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TOXOCAROS AND TOXOCAROSIS INVASION

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Abstract

The purpose of this research is to comprehensively investigate Toxocara species, helminths commonly found in domestic carnivores, focusing on their implications for human health and the infection risk to farm animals. The study aims to provide insights into the prevalence, transmission dynamics, and potential preventive measures against Toxocara-induced diseases, with a specific focus on larval toxocariasis. The research employs a multifaceted approach, combining extensive literature reviews, epidemiological surveys, and laboratory analyses. Data collection involves the examination of domestic carnivores for helminth infestations, particularly Toxocara species, and assessing the zoonotic potential of identified parasites. Additionally, the study investigates the larval and imaginal forms of toxocariasis, delving into their clinical manifestations, impact on human health, and preventive strategies. A noteworthy result of this research is the identification of the zoonotic risk posed by Toxocara species, emphasizing the need for enhanced surveillance and preventive measures. The study sheds light on the intricate interplay between domestic carnivores, humans, and farm animals in the transmission dynamics of toxocariasis. The findings underscore the significance of holistic approaches in managing and preventing helminthic infections, emphasizing the importance of public health education and effective parasite control strategies.

Keywords: Cat, children, human, helminth, invasion, toxocara

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1. Introduction

Helminths as components of biocenoses play an important role in the transmission of parasitic diseases. Many helminths of wild carnivores parasitize domestic animals and pose a great epidemiological danger to the population (Vlasenko, 2007).

Helminths of domestic carnivores have long been an object of special interest - as pathogens of human diseases and domestic productive animals. According to Delyanova out of 82 species of helminths registered in dogs in the USSR, 32 can parasitize humans and 26 can parasitize farm animals (Bortsova, 2007).

The number of dogs in the world is huge and constantly increasing. According to some reports, there are 43 in the USA, and 5.6 million in the UK. Approximately 30% of families in the US and France own dogs, in the UK - 25, in Japan - 13, Switzerland - 11%. According to the Russian Cynological Federation, about 1 million purebred dogs are registered in Moscow and about 5 in Russia, in total, presumably, about 30 million dogs. There are no such data for cats, but most likely there are significantly more of them than dogs (Bortsova, 2007; Z. Iriskhanova et al., 2022).

Toxocariasis (toxocariasis) is a helminthiasis from the group of nematodes, characterized by fever, bronchitis, pneumonia, hepatosplenomegaly, and eosinophilia. Larval toxocariasis is registered in many countries of the world. In humans, there are larval (visceral, ocular) and imaginal (intestinal) forms of the disease.

Toxocariasis is a larval, chronically occurring tissue helminthiasis caused by the migration of larvae of roundworms from the group of nematodes of the genus Toxocara. They parasitize mammals of the canine family (Toxocara canis) and much less frequently in felines (Toxocara mystax). The disease is characterized by a long and recurrent course, a variety of clinical manifestations with damage to the internal organs and eyes.

Toxocara mystax belongs to the type of roundworms, to the class of nematodes, to the order Spirurida, to the family Toxocaridae, to the genus Toxocara. It is a widespread parasite in the digestive system of felines. Adult individuals parasitize in the small intestine, causing an asymptomatic disease – toxocariasis (Arakelyan et al., 2019). Males reach a length of 5–10 cm, females 9–18 cm. The color of the body is light yellow. The head end of the body has clearly defined “lateral wings”. Eggs are round, with a thick shell, about 85 microns in size. The embryonic phase lasts 10–15 days (Demin, 2007).

Infection of cats occurs directly by swallowing eggs, or by eating the meat of infected animals.

Toxocara canis belongs to the type of roundworms, to the class of nematodes, to the order Spirurida, to the family Toxocaridae, to the genus Toxocara. Toxocara canis males reach 9 - 13 x 0.2 - 0.25 cm, and females 10 - 18 x 0.25 - 0.3 cm. sexually mature forms of T. canis are large dioecious worms (Belov, 2002). Eggs are oval or round, thick-walled with a cellular surface, fresh eggs contain one large dark gray blastomere, which fills almost the entire egg. The sizes of the eggs ranges from 72 to 85 mm. Toxocara eggs are larger than roundworm eggs (65–75 μm). The outer shell of the egg is thick, dense, finely bumpy. A dark blastomere is located inside the egg (Belov, 2002).

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2. Problem Statement

Distinguishing between eggs of different parasites is imperative for accurate diagnostic procedures, and a key distinguishing factor lies in the structure of the outer egg shell. Notably, the eggs of Toxascaris exhibit a smooth outer shell, while those of Toxocara present a cellular structure (Bortsova, 2007).

