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Case Report

Bilateral Morgagni hernia in a donkey

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Summary

This case report describes the clinical presentation and management of a donkey admitted with acute signs of abdominal pain that was diagnosed with a bilateral Morgagni hernia, a rare type of congenital diaphragmatic hernia. For more than 8 months before presentation, the donkey had been showing signs of recurrent mild abdominal pain that responded favourably to medical treatment. On admission, the donkey had mild tachycardia and tachypnoea. Radiography and ultrasound of the thorax and abdomen showed thoracic herniation of the large colon. Exploratory laparotomy was performed, and the sternal and diaphragmatic flexures of the large colon, as well as the left hepatic lobe, were found incarcerated in a bilateral Morgagni hernia. Intestine and liver were removed from the hernia, and the large colon was exteriorised. The defect in the diaphragm was repaired by stapling a polyester mesh circumferentially around the hernia ring and covering the mesh with an excised section of the greater omentum. No further complications and no recurrence of colic were observed during an 8-month follow-up period.

Introduction

Diaphragmatic hernias are a rare condition in equids and are associated with a poor prognosis (Hart and Brown 2009; Romero and Rodgerson 2010). Most diaphragmatic hernias are traumatic and do not contain a hernial sac, so they should be considered as 'false hernias', ruptures or rents (Rubio-Martínez 2015). Congenital diaphragmatic hernias may develop due to embryological failure during fetal development or rupture of the diaphragm *in utero* or during delivery (Toth and Schumacher 2019).

True diaphragmatic hernias contain a hernial sac composed of peritoneum and pleura and are generally found on the right side of the diaphragm (Pauwels *et al.* 2007). These types of hernias are called retrosternal or Morgagni hernias and result from the incomplete fusion of the *septum transversum* and the pleuroperitoneal folds (Pauwels *et al.* 2007). In humans, they are the least common of the four types of congenital diaphragmatic hernias, accounting for 2–3% of all cases (Papanikolaou *et al.* 2008). The majority of Morgagni hernias occur on the right side (91%) with rare left or bilateral occurrences (Horton *et al.* 2008). To our knowledge, only three cases of Morgagni hernia have been reported in horses (Pauwels *et al.* 2007) and all of them had right ventral diaphragmatic defects.

This manuscript describes the presentation and management of a bilateral Morgagni hernia causing signs of abdominal pain in a donkey. This is, to our knowledge, the first bilateral Morgagni hernia reported in equids.

Case history

A 2-year-old 150 kg donkey gelding was referred for emergency evaluation because of abdominal pain to the Equine Clinic of the University of Liege. For the last 8 months, the donkey had been showing intermittent colic without a precise diagnosis. Nasogastric intubation with mineral oil and intravenous administration of metamizole (40 mg/kg [Vetalgin])[1] were usually sufficient to resolve the colic episodes. This time, signs of colic persisted and the donkey was referred to the clinic.

Clinical findings and ancillary tests

On admission, the donkey showed moderate signs of abdominal pain. Results of physical examination identified a rectal temperature of 36.9°C, mild tachycardia (54 beats/min) and tachypnoea (28 breaths/min). Mucous membrane colour and capillary fill time were within normal limits. Borborygmi were decreased on abdominal auscultation. Nasogastric intubation did not reveal gastric reflux. Because of the small size of the patient, a rectal examination was not performed.

Complete blood count, serum biochemical analyses, and the concentration of electrolytes and lactate in the blood were within normal limits. Abdominal radiography showed a rounded structure of granular opacity within the caudo-ventral part of the thorax, overlapping with and causing border effacement of the cardiac silhouette and diaphragmatic *crus* (**Fig 1**). These findings were suggestive of cranial displacement of the large colon into the caudal thoracic cavity, which was confirmed by trans-parietal abdominal and thoracic ultrasonography. A presumptive diagnosis of diaphragmatic hernia was established, and an emergency exploratory laparotomy was performed.

Treatment

Prior to exploratory celiotomy, penicillin G sodium (22,000 U/kg intravenously [penicillin Na])[2], gentamicin sulphate (6.6 mg/kg intravenously [Genta-Equine])[3], flunixin meglumine (1.1 mg/kg intravenously [Emdofluxin])[4] and enoxaparin sodium (80 mg subcutaneous [Clexane])[5] were administered to the donkey. The patient was sedated with xylazine hydrochloride (0.6 mg/kg

Correction added on 22 March 2020, after first online publication: An author name has been amended in this version.

