Intestinal obstruction by *Toxocara vitulorum* in a calf

Obstructie van de dunne darm door Toxocara vitulorum *bij een kalf*

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ABSTRACT

A one-month-old Belgian blue bull calf was referred to the animal hospital of the Faculty of Veterinary Medicine (UGhent) because of the sudden onset of severe colic. The animal showed intermittent recumbency, kicking to the abdomen, abdominal distension of the right quadrants, absence of feces and fluid-splashing and the presence of ping sounds on auscultation of the right side. Abdominal ultrasound showed distended, but still contractile small intestines with thickened walls. On exploratory laparotomy, a complete obstruction with adult *Toxocara vitulorum* extending from duodenum to mid-jejunum was diagnosed. On the punctum maximum of the obstruction, the ascarides were partially removed through an enterotomy. After vermifugation with doramectin, ascarides were found in the animal's feces in the next days. In contrast to ascaride infections in puppies, piglets and foals, to the author's knowledge, intestinal obstruction caused by *T. vitulorum* has not been described previously in calves.

SAMENVATTING

Een Belgisch witblauw stierkalf van één maand oud werd aangeboden in de kliniek van de Faculteit Diergeneeskunde (UGent) vanwege plotseling optredende koliek. Het dier vertoonde kolieksymptomen, dilatatie van de beide rechterkwadranten van het abdomen, afwezigheid van mest en de aanwezigheid van klots- en pinggeluiden op auscultatie van de rechterzijde. Op het abdominale echografische onderzoek waren gedilateerde, contractiele dunne darmen zichtbaar met een verdikte wand. Bij de exploratieve laparotomie werd een volledige obstructie door volwassen *Toxocara vitulorum* wormen van het duodenum tot halfweg het jejunum gediagnostiseerd. Ter hoogte van het punctum maximum van de obstructie werd een deel van de ascariden verwijderd via enterotomie. Na ontworming met doramectine werden de volgende dagen ascariden gevonden in de mest van het dier. In tegenstelling tot ascarideninfecties bij pups, biggen en veulens, werd een obstructie door *T. vitulorum* bij kalveren volgens de auteurs nog niet eerder beschreven.

INTRODUCTION

Mechanical ileus in cattle is most frequently caused by a partial or complete mesenteric torsion or an intussusception (Iselin et al., 1987). In rarer cases, intestines are trapped into internal or external hernias, or by embryonic or acquired remnants (Deprez et al., 2006; Pardon et al., 2009; Ruf-Ritz et al., 2013). In contrast to other species, intestinal obstruction is less common in cattle. Obstruction by blood clots in hemorrhagic bowel disease and, less frequently, obstruction by a trichobezoar or fytobezoar have been documented in the literature (Abutarbush and Radostis, 1994; Iselin et al., 1997). In puppies, foals and piglets, massive ascarid infections have been reported to completely obstruct the small intestine (Cribb et al., 2006; Willard, 2009; Zimmerman et al., 2012). In cattle, ascarid infestations by *Toxocara vitulorum* are endemic in regions with a tropical and subtropical climate (Roberts, 1993). In these countries, severe infections are no exception, in contrast to countries with a more temperate climate, such as Belgium (Goossens et al., 2007; Borgsteede et al., 2012). This case report describes a case of intestinal obstruction by *T. vitulorum* in a heavily infected Belgian blue calf.

CASE DESCRIPTION

In February 2014, a one-month-old Belgian blue bull calf of 56 kilograms was referred to the animal hospital of the Faculty of Veterinary Medicine (UGhent) on suspicion of intussusception. The calf was housed in a box with three dams and two calves, and had been suffering from diarrhea for already one week. During the last two days, it had lost appetite and showed colic symptoms such as kicking to the abdomen.

Condition and vital signs of the calf were normal, apart from moderately congested mucosae. On auscultation of the left side, no ruminal sounds were audible. On the right side, fluid-splashing and ping sounds were present. Both right abdominal quadrants were dilated and painful upon palpation.

Transcutaneous ultrasound of the right abdomen with a 5.4 MHz probe (Mylab 25 Gold, Esaote, Belgium) showed contractile small intestines, partly with a thickened intestinal wall. In the right dorsal quadrant, a dilated cecum with gas content could be visualized. No abnormalities were detected in the thorax. Based on the obvious colic signs and the thickened intestinal wall, a tentative diagnosis of mechanical ileus was made and an explorative laparotomy was performed.

