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Interleukins profile among patients infected with ocular toxoplasmosis in Baghdad city, Iraq

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Abstract

Toxoplasma gondii is an intracellular organism that causes serious illness in both animals and people all over the world. It is often asymptomatic, but in immunocompromised people, it can cause pneumonia, ocular toxoplasmosis, and even mis1carriages. Research into *T. gondii* in cancer patients is extensive. However, no one has yet discussed the implications of widespread parasite infection in this population. Ocular toxoplasmosis (OT) is the infection of the eye caused by toxoplasmosis. *Toxoplasma gondii* infection, which causes infectious posterior uveitis and consequent vision loss, is a significant health damage, particularly in developing nations.

Introduction:

Ocular toxoplasmosis (OT) is the infection of the eye caused by toxoplasmosis. *Toxoplasma gondii* infection, which causes infectious posterior uveitis and consequent vision loss, is a significant health damage, particularly in developing nations [1,2].

The most prevalent etiology of infectious posterior uveitis is ocular toxoplasmosis, and the accurate identification of distinctive clinical presentations plays a crucial role in its diagnosis. The laboratory confirmation of a condition can be achieved by utilizing the detection of antibodies in serum or intraocular fluids [3].

The acute OT shows a good-defined retinal necrosis. The individual exhibits visual attention accompanied by inflammation of the eye. Additionally, it is frequently observed that there is a prevalent occurrence of inflammation in the adjacent retinal and choroidal tissue(Fig. 1A,B). Retinochoroiditis is a word that can be applied when the underlying choroid is impacted in a significant number of patients. In individuals with a fully functioning immune system, these

dynamic lesions generally undergo resolution during a span of two to four months, resulting in the formation of a hyperpigmented scar because of the impairment of the retinal pigment epithelium (Figure 1C). The presence of active ocular toxoplasmosis (OT) lesions in human histology is infrequently observed. However, initial studies conducted on individuals with AIDS have demonstrated the ability to detect *T. gondii* antigens in regions of retinal necrosis [4]. In addition, parasites were identified by immunohistopathology in more than fifty percent of examined eyes from fetuses with congenital toxoplasmosis, which was covered by an inflammatory cell infiltrate [5]. An essential comprehension of the varied inflammatory response and morphological destruction derived from a mouse model of congenital otitis media is necessary. Multiple layers of the ocular structure, such as the outer retina, retinal pigment epithelium (RPE), and choroid, exhibited a range of modifications, encompassing modest retinal infiltration to extensive necrotic damage [6]. It is noteworthy that the inflammatory infiltrates did not primarily target *T. gondii* cysts. Cysts have been observed in certain specimens, located at a considerable distance from a scar inside the inner retinal layers of intact retinas, exhibiting an absence of inflammatory response. The ingestion of a portion of the photoreceptor outer segments by macrophages has given rise to the concept that autoimmune mechanisms may be implicated in the occurrence of tissue harm.

IL-6 plays an important function in protecting the body from Toxoplasma infection; mice lacking the gene response to produce IL-6 are more susceptible to infection [62].

Shepherd, (2019), reports that parasite infections elicit Th2 type responses, producing key cytokines such as IL-4, IL-13, and IL-5, which shape immunopathology and ultimately impart protection against disease.

Nickdel et al. (2004) have demonstrated that at an early stage of T. gondii infection, coupled with eosinophilia and an elevated level of IL-5, pathological alterations are prevalent in the small intestine, which is accompanied by a concurrent reduction in IL-12 and IFN-*γ.*

Interleukin 10 (IL-10) is a cytokine with strong anti-inflammatory properties that plays a central role in limiting the immune response of the host to pathogens, thereby preventing host injury and preserving normal tissue homeostasis. Dysregulation of IL-10 is linked to enhanced immunopathology in response to infection and an increased risk for the development of numerous autoimmune diseases [65].