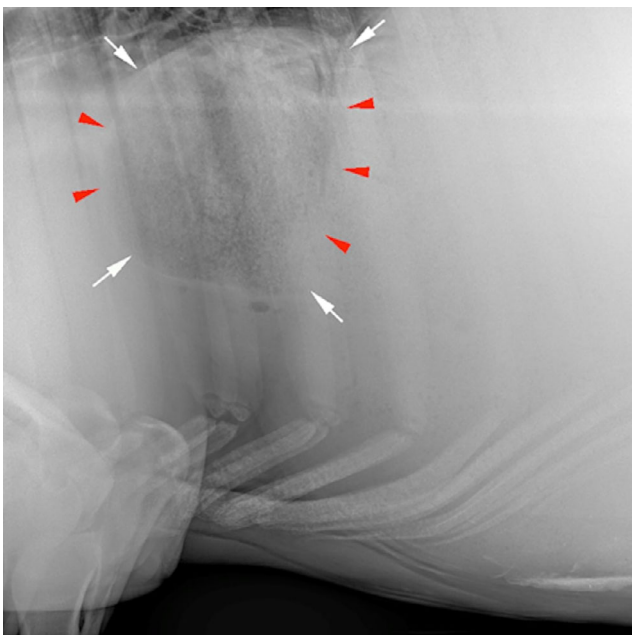

Fig 1: Latero-lateral radiograph of the caudo-ventral thoracic and cranio-ventral abdominal areas. The large granular structure (white arrows) causing border effacement of the diaphragmatic crus and cardiac silhouette (red arrowheads) is the herniated colon.

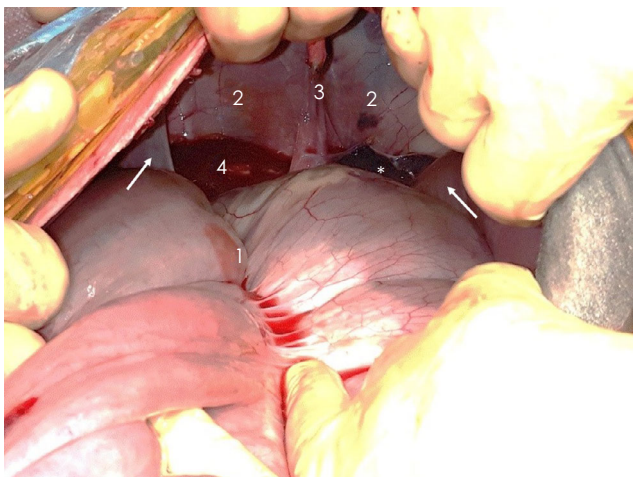

Fig 2: Intraoperative view (after removal of the large intestine) of the large diaphragmatic defect with round margins (arrows), which allowed the partial migration of liver and the sternal and diaphragmatic flexures of the ascending colon from the abdomen into the thorax. Note the presence of the migrated lobe of the liver (white). 1: Large colon. 2: Hernial sac. 3: Band of hernial sac covering the oesophagus. 4: Fluid accumulated into the hernial sac.*

intravenously [Proxylaz 2%])[6], and anaesthesia was induced with ketamine hydrochloride (2.2 mg/kg intravenously [Ketamidor])[7] and midazolam (0.06 mg/kg intravenously [Midazolam mylan])[8]. General anaesthesia was maintained with isoflurane (Isoflo)[9] vaporised in oxygen, and the donkey was placed in dorsal recumbency to allow access to the abdominal cavity through a midline celiotomy. Abdominal exploration confirmed the presumptive diagnosis of diaphragmatic hernia with the presence of the sternal and diaphragmatic flexures of the ascending colon as well as the left hepatic lobe in a central diaphragmatic defect. The incarcerated, moderately impacted segment of the colon was removed from the diaphragmatic defect and exteriorised. The central tendinous portion of the diaphragm was bilaterally absent. The diaphragm only showed muscular margins on the entire circumference of the thorax. The edges of the defect were smooth, and a large hernial sac was present preventing direct communication between the abdominal and thoracic cavities (**Fig 2**). The size of the defect did not allow closure with sutures, and therefore, a polyester mesh was implanted to cover it. The mesh (Covidien Parietex Polyester Mesh: 30 × 30 cm)[10] was doubled and laid over the defect, before securing it to the hernia ring using a skin stapler. The greater omentum was resected using LigaSure[11] device in order to cover the mesh and was also secured with skin staples (**Fig 3**). The colon was replaced in its normal physiological position in the abdomen, the rest of the abdominal topography was verified, and no other anomaly was observed. Standard closure of the abdomen was carried out. The donkey recovered from anaesthesia without complications.

