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Hematological Changes during Chronic *Toxoplasma gondii* Infection in Pregnant Women in Makkah, Saudi Arabia

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Abstract: *Toxoplasma gondii* is an obligate parasite and intracellular protozoans infect all kinds of animals and humans. The aim of the present study was to determine whether there was any effect on complete blood count parameters in the blood of pregnant women. A case-control study was performed in pregnant women divided into two groups according to their age: group one (17-27 years) and group two (28-45 years). A total of 130 pregnant women participated in the present study. A questionnaire was used to collect the data. IgG and IgM ELISAs were performed to detect antibodies against *T. gondii* and differentiate between acute and chronic diseases. The results showed a significant change in monocytes in the younger infected group (p<0.05). In the older infected group, WBCs were significantly reduced (p<0.05), while neutrophils also decreased significantly in the infected group (p<0.05). Moreover, the association between decreased HCV and infection with *T. gondii* was significant (p<0.05). A relationship between the decrease in MCH and *T. gondii* infection was found in group two (p<0.05). An increase in MPV and infection with *T. gondii* in group two was found to be significantly associated (p<0.05). In the current study, anemia was associated with chronic *T. gondii* infection.

Keywords: Toxoplasmosis, Hematological Changes, Pregnancy

Introduction

Toxoplasmosis is a severe and life-threatening parasitic infection caused by *Toxoplasma gondii (T. gondii)*. *T. gondii* is an obligate parasite and intracellular protozoan classified under the phylum Apicomplexa and it has a complicated life cycle consisting of an asexual phase found in all hosts and a sexual phase present only in cats, which are the definitive host (Frenkel, 1970). The transmission modes of *T. gondii* parasites, in general, are ingestion of uncooked or raw meat, water contaminated with oocysts from infected cat feces and infected organ transplant and blood transfusion (Singh, 2003; Robert-Gangneu and Darde, 2012). Congenital toxoplasmosis occurs through the transmission of parasites from the infected mother's placenta to the unborn fetus during pregnancy and critical medical complications occur in infected newborn babies, such as brain damage, retinochoroiditis and stillbirth (Singh, 2003; 2016).

Infection with *T. gondii* occurs worldwide and the disease is widely distributed. Some serological studies confirmed that one-third of the world population has had the infection (Tenter *et al*., 2000; Mahmood, 2016).

The tissue cysts of *T. gondii* have a high affinity for neural and muscular tissues. They are located predominantly in the central nervous system, eye and skeletal and cardiac muscles. However, to a lesser extent, they may also be found in visceral organs, such as the lungs, liver and kidneys (Dubey, 1993; Dubey *et al*., 1998; Tenter *et al*., 2000). In the acute phase and latent infection reactivation, the tachyzoite of the parasite is seen free in the blood and it can be located in every organ (Guruz and Ozcel, 2007; Mahmood, 2016).

Several types of research have been performed on different clinical forms of the disease and the relationship between toxoplasmosis and hepatomegaly and some abnormal liver function tests has been detected (Jacobs, 1970; Mahmood, 2016). Additionally, the involvement of the kidney during infection with *T. gondii* leads to impairment of kidney function (Mahmood, 2016). In parasitic invasions, lymphocytes synthesize many specific cytokines that play a significant role in the pathogenesis of parasitic diseases. IL-10 and IL-12 control the type of

immune response (Zaccone *et al*., 2006; Lang *et al*., 2007; Mahmood, 2016).

The effects of toxoplasmosis on the blood during pregnancy have been detected in a few studies. Some research found no changes in blood components, while other studies found increases in PCV and Hb, particularly during pregnancy (Mahmood, 2016).

Therefore, the current research was conducted to determine whether there was any effect-on the complete blood count of pregnant women in Makkah Al Mukaramah.

