reverse rotation. A pelvic flexure enterotomy was also performed to resolve the initial colon impaction. The large colon presented just mild oedematous intestinal walls, whose colour improved during surgery. Palpation revealed the presence of a distended stomach with solid content. At the end of the surgery, the abdomen was closed routinely with a double-layer closure on the *linea alba* and on the skin. Surgery lasted 125 min, and the horse recovered from anaesthesia uneventfully. In the first postoperative day, a gastroscopy was performed, and gastric impaction confirmed (Fig.1 A, B). The horse was then administered 2 litres of water with 240 mg of dioctyl sodium sulfosuccinate (DSS)[5] and 36 g of Sorbitol[5] twice a day for 3 days. Follow-up gastroscopy on the fourth postoperative day confirmed resolution of the impaction. No complications were encountered during hospitalisation, and the patient was discharged after eight days. A telephone follow-up was obtained by owner interview, and the horse was alive after 40 months.

2.1.2 Case 2 A 17-year-old 535-kg Warmblood entire male was referred for severe colic pain. The referring veterinarian carried out the clinical examination and rectal exploration, and a severe large colon impaction was diagnosed. Treatment was initiated with intravenous fluid therapy, and approximately 10 litres of water (18 ml/kg) were administered via a nasogastric tube. Approximately 10 minutes later, the horse began to show

worsening of the clinical signs, with colic pain not respondent to treatment with analgesics. At presentation, the horse had severe abdominal pain, heart rate was increased, and there was decreased intestinal motility. A distended small intestine was palpated on rectal examination. Exploratory laparotomy was recommended due to the severity of abdominal pain. A 270° counterclockwise colon volvulus was found and corrected by reverse rotation; additionally, pelvic flexure enterotomy was performed. The intra-abdominal palpation revealed the concomitant presence of gastric impaction which was not surgically resolved. Postoperative gastroscopy confirmed the presence of the gastric impaction (Fig. 1C) that was treated as per case #1 and was resolved at follow-up gastroscopy 4 days later. The horse was discharged on the 9th day postoperation and was alive at 20 months follow-up.

2.1.3 Case 3 An 18-year-old 675-kg Warmblood broodmare was referred for abdominal pain. The referring veterinarian had diagnosed a large colon impaction which was treated medically with administration of parenteral fluids, analgesics and abundant enteral fluids (approximately 15 litres- “one full bucket”- according to the referring veterinarian) via a nasogastric tube. After gastric intubation, the horse began to show severe colic pain and was referred. Upon arrival, the horse had moderate abdominal pain, a slightly increased heart rate, decreased intestinal motility and mild dehydration. The large colon was distended, and a taenial band, painful on traction, was palpated on rectal examination; exploratory laparotomy was recommended. A 360° counterclockwise colon volvulus was found and resolved with

reverse rotation; the large colon was exteriorised, and a pelvic flexure enterotomy was performed to resolve the initial colon impaction. Intra-abdominal palpation revealed the concomitant presence of a moderate gastric impaction. The abdomen was closed routinely. The surgery lasted approximately 80 minutes, and the horse recovered from anaesthesia uneventfully. No complications were encountered during hospitalisation, the patient was discharged after 8 days and resulted alive after 12 months.

2.1.4 Case 4 A 19-year-old 540-kg Warmblood gelding was referred for acute abdominal pain, which started after the administration of about 10 litres of water via a nasogastric tube to resolve an initial colon impaction. Upon arrival, the horse showed moderate abdominal pain not responding to analgesics and had an increased heart rate and decreased intestinal motility. A large colon displacement was suspected on rectal examination, and an exploratory laparotomy was performed. A 360° counterclockwise colon volvulus, which was resolved by reverse rotation, and a gastric impaction were found. A pelvic flexure enterotomy was performed, and the abdomen was closed routinely. Treatment with DSS and sorbitol was performed as in the previous cases, and the horse was discharged on postoperative day 10. The horse was alive at follow-up at 5 months.

3. Discussion

All horses included in this study had an initial large colon impaction and began to show a worsening of their clinical condition following the enteral administration of large quantities of water (18–22 ml/kg) through gravity flow. Pain demonstrated by the

subjects after administration of water was well more than what is normally shown by horses with colon impaction. Administration of analgesic did not resolve the pain in any of the horses, which were then referred because of the unrelentless pain. Based on clinical findings, surgical treatment was advised and colon torsion was diagnosed in all patients during exploratory laparotomy Torsion of the colon is one of the most painful and rapidly fatal causes of colic in horses, with a high mortality rate associated with the onset of postoperative complications. Therefore, recognising the risk factors could be beneficial to prevent the onset of this problem. Receiving medication in the previous 7 days, drastic changes in diet, reduced exercise, increased height, management changes and parturition in mares are the main risk factors [11]. However, the horses included in our study had not been exposed to these risk factors for LCV, if not an anatomical predisposition relating to the height of the animals, as they are all Warm-blood horses. Gastric impaction, which is a rare condition characterised by persistent and progressive accumulation of dehydrated ingesta in the stomach [12], is also hypothesised to be considered among the predisposing factors of large colon volvulus [13].

