Human Toxocariasis: Secondary Data Analysis

Eleuza Rodrigues Machado¹, Luciana Barroso de Araujo², and Anna Maly de Leão e Neves Eduardo¹

¹Federal District Health Department, Universidade Kroton, Brazil
²Course of Biological Sciences, Anhanguera College of Brasilia, Brazil

Abstract

Introduction: Toxocariasis is a helminthiasis caused by Toxocara spp., and result of the migration of infective larvae into the visceral, causing disease. There are 21 species belonging to the Toxocara genus, but only T. canis and T. cati are important in public health.

Objective: To produce a review of the literature about human toxocariasis using the methodology of secondary data analysis. The aspects approached were morphobiological, immunological, pathological, clinical, and epidemiological to comprehend the evolution and therapeutic procedures of this helminthiasis.

Methods: The search period of the articles covered the last 70 years. Publications in different languages took part on the review and they are available online. The sources used to obtain these documents were Medline, Lilacs, PubMed, Google Scholar, and SciELO. The key words used to select the scientific documents were toxocariasis, T. canis and T. cati, epidemiology, clinical diagnosis, serological diagnosis, clinical symptoms, and treatment.

Results: 217 complete articles entered the review; they were all related to human. Conclusions: Human toxocariasis occurs in various countries; however, the data on this disease are fragmented, requiring publications that gather all data about the morphology, clinical symptoms, immunological response, diagnosis, treatment, epidemiology and control of this parasitosis. The real frequency of this disease is yet unknown worldwide as there are no studies on human toxocariasis in all countries. The techniques for diagnosis are limited, locking an easy access kit for the diagnosis with high specificity and sensitivity for the disease.

INTRODUCTION

Human toxocariasis is a parasitic zoonosis with a worldwide distribution but is under diagnosed with an under estimated impact on human health. In addition, the Centers for Disease Control and Prevention (CDC) considers this parasitosis among the five parasitic diseases that require public health actions [1,2]. Serologic studies in children have shown prevalence rates of the five parasitic diseases that require public health actions [1,2]. Toxocariasis is not classified among the diseases for the diagnosis with high specificity and sensitivity for the disease.

In soil, if temperature, oxygenation, and soil type are adequate, the eggs become larvae and infectious (eggs with larvae L3) [27,28]. People might get infected and acquire toxocariasis by different ways, such as: placing contaminated hands in the mouth and ingesting eggs, contaminating food with infected hands, eating fruits and vegetables poorly sanitized, eating raw meat from paratenic hosts with infective larvae of Toxocara spp., drinking water contaminated with larval eggs [29-31]. The infections caused by Toxocara spp. may be asymptomatic or symptomatic. In symptomatic cases, parasitosis can be severe.

and generate irreparable sequel for individuals such as partial or total blindness, neurological problems, etc. [8,32].

The disease consists of the migration of larvae of the nematode parasites common to the animals, but in the human body, these evolutionary forms of helminths migrate through the viscera or through the eyeball, without completing their biological cycle. During the larvae’s lifetime inside the individual, they produce and release large amounts of antigens which triggers an intense inflammatory process in the host [33,34] as well as the characteristic symptoms of toxocariasis.

In many countries of the world as well as in Brazil, it is common for the population to have dogs and cats as pets [35]. These animals are kept at home as family members. They live inside homes or apartments, and usually, when these animals need to fulfill their physiological needs, they are led to walk the streets, playgrounds, and gardens. On these places, such animals defecate and urinate creating a serious problem when their owners do not collect their wastes, possibly Toxocara positive, giving it the correct destination.

The exposure of population to Toxocara spp. demonstrates the need for attention for the completion of clinical diagnosis parameters, as well as, the expansion of highly specific serological studies in different regions to understand the impact of toxocariasis.

There is a need for studies on complementary data such as morphobiological characteristics and epidemiological aspects, clinical, pathological, immunological, diagnosis, treatment and the control.

Articles that entered the review were obtained from the following data sources: LILACS, MEDLINE, PubMed, Google Academic, and SciELO.

The objective of the review was to verify the distribution of human toxocariasis in Brazil and in the world in the last 70 years, showing the morphobiological characteristics and epidemiological aspects of the etiological agents T. canis and T. cati, clinical, pathological, immunological, diagnosis, treatment and the control of this helminthiasis.

