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Toxoplasma gondii: Fact Review

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ABSTRACT

Here the general aspects of *Toxoplasma gondii* infection will reviewed in short, Generally, *Toxoplasma gondii* is a parasite that causes the toxoplasmosis with complications varying from mental diseases to death. It is estimated that at least a third of the world human population is infected with *T. gondii*, suggesting that it is the most common parasitic infections worldwide. Many of people carry the Toxoplasma parasite, but very few have symptoms because the immune response controls of the infection intensity.

KEY WORDS: *Toxoplasma gondii*, infection, host, diagnosis, IgG, IgM.

1. INTRODUCTION

Toxoplasmosis is a disease caused by parasitic infection *Toxoplasma gondii* which affect humans and animals alike. Healthy individuals who become infected with *Toxoplasma gondii* often do not develop any symptoms because their immune system keeps the parasite from causing illness. Up to 95% of the population has been infected with Toxoplasma without developing any symptoms (World health organization, 2015).

Although the parasitic infection *T. gondii* usually without symptoms in adults, when illness occurs, it is usually being "flu-like" symptoms that last for weeks to months. However, the parasite remains in their body in an inactive state and can becomes reactivated if the person becomes immunosuppressed, it causes serious health problems for pregnant women, especially when the transmission of the infection moves to the fetus, as the transmission of the parasite to the fetus causes many of the symptoms of mental retardation, blindness, hydrocephalus, small Head size (Microcephaly) or may even lead to death.

Although the rate of transmission of the disease from the mother to the fetus tends to decline in the early stages of pregnancy, the vulnerability of the fetus to the disease is high when it occurs in the early stages of pregnancy and result in the death of the fetus in the womb or at birth. Early transmission leads to fetal death or abortion. If the fetus is infected in the second and third trimesters, it will be normal at first and does not show symptoms until 4-12 weeks after birth.

T.gondii infections occur in different ways, such as by drinking contaminated water or eating food with infected cat feces or by eating poorly cooked meat which contain spores, or by passing from the pregnant mother to the fetus through the placenta, often during the stage of acute infection with rapid phase transmission (Tachyzoite) (World health organization, 2015; Veeranoot Nissapatorn, 2013; New Zealand Food Safety, 2008).

Discovery of the parasite: *Toxoplasma gondii* was first discovered in a small rodent in Tunisia in 1908 by researchers Nicolle and Manceaux in the North of Africa (Ctenuductylus gundii). This rodent settled in the southern Tunisian mountains. In 1909, Splendor observed the infection in rabbits, birds and humans in different parts of the world. Recent studies have shown that the Arched convex is the only type of Toxoplasmidae family, which has two stages: sexual and non-sexual. In 1923 Janku noted parasite bags in the retina of an infected child diagnosed with Congenital toxoplasmosis, with hydrocephalus and microphthalmia.

In 1937, Wolf and Cowen were able to diagnose parasites in newborn babies. In 1948, Sabin and Feldman discovered the first serological test to diagnose parasitic infection, called the Dye test, which helped to explain the high incidence of parasitic infection in different communities. In 1952, Wilder realized the role of chronic infection in the retinal necrosis of the retina (Innes, 2010).

Description and Classification of the parasite: *Toxoplasma gondii* take the form of crescent shapes, which are compulsory in the host cells, the *t.gondii* cell consists of rounded end and a spiked end. The nucleus is near the end of the spiral, and conoid which responsible for ruining the wall of the cell host (Dubey, 1998; Arnault Graindorge, 2016).

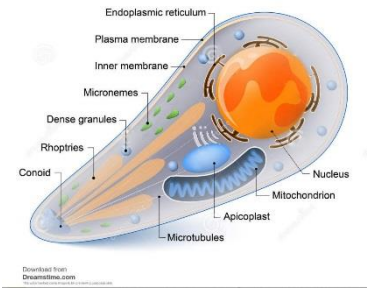

Figure.1. Structure of *Toxoplasma gondii*

There are three species of Toxoplasma genus: (*T. gondii*, *T. bahaiensis*, and *T. hommandi.*

T. gondii includes three strains (I, II, III). The incidence of strain (I) is very severe in rats and may cause congenital malformations in humans. The incidence of strains (II) and (III) is low in virility (Boughattas, 2011).

The second strain is more common in humans, while in animals, the third strain is the most common type Strains I, II, III can cause human infection, but strain II is superior in causing the infection, especially in AIDS. *T.gondii* belongs to the primary animals within the phylogenetic division of the kinematic complex. The conical curve is classified by Levin as follows: Kingdom: Protista, Phylum: Apicomplexa, Class: Sporozoa, Sub class: Coccidia, Order: Eucoccidia, Sub order: Eimeria, Family: Sarcocystidae, Sub family: Toxoplasmatinae, Genus: Toxoplasma, Species: gondii

Methods of Infection: World Health Organization (WHO) estimates that every year there are over 1 million cases of toxoplasmosis in the European region caused by contaminated food.