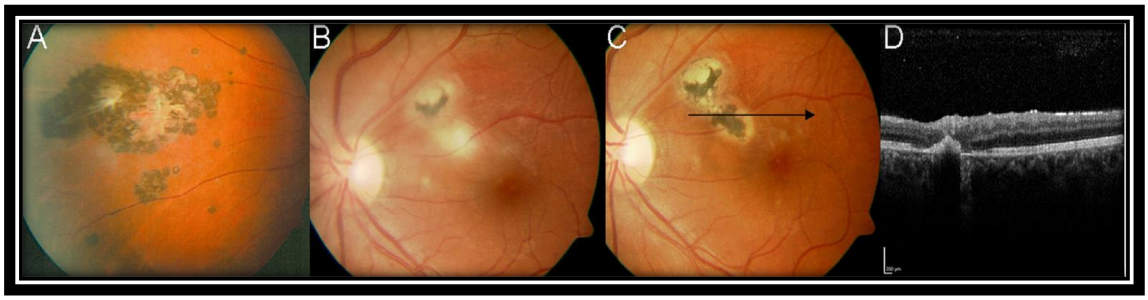

Fig. 1 Fundus photography is employed to capture images of patients who have been diagnosed with postnatal acquired optic tract (O.T.) abnormalities [59]. A,B) inflammation in the adjacent retinal and choroidal tissue C) retinal pigment epithelium D)Damage Optic tract.

Materials and Methods

The current study was carried out on 80 samples(50 are patients and 30 as a control) with an age range (15-65) years, attended from Ibin-alhaitham hospital (Iraq / Baghdad), during the period extended between January / 2022 to February /2023. The current study included 30 apparently healthy volunteers who were considered as control, their age ranged between (20-40) ages. All of them had no problem and they are clear of any chronic or systemic disease. The patients are 50 and they are divided into two groups (25 patients are infected with Ocular toxoplasmosis (O.T.) and 25 are Uveitis A.T.), after diagnosis with ELISA serological test (IgG and IgM) and funduscopic by doctors.

Approximately (5ml) of human blood was collected intravenously from patient and control groups under a septic technique, using a 5 ml disposable syringe. A 3ml was put in clot activator gel tubes for serum separation and allowed for 30 minutes to clot at room temperature, the sample was centrifuged at 3000rpm for 10 minutes and the serum was immediately separated into small equal parts in Eppendorf tubes and stored in deep freeze at -20 C till used. All sample are labelled by a serial number and the person's name.

Result and Discussion

The serum level of IL-6 of the group was highly significant increase in O.T. patients than controls, (118.99 ± 9.1 vs. 67.57 ± 6.9 pg/ml), (P= < 0.001), as shown in table (1). As well as, the serum level of IL-6 of the group was significantly increased in A.T. patients than controls, (90.72 ± 5.9 vs. 67.57 ± 6.9 pg/ml), (P= 0.017), as shown in table (2). On the other hand, the serum level of IL-6 of the patients groups was significantly increased in O.T. patients than in A.T., (118.99 ± 9.1 vs. 90.72 ± 5.9 pg/ml), (P= 0.013), as shown in table (3).

Table 1: Serum Levels of IL-6 in O.T. patients and control group.

IL-6 (pg/ml)	**Patient (No. = 25)**	**Control (No. = 30)**
Mean ± S.E.	118.99 ± 9.1	67.57 ± 6.9
***P*-value**	< 0.001** HS	

- (**) Highly Significant increase $P < 0.01$ compared to control.
- S.E: Standard Error, No: Number, *P*: Probability.

Table 2: Serum Levels of IL-6 in A.T. patients and control group.

IL-6 (pg/ml)	**Patient (No. = 25)**	**Control (No. = 30)**
Mean ± S.E.	90.72 ± 5.9	67.57 ± 6.9
***P*-value**	0.017*	

- (*) Significant increase $P < 0.05$ compared to control.
- S.E: Standard Error, No: Number, *P*: Probability.