The calf was sedated with xylazine (0.2 mg/kg IM, Xyl-M 2%, VMD, Belgium) and induced with ketamine (2.2 mg/kg IM, Anesketin, Eurovet, Belgium). Anesthesia was maintained by injection of ketamine (2.2 mg/kg IM, Anesketin, Eurovet, Belgium). After opening the abdominal cavity, a moderate cecal and abomasal distension was detected. Gas was aspirated from the cecum and abomasum. From duodenum to mid-jejunum, a severe infestation with worm-like structures could be visualized through the intestinal wall (Figure 1). The intestinal wall was locally thickened. At the punctum maximum of an apparent obstruction, a 2 cm antimesenterial incision was made. The intestinal lumen was completely obstructed by adult worms. These worms were identified based on macroscopic appearance, host species and age as *T. vitulorum* (Figure 1). The final diagnosis was an intestinal obstruction caused by *T. vitulorum*. After partially removing the adult worms, the intestine was closed in two layers with synthetic absorbable gluconate (Monosyn 4/0®, B. Braun Medical,

Figure 1. Macroscopic appearance of adult *T. vitulorum* (A and B) in a one-month-old Belgian blue calf. Worms can already be palpated and visualized through the intestinal wall (C). Enterotomy showed that the lumen was completely obstructed (D).

Belgium) using an inverted suture pattern (Cushing). The abdominal cavity was closed continuously with synthetic absorbable polyglycolic acid (Surgicryl®, SMI, Belgium).

To confirm the final diagnosis, feces from the patient was examined for worm eggs by sedimentation flotation. At the same time, the two other calves and three cows (including the dam of the case calf) were sampled. In Table 1, the results of the first fecal examinations are shown. Only in the case calf, *T. vitulorum* eggs (with a very high count) could be found.

After surgery, a blood sample was taken to determine the hematocrit and base excess. The hematocrit was 48% (25-35), the base excess -8 meq/L (-5 – 5). For this reason, a hypertonic alkalizing perfusion was applied (40g bicarbonate in 1L sodium chloride). Both values normalized to 30% and -2.1 meq/L, respectively. Fluid therapy was continued with an isotonic polyionic infusion.

The calf was given a single dose of doramectin (0.2 mg/kg SC, Dectomax®, Eli Lilly, Belgium) to eliminate the worms that were not removed surgically, and pain relief was obtained with flunixin meglumine (2.2 mg/kg IV, Emdofluxin 50®, Emdoka, Belgium). For five consecutive days, procaine penicillin G and neomycin (0.05 mg/kg IM, Neopen®, MSD, Belgium) were injected. The second and third days after surgery, additionally, erythromycin (Erythrocine 200®, Ceva vet, the Netherlands) was administered intramuscularly at a prokinetic dose of 8.8 mg/kg. After five days, the calf could be discharged from the clinic. The owner was advised to deworm the other animals on the farm with a macrocyclic lactone and to disinfect the stable. Two months later, the animal was still in good condition and no new cases had occurred. Fecal samples of the same animals (three calves, three dams), taken three months after admission of the clinical case, were all negative for strongylides, ascarids, *Giardia duodenalis* and coccidiosis (Table 2). At that time, the farmer had not dewormed his animals yet .

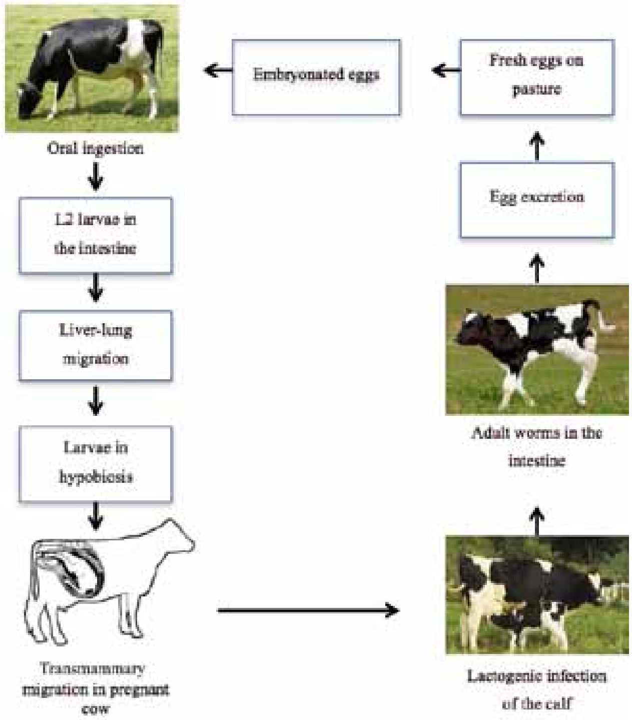

Figure 2. Schematic representation of the life cycle of *T. vitulorum* in cattle.