T.gondii is one of the most widely spread parasites in the world. This parasite is transmitted to humans and animals in many ways. Many factors contribute to the transmission of toxoplasmosis. Large numbers of Oocysts are deposited with cat feces and maintain their ability to cause infections. When cats are infected, the feces of the infected cats are the source of infection for the birds, and the animals upon eating weeds and herbs contaminated with the Oocysts. The carnivores are infected upon eating raw meat containing the parasites. People get infected from eating poorly cooked meat, especially sheep and pigs meat, indicating that these animals have an important role in the transmission of the disease to humans, and the meat of sheep is very important in the transfer of human infection in Arab countries. People and animals can be infected by eating contaminated food with Oocysts or drinking water contaminated with the feces of infected cats.

Symptoms of infection appear within 10-20 days after eating poorly cooked meat, and within 5-20 days after ingestion of ovarian sores. Oocyst, poultry meat and poultry are of little importance in this field. The parasite can be transmitted through the Mouth and the mucosa lining the eye, nose, pharynx, and respiratory tract.

The infection can be transmitted from the pregnant mother to her fetus by the Placenta (Transplacentally), which is one of the important methods in the transmission of the disease in humans and animals. This infection is often acquired during the acute phase of the disease, by the rapid transition of the Tachyzoite. The infection can also be transmitted through the use of non-pasteurized milk and its products. Infection can occur during blood transfusion, as well as after transplantation.

Another source of infection is the consumption of food and vegetables contaminated with egg feces containing egg bags. For parasites is one of the important methods of transmission of the disease to vegetarians due to contaminated vegetables, and the incidence of infection is higher in the breeders of cats. Insects such as flies and roaches transmit eggs bags from cat's feces to food (Veeranoot Nissapatorn, 2013; Buzby, 1996; Patcharee Chaichan, 2018).

Life cycle and parasite phases: The life cycle of *T.gondii* was not known before 1969, in 1972, Dubey and Frankel confirmed that cats are the definitive and intermediates hosts of the parasite at the same time while birds and rabbits are only intermediates.

There are two forms of *T.gondii* infections (Patcharee Chaichan, 2018):

Bradyzoites Cysts: Spherical or oval - shaped, measuring from 30-300 microns, contains several hundred of Trophozoite, resulting from asexual reproduction, which gradually file the inside of the host cells and compressed on each other, each of cysts is surrounded by a thick and resistant wall.

Sporozoites Oocysts: Oval-shaped surrounded by a thick and resistant wall, measuring 9-14 microns, resulting from sexual reproduction in the Enterocytes of the cats. Oocysts contains two sporocysts inside each of them four sporozoites development later into merozoites.

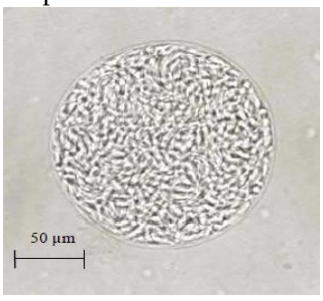

Figure.2A. Bradyzoites Cysts

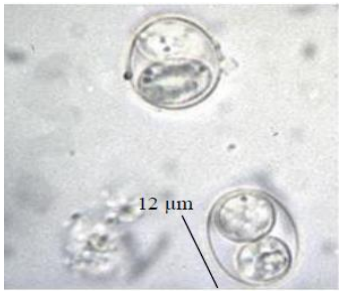

Figure.2B. Sporozoites Oocysts

The life cycle of *T.gondii* consists of two stages:

Sexual stage in definitive host: This stage occurs when the definitive host eats the infected intermediates host (Mouse, bird…) where intestines Sap in the intestines ruptures the bradyzoite cysts wall releasing trophozoites which in turn infect new cells of the lining of the intestines. These trophozoites develop to microgametes and marcogametes,

the fertilized macrogametes forms a wall and development to Oocyst with tow sporoblasts each containing 4 sporozoites, which is passed in the feces of the cat.

Asexual stage in intermediates host: This occurs when the intermediates host eats Contaminated food with Oocysts, the intestines Sap in the intestines ruptures the Oocyst wall releasing the sporozoites which in turn infect the lining of the intestines and move with the bloodstream and lymph to achieve new infections in the cells of other organs and tissues such as the heart, brain, lungs and eyes. At this stage the host body excretions antibodies to prevent the spread of the infection, the spores become slow and surrounded by a thick body and turn into a cysts filled with bradyzoites (William J Sullivan, 2012; Florence Robert-Gangneuxa, 2012; Ira J Blader, 2010).