Table 3: Serum Levels of IL-6 in O.T. and A.T. patients groups.

IL-6 (pg/ml)	**O.T. (No. = 25)**	**A.T. (No. = 25)**
Mean ± S.E.	118.99 ± 9.1	90.72 ± 5.9

***P*-value**	0.013*

- (*) Significant increase $P < 0.05$ compared to control.
- S.E: Standard Error, No: Number, *P*: Probability.

According to first group ther is a highly significant between patients and control of IL-6 due to infection with toxoplasmosis.

De-la-Torre (2014) showed that IL-6 was elevated in OT patients compared to control, and they explained It has been observed that interleukin-6 (IL-6) plays a significant role as a proinflammatory cytokine in uveitis. Furthermore, increased levels of IL-6 have been detected in the aqueous humor of patients with uveitis of various etiologies, such as viral uveitis, ocular toxoplasmosis, and Fuchs heterochromic uveitis syndrome [8]. The potential promotion of parasite growth and development may arise from the activation of STAT-3, an inhibitor of the protective cytokine IL-12, by IL-6[55].

Marino Ana et al., It was determined that there was no statistically significant disparity detected in the serum concentrations of interleukin-6 (IL-6) when comparing patients infected with *Toxoplasma gondii* to persons who were in good health [9].

smarioMatowicka-Karna (2009) The researchers observed elevated levels of IL-6 in comparison to the control group, indicating the presence of an inflammatory condition. This significant discovery was the focus of their investigation. IL-6's primary function is to participate in the immune response By exerting an effect on B cells. The mediator in question is accountable for the synthesis of acute phase proteins and the augmentation of natural killer cell cytotoxicity. Interleukin-6 (IL-6) is an early and highly responsive biomarker, however, it lacks specificity, an indicator of the presence of inflammation [10].

Nagineni (1996) said that the levels of cytokines increase with time and are correlated to the number of infected host cells and the intracellular parasite load. Secretion of IL-6 by T. gondii suggests that T. gondii has elevated secretion of inflammatory molecules [11].

Fischer (1997) It was shown that in cultures of astrocyte and microglial cells in the mouse brain, both infected with virulent and a virulent strains of *T. gondii*, the presence of IL-1, IL-6, and GM-CSF was identified [12].

Elevated levels of interleukin-6 (IL-6) and soluble intercellular adhesion molecule-1 (sICAM-1) have been seen in the aqueous fluids of patients diagnosed with uveitis and proliferative vitreoretinal diseases [13]. The upregulation of interleukin-6 (IL-6) has been observed in patients with uveitis [14], as well as in the development of epiretinal membranes in proliferative vitreoretinopathy, as previously documented [15].

Rosenbaum (1987) These data suggest that IL-6, IL-1, and ICAM-1 are significant contributors to the pathogenesis of intraocular inflammatory disorders [16].

The retinas, aqueous humor, and choroid of mice infected with *T. gondii* exhibited inflammation. Inflammatory cells were also observed in the ciliary body and anterior chamber. The inner layers of the retina had the highest degree of inflammation [17].

Interleukin-6 (IL-6) has been identified in the ocular tissues of felines affected by ocular toxoplasmosis (OT), as well as in the aqueous humor of individuals with ocular infections [18].

Further investigation suggests that IL-6 has the potential to impede parasite replication through the activation of encystment [19].

The involvement of IL-6 in the suppression of an inflammatory response by suppressing the production of IL-1 and TNF-α has been demonstrated [20]. This implies that IL-6 may potentially facilitate the proliferation of parasites while mitigating the associated pathological effects. Therefore, Further investigation was undertaken to ascertain whether the heightened intensity of ocular inflammation found in IL-6 animals could be attributed to escalated parasite proliferation and subsequent host cell damage, or if it was a direct consequence of an inability to regulate inflammation in the absence of IL-6.

