

## Conference Paper

# Standard Blood Tests Indicate Changes of Toxocariasis in Carnivores

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**Abstract**

This study presents the main changes in the biochemical and hematological blood parameters of dogs and cats infected with toxocara. Presented data are based on the animal's age and welfare. The authors conclude that the pattern of hematological disorders is most pronounced in young animals and proceeds with signs of general intoxication and sensibilization of the body, hypoxia, anemia and damage to the internal organs (liver and pancreas).

**Keywords:** hematological studies, biochemical studies, toxocariasis, *Toxocara canis*, *T. cati*.

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## 1. Introduction

Many parasitic diseases of carnivores are zoonotic and pose a danger to both animals and humans [1]. The domestic animals are considered the main carriers of toxocariasis [1–3]. Eggs are highly resistant to destruction in the environment and can remain invasive for a long time, creating a threat to public health [4].

Issues of timely diagnosis of toxocariasis in animals remain relevant. An integrated approach to identifying concomitant pathology with intestinal infection and its timely relief is important in animal medicine. One of the main indicators revealing the picture of metabolism in animals is blood [5, 6]. Hematological and biochemical blood parameters can respond with changes to invasions that occur secretly, and to the initial stages of the disease with no clinical diagnosis.

Despite active research in the field of clinical parasitology of domestic carnivores [7–9], changes in the hematological status with toxocariasis is not yet sufficiently studied.

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In addition, to date, the clinical characteristics of toxocariasis infestation in cats have remained largely unexplored.

The aim of the study is to identify the pathological effects on the naturally infected dogs and cats *Toxocara* spp. by changes in clinical, hematological and biochemical blood parameters within the conditions of detention.

## 2. Methods and Equipment

The experiment included animals naturally infected *Toxocara* spp.. Coprological studies of dogs and cats feces were carried out by flotation with a solution of sodium nitrate ( $\text{NaNO}_3$ , SG = 1.32) [10]. Animals were divided into groups according to age and habitat.

The study included 44 dogs with natural *Toxocara canis* infection. 35 out of 44 were divided into groups: 24 from the street and 11 domestic animals, aged 1.5 to 9 months. 9 adult dogs kept at home age from 1.5 years to 5. The control group included 8 puppies of 4–6 months of age and 10 adult dogs (older than 1 year) not having the propagative stages of parasites in the intestine.

There were 23 cats with *T. cati* natural infection selected for the experiment. Of these, 17 kittens are aged 2 to 10 months. Animals were divided into groups according to the habitat: domestic kittens born at home from domestic cats – 5, and kittens picked up from the street or born in shelters – 13. The control group included kittens of 5–6 months of age, free from intestinal nematodes – 10. Adult cats with confirmed intestinal toxocariasis – 6. The control group included 8 adult cats showing no propagative stages of parasites in the intestine.

Blood was taken from animals for analysis in the morning from vena saphena in plastic tubes for hematological analysis of 2.0 ml containing EDTA for biochemical studies of a 3 ml tube. A blood test was performed within 4 hours after taking.

Clinical blood tests were performed on ABC VET hematology analyzer (France). Blood smears were stained hematoxylin-eosin, examined the morphology of blood elements and counted white blood cells. Blood serum was obtained after settling whole blood and retracting a blood clot, followed by centrifugation at 2000 rpm for 10–15 minutes. Samples with hemolysis and chiles were not used. The biochemical (BH) composition of blood serum was studied on a Humalizer Junior automatic biochemical analyzer with the determination of a detailed profile of indicators (24 points).

Data were analyzed in accordance with the guidelines for hematology in dogs and cats A.H. Rebar et al. (2001) [5] and the diagnostic manual and atlas of J.W. Harvey (2012) [6].

The reliability of the results relative to each other and relative to the norm was evaluated by the standard student criterion. Values of  $P < 0.05$  were considered significant. All analyses were performed using SPSS software for Windows version 20.

### 3. Results

The results of clinical, hematological and biochemical blood tests dogs and cats of naturally infection are the following:

Clinical, hematological and biochemical changes in blood serum of dogs naturally infected *Toxocara canis*. The research results are shown in tables 1 and 2.