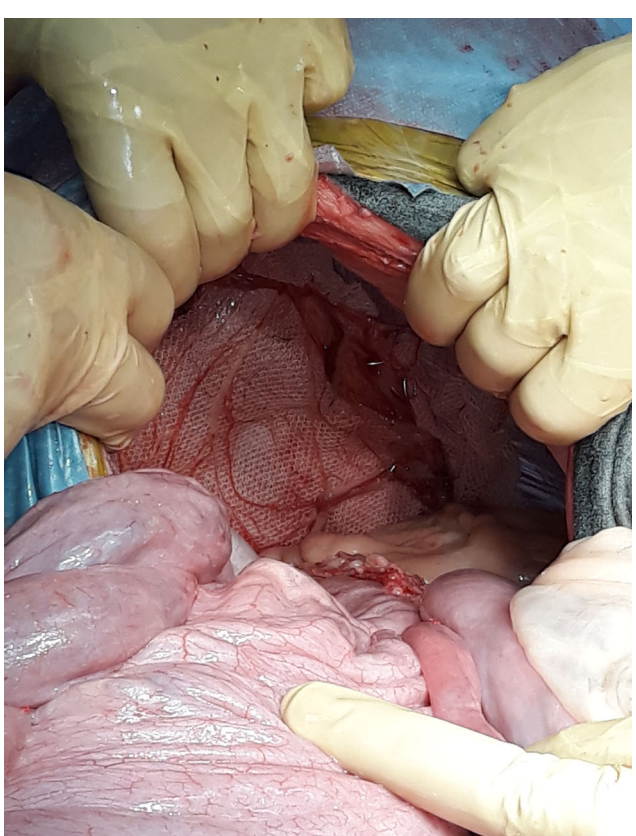

Fig 3: Intraoperative view of the surgical repair of the Morgagni hernia. Mesh herniorrhaphy was performed with a polyester mesh covered by the greater omentum.

Outcome

Post-operative treatment included fluid therapy (Ringer's lactate solution[12] at 2 mL/kg bwt/h and glucose 50%[13] at

2 mg/kg bwt/min) during the first 24 h, and broad-spectrum antimicrobials (penicillin G sodium and gentamicin sulphate), enoxaparin sodium and flunixin meglumine at the aforementioned dosages. Mineral oil and electrolytes in water were administered through a nasogastric tube during the first 24 h after surgery to improve colon emptying. Afterwards, the donkey returned gradually to full feed without any remarkable complications.

Post-operative radiographs showed a fluid-filled cavitary lesion at the previous location of the herniated large colon, associated with pleural effusion. Ultrasonography confirmed the liquid content of the intrathoracic collection, which was interpreted as fluid-filled dead space of the hernial sac secondary to mesh porosity. The mesh was seen as a striated structure along the diaphragm, and there was no recurrence of large colon herniation (**Fig 4**). At follow-up, the pleural effusion progressively resolved, but the fluid-filled hernial sac remained unchanged. The antimicrobials were administered for a week post-intervention. Forty-eight hours after stopping antimicrobials, the donkey became pyrexic (rectal temperature 39.1°C) and tachycardic (66 beats/min). No other abnormality was noted apart from the persisting fluid-filled cavity cranial to the mesh. As the ultrasonographic appearance of the fluid remained anechoic (i.e. not suggestive of peritonitis), it was decided not to sample the fluid. Although the exact origin of the pyrexia was not identified, an infectious origin was suspected and antimicrobial therapy was re-initiated administering penicillin G sodium (22,000 U/kg bwt intravenously)[2] and marbofloxacin (2.2 mg/kg intravenously [Marbocyl])[14]. Rectal temperature normalised and has remained within normal limits ever since. Seven days later, penicillin G sodium was discontinued and marbofloxacin[14] was administered orally (3.4 mg/kg bwt). The donkey was discharged 25 days after surgery with the recommendation to continue oral administration of marbofloxacin for 10 more days. Eight months after discharge, the donkey is still alive and has not developed further signs of abdominal pain since its discharge from the hospital.