Elevated levels of interleukin-6 (IL-6) are associated with various ocular diseases, such as glaucoma, central vein occlusion, dry eye disease, chemical burn injuries, corneal infections, allergic eye diseases, ocular inflammatory diseases, infectious keratitis, ocular neovascularization, and posterior capsular opacification [21]. This observation highlights the significant differences in IL-6 levels between the affected groups and the control group.

Murray (1990) the initial study showcased the presence of heightened levels of interleukin-6 (IL-6) in the aqueous humor of 24 individuals afflicted with uveitis, encompassing toxoplasma uveitis and Fuchs' heterochromic iridocyclitis [22].

Li (2021) said The IL-6 of A.H. The study findings indicated that patients with active OT had greater group levels in comparison to individuals whose illness was nonactive [24]. The levels of IL-6 in blood have been observed to exhibit a rise during the acute-phase [25], followed by a subsequent decline or no significant difference compared to baseline levels, indicating no discernible variation between phases (9) The results of this study indicate that interleukin-6 (IL-6) within the aqueous humor (AH) plays a significant role in the immunopathogenesis of active ocular toxoplasmosis (OT). Furthermore, it is suggested that IL-6 levels in the AH, rather than in the serum, could potentially serve as an indicator of disease status [23].

The serum level of IL-5 of the group was significantly increased in O.T. patients than controls, (151.16 ± 13.2 vs. 115.38 ± 6.4 pg/ml), (*P*= 0.041), as shown in table (4). As well as, the serum level of IL-5 of the group was non-significantly increased in A.T. patients than controls, (130.21 ± 8.1 vs. 115.38 ± 6.4 pg/ml), (*P*= 0.155), as shown in table (5). On the other hand, the serum level of IL-5 of the patients groups was non-significantly increased in O.T. patients than in A.T., (151.16 ± 13.2 vs. 130.21 ± 8.1 pg/ml), (*P*= 0.185), as shown in table (6).

Table 4: Serum Levels of IL-5 in O.T. patients and control group.

IL-5 (pg/ml)	**Patient (No. = 25)**	**Control (No. = 30)**
Mean ± S.E.	151.16 ± 13.2	115.38 ± 6.4
***P*-value**	0.014*	

- (*) Significant increase $P < 0.05$ compared to control.

- S.E: Standard Error, No: Number, *P*: Probability.

Table 5: Serum Levels of IL-5 in A.T. patients and control group.

IL-5 (pg/ml)	**Patient (No. = 25)**	**Control (No. = 30)**
Mean ± S.E.	130.21 ± 8.1	115.38 ± 6.4
***P*-value**	0.155 NS	

- NS: Non-Significant.

Table 6: Serum Levels of IL-5 in O.T. and A.T. patients groups.

IL-5 (pg/ml)	**O.T. (No. = 25)**	**A.T. (No. = 25)**
Mean ± S.E.	151.16 ± 13.2	130.21 ± 8.1
***P*-value**	0.185 NS	

- NS: Non-Significant.
- S.E: Standard Error, No: Number, *P*: Probability.

De-la-Torre (2014) showed that the authors of the study observed a correlation between IL-5 and recurrences, which establishes a new association between specific cytokine patterns, clinical characteristics, and the infecting Toxoplasma strain. The authors explain that IL-5 plays a crucial role in initiating a Th2 immune response and promoting the production of specific IgA antibodies. [26], the variable under consideration has been recognized as a potential predictor of future events in instances of ocular toxoplasmosis [8]. The aforementioned attribute renders IL-5 a highly auspicious selection as a predictive indicator. In a similar vein, a notable correlation was identified between the concentrations of Vascular Endothelial Growth Factor (VEGF) and both the incidence of recurrences and the existence of inactive lesions. The prevalence of being frequently observed in patients undergoing occupational therapy (OT) in Colombia is a noteworthy phenomenon[56].