Material and Methods

The present study was a case-control study conducted in pregnant women to determine the changes in blood components between pregnant women chronically infected with toxoplasmosis and noninfected pregnant women serving as controls. All the samples were negative for *Toxoplasma* IgM and 65 samples were positive for *Toxoplasma* IgG. The study was performed according to the guidelines of ethics and scientific research of the Faculty of Public Health and Health Informatics at Umm Al-Qura University and approved by the committee. All participants provided written informed consent.

All the participants were Saudi. Approximately 129 pregnant women aged between 17-45 years, with a mean age of 29.81±6.3 years, agreed to participate in the current study and signed the consent form; for those participants whose age was below 18 years, a consent form was obtained from parents or legal guardians. Approximately 84.5% of the participants live inside Makkah. Some of the participants (34.1%) had higher education and few of them were uneducated (3.1%), while 14% were working. The mean height of the participants was 155±5.2 cm and the mean weight was 69.9±19.4 kg. The most common blood grouping was O positive (34.1%) and 32.6% of participants experienced an abortion.

Blood samples were collected from 130 participants; the blood samples were divided into two tubes: Tube one for a CBC and tube two for obtaining serum to run IgG and IgM ELISAs.

The tests were carried out according to the manufacturer's instructions (Toxo IgM ® and IgG ®, Human, Germany). All sera collected from the pregnant women who participated in the current study were detected against *T. gondii* IgM and IgG. One sample was positive for IgM and was excluded from the present study. The other 129 samples were divided into two groups according to IgG results and the negative group was used as a control.

The hemoglobin concentration of the whole blood, counts, sizes and blood cell classifications were measured using two techniques: Flow cytometry and absorption spectrophotometry.

SPSS software (version 20) was used to enter the data collected and for analysis. A t-test was used to detect significance. A p-value less than 0.05 was considered significant.

Results

A total of 129 samples were split into two groups according to age. Each group was divided into two groups according to the IgG results. The findings of the Toxo IgG test in both groups are presented in Table 1.

The younger pregnant women who participated in the current study showed a normal Complete Blood Count (CBC) in the infected group compared with that in the uninfected group, except for one parameter. In the younger infected group, monocytes were increased significantly ($p<0.05$) (Table 2).

In the other age group, which was older than group one, there were significant differences in some blood parameters, including White Blood Cells (WBCs), neutrophils, Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH) and Mean Platelet Volume (MPV) (Table 2).

According to the observations presented in Table 2, monocytes were significantly increased in group one compared with those in the control group at similar ages ($p<0.05$). In the other age group, the results shown in Table 2 demonstrate that in the infected group, WBCs decreased significantly ($p<0.05$), while neutrophils were also reduced significantly in the infected group ($p<0.05$). However, the association between decreased HCV and infection with *T. gondii* was significant ($p<0.05$). A relationship between the decrease in MCH and *T. gondii* infection was found in group two ($p<0.05$). An increase in MPV and infection with *T. gondii* in group two was found to be significantly associated ($p<0.05$).

Table 1: Detection of anti-*T. gondii* IgG in patient groups

	Toxo IgG		
Age group years	Positive (Infected Group)	Negative (Control Group)	Total
17-27	21	31	52
28-45	44	33	77
Total	65	64	129

Table 2: The level of hematological parameters in pregnant women with toxoplasmosis and controls