DISCUSSION

T. vitulorum is a roundworm, belonging to the phylum *Nematoda*, class *Secernentea*, order *Ascaridida* and the family of *Toxocaridae*. Within the genus *Toxocara*, there are three species: *T. vitulorum, T. cati* and *T. canis* (Roberts, 1993). Other well-known species within this order are *Parascaris equorum, Ascaris suum* and *Oxyuris equi*.

T. vitulorum is widespread, but the prevalence is strongly related to climatic conditions. In countries with a hot and humid climate, such as the (sub) tropics, the prevalence is significantly higher than in countries with a cold and dry climate (Roberts, 1993; Aydin et al., 2006; Borgsteede et al., 2012; Murray et al., 2012; Rast et al., 2013). In Table 3, an overview of prevalence studies on *T. vitulorum* in different countries is provided. Also in Belgium

Table 1. Results of the first fecal examination of the animals.

Animal	Strongyles (EPG) [a]	*Eimeria* spp. (OPG) [a]	*Giardia* [b]	*T. vitulorum* (EPG)
Calf 1	0	0	+	57.500
Calf 2	7.650	0	-	
Calf 3	0	0	+	
Cow 1	0	0	-	
Cow 2	0	0	-	
Cow 3	100	0	-	

a) McMastermethod
b) SNAP test

Table 2. Results of the second fecal examination of the animals.

Animal	Strongyles (EPG) [a]	*Eimeria* spp. (OPG) [a]	*Giardia* [b]	*Ascarids* (EPG)
Calf 1	0	0	-	0
Calf 2	0	0	-	0
Calf 3	0	0	-	0
Cow 1	0	0	-	0
Cow 2	0	0	-	0
Cow 3	0	0	-	0

a) McMastermethod
b) SNAP test

Table 3. Prevalence of *T. vitulorum* in different countries.

Year	Country/Place	Species	Study	Number of animals	% infected	Reference
2000	Hai Boi (Vietnam)	Cattle	Randomized	74	36	Holland et al. (2000)
2002	Guadeloupe	Cattle	Not randomized	247	77	Mahieu en Naves (2008)
2003	Belgium	American Bison	Not randomized	82	61	Goossens et al. (2007)
2003	Bamako (Mali)	Cattle	Randomized	490	7.6	Wymann et al. (2008)
2004	Toumodi (Ivory coast)	Cattle	Randomized	144	12	Knopf et al. (2004)
2004	Hakkari (Turkey)	Cattle	Randomized	718	29	Aydin et al. (2006)
2006	Van (Turkey)	Cattle	Not randomized	231	17.7	Göz et al. (2006)
2006	Florida	Cattle	Not randomized	105	17.6	Davila et al. (2010)
2008	Punjab (India)	Cattle	Randomized	1582	8.5	Jyoti et al. (2013)
2008	Multan (Pakistan)	Water buffalo	Randomized	282	63.8	Raza et al. (2013)
2008	Multan (Pakistan)	Cattle	Randomized	144	37.5	Raza et al. (2013)
2009	Laos	Water buffalo	Randomized	329	25.5	Rast et al. (2013)
2009	Laos	Cattle	Randomized	566	20.9	Rast et al. (2013)
2010	Erzurum (Turkey)	Cattle	Randomized	508	22.2	Avcioğlu en Balkaya (2011b)
2011	Serbia	Cattle	Randomized	600	35	Kulišić et al. (2012)
2012	Hyderabad (Pakistan)	Cattle	Randomized	1000	8	Mirani et al. (2012)

and in its neighboring countries with a moderate climate (Germany, Italy, the Netherlands), cases have been reported, albeit at low frequency (Goossens et al., 2007; Borgsteede et al., 2012; Dorchies, 2010). In the south of France, the parasite is believed to be endemic (Dorchies, 2010). To date, the parasite has been found in water buffalo (*Bubalus bubalis*), zebu (*Bos indicus*), cattle (*Bos taurus*), Bali cattle (*Bos sondaicus*), bison (*Bison* spp.) and sheep (*Ovis aries*) (Matoff and Vassilev, 1959; Khan et al., 2010). However, experimental infections in sheep have been found to be unsuccessful (Warren, 1970; Mozgovoi et al., 1973). Therefore, the most important host species are water buffalo and cattle (Roberts, 1993).