MORPHBIOLOGICAL AND EPIDEMIOLOGICAL CHARACTERISTICS OF TOXOCARA CANIS AND T. CATI

Morphological and biological characteristics of T. canis and T. cati

The nematode Toxocara canis (WERNER, 1782) [36] is the main intestinal parasite of canids, and T. cati (SCHRANK, 1788) [37] of felids. Both species cause infections in domestic and wild animals. These helminths belong to the Nematoda Phylum, Secernentea class, Ascaridida order, and Ascarididae family [38].

Toxocara genus. This genus covers more than 21 species, being two of them of fundamental importance in public health: T. canis parasito of the canids: dogs, wolves, foxes, etc., and T. cati of felines: cats, leopard, etc. [39-44], being, therefore, a zoonosis of universal importance [43-46].

T. canis and T. cati present three evolutionary forms: adult males and females, eggs and larvae [45-49]. The morphological characteristics of these two species are similar. Both helminths present clear sexual dimorphism, and with considerable size. Adult males reach 3 to 10 cm, depending on the species and parasitic load that the definitive host holds. They have the posterior region ventrally curved (Table 1, Figure 1 A and B, Figure 2 A). Adult females present a variable size from 10 to 15 cm length and a tapered posterior region (Table 1, Figure 1 C and D, Figure 2 B). The sizes of the adult worms depend on the Toxocara species and the parasitic load per host [38,49].

In addition, adult worms reveal common features such as milky color, three large lips around the mouth and the presence of two fin-shaped cervical alae that vary in shape and size depending on the species of Toxocara (Figure 3A), the T. canis and T. cati, respectively [38, 49, 51-54].

The female’s genitals begin in the anterior region and extend to the posterior one, in the vulvar region. The male’s tail has a slender terminal appendix and caudal wings. The spicules measuring between 0.75 and 0.95 mm [15,38, 49,54].

The eggs are large and they are eliminated in the feces of the definitive hosts (dogs and cats). In T. canis, the average size of the eggs ranges from 75 to 90 micrometers, and in T. cati, from 65 to 70 μm [36,48,49,53]. These eggs possess a thick membrane that provides the eggs great resistance to the adverse conditions of the environment. The females of both helminths release about 200,000 eggs per day. They become infective within 2 to 3 weeks with larvae in the L3 stage [38,49,54-57], as shown in Figure 4 (A and B). Studies demonstrate that these eggs are extremely resistant to the action of chemicals and physical agents. Also resistant to temperature variations, remaining viable of infection for years [58-66].

Figure 1 Morphology of adult worms: males (A and B), females (C and D) of T. canis and T. cati respectively. Source [48]. Viewed on the site: http://www.fcmed.unam.mx/deptos/microbiologia/parasitologia/larva-migrans-visceral.html
**Table 1:** Differences in morphological characteristics of adult worms, eggs, and larvae of *T. canis* and *T. cati* species.

<table>
<thead>
<tr>
<th>Evolutionary forms</th>
<th>Morphological characteristics</th>
<th><em>T. canis</em></th>
<th><em>T. cati</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td>Males</td>
<td>4 - 6 cm</td>
<td>3 - 6 cm</td>
</tr>
<tr>
<td></td>
<td>Females</td>
<td>15 cm</td>
<td>10 cm</td>
</tr>
<tr>
<td>Eggs</td>
<td><em>T. canis:</em> Spherical shape</td>
<td>75 - 90 µm (diameter)</td>
<td>65 - 70 µm (diameter)</td>
</tr>
<tr>
<td></td>
<td><em>T. cati:</em> Elongated shape</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd stage larvae (infectious)</td>
<td><em>T. canis:</em> Size length per diameter</td>
<td>About 0.5 mm/0.02 mm</td>
<td>About 0.4 mm/0.02 mm</td>
</tr>
<tr>
<td></td>
<td><em>T. cati:</em> Size length per diameter</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The biological cycle of these helminths is quite complex and the age of the definitive host is related to the transmission of the infection which might be transplacental, transmammary and by ingestion of paratenic hosts infected with third-stage larvae [36,38,49,67-69]. In dogs up to three months of age, tracheal migration occurs [36,49,55,70], although some authors disagree with this timing, indicating that this migratory route can occur in animals up to six months of age [38]. Paratenic hosts acquire this parasitosis by ingesting infective eggs present in the soil, water, food, and dirty and contaminated hands placed in the mouth. Also from meat of paratenic hosts infected with *Toxocara* spp. larvae [38,71], as shown in Figure 5.