Gastric impaction also leads to a reduction in the passage of ingesta, which causes an alteration of the colon contents and, therefore, a change in the colonic microbiota and pH that can predispose to the onset of dislocation or volvulus [11]. However, the connection between the two problems it not well known, since gastric impaction could cause variations in intra-abdominal pressure that predispose to variations in the position of the large colon. However, it is possible that the displaced colon compresses the pylorus, causing an arrest of the passage of gastric contents into the small intestine; therefore, gastric impaction is not a cause, but a consequence [13]. Also, a

reduced gastrointestinal motility cloud explain the concurrent presence of large colon impactions and gastric impactions. Changes in intra-abdominal pressure have been studied mainly in post-partum mares [14]. Both in horses with gastric impaction and in mares after parturition, pressure changes, albeit opposite, occur in the abdominal cavity, which could make the colon more prone to dislocation or torsion [10]. Also, in our study, we hypothesised that gastric distension could predispose to the development of volvulus of the large colon; however, while Mcgovern [13] describes cases of severe gastric impaction, in our cases, gastric distension could have been caused by enteral administration of large volumes of fluids in conjunction with the pre-existing condition of mild or moderate gastric impaction, found intraoperatively and confirmed at gastroscopy. In both cases, however, it is not possible to say with certainty that this is a causal association rather than a coincidence.

The presence of a gastric impaction must be considered when initiating an enteral fluid therapy to resolve the large colon impaction because the gastric distension could cause a drastic increase in intra-abdominal pressure, with a consequent greater predisposition of the colon to torsion. There are several risk factors, as previously mentioned, for the development of large colon volvulus. Even severe large colon impaction could physically displace the large colon due to the weight of the ingesta, which could propagate into a large colon volvulus, could worsen the clinical conditions of horses with colic syndrome. It is advisable to assess the severity of intestinal impaction by rectal examination, and it is also advisable, whenever possible, to perform a transabdominal ultrasound exam to evaluate gastric distension before starting enteral therapy to avoid worsening a pre-existing gastric distension condition.

An experimental study has shown that intra-abdominal pressure increases already after the enteral administration of 5 litres of fluids [9]; the clinical significance of this condition is unknown. It is not possible, however, to establish whether the change in intra-abdominal pressure also occurred in our cases, since intra-abdominal pressure was not measured before and after the administration of fluids. However, the number of cases considered is small, and it is impossible to know if there was some partial rotation of the colon before the torsion and, at the same time, it is not clear whether the gastric impaction, found intraoperatively, was present at the first visit by the referring vet. The effectiveness of enteral fluid therapy can be enhanced, rather than by increasing the amount of water administered, by combining the administration of water with the use of other products such as DSS. It is an anionic surfactant, and several studies have been conducted using extremely high dosages of DSS as laxatives and to define its toxic dose in horses [15-17]. Dioctyl sodium sulfosuccinate is also a surfactant and used in humans mainly to promote hydration of faecal content by reducing the surface tension and allowing fluids to penetrate ingesta or faecal mass [18].We hypothesised that water alone is not able to permeate the gastric ingesta. Administration of a low quantity of water with a low DSS amount twice daily for 3 days resulted in a resolution of the gastric impaction, possibly by increasing water permeability of the ingesta. In the study by Mcgovern et al., cases of gastric impaction associated with colon dislocation and torsion were subjected to intraoperative or postoperative euthanasia [13]. Although the number of cases is smaller, we report a favourable short- and long-term survival. Further, in our cases, the colon resulted oedematous and hyperhaemic, no resection was considered necessary, and simple reposition and emptying were performed. This is probably due to the short-time

234 intercourse between the onset of symptoms and surgical treatment, with a prompt
235 referral by the attending veterinarians.

236 **4. Conclusions**

237 It is possible that the enteral administration of large quantities of water may lead to a
238 worsening of colic symptoms and predispose to further problems such as colon
239 displacement or torsion. Although enteral fluid therapy is the most effective treatment
240 for resolving episodes of colon impaction, it must be calibrated to hydrate the gastro-
241 enteric content and stimulate motility, but not to cause excessive distension of the
242 stomach that can be a pain stimulus and a predisposing factor to the development of
243 further problems such as large colon volvulus.

244 Based on what has been observed in these cases, we have modified our approach for
245 the therapy of gastric and large colon impaction referred to the hospital in cases like
246 those described in our study. Therapy consists of combining parenteral administration
247 of crystalloids with continuous enteral administration of fluids (through a nasogastric
248 tube connected to fluid bags).This method may reduce the risk of a sudden distension
249 of the gastric wall, as could happen by administration of bolus fluids through gravity
250 flow or via a pump. Another alternative could be the frequent enteral administration of
251 small volumes of water (4–10 ml/kg) through gravity flow with low doses of DSS. We
252 therefore hypothesise that this therapy may resolve impactions whilst reducing the risk
253 of colon volvulus.

254 **Authors' declaration of interest:** no conflict of interest have been declared.

255 **Ethical animal research**: the owners were informed and signed an informed consent
256 form. Animal welfare was respected throughout the hospital stay.

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[2]Ecuphar Italia S.R.L. Viale Francesco Restelli, 3/7, piano 1, 20124 Milano (MI) – Italia

[3]P.H. Farmaceutici SpA – Via Aguggiari, 4, 20900 Monza (MB) – Italia

[4]ACME s.r.l. – Via Portella della Ginestra, 9, 42025, Cavriago (RE) – Italia

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Figure legends

Figure 1: Gastric impaction of Case 1 at gastroscopy in the first postoperative day(A, B). Gastroscopy of Case 2 obtained during the second postoperative day (C).