Larval cyathostominosis in horses

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Abstract

Small strongyles are the most common parasites of horses, capable of surviving different climate conditions. Though the infection is usually asymptomatic, young horses are considered more prone to developing a parasitic syndrome called larval cyathostominosis. In most cases, gastrointestinal symptoms are most prevalent. Treatment is based on the use of fenbendazole and moxidectin. Diagnosis is difficult and serological methods are still under development. The main prevention methods include regular coprological testing, pasture rotation, co-grazing with ruminants, and regular removal of faeces from the pasture.

Key words: *larval cyathostominosis; small strongyles; equine parasitology*

Introduction

Small strongyles, subfamily *Cyathostominae*, are the most widespread parasites of horses (Rendle et al., 2019). They are characterised by high adaptability, so they can be found on pastures in tropical and colder climates (Osterman-Lind et al., 2022). Due to their capacity for arrested development, hypobiosis, they can survive for several years in the intestines of horses, awaiting favourable conditions for further development (Proudman and Matthews, 2000). To date, 50 species of small strongyles from 14 genera have been described, and have varying degrees of pathogenicity (Lichtenfelds et al., 2008). When it comes to pathogenic parasites causing death in horses, the first thing that comes to mind for most veterinarians and horse owners is the large strongyle, nematode *Strongylus vulgaris*.

However, according to recent studies, it is clear that the crown of "king of parasites" has now been taken over by small strongyles (Salle et al., 2020). They can pose a particular health threat to young horses, where they more commonly cause a clinical parasitic syndrome called larval cyathostominosis (Reid et al., 1995).

Over the past decade, the field of equine parasitology has changed rapidly with new discoveries. The aim of this article is to provide an overview of the latest information on the causative agents, pathogenesis, clinical signs, diagnosis and prevention of the development of larval cyathostominosis in horses.

Morphology

Small strongyles are nematodes that inhabit the caecum and the ventral and dorsal colon. They vary in length between 1.5–2.5 cm, and can be red or white depending on the stage of development.

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Sexual dimorphism is present, with females larger than males. On the anterior part of the body there is a small mouth capsule and a crown of leaflets, and this crown morphology is dependent on the species and genus. Adult males have a copulatory bursa and two spicules at the posterior end. Females become narrower towards the posterior end and have no spicules or bursa. The eggs of the small strongyles belong to the strongylid type (Nielsen and Reinemeyer, 2018).

Pathogenesis

Development of small strongyles in the intestines does not involve migration. Therefore, the pathogenic effects in most horses are usually milder than those caused by the migration of *S. vulgaris* larvae through the arteries of the digestive system with the consequent development of thromboembolic colic (Bowman, 2021). After oral ingestion, the infective third-stage larva (L3) invades the mucosa and submucosa of the cecum and colon. As a result of the host's immune reaction, a fibrous capsule is formed and the larvae are encysted. Under favourable conditions, development progresses to the L4 stage. Under unfavourable conditions, development stops at the L3 stage and hypobiosis occurs, which can last from months to years (Love and Duncan, 1992). Up to 90% of L3 can enter hypobiosis (Proudman and Matthews, 2000).

As L4 grows and develops, it breaks through the capsule and enters the intestinal lumen, where it develops into L5. This stage represents the sexually immature, nearly adult stage. With further growth and development of sex organs,

Figure 1. Small strongyles in the faeces of the young horse.