The life cycle of *Toxocara* is monoxenic. Dogs and cats ingest larval eggs that are submitted to the action of the gastric juice and stimulate the exit of infective larvae (L3) in the small intestine. These larvae penetrate the intestinal mucosa, fall into the bloodstream, pass through the liver, heart, and reach the lungs. In the lungs, the L3 larvae make a molt and transform into L4 larvae. These larvae rupture the blood vessels, fall into the alveoli and rise through the trachea, being swallowed in the sequence. Once they reach the small intestine, they attach themselves to the intestinal mucosa and grow into male and female worms. Adult males and females copulate. The females release their eggs in the feces, which will contaminate the environment [49,55], as shown in Figure 5 [38,49,55].

The biological cycle of *T. canis* in animals and in man, in other words, begins with the ingestion of eggs with the L3 larvae. The eggs hatch and eliminate larvae in the small intestine. After that, these larvae enter the intestinal mucosa and blood or lymphatic pathways reaching the liver, lungs, brain, eyes, bone marrow, and lymph nodes. In humans, L3 larvae do not experience ecdises, remaining in the form of L3 at these sites. The life span of the larvae in these organs varies from weeks to months [38,49,55], as shown in Figure 6.

The long stay of the larvae in the tissues, the ingestion of food by them and the synthesis and release of secretions in the paratenic hosts induce the formation of an intense inflammatory process characterized by the presence of eosinophils, macrophages, mast cells, and formation of granulomas [72-81]. These processes are responsible for the clinical and pathological manifestations in these individuals.

The infection of the definitive hosts, dogs and cats, and paratenic hosts by *T. canis* and *T. cati* is worldwide. However, the true dimension of the parasitosis is not yet fully known [24,49,82-85].

**Epidemiological aspects of *T. canis* and *T. cati***

Toxocariasis is a global public health problem [38,49,82-85]. The number of research related to this topic has increased over the last decades; however, due to the magnitude of the disease for man, the number of studies related to it remains low. There are three factors considered obstacles to the achievement and dissemination of the results: First: the similarity of symptoms to other diseases, including other helminthiasis [32,33,72-79,81]. Second: the diagnosis difficulties, since there are no standardized kits with high sensitivity and specificity for the disease [86]. Third: the lack of control programs for this disease [24,49,78,83-85].

**Figure 2** Morphology of the posterior regions of adults male (A) and female (B) worms of the genus *Toxocara*. Source [48,49].

Viewed on site: [http://animaldiversity.ummz.umich.edu/site/accounts/information/Toxocara_canis.html](http://animaldiversity.ummz.umich.edu/site/accounts/information/Toxocara_canis.html)

**Figure 3** Morphology of anterior (A) regions common and present in adult worms of the *Toxocara* genus. Figures (B and C) show the cephalic wings presented in male and female adult worms of *T. canis* and *T. cati*, respectively [15,36,48,49].
In all continents, this helminthiasis is directly related to the sources of infection, which are dogs and cats [87-95]. The coexistence of man with these animals and the precarious hygienic habits of pet owners while handling them on already contaminated soil are contributors to the spread of the disease [93-98].

Dogs and cats with a few months of age (two or three) are the most infected, but as they grow older, they become more resistance to toxocariasis [49,55]. Concerning the gender, there is no consensus if male is more infected than females. In some works show that males are more susceptible than the females [49,55], but in other articles do not show significant differences [100]. The frequency of T. canis in dogs and T. cati in cats vary greatly from region to region in different countries. However, on all continents the animals harbor about a dozen females, which produce about 200,000 eggs daily [49,54-57], released into the environment.

It is important to emphasize that the coexistence between Man and the animals is not the main source for toxocariasis. This parasitosis is acquired by man when placing in the mouth larvae eggs of T. canis and T. cati, water or food [29,30,31,94,101-105] contaminated with soils polluted with feces of dogs and cats [106-110].

The eggs of Toxocara spp. [49,55] can remain viable for months in the soil if the climatic conditions of the environment is favorable with temperature between 18º to 30ºC, high relative humidity, no direct light action and oxygenated soil [49,55,59,60,95,106,107]. Under these conditions, the eggs need 9 to 15 days to produce infective larvae inside and become embryonated (stage 3). Eggs do not develop themselves into an embryo at temperatures below 12ºC [49,55,59,60,95,103,104].