	Group one (17-27 years old)			Group two (28-45 years old)		
Parameter	Infected Women	Controls	P- value	Infected Women	Controls	P- value
WBC	8864±318 mm^3	8305±233 mm^3	0.53	8969±252 mm^3	10757±368 mm^3	0.01
NEU	5939±317 mm^3	5293±190 mm^3	0.50	5384±245 mm^3	7375±292 mm^3	0.017
LYM	2193±537 mm^3	2310±672 mm^3	0.61	2482±580 mm^3	2882±929 mm^3	0.085
MONO	657±21 mm^3	497±11 mm^3	0.015	588±19 mm^3	614±18 mm^3	0.64
EOS	117±6 mm^3	158±14 mm^3	0.36	204±2 mm^3	231±2 mm^3	0.67
BASO	89±3 mm^3	99±4 mm^3	0.52	105±9 mm^3	99±4 mm^3	0.8
RBC	4.5±0.46 µL	4.6±0.45 µL	0.48	4.5±0.45 µL	4.3±0.5 µL	0.13
HGB	11.7±1.1 g/dl	12.0±1.4 g/dl	0.47	11.3±1.3 g/dl	11.6±1.2 g/dl	0.28
HCT	36.2 ±3.3%	37.3±3.6%	0.32	35.3±3.3%	36.3±3.7%	0.27
MCV	80.7±9 fL	79.0±14 fL	0.59	79.8±7.6 fL	85.5±6.1 fL	0.003
MCH	26.1±3.4 pg	26.2±3.8 pg	0.95	25.5±3.4 pg	27.4±2.1 pg	0.02
MCHC	31.8±2.8 g/dL	32.1±1.6 g/dL	0.69	31.9±2 g/dL	32.1±1 g/dL	0.67
RDW	14.4±1.7%	14.1±2.7%	0.74	14.9±3.1%	13.4±1.3%	0.056
PLT	263.4±104 µL	245.7±52 µL	0.49	230.1±68 µL	247±50 µL	0.28
MPV	6.9±1.3 fL	7.1±1.4 fL	0.83	7.9±1.5 fL	6.7±1 fL	0.003

mm^3: Cubic millimeter; µL: microliter; g/dl: Grams Per Decilitre; %: Percent; fL: femtoliters; pg: picogram

Discussion

The current study demonstrated the relationship between chronic *T. gondii* infection and the Complete Blood Count (CBC) in pregnant women in different age categories. The results obtained from the present study showed significant differences in some blood components, while no change was detected in other components.

An evaluation of the effects of the disease on the prognosis can be made on the basis of the clinical features and laboratory data, such as biochemical and hematological parameters (Matanovic *et al*., 2007). Therefore, the current study was performed to assess chronic *T. gondii* infection in pregnant women.

In the present study, a significant difference was detected in white blood cells in the second group, which consisted of women between 28 and 45 years of age. A similar result was found in another study performed by Mahmood (2016) in Tikrit city, Iraq (Mahmood, 2016). The results obtained in both studies showed a decrease in WBCs, perhaps due to the fact that toxoplasmosis affects WBCs (Ajioka *et al*., 2002).

The result also showed a significance association between infection and decreased neutrophils in the second group. In a study performed in gerbils infected with *T. gondii*, an increase in neutrophils was observed (Atmaca *et al*., 2015). On the other hand, the increase in monocytes was significant in group one. A similar result was obtained in sheep in a case control study (Castello *et al*., 2018). According to the observations obtained in the present study, chronic infection by *T. gondii* increased monocytes in younger pregnant women but decreased neutrophils in older pregnant women.

The results presented significant differences in MCV in the infected pregnant women in group two compared with that in the women in the control group. Moreover, the results were similar to those of a recent study conducted in Libya in women who experienced an abortion (Hassen *et al*., 2019) and in a study conducted in Iraq (Zakaria, 2013). Low MCV is associated with microcytosis anemia, which facilitates the relationship of *T. gondii* with microcytosis in pregnant women.

The results also confirmed the relationship between chronic *T. gondii* infection and decreased MCH. The MCH value refers to the average quantity of hemoglobin present in a single red blood cell. Anemia can occur in this case as hemolytic anemia.

Compared with that in the control women, MPV was increased in pregnant women and associated with chronic *T. gondii* infection. A high MPV means that the platelets are larger than average and implies that the body produces more platelets than usual, which may be caused by chronic *T. gondii* infection, which increases platelet production.

Conclusion

Chronic *T. gondii* infection in older pregnant women was associated with anemia. The anemia resulting from chronic *T. gondii* infection needs additional investigation to determine whether the reasons included iron deficiency or chronic disorders.

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Ethics

Ethical approval was obtained from the committee of ethical and scientific research in the Faculty of Public Health and Health Informatics, Umm Al-Qura University.

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