The average value of the erythrocyte index at home puppies was at the lower limit of the norm of  $5.46 \pm 0.6 \times 10^6/\mu\text{l}$ . In stray puppies the changes were more expressed. Red blood cells –  $4.11 \pm 0.4 \times 10^6/\mu\text{l}$ , hemoglobin –  $101.0 \pm 4.7 \text{ g/l}$  and hematocrit –  $28.77 \pm 1.8 \%$  were reduced. At the upper border were leukocyte counts a  $14.77 \pm 1.1 \times 10^3/\mu\text{l}$ , lymphocytes  $33.9 \pm 2.8 \%$  and eosinophils  $6.5 \pm 1.0 \%$ .

In 75% of the examined stray puppies (18), the level of red blood cells was reduced relative to normal values with a minimum level of  $3.97 \times 10^6/\mu\text{l}$ . In 62.5 % of puppies – 15, hematocrit was reduced to 24.2 % and hemoglobin to 96 g/dl (minimum values). The 50 % of samples (12 puppies) showed the level of lymphocytes was increased (maximum 38 %). The 20.8 % (5 puppies) leukocytosis was  $22.7 \times 10^3/\mu\text{l}$ .

Hematological parameters in adult infected *T. canis* dogs and animals of control groups meet the physiological norm.

According to the results of BH studies indomestic puppies, an increase in the values of aspartate aminotransferase (AST) is observed –  $43.3 \pm 4.9 \text{ IU/L}$ , alanine aminotransferase (ALT) –  $58.1 \pm 8.2 \text{ IU/L}$ , alkaline phosphatase (ALP) –  $85.3 \pm 5.5 \text{ IU/L}$ . Decrease in glucose –  $4.2 \pm 0.56 \text{ Umol/L}$  and sodium –  $145.66 \pm 1.3 \text{ Umol/L}$  to the level of the lower normal values (Table 2).

Stray puppies show an increase in AST values of  $80.1 \pm 9.6 \text{ IU/L}$ , ALT –  $76.4 \pm 11.6 \text{ IU/L}$ , ALP –  $107.9 \pm 17.6 \text{ IU/L}$ , lipases –  $32.2 \pm 7.9 \text{ IU/L}$ . Decrease in glucose –  $3.85 \pm 0.9 \text{ mmol/l}$ , total protein –  $43.4 \pm 6.2 \text{ g/l}$ . Iron ions  $19.6 \pm 4.8 \text{ mmol/L}$ , potassium ions  $4.18 \pm 0.8 \text{ mmol/L}$  and sodium  $144.4 \pm 5.5 \text{ mmol/L}$  were at the lower boundary of the norm.

In adult dogs, when compared with the norm, only AST  $57.6 \pm 28.9 \text{ IU / L}$  was overestimated, and the total protein content in the blood serum was  $60.2 \pm 5.5 \text{ g / L}$  at