All people can be infected with Toxocara spp. eggs. However, children between two and five years of age are the most infected due to their precarious hygienic conditions since they are most of the times with dirty hands, and always putting them in the mouth [49,92,108-110].

The enzootic cycle of T. canis in dogs is ensured mainly by congenital transmission, in the prenatal period [111]. In cats, transmission by infective eggs present in the soil occurs. There are animals that ingest larvae eggs from the soil and feed cats such as earthworms, cockroaches, and mice [49]. These animals also generate infection. The transplacental transmission of T. cati to the offspring, so far is not conclusive [56,64,71,99,108-111] however it can occur.

Another form of acquisition of Toxocara by man is the ingestion of raw or undercooked meat of paratenic helminth animals such as birds [101,102], bovine [112], oysters [113], or contaminated vegetables [94,105].

In developing countries, some factors have contributed a lot to the increasing number of animals in contact with humans. Housing conditions have increased closer and more frequent contact of domestic animals and their owners. In addition, movements of ecologists resulted in individuals that are more conscious and better informed of the policies of protection and preservation of...
animals. On the other hand, there are no government actions to inform the population about the risks of disease transmission, or the control of zoonoses transmitted by domestic animals. There is no initiative towards the control of populations of stray animals on the streets. Thus, these facts result in an increased risk of human exposure to zoonoses transmitted by animals such as dogs and cats [16,20,25,30,49,114,115].

The human infection with *Toxocara* spp. results from the ingestion of infective eggs of *T. canis* and *T. cati* present in soil contaminated with feces of dogs and cats respectively. The prevalence of canine and cat intestinal infection may be an indicator of the risk of human infection in different areas, both urban and rural [61,66,71,91,96,100,109,110,115].

Some studies have evaluated the levels of environmental contamination, mainly in public areas, through analysis of soil, sand, and feces samples from domestic, urban and rural centers. They revealed a strong correlation with human infection [49,55,91,107-110]. In other studies about the frequency of seropositive for *T. canis* antigens, they show high rates, especially in children living in more needy communities [114,116,117], and in areas populated by dogs and cats [118].

The frequency of infected people results from seroprevalence surveys conducted in different regions of the world, using different methodologies for the diagnosis. The data of these studies demonstrates that the rates of parasitism vary between different countries such as: 4.6% to 7.3% in United States [82], 3.4% in Japan [119], 7.0% in Sweden [120], 35.6% in Peru [121], 47.5% in Colombia [122], and 86.0% in Caribbean [123]. Research results using serological tests suggest that about 7.0% of the clinically healthy human population of the United States, about 5.0% of that Canada, and about 4.0% of that in Great Britain is infected with the *Toxocara* spp. [124]. Yet, these data are punctual, although they come from few counties in each country, being therefore poorly noticed.

In Brazil, a number of studies show that toxocariasis varies from 4.2% to 91.4%, depending on the type of sample and method used, and the socioeconomic level of the sample population [125,126]. The frequency of infection with *Toxocara* spp., in patients examined by the Immunoenzymeatic method (ELISA) in Brazil varies from state to state such as: São Paulo from 3.6% to 38.8% [127,128], Pernambuco from 12.1% to 40.0% [129,130], Minas Gerais from 8.7% to 19.6% [131,132], Paraná from 17.8% to 56.0% [133,134], Brasilia from 21.8% to 26.0% [116,135].

Study conducted in Brazil show a variation of positivity for toxocariasis between children and adults. These studies in children revealed high *Toxocara* spp. seroprevalence (IgG), with rates varying from 3.0% to 90.0% [3,136,137]. Furthermore, few studies involving adults recorded rates below 8.7% [4], 6.4% [138] and 14.9% [139].

Currently, with the development of the ELISA technique using *Toxocara* spp. secreted and excreted (TES) the sensitivity and specificity of the diagnosis of the infection has increased. This will permit the execution of seroepidemiological studies for toxocariasis, elucidating accurately the frequency of this disease in Brazil and worldwide, and lead to the development of new strategies for diagnostics or vaccination [140].