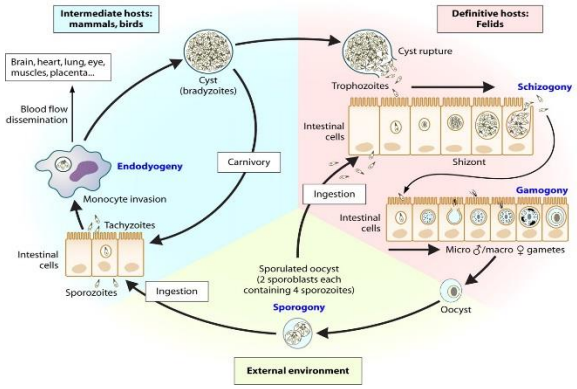

Figure.3. Life Cycle of *Toxoplasma gondii*

Symptoms of disease: Most human infections with *T.gondii* are asymptomatic, but infection may result in severe clinical disease and in some cases be fatal. Here we can distinguish between three types of clinical forms of disease: **Acquired form**: the infection is caused after eating meat infected with Oocyte or vegetables contaminated with it. Symptoms of disease is flu-like Symptoms with low fever, muscular pain, swollen lymph nodes, lethargy and headache. Enlarged lymph nodes are the most commonly observed clinical manifestation of human toxoplasmosis (Hill, 2002).

Congenital form: Congenital toxoplasmosis occurs when *T. gondii* parasite moves from the pregnant mother to her embryo through the placental barrier, causing congenital toxoplasmosis. This is followed by acute maternal infection. The severity of infection depends on pregnancy period. If the mother is infected early in pregnancy and without the use of a medicine for the parasite *T. gondii*, the embryo is often affected by the infection, resulting in the death of the embryo in the womb or at birth as the early infection is linked to death. The embryo is affected by the reactivation of the disease. The rate of transmission to the embryo is approximately 15% during the first trimester of pregnancy, and 30% in the second trimester and 60% in the third trimester. These congenital defects can include ocular toxoplasmosis, hydrocephalus (big head), deafness, mental retardation and intracranial calcifications (Florence Robert-Gangneuxa, 2012).

Figure.4. New baby born infected by congenital Toxoplasmosis (Dubey1988)

Ocular Toxoplasmosis: causing eye pain, blurred vision, and possibly permanent damage, including blindness. Although most cases of toxoplasmosis resolve on their own, for some, inflammation can be treated with antibiotics and steroids (Young-Hoon Park, 2013).

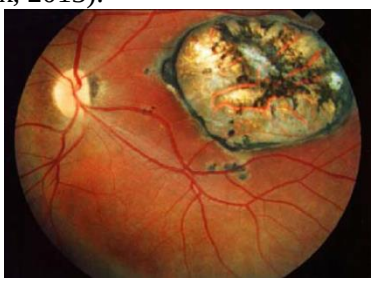

Figure.5. Ocular Toxoplasmosis

In immunocompetent patients, 80-90% of all non-symptomatic lesions are symptomatic with Cervical lympho - denopathy or similar symptoms of flu (A flu-like illness) in patients with Immuno-deficient. Patients often have central nervous system (CNS) or may develop myocarditis or Pneumonitis. In AIDS, toxoplasmosis causes encephalitis. The most common lesions are intracranial lesions, and most of the infections in women with AIDS occur as a result of reactivation of chronic injury.

The incidence of Toxoplasmosis and its relationship to abortion: *Toxoplasma gondii* is one of the parasites that crosses the placenta and infects the fetal. It is considered a common parasite that responsible for both severe congenital birth defect and fetal Toxoplasmic encephalitis. Though most of infected patients are asymptomatic, the congenital fetal toxoplasmosis may result in abortion, stillbirth, or severe mental retardation; infections in late pregnancy may be asymptomatic but present with retinal or neurological damage later in life However, the most common pregnancy complication is fetal loss. Studies and research have shown a link between brucellosis, miscarriages and congenital malformations (Mohamed Abdelgadir Shaaeldin, 2018; Mousa, 2011; Nariman H Darweesh, 2018; Fatemeh Ghasemi, 2015).

AL-Hamadani and Mahdi conducted a study on 81 samples of women with recurrent miscarriage, with 18.5% using IHAT compared to women with normal pregnancies (Al- Hamadani, 1997).

The highest incidence of this test was in the age group 36-40, or 83.33%. In ELISA, 38 IgM was positive from 114 cases, or 33.33%, with the highest incidence in the 36-40 age group by 40.0%. The IgM immunoglobulin had 54 positive cases out of 114 cases, or 47.37%. The highest rate of infection was in the 15-25 age group, with 55.56%. In the PCR test, 14 samples from 75 samples were tested. In the 2-25 age group with 29.41% (Razzak, 2005).

Prevention of Disease: To prevent human colonic parasitic parasites *T.gondii*, hands must be washed with soap and water when meat is handled and all the meat-processing tools must be cleaned to eliminate the Infectious phases of the parasite. Animal meat should be cooked to a degree of 64°C before eating, and tasting food while being cooked should be avoided. Pregnant women should avoid salt.

