Toxoplasmosis: An Important Protozoan Zoonosis

Sonar S. S. and Brahmbhatt M.N.*

Department of Veterinary Public Health
College of Veterinary Science & A.H.,
Anand Agricultural University, Anand
* Corresponding author

Abstract

Toxoplasmosis is an important infection caused by single celled parasite Toxoplasma gondii which is one of the world's most common parasites. Toxoplasmosis is considered to be the third leading cause of death attributed to food-borne illness in the United States. Most people affected never develop signs and symptoms. But for infants born to infected mothers and for people with compromised immune systems, toxoplasmosis can cause extremely serious complications. Toxoplasmosis was first described in 1908 from a small rodent. The parasite infects almost all worm blooded animals and serological evidence indicates that it is one of the most common of humans' infections throughout the world. The disease is transmitted mainly by ingestion of infective stage of the parasite, organ transplant as well as blood transfusion in addition to the transplacental transmission which is very common. Toxoplasmosis can be presented in various forms of clinical manifestations depending on the immune status of the patient causing life threatening disease in AIDS patient. Pregnant women, cat owners, veterinarians, abattoir workers, children, cooks, butchers are considered as high risk group. Timely treatment of man and animals with proper antibiotic, hygienic measures, proper disinfection, mass education and vaccination are the measures to curtail the disease.
Keywords: Zoonosis, Public Health, Toxoplasmosis, Protozoa.

Introduction

Toxoplasmosis is the most widespread zoonosis and an important human disease, particularly in children whom it could cause visual and neurological impairment and mental retardation. Toxoplasmosis is caused by the protozoan parasite Toxoplasma gondii. (Nicolle and Manceaux,1908). Toxoplasma gondii is a cosmopolitan protozoan classified as a coccidian in the phylum Apicomplexa. This parasite is an ubiquitous, obligate intracellular pathogen in humans and animal (Tedesco, 2004). The parasite is known to cause congenital disease and abortion both in human and livestock (Dubey and Beattle, 1988). The parasite infects most genera of warm-blooded animals, including humans, but the primary host is the felid (cat) family.

History

First described in 1908, in material from a small rodent, Ctenoductyalus gondii (Nicolle and Manceaux, 1908). Rediscovered in 1935 in the brain tissue of guinea pigs used for encephalitis experiment . Found as the cause of encephalitis and chorioretinitis in a 31 day old infant. This stimulated interest in the disease . First reported Toxoplasma in India in a dog which died due to Babesia gibsonii infection (Ray and Raghavachari, 1941).

Etiology

Toxoplasmosis is not a new disease. Cats including wild Felidae are the definite host and all other warm-blooded animals including humans are intermediate hosts. Only cats can excrete the resistant stage of *Toxoplasma gondii* (the oocyst) in faeces. The oocysts are formed as a result of a sexual cycle in the intestine of the cats. Only asexual cycle occurs in intermediate hosts. In intermediate hosts *Toxoplasma gondii* is capable of multiplying in virtually any nucleated cell of the body.

The major forms of the parasite are:

• Oocysts (containing sporozoites), which are shed in the feces.
• Tachyzoites, rapidly multiplying organisms found in the tissues.
• Bradyzoites, slowly multiplying organisms found in the tissues.
• Tissue cysts: walled structures, often found in the muscles and central nervous system (CNS), containing dormant *Toxoplasma gondii* bradyzoites. (Dubey, 1988).

Epidemology

Approximately one-third of all humanity has been

exposed to this parasite. Although usually asymptomatic in immunocompetent adults, it can cause severe disease manifestations and even death in immunocompromised patients (Singh, 2003). The parasite infects most genera of warm-blooded animals, including humans, but the primary host is the felid (cat) family. Cats are the only animal species to shed the infectious stage in their feces (Salvin et al., 1994).

Prevalence

Serologic prevalence data indicate that toxoplasmosis is one of the most common of humans infections throughout the world. Infection is more common in warm climates and at lower altitudes than in cold climates and mountainous regions. High prevalence of infection in France has been related to a preference for eating raw or undercooked meat, while high prevalence in Central America has been related to the frequency of stray cats in a climate favoring survival of oocysts. Until recently the prevalence of T. gondii in the general population of India was considered to be low compared with Western countries (Bowerman, 1991).

Seroprevalence of Toxoplasmosis in Gujarat from zoo personnel

Jani et al. (2006) studied, the prevalence in persons was determined based on IgG and IgM level Toxoplasma gondii antibodies were detected in nine out of 60 persons. The over all prospective prevalence of toxoplasmosis was found about 15 percent with a range of 12-900 iu/ml. The high prevalence in group of zoo attendant working with feline group followed by reptile group. The seroprevalence of parsons working with avian, herbivores and general group was found seronegative for toxoplasmosis.

Transmission

Transmission by ingestion of bradyzoites is common in case of carnivores, while the herbivores usually infected by the fecal-oral route by ingesting sporulated oocysts shed by infected cats. In case of transplacental transmission tachyzoites multiply within the placenta and spread to the fetus. Body excretions and secretions like milk and saliva also play vital role in transmission. (Singh et al., 1997).