Pathological aspects, clinical and immunological symptoms of toxocariasis

The typical lesion produced by the larvae of *Toxocara canis* and *T. cati* is the formation of allergic granuloma around the infective larva (L3) of the parasite [141]. In the central region of the granuloma, there is the L3 and necrotic tissue with fibrinogen degeneration surrounded by eosinophils and monocytes [142]. In addition, in the granuloma region, there are the fibroblasts that participate in the fibrotic capsule formation. There are also giant cells there. Some larvae may incrust and remain viable for several months in the host [83,143].

Clinical symptoms

The severity of the clinical symptoms of people with VLM is variable and depends on factors such as: Location and number of larvae present in the body, as well as the immune response of infected persons [83,144,145].

The individual infected with a low number of larvae is usually asymptomatic [83,146]. However, people who have reinfestions or ingest large numbers of eggs, clinical symptoms are evident [147]. In human infections are by larvae of *Toxocara* spp. The disease is also known as visceral migrans larvae (VLM), as described in the literature [83], and depending on the affected viscus, they are given specific names such as visceral toxocariasis (VLM), ocular toxocariasis or OLM, and occult or atypical toxocariasis [148].

The clinical manifestations of the disease are hepatomegaly, fever, and respiratory problems [149,150-152]. In smaller proportions, patients complain of digestive problems, asthenia, malnutrition, brain involvement, splenomegaly, anorexia, pallor, cutaneous signs, adenopathies, endocarditis, and persistent eosinophilia [153-155].

Respiratory symptoms are frequent and characterized by coughing, wheezing, pulmonary infiltrates, and sometimes nodules [156-158]. Some patients present Central Nervous System (CNS) impairment, convulsive crisis, and behavioral disorder [49,55,159].

Ocular toxocariasis (OLM) characteristic are a decreased ability to see, ocular pain, and strabismus [160]. In addition, the changes are compatible with uveitis, papillitis with or without granuloma in the eyes, cataract, and when undiagnosed in time, parasitism can lead to blindness [160-163].

In atypical or occult toxocariasis, the patient presents with abdominal and lower limb pains, headache, intense and prolonged asthenia and hepatomegaly [161,162,164].

Thereby, the symptoms presented by individuals are related to where the larvae are migrating or encysted [49,55].

Immunological aspects of toxocariasis

The larvae of *Toxocara* spp. establish an intimate interaction with the human or animal parantennial host. The presence of the larvae in the tissues and substances secreted and excreted by them activate the mechanisms of humoral and cellular immunity [165,166].
The cellular immune response is present in the formation of the granuloma around the larvae [143]. However, it is yet unclear whether it is dependent or not dependent on eosinophils or the interference of the specific IgE antibody [146,167].

The granuloma made around the infective larvae does not kill it, but forms a protection around them. They remain active for many months in the tissues, producing and releasing glycosylated antigenic substances, which induce an immunological response with increase of circulating eosinophils and elevation of IgE and IgG levels [168,169]. It is not known for how long the larvae remain viable, but it is believed that they can remain alive within the granuloma for a relatively long time, around five years [49,55].

Data from the literature show that larvae of Toxocara spp. once in the liver and lungs induce the formation of granulomas around them. In this inflammatory process the number of peripheral leukocytes, circulating and tissue eosinophils, IgE and IgG antibodies, cytokines such as IL-4 and IL-10 are increased [170,171]. Other IL-6 and IL-13 cytokines showed elevated serum levels of Toxocara in infected children [172]. Circulating antibodies of the toxocariasis remain elevated during the time that the larvae remain alive, but as they are eliminated from the body, these substances gradually subside until they reach the basal levels of a normal person.

**DIAGNOSIS, TREATMENT, AND TOXOCARIASIS CONTROL**

**Diagnosis**

The diagnosis of toxocariasis is difficult, since the certainty of parasitism consists in the finding and identification of the larvae in the tissues [77,173].

The diagnosis of VLM is based on the clinical and hematological symptoms and in the biopsy, which allows visualization of the larvae in the eosinophilic granulomas [149,174].

Histological examinations are mostly inconclusive due to the difficulty of finding the larvae in the suspected tissue [49,55,144]. This technique is not used so often because it is invasive and the amount of material obtained is very small. It also may not be able to catch the larva in the fragment used.

Thus, for the diagnosis of VLM should consider the individual’s history as age, reports of geophagy, contact with dogs and cats, clinical symptoms as well as laboratory results of the patient such as increased numbers of circulating and persistent tissue eosinophils, hypergammaglobulinemia and increased concentrations of antibodies: IgM, IgE and IgG. These parameters, although indicative of VLM, can be confused with other parasitic infections such as ascariasis, schistosomiasis, strongyloidiasis, fasciolosis, asthma among others [175,176], therefore, must be differentiated.