Discussion

In human medicine, foramen of Morgagni hernias are rare entities accounting for less than 3% of all types of congenital diaphragmatic hernias in the general population (Harrington 1951; Al-Salem *et al.* 2002; Horton *et al.* 2008). In humans, the majority of Morgagni hernias are asymptomatic or present with no specific symptoms and signs (Minneci *et al.* 2004; Aghajanzadeh *et al.* 2012).

In equids, Morgagni hernias are also rarely described in the literature. To our knowledge, the first and only case report describing Morgagni hernias in horses was published by Pauwels in 2007. Three similar cases had been described previously in equids as diaphragmatic diverticula or peritoneopericardeal hernias (Wyn-Jones and Baker 1979; Orsini *et al.* 1981; Proudman and Edwards 1992). All of them had right diaphragmatic defects with large colon incarceration. Pauwels *et al.* (2007) proposed that some of those cases should be termed as retrosternal hernias, rather than diaphragmatic diverticula. In all six cases, defects were located on the right side of the diaphragm. In our case, the hernia was bilateral, a very rare presentation in humans (Horton *et al.* 2008) and never described previously in equids.

In most reported cases, horses had a history of previous colic signs, responding favourably to medical treatment. Some of those horses had a presumptive diagnosis of left dorsal displacement of the colon before the hernia was confirmed. In our case, the donkey did not display dyspnoea or other clinical signs suggestive of diaphragmatic hernia and the size of the animal did not allow a rectal palpation. Because of the history of recurrent colic, the clinician suspected a possible sand impaction and decided to take abdominal radiographs. Due to the small size of the patient, the abdominal radiographs allowed the visualisation of the ascending colon abnormally placed in the thoracic cavity. Only the surgery revealed the additional herniation of a liver lobe. In humans, the most common organs herniated into thorax with Morgagni hernias are colon, omentum, stomach and liver (Godazandeh and Mokhtari-Esbuie 2016). In horses, incarceration of the large colon was reported in all three previous cases (Pauwels *et al.* 2007).

In horses, the overall prognosis for diaphragmatic hernias is poor (Hart and Brown 2009; Romero and Rodgerson 2010) and the main contributing factors are size and location of the rent. In addition, surgical approach to the diaphragm is considered difficult in horses. Nevertheless, the prognosis of the reports of Morgagni hernias appears much better based on the limited case numbers (Proudman and Edwards 1992;

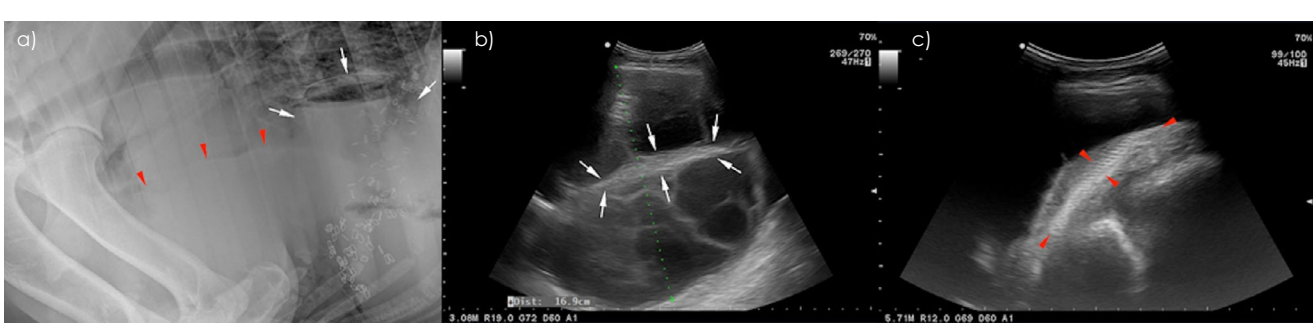

Fig 4: Latero-lateral radiograph of the ventral thoracic area (a), trans-thoracic ultrasonograms (b and c). a) Cavitary lesion with overlapping gas opacity (white arrows), representing the filled dead space of the hernial sac. Note the pleural effusion (red arrowheads). b) Trans-thoracic ultrasonogram of the cavitary lesion mentioned in (a). The hyperechoic longitudinal band (white arrows) running in the middle of the cavity from caudal to cranial is believed to be the mediastinum. Note the multiple septa within the anechoic liquid. c) Trans-thoracic ultrasonogram at the level of the thoraco-abdominal junction. Note the striated appearance of the mesh (red arrowheads).