TABLE 1: Hematological studies of puppies naturally infected *T. canis*

Indicator	Units	Norm	Puppies		
			Domestic	Stray	Control group
RBC	x10 <sup>6</sup> /μl	5.5–8.5	5.46 ± 0.6	4.11 ± 0.4	8.4 ± 0.5
WBC	x 10 <sup>3</sup> / μl	6.0–14.0	9.27 ± 0.9	14.77 ± 1.1	10.3 ± 1.0
HB	g/per L	120–180	164.5 ± 5.4	101.0 ± 4.7	121.3 ± 5.3
HCT	%	39.0–52.0	49.47 ± 2.1	28.77 ± 1.8	39.9 ± 2.4
ESR	mm/h	1.0–3.5	1.25 ± 0.1	2.60 ± 0.2	3.4 ± 0.3
PLT	x 10 <sup>3</sup> / μl	160.0–430.0	253.0 ± 16.3	343.4 ± 19.2	407.5 ± 20.7
MCV	μm <sup>3</sup>	62.0–77.0	68.0 ± 3.4	69.9 ± 3.3	63.7 ± 3.1
MCHC	%	32.0–38.0	33.0 ± 2.1	35.2 ± 2.4	34.1 ± 2.2
RDW	%	14.0–18.0	16.9 ± 1.5	18.6 ± 1.9	16.23 ± 1.7
MCH	P/kg	21.0–27.0	23.2 ± 1.8	24.62 ± 2.1	26.2 ± 1.9
Leucogram:					
MON	%	2.0–5.0	5.5 ± 0.5	5.24 ± 0.7	2.6 ± 0.2
LYM	%	12.0–30.0	32.5 ± 2.5	33.9 ± 2.8	26.8 ± 1.9
BAS	%	0–1	0 ± 0.0	0 ± 0.0	0 ± 0.0
EOS	%	0–5	5.5 ± 0.8	6.5 ± 1.0	4.5 ± 0.7
Neutrophilic granulocyte:					
A band cell	%	0–3	1.5 ± 0.09	1.27 ± 0.12	1.75 ± 0.17
Segmented	%	60–70	53.0 ± 3.6	53.4 ± 3.4	64.5 ± 4.8

the lower boundary. Clinical, hematological and biochemical changes in blood serum of cats naturally infected *Toxocara cati*. The results are shown in tables 3 and 4.

According to the results of hematological studies in domestickittens, the average value of the erythrocyte index was at the lower limit of the norm of  $5.4 \pm 1.2 \times 10^6/\mu\text{l}$ , the level of leukocytes was overestimated for  $19.4 \pm 3.8 \times 10^6/\mu\text{l}$ . The changes in stray kittens were more expressed. Red blood cells are underestimated –  $4.3 \pm 1.0 \times 10^6/\mu\text{l}$ , hemoglobin –  $62.0 \pm 4.8 \text{ g/l}$ , the average concentration of hemoglobin in the red blood cell is  $24.0 \pm 2.0 \%$ . At the upper border, leukocyte counts are  $27.1 \pm 3.3 \times 10^3/\mu\text{l}$  and the width of the distribution of red blood cells is  $23.6 \pm 2.8 \%$  (Table 3).

Hematologic indicators in adult cats infected *T. cati* and animals of control groups were within the physiological norm.

An increase in AST values is observed according to the results of the studies in domestic kittens –  $46.3 \pm 9.4 \text{ IU/L}$ , ALT –  $60.1 \pm 11.4 \text{ IU/L}$ . As for stray kittens, an increase in AST values is observed –  $80.1 \pm 16.6 \text{ IU/L}$ , ALT –  $76.4 \pm 13.6 \text{ IU/L}$ , and alkaline phosphatase –  $107.9 \pm 30.6 \text{ IU/L}$ . The decrease in total protein is  $42.4 \pm 11.2 \text{ g/l}$  and CPK –  $134.4 \pm 41.4 \text{ IU/L}$ .