The imaging methods used in the diagnosis of VLM consist on locating the granulomas around the larvae of Toxocara. The most commonly used methods are ultrasonography and computerized tomography of the abdomen, where areas in the liver and the lungs occupied by the larvae, etc. are visualized [177]. In the lesions of the central nervous system (CNS), magnetic resonance imaging is utilized, with granulomas being clearly visible [178].

Ocular toxocariasis (OLM) is diagnostic based on funduscopic ophthalmic exams; however, it must be differentiated from other ocular diseases such as retinoblastoma, exudative retinitis (Coat’s disease), trauma and other uveitis [49,55]. These examinations should consider the unilocular process, morphological and topographic aspect of the lesions [179]. Another method used to visualize Toxocara larvae in the eyes is ultrasonography, where it shows the larvae involved by the granuloma and the displacement of the retina [173].

Toxocariasis can be diagnosed by means of serological tests, which allows the detection of specific anti-Toxocara antibodies in infected individuals. Larvae of this helminth activate the humoral immune response and the antibodies commonly detected are specific IgA, IgE, and IgG [180-182].

In the research of these antibodies specific for Toxocara the Immunoenzymatic (ELISA) technic is recommended, using the antigen secreted and excreted by the larvae for the detection of IgG and IgE [144,183]. The use of secreted and excreted antigen from T. canis and T. cati present better specificity than those from somatic antigen Larvae source. However, it does not eliminate the cross reactivity with Ascaris sp. [184,185]. However, studies conducted in Brazil or other developing countries, the sera must be pre-adsorbed with other helminth antigens, particularly with Ascaris spp., to prevent cross-reactions [3,186,187]. It is important to note that the TES-ELISA, associated with the pre-adsorption methodology of sera with somatic antigen of Ascaris sp. (SoAs), is indicated to avoid or minimize cross-reactions with other helminths in tropical polyparasitism, such as Brazil [186].

In addition, IgG2 and IgG4 specific searches for Toxocara spp. have been performed to increase sensitivity [188], and specificity [189] of the serological test, respectively [144], and detection of IgG4 may mean infection active [189].

The ELISA technique used in the immunodiagnosis is the one that presents better sensitivity and specificity in relation to other techniques such as Immunofluorescence, Gel diffusion, Hemagglutination and Intradermoreação [92]. The Western blot technique can be used for the diagnosis of toxocariasis, especially for those patients who present chronic manifestations and have low antibody levels, since it is more sensitive than the ELISA [190].

The biological fluids used in the ELISA tests are serum, cerebrospinal fluid, and intraocular [191]. Such material may also be used in the Western blot technique for VLM and OLM [92].

Other non-specific laboratory findings that may suggest toxocariasis are global and specific leukometry, IgM, IgG, and IgE antibodies at high levels, persistent and high eosinophilia ranging from 50 to 90% of the cells. Stool examinations for this parasite are not used, as the eggs elimination does not occur once hosts do not harbor the adult worms [166,192].

**Treatment**

For the treatment of toxocariasis there is no proven effective therapeutic protocol, even if there are anthelmintics that act on Toxocara spp. larvae. Many authors consider that asymptomatic individuals, who have increased levels of anti-Toxocara and eosinophilia antibodies, should not be treated [145,193].
However, other researchers believe that asymptomatic individuals carrying larvae of this parasite in the tissue should be treated because they are at risk of developing toxocariasis ocular [194,195].

Patients with symptomatic toxocariasis should be treated and the course of the disease be monitored after treatment. There is no recommended treatment scheme in the literature. However, the choice of antiparasite should be directed to the affected organ. Thus, treatment should be directed to VLM or to OLM [91,146].

There are several anthelmintics for the treatment of VLM showing different degrees of safety and efficacy [146]. The most commonly used vermifuges are: albendazole, ivermectin, levamisole, thiabendazole, fenbendazole, mebendazole, diethylcarbamazine [178,196]. Of these seven drugs commonly used in the treatment of the disease, albendazole at the dose of 10 mg/kg/day for five days is the most indicated. It is the safest option with no side effects [83,174]. In addition, depending on the inflammatory clinical picture, an association between the vermifuges and an anti-inflammatory like corticosteroids should be administered to the patient [197,198].