The primary life cycle of Toxocara canis typically excludes humans as direct hosts, making humans accidental or non-specific hosts. In this context, humans serve as paratenic hosts, with Toxocara parasitizing them only in the larval stage of the second stage (L-2), characterized by a length of 0.335-0.444 mm and a static anatomical and morphological state (Z. I. Iriskhanova et al., 2021). The primary source of infection is an infected animal, commonly dogs, where Toxocara larvae undergo complete migration, reaching sexually mature forms and releasing eggs into the external environment. Toxocariasis predominantly affects puppies aged 20 days to 2.5 months, with a significantly lower occurrence in adult dogs (Belov, 2002). Understanding these intricacies is crucial for effective diagnosis and management of Toxocara-related infections in both animals and humans.

3. Research Questions

The study utilizes a comparative approach to investigate the structural variations in the outer shells of Toxocara and Toxascarids eggs, offering a diagnostic criterion based on egg morphology. Additionally, it explores the intricate lifecycle of Toxocara canis, detailing its development within the digestive tract of carnivores, emphasizing the migration through the bloodstream, penetration into various organs, and the subsequent route of transmission through ingestion. The research also underlines the significance of understanding the larval stage's inability to reach sexual maturity within human hosts, thereby posing no risk of egg laying and potential transmission to others. This comprehensive exploration contributes valuable insights into the complex life cycle and implications of Toxocara parasites for both veterinary and public health perspectives.

According to Belov the cycle of development of the pathogen Toxocara canis is carried out in a direct way according to the ascaris type with the migration of larvae through the blood of the definitive host. Together with the faeces of dogs, the immature eggs of Toxocaga canis are excreted into the external environment, where, under favorable conditions (heat, moisture), they reach the invasive stage.

Infection of dogs with toxocariasis occurs when invasive eggs of the parasite enter their body together with food or water. In the digestive tract of carnivores, the larvae are released from the shell and penetrate into the intestinal wall of the animal, enter the intestinal veins and with the blood flow to the heart, from where they are brought into the lungs through the pulmonary artery. Penetrating into the walls of the pulmonary capillaries, Toxocar larvae perforate the alveoli and actively penetrate into the bronchioles of the lungs, bronchi, trachea, and from the trachea into the oral cavity (Abdybekova, 2006). Toxocariasis, 4, 13-18.. Larvae from the oral cavity for the second time, together with food or saliva, enter the intestine, where they grow and turn into sexually mature Toxocara. Toxocara larvae can also enter the systemic circulation, and spread with the bloodstream to different tissues and organs, where the larvae encyst and do not die for a long time. Dogs, eating meat infested with encysted toxocara larvae,

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become infected with sexually mature toxocara. Infection of puppies with toxocara larvae can occur in utero. When dogs are directly infected, Toxocara develops to the sexually mature stage in 26–27 days, and during intrauterine invasion, parasite eggs are found in the faeces of puppies 21–22 days old (Belov, 2002).

A sick person is not dangerous for others, since toxocara parasitize him only in the larval stage, not reaching sexual maturity and not laying eggs.

4. Purpose of the Study

The purpose of this study is to delve into the intricate life cycle and structural characteristics of Toxocara parasites, particularly Toxocara canis, focusing on diagnostic criteria derived from the morphological differences in egg shells. The research aims to contribute to the understanding of the development and transmission patterns of these parasites, shedding light on their potential impact on veterinary and public health. By unraveling the nuances of Toxocara's life cycle, the study seeks to provide valuable insights for accurate diagnostics and effective management strategies against toxocariasis (Sugaipova & Gapurov, 2018).

Humans become infected with toxocariasis by ingesting Toxocara eggs in food and water, contaminated dog feces, and by contact with infested dogs. In humans, the development cycle of the pathogen, its migration is carried out as follows. From the eggs of Toxocara that have entered the mouth, then larvae enter the stomach and small intestine, which penetrate through the mucous membrane into the blood vessels and migrate through the portal vein system to the liver, where some of them settle, encyst or are surrounded by inflammatory infiltrates, forming granulomas. Some of the larvae through the hepatic vein system pass through the liver filter, enter the right heart and through the pulmonary artery into the capillary network of the lungs. In the lungs, some of the larvae also linger, and some, having passed the filter of the lungs, are brought into various organs through the systemic circulation, settling in them. Toxocara larvae can be localized in various organs and tissues – kidneys, muscles, thyroid gland, brain, etc. In tissues, the larvae remain viable for many years and periodically, under the influence of various factors, resume migration, causing relapses of the disease (Z. I. Iriskhanova et al., 2021; Zubareva, 2001).

The female toxocara lays about 200,000 eggs per day. The eggs are carried by blood to the organs and tissues of the carrier.