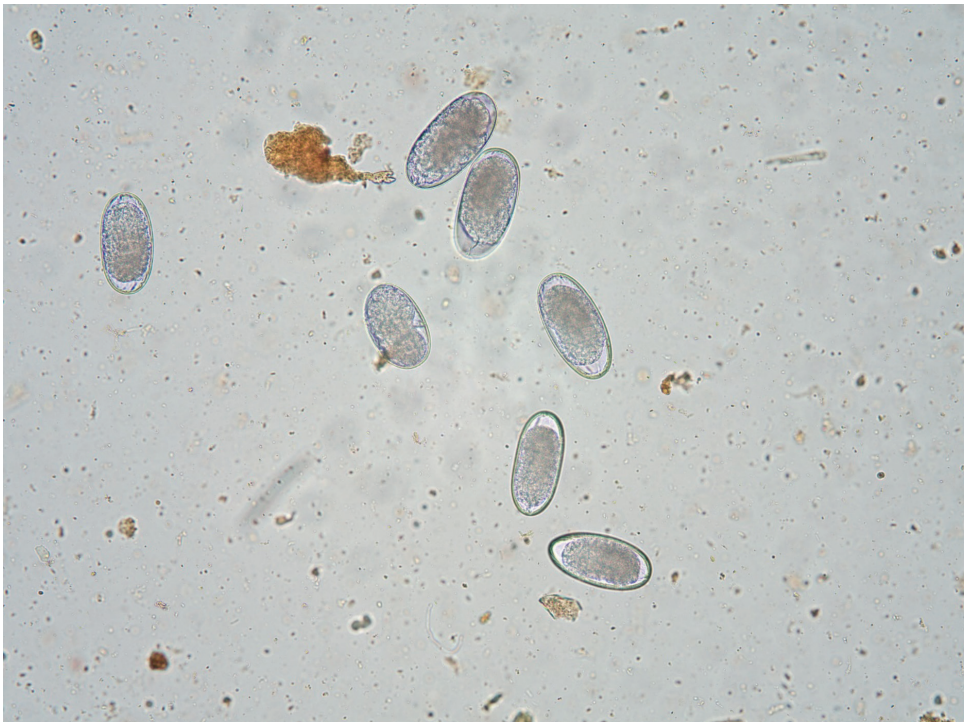

Figure 2. Strongyle-type eggs

they develop into sexually mature adults. After fertilisation, the female produces eggs that are released into the environment via the horse's faeces. L1 and L2 feed on organic material in the pasture. Development into the infective L3 takes place within the L2 cuticle, which protects the larvae against external conditions (Nielsen and Reinemeyer, 2018). Research has shown that the infective stage can survive both warm and cold climate extremes. However, in southern Europe climate conditions, its survival is impaired by very high temperatures in summer, when the number of larvae on pasture decreases due to desiccation. In contrast, temperate winters with only a few days of severe frost do not lead to a significant decline in their population on pastures (Nielsen et al., 2007). Under favourable conditions, development to the infective L3 stage requires only a few days. The infective stage moves freely and is surrounded by a protective cuticle that allows it to survive successfully on the pasture (Love and Duncan, 1992). The prepatent period usually lasts about five weeks, but in cases of hypobiosis it is considerably longer (Round, 1969).

The development of a clinical parasitic syndrome called larval cyathostominosis is a consequence of the mass emergence of larvae from the intestinal mucosa. A fibroblastic inflammatory reaction is triggered by the mere presence of L3 in the intestine. Inflammation intensifies as the larvae grow, forming a capsule of collagen fibres and fibroblasts. The surrounding tissue is infiltrated with lymphocytes, eosinophils and plasma cells. The inflam-

mation and loss of function of the intestinal mucosa lead to increased permeability and loss of protein into the intestinal lumen. Disorders of intestinal motility may also occur, leading to diarrhoea and abdominal pain. The presence of certain pathogenic species of small strongyles in the horse's intestine and the strength of the host's immune response are thought to play a role in the development of the clinical disease (Rendle, 2014).

The trigger for the mass emergence of larvae from the wall into the intestinal lumen and the appearance of clinical signs is the death of adult stages in the lumen, usually following the administration of anthelmintic drugs that are effective against adult stages but only partially or not at all against encysted larval stages. The emergence of large numbers of larvae can also be triggered by changes in external temperature, so this phenomenon is most commonly observed in late winter and early spring (Lyons et al., 1994). During these seasons, larvae make up the majority of the total parasite population in the horse intestine (Eysker et al., 1984; Collobert-Laugier et al., 2002). Buen et al. (1979) showed a correlation between a greater numbers of encysted larvae in the intestine and disorders of intestinal motility, while Unhlinger (1990) warned of the more frequent occurrence of colic in this case.

Clinical signs and treatment

Due to the still insufficiently developed immune system, foals do not develop large numbers of encysted larvae in the intestinal wall. Therefore, the presence of small strongyles is not usually a health risk factor for this age group (Nielsen and Lyons, 2017).

Clinical signs of larval cyatostominosis are most common in horses between one and four years of age (Lyons et al., 2000), though horses of any age can be affected (Mair, 1993). Mortality of affected horses can be as high as 50% (Reid et al., 1995) or even 60% (Giles et al., 1985).

Mair (2002) describes several clinical syndromes associated with the development of larval cyathostominosis:

1. Seasonal "fatigue syndrome", which is mainly manifested by lethargy, altered stool consistency and loss of appetite.
2. Intermittent diarrhoea, which can also occur in older horses.
3. Acute diarrhoea with protein loss, which can develop into a chronic form.
4. Rapid weight loss followed by subcutaneous oedema as a result of hypoalbuminemia.
5. Nonspecific colic.

