Haematological profile in *Rattus norvegicus* during experimental cysticercosis

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Abstract The present study pertains to the haematological examination of the rats experimentally infected with cysticercosis which revealed significant alterations in several parameters. Haemoglobin concentration was observed to be significantly lower in later stages of cysticercosis with respect to the control rats whereby 36% decline was observed at 60 days post infection (pi). These changes in haemoglobin were more or less parallel to those recorded for RBC counts with 18% reduction at 60 days pi. A significant rise was noticed in the erythrocyte sedimentation rates throughout the course of infection with a maximum increase (42%) at 60 days pi whereas a decline in packed cell volume as the cyst development was also evident. Leucocytosis was observed at 10, 30 and 60 days post infection with 2.6, 2.5 and 1.5 fold increase, respectively. Moreover, haematological indices were prominently altered by cysticercosis indicating macrocytic hypochromia in advance stages of the cyst development.

Keywords Cysticercosis · Haematological · *Rattus norvegicus* · Days post infection

Introduction

Cysticercosis is a major public health problem in developing countries caused by the cystic forms of various tapeworms (Preet and Prakash 2000a; Gracia and Del

Brutto 2003; Prasad et al. 2008a). Neurocysticercosis is clinically the most important manifestation of *Taenia* infection with estimated 50 million epileptic seizures in poor countries (WHO 1983; Engels et al. 2003; Prasad et al. 2008b) and cause 50,000 deaths annually worldwide. Recent reports indicate that neurocysticercosis should be suspected in every child seizures (Sharma et al. 1995). Although man is the only definitive host for the disease with taeniasis, man and pig or other vertebrates may serve as a secondary host by harbouring the larval stages of this parasite through ingestion of the eggs through environment. The eggs following oral administration reach the intestine where the oncospheres are liberated. These larvae then migrate to the vital organs including brain, become lodge there and develop a protective covering known as cyst (Cook et al. 1981). These obligatory larval cysts may cause an appreciable damage to the host tissues which can be reflected in the body fluids. The present attempt was therefore, undertaken to gain insight regarding the fluctuations in several haematological elements during experimentally induced cysticercosis in a laboratory animal *Rattus norvegicus* with the progression of cyst development for a period of 2 months when they become infective for their final host, the cat.

Materials and methods

Thirty rats weighing 40–45 g (procured from Central Drug Research Institute, Lucknow) were housed in plastic cages with standard rodent pellets (Hindustan Lever Limited, Ghaziabad) and water ad libitum. A batch of 18 rats was infected orally with 1000 ± 50 *Taenia taeniaeformis* eggs via a feeding needle (20-gauge) attached to a tuberculin syringe. They were sacrificed as per the guidelines of INSA

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(2000). In the groups of three rats each at 10, 20, 30, 40, 50, and 60 days post infection (pi). Remaining 12 were considered as control and were killed on alternate days from those on which infected rats were killed.

Blood was collected directly from the heart with the help of a heparinised syringe. The haemoglobin concentration was determined by calorimetric method. Improved Neubauer counting chamber was used for red blood corpuscles (RBC) and total leucocyte count (TLC) utilizing Hayem's fluid and Turk's solution as diluting solutions, respectively. Leishman's stain was used for differential leucocyte counts (DLC) whereas, erythrocyte sedimentation rate (ESR), packed cell volume (PCV) and various haematological indices were determined using Wintrobe's manual (Wintrobe 1976). Data on haematological studies were statistically calculated using GraphPad software and student's *t* test was employed to establish levels of significance.

Results and discussion

Blood has an important physiological bearing on the general metabolism of the body (Preet and Prakash 2000b) and it was expected to reflect the pathophysiological reactions caused by the cysticercosis. The present results revealed that larval *Taenia taeniaeformis* infection affects various elements of the blood in albino rats (Table 1). The haemoglobin makes up the greatest share of the solid contents of the erythrocytes and performs the vital functions of the

transportation of the oxygen and maintenance of acid–base balance. The anaemia so characteristic of a helminth infection (Baker and Douglas 1966; Sinha 2000; Gill et al. 2007) is exhibited here by reduced amount of haemoglobin in infected rats whereby 36% decline was observed at 60 days pi. The enumeration of red cells is one of the prerequisites in the understanding of the haematological picture in parasitic infections. A decrease in RBC counts was noticeable in infected rats at later stages of infection (18% reduction at 60 days pi). Significantly low values of RBCs may be accounted for their low haemoglobin concentration (Waweru et al. 1999). ESR denotes the presence of disease but not its severity while the PCV represents the concentration of erythrocytes in blood. Significant rise can be noticed in the ESR value throughout the course of infection with a maximum increase (42%) at 60 days pi and likewise a constant decline in the PCV was evident which is in conformity with the findings of previous workers (Gill et al. 2007; Hasanpour et al. 2008).