T. vitulorum has a direct lifecycle. Excreted eggs are round, measure 70 to 100 µm and develop into a first stage larva in about seven days under optimal circumstances (28 to 30°C) (Roberts, 1993) (Figures 2 and 3). Below 12°C, no development occurs, but eggs can survive for several months (Enyenihi, 1972; Thienpont and De Keyser, 1981; Anwar and Chaudhry, 1984; Roberts, 1989). A minimum humidity of 80% is required for survival and of 90% for development (Enyenihi, 1969). The eggs are sensitive to heat and dehydration (Roberts, 1989). Within the egg, the larva molts two times. Two or three days after the last molding, hence, under optimal circumstances, nine to ten days after excrection, the larva reaches its infective stadium (Roberts, 1993). After being swallowed by a mammalian host, the larva actively hatches. In experimental conditions, this has already occurred five to six hours after oral intake (Mozgovoi and Shikhov, 1971; Roberts, 1993). After hatching, the larvae penetrate the intestinal wall. The largest part migrates through the portal vein to the liver. A small part is found in the mesenteric lymph nodes or the lungs (Roberts, 1990). After this tissue migration, the larvae remain present in an inactive state (hypobiosis) in different organs (Abo-Shehada and Herbert, 1984; Murray et al., 2012). In male hosts, infection appears to be dead ending. The cycle only continues in pregnant hosts (Murray et al., 2012).

Approximately eight days before parturition, the larvae start migrating to the udder. The exact stimuli for this migration are not yet completely understood (Roberts, 1993). The larvae are mainly excreted in the milk during the first eleven days after parturition with a peak at days two and three (Roberts et al., 1990), but larvae can be found in the milk of the dam up to three to four weeks after giving birth (Taylor et al., 2007). The larval stages may be present in the tissues of the dam for years and can potentially infect calves over one to three consecutive parturitions (Rast et al., 2013). Lactogenic infection is the only evidenced route of infection.

The larvae reach the adult stage in the duodenum of the calf when it is ten to twelve days old (Warren, 1971). Approximately 22.8 ± 1.8 days after oral ingestion, eggs can be found in the feces (prepatent period) (Roberts, 1993). Peak excretion occurs at five to seven weeks of age and can last until the age of two to four months. During this patent period, approximately 110.000 eggs are excreted by one parasite every day. Overall, this can add up to 70 million eggs per calf, which leads to very high egg counts in the diagnosis (Roberts, 1990). In the present case, only one calf had a positive result on fecal examination. Most likely, the other two calves did experience an infection, but with no or minor clinical symptoms. At the time of the first fecal examination, the patent period had already passed and eggs were no longer excreted.

Infection in adult cattle causes no visible clinical signs in contrast to infection in newborn calves (Roberts, 1990). The symptoms in calves are mainly related to the number of adult worms in the small intestine. Whereas moderate infection only causes

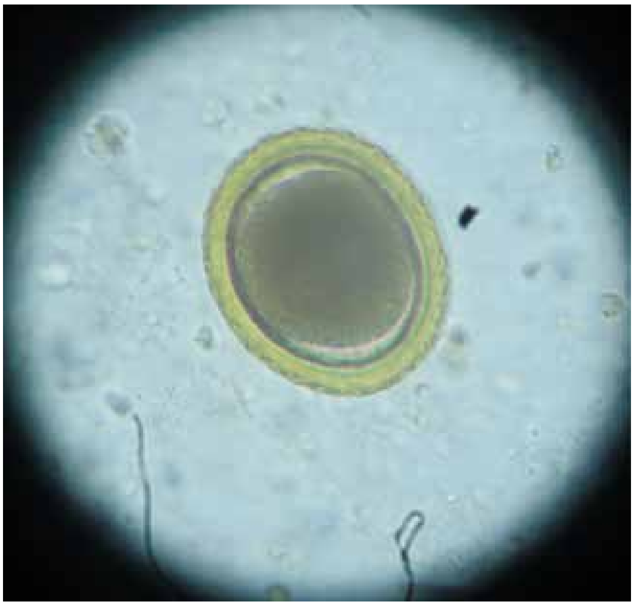

Figure 3. Microscopic appearance of eggs of *T. vitulorum* in feces of a one-month-old Belgian blue calf with intestinal obstruction.