However, such a strict division of clinical syndromes is not possible in clinical cases, as several can occur simultaneously (Bodecek et al., 2010).

Lawson et al. (2023) described clinical signs in 38 hospitalised horses suffering from larval cyathostominosis, including diarrhoea, loss of appetite, lethargy, subcutaneous oedema, thickened mucosa of the colon, and tachycardia. The bloodwork showed leucocytosis, neutrophilia, hypoalbuminemia, hyperfibrinogenaemia and an elevated level of serum amyloid A (SAA). Elevated SAA, decreased total protein concentration and the need for fluid therapy were correlated with higher mortality.

The occurrence of anaemia, thrombocytosis, lymphocytosis and elevated levels of alkaline phosphatase and beta-globulin have also been described (Love et al., 1992; Mair et al., 2000; Lyons et al., 2000).

Interestingly, the occurrence of eosinophilia, which is often associated with

parasite infection, is not present in all cases (Love et al., 1999). In the study by Mair (1994), clinical signs associated with the digestive system were most common, but in several horses, only fever and oedema were observed.

It has been found that larval cyathostominosis was more common in animals with chronic diarrhoea occurring during the winter months (Giles et al. 1985). Tamzali (2006) found significant weight loss in some horses, which correlated with the occurrence of clinical larval cyathostominosis.

Some studies have described the occurrence of different types of colic. The causes of colic in horses are numerous (Abutarbush et al., 2005), but the influence of parasites on the pathogenesis has not yet been confirmed. There is conflicting work on the relationship between invasion of small strongyles and the incidence of colic. Mair and Pearson (1995) associated the invasion of small strongyles with the occurrence of non-strangulating intestinal infarcts and caecal tympani. Cecocolic and cecocecal intussusception have also been described (Mair et al., 2000, Love, 2002), as has the occurrence of mild, non-specific colic (Uhlinger, 1990). The occurrence of colic has been also noted in some more recent studies (Bodecek et al., 2010). However, Reinemeyer and Nielsen (2009) questioned this claim due to the still insufficiently clarified pathogenesis. Stancampiano et al. (2017) also found no clear correlation between invasion by small strongyles and the occurrence of colic. In addition, the mechanism of the protective effect of the adult stages in the intestinal lumen has been described, preventing the excessive emergence of L4 and the development of larval cyathostominosis (Leathwick et al., 2019).

The challenge in the treatment of larval cyathostominosis lies in the effective removal of encysted larvae from the intestinal wall. Almost all groups of anthelmintics are affective on adult forms. With the aim of removing the larvae, the five-day protocol of fenbendazole administration was long considered the most successful (Dipietro et al., 1977; Duncan et al., 1998).

However, more recent studies have shown several negative effects of fenbendazole compared to the use of moxidectin. After the larvae die in the intestinal wall, a strong inflammatory reaction develops and there is a tendency for abscesses to form, from which the dead larvae emerge into the intestinal lumen. Dead and damaged larvae release allergens and type I, II and III hypersensitivity reactions may occur, which are manifested by the formation of oedema in the submucosa. In contrast, dead larvae do not trigger a strong inflammatory reaction when treated with moxidectin, and in most cases granulomas and abscesses do not form (Steinbach et al., 2006). In view of this fact and the widespread resistance of small strongyles to benzimidazoles, a single dose of moxidectin is now the favoured treatment for larval cyathostominosis (Bellaw et al., 2018). In milder cases, the use of an anthelmintic is sufficient; in more severe cases, glucocorticoids, non-steroidal anti-inflammatory drugs, misoprostol, antibiotics, plasma and fluid therapy are also used. It is necessary to monitor the animal's food and water intake, faecal consistency, behaviour and temperature daily (Love, 2003; Walshe et al., 2021; Lawson, 2023).

Although effective anthelmintics currently exist for the treatment of small strongyles, the development of their widespread resistance worldwide is worrying, especially as there is no evidence of new anthelmintics being developed (Nielsen, 2022).

Figure 3. FLOTAC diagnosis.

Depending on the clinical presentation, the list of differential diagnoses should include salmonellosis, colitis caused by anti-inflammatory and non-steroidal drugs, intestinal lymphosarcoma, inflammatory bowel disease, infection with the bacteria *Lawsonia interacellularis*, *Clostridium difficile*, *C. perfringens* and other causes of acute enteritis. If diarrhoea is not present, other causes of weight loss and hypoproteinaemia may include renal, hepatic, peritonitis, pleuritis, starvation, and other chronic diseases (Peregrine et al., 2006).