During investigation, TLC increased abruptly at 10, 30, and 60 days pi (2.6, 2.5 and 1.5 fold increase, respectively) and this reflected absolute increases in circulating neutrophils and lymphocytes (Fig. 1). The short period of intense neutrophilia probably resulted from a transient stimulation of neutrophil release from the bone marrow pool but the fate of these cells is not clear at all. However, it is believed that they appear early in response to infection and usually immature form of neutrophils are seen. Sometimes, neutrophilia occurs in response to tissue necrosis which occurred here at host parasite interface in the liver and

Table 1 Blood picture during experimental cysticercosis in *Rattus norvegicus*

Blood parameters	Groups	Days post infection					
		10	20	30	40	50	60
Hb conc. (gm/dl)	Control	12.96 ± 0.07	13.34 ± 0.11	13.92 ± 0.45	14.28 ± 0.12	15.68 ± 0.10	16.78 ± 0.21
	Expl	13.12 ± 0.08	13.26 ± 0.15	13.50 ± 0.10	13.08 ± 0.21*	12.96 ± 0.26**	12.36 ± 0.19***
RBC (×10 ⁶ /mm ³)	Control	6.50 ± 0.08	6.72 ± 0.09	7.04 ± 0.07	7.30 ± 0.08	8.16 ± 0.07	8.54 ± 0.17
	Expl	6.82 ± 0.05	6.98 ± 0.07	6.82 ± 0.07	6.96 ± 0.07*	7.14 ± 0.13*	6.98 ± 0.11**
TLC (×10 ³ /mm ³)	Control	11.02 ± 0.33	13.32 ± 0.21	10.46 ± 0.20	9.46 ± 0.20	11.04 ± 0.14	14.46 ± 0.16
	Expl	29.00 ± 0.15***	15.72 ± 0.21**	26.04 ± 0.13***	11.08 ± 0.12**	15.08 ± 0.12***	23.04 ± 0.09***
ESR (mm/hr)	Control	0.57 ± 0.04	0.64 ± 0.06	0.86 ± 0.09	1.34 ± 0.15	1.38 ± 0.16	1.73 ± 0.08
	Expl	0.83 ± 0.07*	1.12 ± 0.16*	1.51 ± 0.14*	2.34 ± 0.19*	2.40 ± 0.14*	2.46 ± 0.16*
PCV (%)	Control	42.40 ± 0.75	43.60 ± 1.17	44.40 ± 1.60	44.80 ± 1.02	46.80 ± 0.49	48.00 ± 0.89
	Expl	44.40 ± 0.75	44.80 ± 1.36	50.40 ± 0.75*	52.40 ± 1.44*	52.60 ± 1.78*	52.20 ± 1.49
MCV (μ ³)	Control	65.28 ± 1.52	64.93 ± 1.97	63.07 ± 2.23	61.39 ± 1.45	57.35 ± 0.39	56.30 ± 1.57
	Expl	65.12 ± 1.21	64.15 ± 1.56	73.94 ± 1.47*	75.32 ± 2.25*	73.78 ± 3.01*	74.93 ± 2.95*
MCH (μg)	Control	19.35 ± 0.70	19.86 ± 0.23	19.78 ± 0.18	19.37 ± 0.32	19.22 ± 0.20	19.67 ± 0.36
	Expl	19.24 ± 0.21	18.99 ± 0.18*	19.80 ± 0.27	18.79 ± 0.31	18.16 ± 0.39	17.73 ± 0.43*
MCHC (%)	Control	30.59 ± 0.42	30.66 ± 0.64	31.49 ± 1.05	31.92 ± 0.49	33.51 ± 0.31	34.98 ± 0.40
	Expl	29.57 ± 0.45	29.69 ± 0.86	26.80 ± 0.36*	25.02 ± 0.67**	20.00 ± 0.74***	23.65 ± 0.69***

Values represent mean ± SE of 3 samples; * *P* < 0.05, ** *P* < 0.001, *** *P* < 0.0001

Fig. 1 Variations in lymphocyte and neutrophil counts during experimental cysticercosis

Fig. 2 Variations in eosinophil and monocyte counts during experimental cysticercosis

other tissues. This overall increase in the TLC serves as a defense phenomena which is a characteristic of helminth infection (Hasanpour et al. 2008). A perusal of existing literature revealed that cysticercosis may result in eosinophilia in peripheral blood (Vanajakshi et al. 1984; Sinha 2000; Hasanpour et al. 2008). In our study peaks of eosinophilia occurred at 10, 30, and 60 days pi (Fig. 2). At the same time, eosinophils were observed accumulating at the interface between the metacystode and the developing

capsule. It seems likely that some chemotactic mechanism attracts eosinophils to the area surrounding the parasite at this stage and that the mechanism operates to a lesser extent throughout the subsequent course of infection.

The haematological indices are used to define the size and haemoglobin content of the red blood cells. They consist of MCV, MCH and MCHC and used as an aid in differentiating anaemias. Presently, calculation of these indices indicated a macrocytic hypochromic anaemia in the infected rats. Since, blood takes part either directly or indirectly in all biochemical processes of the body, it is obvious to expect alterations in haematological parameters as a result of manifestations of the disease in hosts. Although, present investigation provides an interesting evidence for macrocytic anaemia in infected rats which can be considered as a diagnostic measure for such infections, sero-epidemiological studies may be conducted for the control of the disease at large.

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Conflict of interest None.

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