De-laTorre (2009) elevated levels of IL-5 were seen in compared to those of healthy individuals, indicating the potential existence of an inflammatory condition. The authors provided an explaned that IL-5 can to extend the lifespan of eosinophils, induce the release of granules and the generation of reactive oxygen species by eosinophils, and elicit a chemotactic response in these cellular entities [27]. The study has demonstrated that the invasion of Toxocara canis leads to an increased release of IL-8, IL-5, and TNF-α. This finding is further supported by the presence of eosinophilia and an inflammatory state [27]. However, previous studies (28) have demonstrated that during the initial phase of Toxoplasma gondii infection, there are notable pathological changes observed in the small intestine. The condition is characterized by the simultaneous presence of eosinophilia and elevated levels of IL-5, along with a concomitant decrease in IL-12 and IFN-. Additionally, an elevation in IL-5 concentrations and a reduction in IL-12 concentrations were noted [29].

Interleukin-5(IL-5) is frequently associated with both parasitic infections and allergic reactions [30]. Moreover, it plays a crucial function in the regulation of intracellular infections,

such as Toxoplasma gondii. However, [31The study revealed that infected mice demonstrated the synthesis of IL-5 when exposed to in vitro restimulation utilizing both toxoplasma sonicate and pure T. gondii Ag, Additionally, the results of the study provide significant evidence suggesting that the source of IL-5 in the brains and spleens of infected mice is not T-cells or B-cells. Moreover, the production of this cytokine seems to occur autonomously, without reliance on T-cells and B-cells. There exists a favorable correlation between the levels of IL-4 and IL-13 and both the number and size of active lesions. Additionally, IL-5 serves as a predictive factor for the recurrence of O.T. [7].

de Araújo, (2020) in their results showed that the ability to accurately differentiate infants with retinochoroidal lesions from those without ocular disease can be achieved through the identification of interleukin-5 (IL-5) production by CD4+ T-cells. Therefore, the examination of IL-5+CD4+ T-cells following stimulation with T. gondii antigens is a possible biomarker for early prognosis of congenital toxoplasmosis and a potential indicator of ocular complications in children affected by congenital toxoplasmosis. The severe clinical signs of ocular toxoplasmosis are linked to the upregulation of IL-5. Elevated levels of IL-5 have been seen in aqueous humor samples obtained from patients experiencing acute and recurring ocular toxoplasmosis [7]. The up-regulation of Type 2 cytokines, specifically IL-5 and IL-10, in cases of O.T. and viral uveitis has the potential to down-regulate the inflammatory response at the local level. This down-regulation occurs through the inhibition of IL-12 and TNF-α production by macrophages [33].

IL-5 has been found to potentially play a protective role, as indicated by previous research [34]. This cytokine is essential for the generation of eosinophils and the stimulation of protective antibodies in adaptive immune responses. Consequently, IL-5 is closely linked to the augmentation of the Th2 response.

Lahmar (2009) said our study, 55% of patients with ocular toxoplasmosis Exhibited elevated levels of interleukin-5 (IL-5), which were found to be correlated with heightened production of interleukin-12 (IL-12) and interferon-gamma (IFN-γ). The aforementioned finding signifies a new and noteworthy discovery about to the influence of IL-5 on the control of IL-12 and IFN- (as previously documented) [36]. Furthermore, it has been suggested that interleukin-5 (IL-5) and interleukin-10 (IL-10) might play a crucial role in the generation of immunoglobulin G (IgG) antibodies in response to Toxoplasma infections [26].

Lahmar (2009) said A diverse spectrum of cytokine levels was observed in all samples exhibiting uveitis. The lack of a link between cytokine titers and clinical features observed in ocular toxoplasmosis implies that genetic variables play a role in cytokine production [37].

