Clinical Commentary

Small colon obstructions in foals

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The interesting report by Pilati et al. (2013) describes the uncommon case of a small colon obstruction by an ovarian pedicle. Obstruction of the small colon, however, is a common cause for colic in foals.

Intraluminal obstructions

Meconium impaction

The meconium of the newborn foal is of dark brown to black colour and consists of glandular secretions, bile, cellular debris and amniotic fluid. In the healthy foal, the passing of meconium begins 1–2 h after birth and is completed within 24 h, typically indicated by the appearance of the soft and yellowish ‘milk-stool’ (McCue 2006; Bernard 2012).

In response to the high incidence of meconium impactions, up to 3% of foals are affected, the administration of preventative enemas to newborn foals has become a routine procedure in many breeding operations (Morley and Townsend 1997; McCue 2006). Despite these efforts, meconium impactions remain one of the most common causes for colic in equine neonates (Rogers et al. 2007). Delayed ingestion of colostrum, dystocia, prematurity, low birth weight, asphyxia and dehydration have been suggested as predisposing factors. Probably because of a narrower pelvic canal, male foals are more often affected than females (Pusterla et al. 2004).

First clinical signs include restlessness, tail flagging/swishing, inappetence and repeated, unproductive straining to defaecate (Fig 1). More severe signs of colic and abdominal distension (Fig 2) develop with time and are typically accompanied by tachycardia and tachypnoea (Pusterla et al. 2004). Low meconium impactions, located at the level of the pelvic inlet, are frequently diagnosed by digital rectal examination (Bernard 2012), while deep abdominal palpation can be helpful in identifying a high meconium impaction (transverse or ascending colon) (Barton 2006). Abdominal radiographs typically show gas distention of the colon orad to the impaction and the meconium might be seen as granular material within the colon (Fig 3). If plain radiography is inconclusive, a barium contrast study (retrograde contrast radiography) can be performed: following appropriate sedation and restraint of the foal, a 28–30 French Foley catheter is placed into the rectum, the bulb is carefully inflated and up to 20 ml/kg bwt of 30% w/v barium are administered by gravity flow. This technique is reportedly 100% sensitive and specific for identifying mechanical obstructions of the transverse and small colon in foals aged ≤30 days of age (Fischer and Yarbrough 1995). Ultrasonography commonly reveals gas distended large intestine and, in some cases, the meconium itself can be identified as a row of faecal balls in the small colon. The echogenicity of the meconium varies, but a typical ‘speckled’ appearance has been described and might aid with the final diagnosis (Semrad and Shaftoe 1997; Barton 2006).

The centrepiece of medical treatment for foals with meconium impaction is the administration of enemas, combined with intravenous fluids, oral laxatives and analgesics. Simple impactions can often be resolved by phosphate or soap-water enemas (300–500 ml of warm soapy water). In more difficult cases, the use of retention enemas...
with 200 ml of 4% acetylcystein solution has been highly successful (Pusterla et al. 2004). Similar to a barium enema, an inflated Foley catheter is used to instill the solution into the rectum, where it should be retained for 30–45 min. This can be repeated up to 3 times. Pusterla et al. (2004) report a 100% success rate in 41 foals where this treatment protocol was applied and most impactions resolved within 24 h. However, 3 foals developed a bladder rupture, possibly as a result of the excessive straining to defaecate (Pusterla et al. 2004).

Despite the high success rates of medical treatment, meconium impactions are a main reason for exploratory laparotomy in newborn foals (Valistas et al. 1996). In cases unresponsive to medical therapy, surgical intervention should not be delayed. Deferred abdominal exploration can negatively affect the short-term survival (Cable et al. 1997) or even result in rupture of the intestine at or proximal to the site of impaction (Sobiraj et al. 2000). In surgery, the impaction is broken down by careful transluminal massage in combination with a warm water enema. If this proves to be unsuccessful, an enterotomy can be performed.

While the short-term survival following surgery for meconium impaction is very good, the long-term success is often dampened by the development of intra-abdominal adhesions (Hughes et al. 1996; Pusterla et al. 2004). Adhesions can be found in up to 33% of foals that underwent gastrointestinal surgery and, while not all of these cases will show clinical signs, the prevention of intestinal adhesions is critical to improve survival rates (Cable et al. 1997). A combination of atraumatic surgical technique and pharmacological therapies is believed to reduce the risk of this complication. The intra-abdominal use of 1% sodium carboxymethylcellulose during manipulation of the intestine and the perioperative administration of penicillin, gentamicin, and flunixin meglumin or dimethyl sulfoxide can reduce serosal irritation and abdominal inflammation (Sullins et al. 2004; Fogle et al. 2008). Most recently, the intra-abdominal administration of a 0.03% fucoidan solution successfully prevented the formation of experimentally induced adhesions in healthy pony foals (Yamout et al. 2007).