Diagnosis

The diagnosis of larval cyathostominosis is difficult and is often only confirmed at autopsy (Kelly and Fogarty, 1993). During parasitological-coprological examination, parasite eggs are often not found or only found in very small numbers. Adults and larvae can be found in faeces, but this is not always the case (Smets et al., 1999). Recently, older quantitative methods such as the McMaster test have been replaced by the newer, more accurate FLOTAC method (Cringoli, 2006).

The morphology of L3 obtained by larval culture method can be used to differentiate between small and large strongyles. An experienced parasitologist can also differentiate between species of small strongyles (Madeira de Carvalho et al., 2004; Santos et al., 2018). The coprological parasitological examination and the larval culture method can detect small strongyles in the paten phase, but not the larvae in the intestinal wall (Deprez, 2003; Schneider et al., 2014). The most recent breakthrough in diagnostics

Figure 4. L3 of small strongyles, obtained by the method of larval culture.

was achieved with the development of an immunoenzyme test (Small Redworm Blood Test, AustinDavies Biologics Etc, UK) that detects the three most common species of small strongyles in the prepatent phase: *Cyathostomum catinatum*, *Cylicocyclus nassatus* and *Cylicostephanus longibursatus* (Tzelos et al., 2020). This test measures the level of IgG(T) antibodies and thus determine the presence of up to 10,000 adults and the developmental stage of the small strongyles in the horse intestine. In an attempt to assess a larger number of nematodes, the test did not meet expectations and is undergoing further development (Lightbody, 2024). It is important to emphasise that invasions with more than 10,000 nematodes in the intestine have been described that did not cause clinical symptoms (Nielsen et al., 2010)

Considering that the test is not able to detect only the number of larvae in the intestinal wall (as the number includes all developmental stages of the parasite), it is not entirely appropriate. However, if the test gives a negative result, this can serve as a reason to exclude larval cyathostominosis from the list of differential diagnoses (Rendle et al., 2024).

Despite the difficulty of diagnosis, the diagnosis of larval cyathostominosis should be considered in all young horses showing signs of protein-losing enteropathy, especially if the history of deworming is unknown (Rendle, 2014).

Prevention

In studies conducted several decades ago, resistance of small strongyles to certain groups of anthelmintics was

mentioned as a factor in increased risk in the development of clinical larval cyathostominosis (Mair and Cripps, 1991). Concern is growing as the phenomenon assumes global proportions (Kaplan et al., 2004).

A regular coprological examination (faecal egg count, FEC) prevents the unnecessary administration of anthelmintic drugs and thus slows the development of resistance. It also detects horses that excrete a high number of parasite eggs in their faeces (high shedders). By adapting the deworming program, pasture contamination is reduced. This will significantly reduce the possibility of developing larval cyathostominosis in horses in at-risk groups (Kaplan and Nielsen, 2010).

Recommended methods to keep the parasite population under control include alternating grazing and rest periods of pastures, grazing with ruminants, and frequent removal of faeces from the pasture. Depending on climatic conditions, faeces should be removed at least twice a week (Nielsen, 2012).

Conclusion

Small strongyles are ubiquitous parasites of horses that can survive in various climatic conditions. Although most invasions are asymptomatic, young horses are at increased risk of developing a parasitic syndrome called larval cyathostominosis. This poses a diagnostic challenge due to the demanding diagnostics and often non-specific clinical signs. It is therefore necessary to educate veterinarians and horse owners about the latest findings in equine parasitology. Above all, because prevention through regular parasitological exam of manure and compliance with pasture hygiene is incomparably easier and more cost effective than treatment.

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Larvalna cijatostominoza konja

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Mali stronglidi ubikvitarni su paraziti konja, sposobni preživjeti u različitim klimatskim uvjetima. Unatoč tome što većina invazija prolazi asimptomatski, mladi konji u povećanom su riziku od razvoja parazitskog sindroma nazvanog larvalna cijatostominoza. Najčešće se očituje kliničkim znacima probavnog trakta, a liječenje se oslanja na uporabu fenbendazola i moksidektina. Dijagnostika je zahtjevna i još u razvoju. Glavne metode prevencije razvoja larvalne cijatostominoze su provedba redovitih parazitoloških pretraga izmeta, rotacija i odmor pašnjaka, napasivanje s preživačima i redovito uklanjanje izmeta s pašnjaka.

Ključne riječi: *larvalna cijatostominoza, mali strongilidi, parazitologija konja*