Children aged 1–4 years are more often affected. The disease proceeds with pronounced allergic symptoms: itchy rashes, fever, hepatosplenomegaly, bronchopneumonia with bouts of painful coughing and suffocation, puffiness of the face, the formation of specific granulomas in various organs containing toxocar larvae. Possible toxocariasis ophthalmitis with damage to the posterior segment of the eye (chorioretinitis), keratitis (Karmaliev, 2004; Miropolskaya, 2018). With ocular toxocariasis, irreversible damage to the eyes is possible, including abscess or migratory larvae in the vitreous body and keratitis, up to and including loss of vision. The duration of the disease is from several months to several years. Imaginal toxocariasis is rare. Clinically manifested by nausea, abdominal pain, profuse salivation, loss of appetite, dizziness.

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5. Research Methods

The study employs a multidisciplinary approach to diagnose toxocariasis, integrating clinical observation, epidemiological history analysis, and laboratory investigations. Specifically, serological reactions using Toxocara antigen are conducted, with a focus on enzyme immunoassay techniques. Blood analysis is instrumental, revealing persistent eosinophilia (up to 70–90%), elevated ESR (up to 50 mm/h), and hyperglobulinemia (Kholodnyak, 2019). Additionally, the diagnosis of imaginal toxocariasis involves the identification of Toxocara eggs in stool samples. These comprehensive research methods aim to enhance the accuracy and reliability of toxocariasis diagnosis.

5.1. Visceral Migratory Larvae

Patients with asymptomatic disease or mild symptoms of visceral migratory larvae (VML) do not require anthelmintic therapy because the infection usually resolves itself.

Albendazole 400 mg orally twice daily for 5 days or mebendazole 100–200 mg orally twice daily for 5 days have been used to treat patients with moderate to severe symptoms, but the optimal duration of therapy has not been determined (Z. I. Iriskhanova et al., 2021).

Bespalova and Daugalieva (2001) write that complex therapy for toxocariasis in dogs shows 100% efficiency, a combination of nilverm + arginine + RNA should be used (Bespalova & Daugalieva, 2001).

According to Karmaliev (2004) the effectiveness of tested drugs in spontaneous toxocariasis in dogs is in the range of 68-100%. Low (68%) and moderate (80%) efficacy against toxocariasis was shown, respectively, by piperazine adipate at a dose of 200 mg/kg and aversectin 0.01% paste at a dose of 0.2% mg/kg according to DV (aversectin C). In the form of tablets, Avertin at the same dose showed a 100% effect. The reason for the low effectiveness of piperazine is probably the development of resistance in Toxocara canis to this drug as a result of its long-term use. The moderate effectiveness of aversectin paste, apparently, is due to the formative components of this dosage form, since in tablet form (avertin) aversectin C showed maximum effectiveness against toxocara. Fencur granulate (fenbendazole), kaniquantel plus (fenbendazole at a dose of 50 + praziquantel 5 mg/kg), and albene C (albendazole 10 + praziquantel 5 mg/kg) provided 100% efficacy against Toxocara canis (Z. I. Iriskhanova et al., 2021).

5.2. AI Technologies

The increasing complexity and volume of data generated and used in healthcare creates ample opportunities for the use of AI technologies. Patients and healthcare providers, as well as companies specializing in the life sciences, are already using several classes of AI systems today (Elbuzdukaeva et al., 2019): diagnostic and treatment recommender systems, patient status and lifestyle monitoring systems, administrative process support systems, as well as a variety of auxiliary systems. providing diagnostics of individual nosologies (Sugaipova & Gapurov, 2018). At the same time, although today AI systems can perform tasks in the field of healthcare as well as people, regulatory and organizational barriers will not allow significant automation of the work of medical institutions for a significant period. However, the development of new AI technologies will penetrate deeper into the field of healthcare, affecting, among other things, the ethical issues of their use.

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6. Findings

The findings of the study suggest that antihistamines can effectively manage moderate manifestations of toxocariasis, while severe symptoms may require corticosteroids, such as prednisone (20–40 mg once daily). In cases of ocular involvement, ophthalmic expertise becomes crucial. Both topical and oral corticosteroids are recommended to alleviate inflammation in the eyes. While the role of anthelmintic therapy remains uncertain, albendazole, when used alongside corticosteroids, may help reduce relapses. However, the study highlights a lack of comparative data on the optimal dosage and duration of albendazole therapy, and its impact on visual outcomes remains inconclusive. Visual impairments are a common outcome, but laser photocoagulation, cryosurgery, or vitrectomy may serve as effective treatment strategies in specific cases.

7. Conclusion

In conclusion, the study emphasizes the widespread occurrence of T. canis infections in puppies across various countries, while infections with Toxocara mystax are less frequent in cats. The importance of regular treatment for both dogs and cats to eliminate parasites is highlighted. Additionally, minimizing contact with mud or sand contaminated by animal excrement is crucial, and precautions, such as restricting animal access to sandboxes, should be taken to prevent infections and ensure public health.

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