**Impaction with feed material**

Impactions of the small colon are a common cause for colic in foals, even when discounting for cases with meconium retention (Reeves et al. 1989; De Bont et al. 2012). Diffuse faecal impactions can be differentiated from obstructions caused by inspissated masses of faecal material (faecaliths). Decreased water intake, poor quality roughage and inadequate mastication have been suggested as contributing factors (Edwards 1997). Faecaliths are frequently found in American Miniature Horse and pony foals (Dart et al. 1992; Valistas et al. 1996; Hughes et al. 2003; Dehghani and Bigham 2007; Haupt et al. 2008). While the reason for the breed predisposition is unknown, it has been speculated that the inability to masticate or digest forage adequately contributes to the high incidence in foals. This theory is supported by the report of recurrent small colon obstructions in a 7-week-old colt with a mandibular fracture (Smith and Mair 2004). The authors suggested that the mandibular fracture predisposed the foal to the formation of faecaliths, as the colt was not able to completely masticate the consumed roughage.

Impactions typically occur in foals aged ≥1 month, but faecaliths have been found in miniature horses at age 7–21 days (McClure et al. 1992; Haupt et al. 2008). Clinical signs include abdominal pain and distention, lethargy, inappetence, decreased or no faecal output and straining to defaecate. Only a few cases respond to medical treatment. While abdominal exploration is necessary (Valistas et al. 1996), the most common surgical technique to resolve diffuse faecal impactions is the careful administration of warm water enemas, while the surgeon breaks the impaction down with gentle transluminal massage. Faecaliths are removed via a small colon enterotomy, unless they are located too far orally in the small colon to be exteriorised. In these cases, they are carefully retropropulsed into the right dorsal colon and removed through a large colon enterotomy.

Earlier reports showed a high incidence of intra-abdominal adhesions after surgery for small colon impactions in miniature horse foals (Ragle et al. 1992), but more recent studies document good to excellent short- and long-term survival (Valistas et al. 1996; Haupt et al. 2008).

**Foreign body obstructions**

Obstructions with foreign bodies are very uncommon in horses and have primarily been reported in young horses and foals, possibly due to their inquisitive nature and less discriminative eating habits (Boles and Kohn 1977; Dart et al. 1992). Various materials have been found to obstruct the small colon, including halters, ropes, haynets, plastic bags, bailing twine and different types of rubberised fencing material (Getty et al. 1976; Boles and Kohn 1977; Gay et al. 1979). Schmitt et al. (1999) removed rubberised fencing material of up to 1 m in length from the small colon of 6 foals that all lived on the same farm. It is therefore sensible to identify the origin of a foreign body and, if possible, remove it from the reach of other horses. The fact that horses may remain asymptomatic for months or years after ingestion of the material can make this a very difficult task (Boles and Kohn 1977).

Clinical signs are similar to those seen in other small colon obstructions, including abdominal distention and scant

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**Fig 3: Radiographic appearance of a meconium impaction.** In addition to the gas distention of the large and small colon, granular intestinal contents can be seen at the level of the pelvic inlet, indicating a low meconium impaction (white arrow).
passing of faeces. Depending on the configuration of the foreign body, the obstruction may be incomplete and horses might still be able to pass gas and liquid faeces.

Treatment is surgical removal through a small colon enterotomy or, if their obstruction is in an inaccessible portion of the proximal small colon, via a large colon enterotomy after retroperitoneoposis into the right dorsal colon. Linear foreign bodies tend to cause plication of the small colon. Not only does this complicate their removal, it can also lead to ischaemia or mechanical damage of the intestinal wall. Oversewing of these areas or even resection and subsequent end-to-end anastomosis might be necessary (Boles and Kohn 1977; Gay et al. 1979; Schmitt et al. 1999). The post surgical prognosis should be comparable to the outcome after faecalith removal, unless small colon segments are devitalised and require removal. In these cases, the risk for post operative complications is higher (Cable et al. 1997).

Enteroliths and bezoars

Enterolithiasis typically occurs in mature horses, the reported average age is 11.4 years (Hassel et al. 1999). Occasionally, young horses are affected. Peloso et al. (1992) described the removal of an obstructive enterolith in an 11-month-old miniature horse foal.