The serum level of IL-13 of the group was significantly increased in O.T. patients than controls, (250.94 ± 34.14 vs. 168.80 ± 17.9 pg/ml), (*P*= 0.03), as shown in table (7). As well as, the serum level of IL-13 of the group was non-significantly increased in A.T. patients than controls, (177.11 ± 22.5 vs. 168.80 ± 17.9 pg/ml), (*P*= 0.771), as shown in table (8). On the other hand, the serum level of IL-13 of the patients groups was non-significantly increased in O.T. patients than in A.T., (250.94 ± 34.14 vs. 177.11 ± 22.5 pg/ml), (*P*= 0.078), as shown in table (9).

Table 7: Serum Levels of IL-13 in O.T. patients and control group.

IL-13 (pg/ml)	Patient (No. = 25)	Control (No. = 30)
Mean ± S.E.	250.94 ± 34.14	168.80 ± 17.9
***P*-value**	0.03*	
- (*) Significant increase $P < 0.05$ compared to control.		
- S.E: Standard Error, No: Number, *P*: Probability.		

Table 8: Serum Levels of IL-13 in A.T. patients and control group.

IL-13 (pg/ml)	Patient (No. = 25)	Control (No. = 30)
Mean ± S.E.	177.11 ± 22.5	168.80 ± 17.9
***P*-value**	0.771 NS	
- NS: Non-Significant.		
- S.E: Standard Error, No: Number, *P*: Probability.		

Table 9: Serum Levels of IL-13 in O.T. and A.T. patients groups.

IL-13 (pg/ml)	O.T. (No. = 25)	A.T. (No. = 25)
Mean ± S.E.	250.94 ± 34.14	177.11 ± 22.5
***P*-value**	0.078 NS	
- NS: Non-Significant.		
- S.E: Standard Error, No: Number, *P*: Probability.		

In active O.T., The initiation of the immune response occurs upon the identification of the parasite, prompting the synthesis of cytokines such as interferon (IFN-) and tumor necrosis factor (TNF-) by many cell types, including natural killer (NK) cells and macrophages. [38].

De-la-Torre (2014) It was discovered that patients with O.T. exhibited an increased Th2 response, principally indicated by heightened levels of IL-13. The authors explained for the lack of significance observed in the second group, attributing it to the absence of lesions or their small size, which resulted in a correlation between IL13 levels and the size and number of lesions.

Bahia(2009) said in there experiment that a High levels of IL-13 (Th-2) saw in groups of co-infected individuals representing toxoplasmic ocular lesions[39]

As shown in table [7] first group (O.T.)is not highly significant this could be because of recurrences and this agrees with [25] It was observed that the release of immune mediators decreased as the number of recurrences decreased.

Thieme(2019) said in there studies that Compared to the control group, we found elevated levels of IL-4 in primary acquired O.T. (pOT) and recurrent O.T.(rOT) and of IL-13 in pOT.

However, There was a tendency to more elevated IL-13 in pOT than in rOT (that is why our O.T. group is not highly significant) , suggesting the possibility that the intraocular absence of cytokines may play a role in OT recurrence ,the significance of IL-13 and IL-5 compared to control group may suggest that IL-13 and IL-5 could be specific for ocular toxoplasmosis [25] .

Rochet (2015) based on the results of the cytokine analysis, it has been ascertained that IL-6 has a function, albeit to a certain extent, in the production of IL-17 in our experimental model. The generation of IL-17 has been previously identified as having detrimental consequences in instances of acute otitis (Sauer *et al*.,2012). However, In contrast to the results reported in previous research utilizing IL-17, the suppression of IL-6 not only decreased the manifestation of many mediators linked to Th1 response but also did not enhance the generation of Th2 cytokines, including IL-13 [42]. The present study reveals a notable elevation in the production of interleukin-6 (IL-6) and interleukin-13 (IL-13) in patients with ocular toxoplasmosis (OT) from Colombia, in comparison to individuals for European descent [7].