The treatment of patients with VLM as well as administering an anthelmintic, they should get corticosteroids to control the inflammatory lesions from the death of *Toxocara* larvae and release of parasitic antigens [144,199,200].

Many researchers believe that dewormers do not reach the larvae protected by granulomas; therefore, vermifugation is not necessary [201,202]. Another used procedure is photocoagulation in cases of granuloma of the posterior pole, and vitrectomy in cases of peripheral granulomas [49,55,202].

Control

Toxocariasis has a direct association with the presence of dogs and cats in places where humans can get infected such as beaches, parks, and public squares [203,204], and soils of residences in rural or urban area [123,204]. Sandboxes in day care centers, schools, and playgrounds can function as infection sites for children [205,206].

All people can get VLM but children are the most affected because they play on land and sand, coming in direct contact with the infecting eggs [207]. They place their dirty hands as well as objects in the mouth [207]. They also handle food when their hands are contaminated with the eggs of *Toxocara* spp. [49,55,207].

The number of cases of people with toxocariasis described in the literature is low in relation to the high number of dogs and cats infected with *Toxocara*. This is because the disease is underreported, since the symptoms are similar to other helminthiasis and the diagnosis is difficult [201,202].

Some researchers point out that the majority of cases of VLM occur in children with an average age of two years and the cases OLM in older children and adults [208,209]. In these two diseases, there is a strong historical relationship of geophagy and exposure to feces of dogs and cats. Furthermore, animals such as cattle, pigs, chickens are also paratenic hosts for *Toxocara*. So, ingestion of undercooked meat may be a source of infection for humans, particularly in some Asian countries that nurture the habit of eating raw liver of such animals [162,210].

Dogs and cats with a few weeks of age are considered the main source of infection, since they are born with high-acquired transplacental parasite load [68,201,202]. In some regions, the prevalence reaches 100%. Moreover, they eliminate a large number of eggs daily in the soil, which are highly resistant to environmental conditions [109,110].

Existing control measures for toxocariasis are; basic sanitation where dogs’ feces need to be eliminated from the environment frequented by man such as parks, gardens, etc. [109]. Changes of habits such as handling contaminated soil with *Toxocara* eggs with unprotected hands, creating habits of keeping children’s nails short, washing hands before handling food, washing vegetables well before eating them [211,212].

Places where people ingest meat or viscera in the raw state, it is important to educate them about toxocariasis and the need to cook these foods well in order to kill the parasite. Such changes would contribute to reducing the risks of infection [201,202]. The anthelmintic treatment of dogs and cats should be stimulated periodically to reduce soil contamination with the eggs of this ascariid [197,201,202]. It would also be important to induce people who own dogs and cats to collect their animals’ feces and give them proper destination when they are disposed of on land or in areas of public housing [69,115,213].

Another efficient measure to reduce infections by this nematode would be to surround public parks preventing access of dogs and cats, thus reducing contamination of soils with positive feces to *Toxocara* spp. [214-217].

CONCLUSIONS

The clinical symptoms that human individuals with toxocariasis present are indicative of a helminthiasis and dependent on the location where the parasite is. However, none of the clinical manifestations presented by the infected person is specific and indicative of this parasitosis.

The diagnosis of a person with VLM is difficult, since the clinical manifestation of the disease is similar to the symptoms of other diseases. Thus, to differentiate them, it is necessary to carry out the differential diagnosis, and serological tests still are the most indicated.

ACKNOWLEDGMENTS

Eleuza Rodrigues Machado choice of articles and article writing and Luciana Barroso de Araujo Responsible for translation and Revision of English, and Anna Maly de Leão e Neves Eduardo article writing.

REFERENCES


36. Sprent JF. The life history and development of Toxocara cati (Schrank 1788) in the domestic cat. Parasitology. 1956; 46: 54-78.


100. Keegan JD, Holland CV. A comparison of *Toxocara* cati eggs embryonation under controlled conditions in soil and hair. *J Helminthol.* 2013; 87: 78-84.


214. Nijssse R, Mughini-Gras L, Wagenaar JA, Franssen F, Ploeger HW. Environmental contamination with Toxocara eggs: a quantitative approach to estimate the relative contributions of dogs, cats and
foxes, and to assess the efficacy of advised interventions in dogs. Parasit Vectors. 2015; 8: 397.