Several studies have been conducted on cat immunization to prevent, form and secrete egg sacs using Tocus (263). These studies have provided good results but have not yet determined the length of the immunization period that is formed in cats. There are experiments being conducted to immunize farm animals by reducing the harmful effects of the disease and then the spread of the disease in humans (Louis, 2013; World health organization, 2015).

Diagnosis: The determination of IgM and IgG in blood samples helps in sure toxoplasma infection (IgM only or both IgM and IgG). Generally, IgM antibodies increase within the first week of infection, then decrease and disappear within two weeks. IgG increases within two weeks to two months after infection.

When determining the level of antibodies during serological examination we will find many possibilities:

Negative IgM, Negative IgG: Indicates that the infection has not occurred before and thus the person is not prevented from infection later.

Positive IgM, Negative IgG: Indicates that the infection occurred from about a week to two weeks and here must Procedure double check. If IgG rates remains negative indicates that the infection is not chronic and person is not prevented from infection.

Negative IgM, Positive IgG: Indicates that an old infection has returned and activated again or that the infection is acquired resulting for example from blood transfusion.

Positive IgM, Positive IgG: Indicates that an infection occurred about two months ago and if the body immunity is good, the rates of IgG will gradually decrease and the person will be prevented from infection later.

Sabin-Feldman dye test (DT), immunofluorescent antibody test, ELISA, latex agglutination test (LAT), and modified agglutination test (MAT) can be used for detection of IgM and IgG antibodies.

Sabin-Feldman dye test depends on the inability of tachyzoites to absorb the blue dye in tested blood samples, in the latex agglutination test (LAT) soluble antigen is linked on latex particles, and agglutination is observed when the positive serum is added. (LAT) is rapid and easy to detect IgG antibodies. In the indirect (ELISA) test, the antigen is coated onto the solid phase and the sample containing antibodies are added, the antigen-antibody reaction is enhanced by the addition of a secondary enzyme-linked antibody (Quan Liu, 2015).

While laboratory diagnosis depends on the presence of IgM and IgG antibodies and on the parasite isolations, molecular techniques such as polymerase chain reaction (PCR), have recently appeared to improve the laboratory diagnosis of Toxoplasmosis (B1 gene amplified by using certain primers). Although these techniques are inconstant because of large diversity of target genes and primers, in addition to other factors associated with the proficiency of laboratories (Leandro Emidio Teixeira, 2013; Atieh Farhadi, 2017).

Treatment: The treatment of toxoplasmosis is done by using pyrimethamine (Daraprim) 25 to 50 mg / day for 1 month with Trisulfapyrimidines at 2-6 g / day. The two compounds inhibit the production of nucleic acids, protein and dihydrofolate reductase in the parasite. Folic acid (leucovorine) with a dose of 10 - 25 mg/day concomitantly to avoid the toxic effect of pyrimethamine on the bone marrow as it affects folic acid metabolism.

In the pregnant mother, *T. gondii* is treated with Rovamycin (Spiramycin) to prevent transmission of the disease to the fetus. In France, Spiramycin has been used for several years to treat toxoplasmosis during pregnancy, and to prevent transmission of the infection to the fetus. If the infection is identified in the fetus through the embryonic fluid, pregnant women are treated with Daraprim, Pyrimethamine and Sulfadiazine, which are given after the first trimester or after 18 weeks of gestation. Folic acid should be given along with the two compounds to avoid the toxic effect of biryamine on the bone marrow.

In acute cases of retinochoroiditis, 75 mg of pyrimethamine is given daily for 3 to 5 days. Clindamycin is used intravenously for the treatment of encephalitis in AIDS patients. Clindamycin can also be used with Sulfadiazine to treat chorionic retinitis and encephalitis, and there are other effective drugs against T. congenital typhoid *T. gondii* including Azithromycin, Dapsone, Roxithromycin, Clarithromycin, Rifabutin, MinocycliNe, Atovaquone. Corticosteroids should also be used when fecal manifestations occur due to its anti-inflammatory effect on the eyes (Holland Aldaym Joseph Stone Doggett, 2018; Senaka Rajapakse, 2013).

2. CONCLUSION

Toxoplasma gondii is the most common protozoan parasite. It can be transmitted by handling with contaminated animals, meat or having contact with food, water, or dust contaminated with cat feces.

Toxoplasma transmission from Person to person occurs only from mother to her child, she passes the parasite to the developing fetus through the placenta.

Many cases of toxoplasmosis can be prevented and treatment. It's advised to procedure early Laboratory testing for diagnosis and health education towards avoiding eating uncooked meat and avoiding contact with cats are recommended for prevention of abortion or defects during pregnancy.

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