Bonacini (2020) said There was no correlation between IL-13 levels and the number of inflammatory cells. The unexpected nature of this finding arises from the fact that NK cells, T cells, mast cells, basophils, and eosinophils are the main producers of IL-13. Nevertheless, it is plausible to attribute these findings to the secretion of interleukin-2 (IL-2) and interleukin-13 (IL-13) by ocular cells., as evidenced by the detection of IL-2 and IL-13 in A.H. (aqueous humor) from H.C. (healthy control) The composition of an individual's body fluid typically does not include leukocytes. Therefore, it is plausible to hypothesize that interleukin-2 (IL-2) and interleukin-13 (IL-13) have a role not only in the inflammatory response but also in maintaining the equilibrium of the eye. and this agrees with our research about both groups.

Cingu (2020) said The concentration of serum IL-13 was found to be significantly elevated in the group of individuals with active ocular Behc¸et's Disease (BD), namely those with uveitis. This finding contradicts the results observed in our second group.

In another study published by [45There is a notable elevation in Th2 cytokines, including interleukin-4 (IL-4), interleukin-10 (IL-10), and interleukin-13 (IL-13), observed in the serum of individuals with ocular toxoplasmosis, as demonstrated in Table 7. There were noteworthy positive associations between IL-13 and the scores of anterior chamber (AC) cells, as well as fundus, and Fluorescein angiography (FA)The obtained scores indicate a potential association between IL-13 and disease activity.In patients with active ocular Behçet's disease, the presence of high blood levels of IL-13 ultimately suggests a prevailing Th2 response in the disease activity [44].

Interleukin-4 (IL-4) and Interleukin-13 (IL-13) have been found to stimulate the production of periostin in fibroblasts, a phenomenon that has been linked to the sensitivity to steroid treatments. Hence, it is plausible that the efficacy of steroid therapy could be linked to the inhibition of periostin production through the IL-4 and IL-13 signaling pathways. Within this particular setting, it is plausible to utilize the levels of IL-4 and IL-13 as a prognostic indicator for the patient's reaction to steroid therapy [44].

The serum level of IL-10 of the group was highly significant increased in O.T. patients than controls, (264.65 ± 19.8 vs. 123.77 ± 6.1 pg/ml), (P= < 0.001), as shown in table (10). As well

as, the serum level of IL-10 of the group was non-significantly increased in A.T. patients than controls, (156.82 ± 16.3 vs. 123.77 ± 6.1 pg/ml), (*P*= 0.048), as shown in table (11). On the other hand, the serum level of IL-10 of the patients groups was highly-significant increased in O.T. patients than in A.T., (264.65 ± 19.8 vs. 156.82 ± 16.3 pg/ml), (*P*= < 0.001), as shown in table (12).

Table 10: Serum Levels of IL-10 in O.T. patients and control group.

IL-10 (pg/ml)	**Patient (No. = 25)**	**Control (No. = 30)**
Mean ± S.E.	264.65 ± 19.8	123.77 ± 6.1
***P*-value**	< 0.001** HS	
- (**) Highly Significant increase *P* < 0.01 compared to control.		
- S.E: Standard Error, No: Number, *P*: Probability.		

Table 11: Serum Levels of IL-10 in A.T. patients and control group.

IL-10 (pg/ml)	**Patient (No. = 25)**	**Control (No. = 30)**
Mean ± S.E.	156.82 ± 16.3	123.77 ± 6.1
***P*-value**	0.048*	
- (*) Significant increase *P* < 0.05 compared to control.		
- S.E: Standard Error, No: Number, *P*: Probability.		

Table 12: Serum Levels of IL-10 in O.T. and A.T. patients groups.

IL-10 (pg/ml)	**O.T. (No. = 25)**	**A.T. (No. = 25)**
Mean ± S.E.	264.65 ± 19.8	156.82 ± 16.3
***P*-value**	< 0.001** HS	
- (**) Highly Significant increase *P* < 0.01 compared to control.		
- S.E: Standard Error, No: Number, *P*: Probability.		