TABLE 2: Biochemical studies serum of puppies naturally infected *T. canis*

Indicators	Units	Norms	Puppies		
			Domestic	Stray	Control group
Total bilirubin	Umol/L	3.5–13	8.7 ± 2.2	7.7 ± 2.6	6.8 ± 2.6
Direct bilirubin	Umol/L	0	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0
Aspartate transaminase (AST)	IU/L	0–40	43.3 ± 4.9	80.1 ± 9.6	27.3 ± 9.6
Alanine transaminase (ALT)	IU/L	0–55	58.1 ± 8.2	76.4 ± 9.6	35.6 ± 9.4
AST/ALT ratio		0.75–1.4	0.97 ± 0.1	1.21 ± 0.2	1.10 ± 0.3
Urea	Umol/L	3.1–8.5	6.25 ± 1.1	6.14 ± 1.5	5.68 ± 1.1
Creatinin	Umol/L	55–106	81.3 ± 11.7	93.1 ± 17.3	82.8 ± 13.9
Protein	g per L	60–72	53.1 ± 3.1	43.4 ± 6.2	67.2 ± 3.2
Albumen	g per L	26–39	31.8 ± 3.0	30.2 ± 7.4	31.4 ± 2.8
Alkaline phosphatase	IU/L	0–75	85.3 ± 5.5	107.9 ± 17.6	46.3 ± 11.7
Alpha-amylase	IU/L	0–1800	895.55 ± 361.3	1104.58 ± 35.1	912.40 ± 26.7
Lipase	IU/L	0–30	19.9 ± 6.7	32.2 ± 7.9	20.5 ± 5.1
Glucose	Umol/L	4.4–6.5	4.2 ± 0.56	3.85 ± 0.9	5.38 ± 0.6
Lactate dehydrogenase	Umol/L	0–350	195.9 ± 22.6	247.8 ± 23.0	248.6 ± 24.1
Cholesterol	Umol/L	2.9–6.0	4.36 ± 0.8	5.33 ± 11.8	4.37 ± 0.8
Triacylglycerol	Umol/L	0.45–1.1	0.81 ± 0.1	0.77 ± 0.1	0.83 ± 0.1
Creatine kinase (CK)	IU/L	32–154	107.7 ± 33.9	184.4 ± 21.9	120.3 ± 21.2
Potassium	Umol/L	4.2–5.5	4.84 ± 0,3	4.18 ± 0.8	4.99 ± 0.2
Sodium	Umol/L	145–150	145.6 ± 1.3	144.4 ± 5.5	147.2 ± 1.0
Phosphorus	Umol/L	1.1–1.8	1.44 ± 0.1	1.49 ± 0.3	1.48 ± 0.2
Calcium	Umol/L	2.3–2.8	2.44 ± 0.1	2.50 ± 0.2	2.48 ± 0.1
Iron ions	Umol/L	19.8–32	25.2 ± 2.8	19.6 ± 4.8	26.8 ± 3.8
Magnesium	Umol/L	0.86–1.07	0.93 ± 0.2	0.88 ± 0.1	0.95 ± 0.05

P &lt;0.05

Potassium ions —  $3.58 \pm 0.5$  Umol/L and sodium —  $144.4 \pm 6.5$  Umol/L were at the lower boundary of the norm (Table 4).

#### 4. Discussion

The red blood cells, hemoglobin and hematocrit decrease in young animals indicates the development of anemia. An increase in the concentration of folates and a decrease in cobalt-containing biologically active substances (vitamin B12) are used to assess a decrease in the functioning of the mucous membrane of the proximal small intestine [11, 12]. The study suggests the mechanism of the development of anemia is due to the absorption capacity violation of the mucous membrane invaded with toxocara.

TABLE 3: Hematological indicators of kittens infected *T. cati*

Indicators	Units	Norms	Kittens		
			Domestic	Stray	Control group
RBC	$\times 10^6/\mu\text{l}$	5.5–10	$5.4 \pm 1.2$	$4.3 \pm 1.0$	$8.4 \pm 2.0$
WBC	$\times 10^3/\mu\text{l}$	5.5–19.5	$19.4 \pm 3.8$	$27.1 \pm 3.3$	$12.3 \pm 2.8$
HB	g/per L	80–150	$101 \pm 5.5$	$62 \pm 4.8$	$121 \pm 6.8$
HCT	%	30–47	$31.3 \pm 3.2$	$46.7 \pm 3.6$	$39.9 \pm 3.4$
ESR	mm/h	0–13	$10.9 \pm 1.3$	$12.4 \pm 1.6$	$3.4 \pm 2.0$
PLT	$\times 10^3/\mu\text{l}$	300–800	$355 \pm 18.6$	$521 \pm 24.1$	$427 \pm 20.2$
MCV	$\mu\text{m}^3$	43–53	$44.3 \pm 2.0$	$43.5 \pm 2.1$	$43.7 \pm 1.9$
MCHC	%	30–36	$34.9 \pm 4.6$	$24.0 \pm 2.0$	$34.1 \pm 2.9$
RDW	%	14.0–18.0	$16.9 \pm 2.1$	$23.6 \pm 2.8$	$16.2 \pm 2.2$
MCH	P/kg	14–19	$15.3 \pm 1.8$	$15.6 \pm 2.0$	$17.0 \pm 1.9$
Leucogram:					
MON	%	1–4	$1 \pm 0.06$	$3 \pm 0.2$	$1 \pm 0.04$
LYM	%	20–55	$22 \pm 0.6$	$16 \pm 0.4$	$36 \pm 0.8$
BAS	%	0–1	$0 \pm 0.0$	$0 \pm 0.0$	$0 \pm 0.0$
EOS	%	2–12	$6 \pm 0.2$	$7 \pm 0.3$	$5 \pm 0.2$
Neutrophilic granulocyte:					
A band cell	%	0–3	$7 \pm 0.4$	$15 \pm 0.6$	$2 \pm 0.1$
Segmented	%	35–75	$64 \pm 2.8$	$59 \pm 2.5$	$58 \pm 2.4$