diarrhea, heavy infection can cause anorexia, constipation, dehydration, steatorrhea, abdominal pain and as evidenced in this case, even obstruction (Srivastava, 1963; Enyenihi, 1969; Srivastava and Sharma, 1981; Sukhapensa, 1981; Thienpont and De Keyser, 1981). In other animal species, obstructions caused by ascarids have been described previously. For example *P. equorum* can cause obstruction in foals, *T. canis* in puppies and *A. suum* in piglets (Cribb et al., 2006; Willard, 2009; Zimmerman et al., 2012). Without treatment, the prevalence may reach 100% in calves, with mortality rates up to 80% as a result of weakening and dehydration (Roberts, 1993). If calves survive, they develop a strong immunity and adult worms are expelled (Hansen and Perry, 1994).

After diagnosis by fecal examination, treatment can be adjusted. Routine deworming of calves at an age of three months has no effect on the prevalence of *T. vitulorum* because the peak egg excretion has already passed (Goossens et al., 2007). Adult parasites in the intestine of a calf are susceptible to most anthelmintics, although Hassanain and Degheidy (1990) described a reduced susceptibility to ivermectin. Intestinal larvae are most susceptible to levamisole or pyrantel (Davila et al., 2010). Larval stages in maternal hosts are only susceptible to levamisole, but Starke-Buzetti (2006) described a 38% survival rate after thirteen consecutive days of treatment (Roberts, 1992; Starke-Buzetti, 2006). A single administration of levamisole at the age of ten days killed the adult and immature intestinal worms and prevented recontamination of the environment (Roberts, 1993).

Based on the direct life cycle of *T. vitulorum*, there are several ways to prevent infection. Routine treatment with levamisole at the age of ten to twelve days prevents a patent infection and therefore prevents recontamination of the environment (Roberts, 1993). Since lactogenic infection is the only route of infection, it is also possible to prevent infection by feeding calves with milk replacer.

Rajapakse et al. (1994a) described an immune response in adult water buffaloes with the production of antibodies in serum and colostrum after oral ingestion of infective eggs. High numbers of antibodies in the dam's colostrum and the serum of the calf were associated with low egg excretion in the feces. Antibodies would protect the dam against the migration of larvae to the udder (Rajapakse et al., 1994a; Starke-Buzetti et al., 2001). This was confirmed by a study with antibodies of water buffaloes in mice (Rajapakse et al., 1994b). However, despite a high level of antibodies in the serum of the calf, this did not prevent patent infection (Starke-Buzetti et al., 2001; De Souza et al., 2004). Further research into the exact immune response and potential immunization methods is required.

Another way of preventing infection with *T. vitulorum* is hygiene. The feces of the calves should be removed daily to prevent oro-fecal transmission to other adult cattle (Avcioğlu and Balkaya, 2011a). Eggs in the environment are highly resistant against chemical cleaning. They can be destroyed by direct exposure to sunlight, by boiling water or by immersion in 3% hydrogen peroxide for fifteen minutes. However, feces act as protection for the eggs; so these disinfection methods appear to be insufficient (Anonymous, 2005). A completely reliable cleaning and disinfection method does not yet exist. Another possibility would be composting infected feces. Provided that the composting process works sufficiently, temperatures in compost can reach up to 70°C with a relative humidity of 50%. As stated, eggs do not survive in heat and need a minimum relative humidity of 80%.

Concerning the importance of *T. vitulorum* for human health, it should be stated that *T. canis* is a well-known zoonosis, which can cause ocular or visceral *larva migrans*, especially in infants (Glickman and Shofer, 1987). It is unknown whether this is also the case for *T. vitulorum*. In tropic regions, many children are infected by *Toxocara* spp., but it is unclear whether this only involves *T. canis*, or whether other species are important as well and whether they can induce clinical symptoms or not.

CONCLUSION

This case report demonstrates that *T. vitulorum* is present in cattle in Belgium. Moreover, in succession of reports in horses, pigs and dogs, this paper shows that intestinal obstruction by ascarids can also occur in calves. Practitioners should realize that besides levamisole, no common anthelminthic is active against the immature stages of the worm. Preventive measures are general hygiene to prevent the oro-fecal infection route, and feeding milk replacer instead of cow's milk to break the infectious cycle. In practice, on infected herds, systematically treating calves aged 10-12 days with levamisole is likely the most straightforward approach to prevent clinical disease in calves and environmental contamination.

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