De-la-Torre (2014) found that the response of TH2 was elevated in OT patients, mainly characterized by higher levels of the suppressive cytokine IL-10[46].Explained that the deviation to a Th2 immune response, which includes the production of anti-inflammatory cytokines such as IL-10, may facilitate the survival of the parasite, resulting in tissue immune destruction. IL-10 production in *T. gondii*-infected brains may contribute to the persistence of parasites by downregulating the intracerebral immune response, which lends trust to the concept that IL-10 is central to the induction of the permissive state observed in the eyes of South American OT patients [7]. These data, also, that the potential explanation for the parasite's survival lies in the divergence towards a Th2 immune response, characterized by the synthesis of anti-inflammatory cytokines like IL-10, TGF-, and IL-4 [60, 61] This is necessary to sustain immune balance in the eye and prevent tissue immune destruction [47], IL-10 production during *T. gondii*-infection in the eyes also may contribute to parasite persistence by suppressing the intraocular immune response.

Marino(2020) found that no difference was found in serum levels of IL-10 when *T. gondii*-infected patients when compared to healthy (disagreeing with data of table 10) [57] found that

They found the level of IL-10 to be five times higher in toxoplasmosis than in healthy controls and explained that IL-10 plays a crucial role in the inflammatory response during T. gondii infection (agree with data of table 10), since it inhibits the cellular-type immune response (IL-12, TNF-α) and inflammatory response (IL-6) [58]. Immunosuppression induced by IL-10 during T. gondii invasion is helpful for both the host and the parasite [48].

IL-10 counteracts the harmful consequences of the inflammatory response based on the increased production of TNF-, IFN-, and NO that is associated with intestinal proliferation of T. gondii [50]. IL-10 can deactivate macrophages, induce IFN- production by *T. gondii*, and enhance intracellular parasite survival. Immunosuppression induced by IL-10 during *T. gondii* invasion is advantageous for both the host and the parasite. [50].

Dawson (2018) demonstrated in their study that patients ,Patients with uveitis have elevated IL-10 levels and low to undetectable IL-6 levels, whereas patients with lymphoma have an IL-10-to-IL-6 ratio of less than 1[51].

Sijssens (2007) demonstrated in their studied that a High IL-10 levels are primarily associated with active infectious uveitis and are regarded as crucial in the early stages of infection [53], detected significantly increased levels of IL-10 in Uveitis patients compared with normal eyes (as shown in table 11).

In uveitis, IL-10, a primary immunomodulatory cytokine, possesses significant anti-angiogenic and anti-inflammatory properties in ocular tissues (54). IL-10 serves a crucial role in the balance between immune pathology development and protective immunity. Patients with OT were found to have higher levels of IL-10 than healthy controls [24].

Conclusions

A change in the immune response as a result of infection with Ocular toxoplasmosis thus led to the recording of concentrations with a high response for Il-6 ,5 , 10 and 13 .

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صورة للانترلوكينات بين المرضى المصابين بداء المقوسات العيني في مدينة بغداد، العراق

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الخلاصة:

داء المقوسات الكوندية هو كائن حي داخل الخلايا يسبب مرضًا خطيرًا لكل من الحيوانات والبشر في جميع أنحاء العالم. غالبًا ما يكون بدون أعراض، ولكن في الأشخاص الذين يعانون من ضعف المناعة يمكن أن يسبب الالتهاب وداء المقوسات العيني وحتى الإجهاض .عند اجراء بحوث في الاصابة ب *T. gondii* في مرضى السرطان وجد بانه واسع النطاق .ومع ذلك، لم يناقش أحد بعد الآثار المترتبة على انتشار العدوى الطفيلية في هذه الفئة من السكان . داء المقوسات العيني (OT) هو عدوى العين الناجمة عن داء المقوسات الكوندية حيث تعد عدوى التوكسوبلازما، احدى مسببات التهاب القزحية الخلفي وما يترتب على ذلك من فقدان البصر، ضررًا صحيًا كبيرًا، خاصة في الدول النامية