Bezoars are combinations of magnesium ammonium phosphate concretions with hair (trichobezoars), plant material (phytobezoars) or both (trichophytobezoars). They are a very uncommon cause for colic in horses, but have been found in foals aged only a few weeks (Crook 1967; Yvorchuk-St. Jean et al. 1993).

Vascular and strangulating lesions

Intussusceptions

Small colon intussusceptions have been reported in 2 foals. Edwards (1992) describes a small colon prolapse protruding from the anus in a 2-month-old foal. Damage to the vessels of the mesocolon had resulted in infarction of the inner layer of the intussusceptum. The prolapsed tissue was resected and an anastomosis between the edges of the small colon and the mesocolon had resulted in infarction of the inner layer of the intussusceptum. The prolapsed tissue was resected and an anastomosis between the edges of the small colon and rectum was performed (colo-rectostomy). The colt recovered well. The second case was a 2-day-old foal that presented with signs of colic, abdominal distention and blood stained faeces (McClure et al. 1995). Abdominal exploration revealed a small colon intussusception with a meconium impaction orad to it. The 10 cm of affected intestine were resected and a 2-layer, end-to-end anastomosis was performed. The foal recovered without complications and was doing well 9 months after surgery.

Lesions associated with the reproductive tract

Partial obstruction of the small colon by an abdominal testicular teratoma resulted in tenesmus, fever and mild colic in a 4-day-old foal (Parks et al. 1986). In surgery, the spermatic cord of the enlarged right testis appeared to partially occlude the lumen of the small colon. The cord was transected and the testicle removed. The colt had an uneventful recovery and was doing well 9 months after surgery.

Small colon lesions associated with the ovaries are a rare finding in foals. The report by Pilati et al. is the first description of an acquired obstruction by an ovarian pedicle in the English literature. Previously, this condition was only mentioned in the Hungarian literature (Toth et al. 2000). Other reports describe the obstruction of the small colon by a knot formed by the mesovarium of both ovaries (Evrad et al. 1988) and by an ovarian haematoma that developed after a traumatic blow to the abdomen (Mills et al. 1996). Most recently, a case of small colon entrapment through a rent in the mesovarium was documented. After replacement of the intestine and removal of the ovary, the 2-month-old Warmblood foal had an uneventful recovery (Stahl and Hellstrom 2012).

Congenital lesions

Atresia coli is a rare finding in foals and the causes are not completely understood. It has been proposed that vascular injury during fetal development results in necrosis and resorption of the affected intestine (Louw and Barnard 1955). A more recent experimental study showed that lack of fibroblast growth factor 10 or its receptor, results in colonic atresia in mice (Fairbanks et al. 2005). Prenatal absence or deficiency of growth factors could explain the additional congenital malformations that are found in some foals with colonic atresia (Young et al. 1992).

Foals typically present with signs of acute colic and increasing abdominal distention within 24 h after birth (Young et al. 1992). Absence of meconium passage or staining, even after repeated enemas, is considered a characteristic finding, but historical information from the owner can be misleading (Hunter and Belgrave 2010). Radiographic examination frequently shows gas distention of the intestine orad to the atretic segment and retrograde contrast radiography may indicate a blind end. Colonoscopy can provide a definite diagnosis, especially in cases where the blind end is close to the anus. The use of N-butylscopolammonium (Buscopan) can increase the diagnostic value of the examination.

Colo-colonic anastomosis can be attempted in cases where the atretic segment is not too long, both blind ends are accessible and of sufficient diameter. Due to the friability of the tissue, however, failure of the anastomosis is not uncommon (Cho and Taylor 1986; Young et al. 1992; Vatistas et al. 1996). Although it is possible to perform an end-colostomy, the possible short- and long-term complications and the quality of life for the foal following surgery have to be discussed with the owners prior to performing this procedure (Laikul et al. 2010).

Conclusion

The long-term survival for foals following colic surgery has been reported to be 35–57% (Adams et al. 1988; Vatistas et al. 1996; Cable et al. 1997). Since these studies were completed, however, new information about the prevention of intra-abdominal adhesions has been acquired. Whether this knowledge can or already has improved the outcome of colic surgery in foals is yet to be answered. Regardless, timely surgical exploration after unsuccessful medical treatment and delicate tissue handling are and will remain central to the successful treatment of foals with surgical colic.

Author’s declaration of interests

No conflicts of interest have been declared.

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