Pauwels *et al.,* 2007). In our case, the defect was very large; however, the small size of the animal allowed simple access to the diaphragm through standard ventral midline laparotomy. The hernia was closed with a polyester mesh, in contrast to other reported cases in which a polypropylene mesh was used. Unlike polypropylene, polyester is a hydrophilic material, encouraging early biologic fixation and collagen ingrowth from the surrounding tissue (Gonzalez and Ramshaw 2003). The use of skin staples has been described as an effective and inexpensive way to fix meshes in human and equids (Munghate *et al.* 2014; Shnaiderman-Torban *et al.* 2015).

The use of intraperitoneal prosthetic meshes increases the risk of adhesions to viscera (Sanders and Kingsnorth 2012). Bonding an expanded polytetrafluorethylene membrane to a polypropylene or polyester mesh minimises the likelihood of adhesions forming between the mesh and viscera (Toth and Schumacher 2019). In our case, that type of mesh was not available at the time of surgery. Due to the high risk of adhesions, it was decided to use the omentum to cover the mesh and avoid direct contact between mesh and viscera. However, conserving the blood supply meant creating a possible virtual space through which the intestine could incarcerate. Therefore, in this case, the authors considered that the use of the detached omentum was the only option to avoid direct contact between mesh and viscera, even if risks associated to the devitalised omentum were unknown.

In this case, fever of unknown origin and a moderate fluid accumulation in the cavity formed cranial to the mesh were the only post-operative complications noted. In none of the cases described in the literature, the hernial sac was resected, and only one horse had fluid accumulation in the dead space left after resolution of the hernia, without any significal clinical sequelae (Pauwels *et al.* 2007). In humans, surgical removal of the hernial sac is controversial and there is no consensus about the benefit of this procedure (Andelka *et al.* 2011). Some authors recommend sac excision because it may decrease the chance for symptomatic fluid collection and reduce recurrence rate, because the sac itself can act as a lead point for recurrent herniation. Disadvantages of sac excision may include massive pneumomediastinum and iatrogenic injury to the lung, pericardium or mediastinal structures (De-Hoyos 2009). We believe that in horses, due to the weight of viscera, the risks of removing the hernial sac are more important than the consequences of leaving it. In our case, as well as in previously reported cases, the accumulation of fluid did not seem to have major clinical consequences.

In conclusion, bilateral Morgagni hernias can also occur in equids. Unlike diaphragmatic rents, the prognosis for Morgagni hernias appears to be favourable based on the available literature. Surgical repair using a prosthetic mesh seems to be effective to seal the defect and prevent recurrences.

This is, to the authors' knowledge, the first case report describing a bilateral Morgagni hernia in equids.

Authors' declaration of interests

No conflicts of interests have been declared.

Ethical animal research

Permission was obtained from the owner of the donkey for publication of the case for educational purposes.

Source of funding

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Authorship

J. M. Arévalo-Rodríguez and I. Caudron performed the surgery. All authors were responsible for data analysis and interpretation. They all contributed to manuscript preparation and have approved the final manuscript.

Manufacturers' addresses

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[2]Kela Pharma, Sint-Niklaas, Belgium.
[3]V.M.D., Arendonk, Belgium.
[4]Ecuphar NV/SA, Oostkamp, Belgium.
[5]Sanofi Belgium, Diegem, Belgium.
[6]Prodivet pharmaceuticals, Eynatten, Belgium
[7]Ecuphar NV/SA, Oostkamp, Belgium.
[8]Mylan bvba/sprl, Hoeilaart, Belgium.
[9]Zoetis Belgium SA, Louvain-la-Neuve, Belgium.
[10]Covidien, Mansfield, Massachusetts, USA.
[11]Covidien llc, Mansfield, Massachusetts, USA.
[12]Dechra Limited, Skipton, North Yorkshire, United Kingdom.
[13]Dechra Limited, Skipton, North Yorkshire, United Kingdom.
[14]Vetoquinol N.V/S.A., Aartselaar, Belgium.

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