P < 0.05

Long-term B12 deficiency is a serious disease. It appears within the development of megaloblastic anemia and/or neurological disorders. The disease needs a serious treatment, otherwise it leads to the death of the animal [13]. Cats react especially sensitively and hard to a deficiency of cobalt-containing biologically active substances. Therefore, it is important to prescribe parenteral administration of cobalamin in a timely manner [14].

When registering anemia in animals aged up to a year the toxocarasis needs to be excluded. On the other hand, with the described diagnosis of this disease, it is important to prescribe hematological studies additionally and cut down the development of anemia.

An increase in the number of leukocytes and lymphocytes is provoked by the migration of larvae and causes an organism's response to tissue trauma. The increase in the number of eosinophils is obviously due to the response to the products of the metabolism of nematodes in the form of an allergic reaction. It is believed that peripheral blood eosinophilia, although not specific for toxocarainfection, is associated with the process of active migration of larvae [15].

TABLE 4: Biochemical studies serum of kittens naturally infected *T. cati*

Indicators	Units	Norms	Kittens		
			<i>Domestic</i>	<i>Stray</i>	<i>Control group</i>
Total bilirubin	Umol/L	0–10	4.6 ± 1.8	8.4 ± 2.2	4.6 ± 1.6
Direct bilirubin	Umol/L	0–4,9	0.00 ± 0.0	0.00 ± 0.0	0.00 ± 0.0
Aspartate transaminase (AST)	IU/L	12–47	46.3 ± 9.4	80.1 ± 8.6	36.8 ± 5.4
Alanine transaminase (ALT)	IU/L	19–60	60.1 ± 8.9	76.4 ± 9.6	48.1 ± 3.1
AST/ALT ratio		1.1–1.3	1.0 ± 0.03	1.27 ± 0.08	1.24 ± 0.2
Urea	Umol/L	5.4–12.1	8.55 ± 2.3	5.10 ± 1.5	7.85 ± 1.7
Creatinin	Umol/L	70–165	98.6 ± 18.7	103.6 ± 23.4	72.1 ± 14.5
Protein	g/ per L	56–77	63.7 ± 13.1	42.4 ± 11.2	64.4 ± 14.8
Albumen	g/ per L	25–39	27.8 ± 14.0	29.1 ± 16.5	33.0 ± 17.8
Alkaline phosphatase	IU/L	30–130	44.3 ± 11.5	107.9 ± 30.6	76.3 ± 18.4
Alpha-amylase	IU/L	500–1250	436.5 ± 38.3	1146.4 ± 45.5	721.1 ± 36.7
Lipase	IU/L	0–30	23.4 ± 8.1	18.8 ± 7.5	24.8 ± 6.5
Glucose	Umol/L	3.3–6.6	4.0 ± 0.6	3.5 ± 0.4	5.0 ± 0.5
Lactate dehydrogenase	IU/L	35– 500	213.4 ± 20.2	208.1 ± 21.4	313.1 ± 30.1
Cholesterol	Umol/L	1.9– 3.9	3.6 ± 0.6	2.3 ± 1.2	3.7 ± 0.9
Triacylglycerol	Umol/L	0.38–1.1	0.62 ± 0.28	0.97 ± 0.31	0.71 ± 0.26
Creatine kinase (CK)	IU/L	180–814	254.7 ± 23.1	134.4 ± 41.4	218.0 ± 22.7
Potassium	Umol/L	3.6–5.5	4.35 ± 0.6	3.58 ± 0.5	4.27 ± 0.4
Sodium	Umol/L	144–158	146.5 ± 4.1	144.4 ± 6.5	149.2 ± 5.1
Phosphorus	Umol/L	2.1–2.8	1.53 ± 0.32	1.84 ± 0.56	1.53 ± 0.44
Calcium	Umol/L	2.0–2.7	2.34 ± 0.1	2.12 ± 0.1	2.24 ± 0.1
Iron ions	Umol/L	12.0–39.0	25.6 ± 2.0	18.9 ± 1.6	22.8 ± 2.3
Magnesium	Umol/L	0.8–1.15	0.98 ± 0.06	0.89 ± 0.04	0.91 ± 0.07

In a biochemical blood test, an increase in AST, ALT and alkaline phosphatase is observed. This is due to the fact that the migration of *Toxocara* larvae passes through parenchymal organs, primarily, through the liver. An increase in enzymes is directly proportional to the damage to hepatocytes. The decrease in total protein is explained by the suppression of protein biosynthesis by the liver and insufficient absorption of the mucous membrane of the small intestine [16]. Impaired absorption in the intestine also leads to a decrease in total protein, iron, potassium and sodium ions.

According to Kondrakhin I.P. (1985), hypoglycemia appears as a result of disordered nervous system and the influence of catecholamines ejected in blood within a decrease in glucose concentration [17].

An increase in lipase indicates an inflammatory process in the pancreas. With inflammation of the duodenum, the outflow of pancreatic secretion is disrupted, as a result

of which it accumulates in the pancreas itself, causing damage to it, leading to an inflammatory reaction.

The outlined general image of hematological disorders is mostly spread among puppies. In this age group the toxocariasis infestation proceeds with symptoms of general intoxication and sensibilization of the body, hypoxia, anemia and damage to internal organs (liver, pancreas).

As for adult dogs, there are no specific significant changes.

When testing groups of kittens, the level of red blood cells is underestimated and leukocytes are overestimated. In stray kittens, hemoglobin and the average concentration of hemoglobin in the red blood cell are underestimated. The result is similar to the result of the group with puppies.

Biochemical studies of kittens showed an increase in AST and ALT in all groups. In stray kittens: alkaline phosphatase is also overestimated, total protein and creatinine phosphokinase, potassium and sodium ions are reduced. In adult cats invaded by toxocara: blood counts are normal for this species.

The veterinary practice interpret the changes described above as a digestive disorder of unknown etiology, a viral infection or intoxication of the body [17]. The data presented in the study show that a similar pathological picture, especially in young animals, can be caused by toxocariasis infestation. Its exclusion requires a helminth-coprological study.

According to the observations, puppies with good nutrition when naturally invaded with toxocara the changes in blood tests become gradually normalizing. It is explained due to the compensation processes of the body.

The data obtained by us coincide with the studies of A. Mikhin. (2004), Demina V.A. (2007), Akimova S.A. (2008). In the cited works, data on a single experimental infection of puppies with high doses of invasive eggs are presented [7–9]. In vivo, infection, as a rule, has a more gradual nature and the possibility of reinfestation. Thus, the study of the toxocariasis effect on the animal's organism was studied mainly in puppies. The resources did not provide any data on the effects of toxocariasis in cats.

## 5. Conclusion

Generalizing the group of animals aged up to one year old (puppies and kittens), the study presents the following: the toxocariasis occurs with signs of general intoxication and sensibilization of the body, hypoxia, anemia and damage to the internal organs (liver and pancreas). When there are symptoms and diagnosis of toxocariasis revealed, it is



important for animals to prescribe hematological test and cut down the development of anemia as well as other concomitant pathologies. In the opposite, toxocariasis infestation can cause anemia by blood tests in young animals. Its exclusion requires helminth-coprolological examination..

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