Human infection can occur either by Ingestion of undercooked infected meat containing cysts or by ingestion of the sporulated oocysts from contaminated hands or foods. Organ transplantation, Blood transfusion (iatrogenic), Transplacental transmission and accidental inoculation of tachyzoites in the skin are the other modes of transmission. (Parija, 1996).

Life cycle

Toxoplasma gondii is a protozoan parasite with a complex life cycle involving sexual replication in members of the cat family (Felidae) and asexual propagation in a wide variety of warm blooded hosts (Dubey,1977). Three different invasive forms in the life cycle mediate survival and spread in the parasite's various hosts. Each invasive form is designed to accomplish different modes of transmission: Sporozoites are shed into the environment within resistant spores (oocysts), which are capable of causing oral infection in herbivorous animals; tachyzoites rapidly expand and disseminate within the definative host; and bradyzoites infect long-lived host cells, where they are semidormant, survive in immunocompetent hosts, and assure oral transmission into carnivorous hosts. Development in T. gondii is enormously flexible, as interconversion between these stages occurs readily (e.g., sporozoite to tachyzoite,tachyzoite to bradyzoite, and bradyzoite to tachyzoite). The entire life cycle can be regenerated from a single cloned organism, which can undergo differentiation to both male and female gametocytes; this indicates that mating types are not predetermined. Hence, infection of a cat with a single isolate can give rise to progeny through a process of self-mating.(Pfefferkorn et al, 1977). Prepatent period after feeding tissue containing bradyzoites, tachyzoites and feeding sporulated oocystes is 3-5 days, 11-19 days and 21-24 days,respectively.(Frenkel ,1973).

Pathogenesis

When the organism is ingested, bradtzoites are released from cysts or sporozoites are released from oocysts, and the organisms enter gastrointestinal cells. Host cell receptors consisting of laminin, lectin, and SAG1 are involved in T gondii tachyzoite attachment and penetration. Tachyzoites multiply, rupture cells, and infect contiguous cells. They are transported via the lymphatics and are disseminated hematogenously throughout the tissues.

The ability of T gondii to actively penetrate hosts cells results in formation of a parasitophorous vacuole. Following apical attachment, the parasite rapidly enters host cell in a process that is faster than phagocytosis. The vacuole is formed primarily by invagination of host cell plasma membrane, which is pulled over the parasite through the concerted action of the actin-myosin cytoskeleton of the parasite. Tachyzoites proliferate, producing necrotic foci surrounded by a cellular reaction. Upon normal immune response, tachyzoites disappear from tissues. In immunodeficient individuals and in some apparently immunologically healthy patients, the acute infection progresses, resulting in potentially lethal consequences such as pneumonitis, myocarditis, and necrotizing encephalitis (Hokelek, 2009).

Various Form of Toxoplasmosis:

Congenital Toxoplasmosis

Ocular Toxoplasmosis
Toxoplasmosis in AIDS patients
Toxoplasmic Encephalitis - TE
Toxoplasma Pneumonia

Conditions of transmission may be when infection during parasitemia – in unexposed mother with an active primary infection during pregnancy or previously exposed mother before pregnancy with immune compromise (eg. AIDS) and tachyzoites cross placental barrier. The risk of the baby's infection depends partly upon the timing of the mother's infection. When mothers are infected in the first trimester, 15 percent of fetuses become infected,as compared to 30 percent in the second trimester and 65 percent in the third trimester (Jeffrey, 2003).

Toxoplasmosis is often asymptomatic in immunocompetent individuals, but ocular lesions may be present in up to 20% of infected patients. It is common to find cysts and tachyzoites in the retina of T. gondii-infected subjects. Lesions are often necrotic, with destruction of the architecture of the neural retina and choroids (retinochoroiditis) (Vallochi et al. 2002).

Toxoplasmosis in AIDS patients and other immunocompromised patients can be life threatening. Disease in these individuals can be due to recently acquired infection or more commonly due to reactivation of a latent infection. Toxoplasmosis is one of the opportunistic infections that AIDS patients develop.

The major signs or symptoms in Toxoplasmic Encephalitis are Headache, confusion, ataxia Hemiparesis , retinochoroiditis Spinal fluid pleocytosis and in case of Toxoplasma Pneumonia are Signs/Symptoms are cough, rales, shortness of breath fever, diffuse infiltrates of both lungs depato-splenomegaly, lymphadenopathy.

Signs and Symptoms in Animal

The early symptoms include lethargy, persistent fever despite treatment with some antibiotics, and anorexia. In some animals, toxoplasmosis may be characterized by hepatitis or pancreatitis. Central nervous system (CNS) signs, particularly common in older animals, vary with the site of the lesion and may include convulsions, restlessness,somnolence, head pressing, teeth grinding, personality changes, hyperesthesia, atypical vocalizations, incoordination,trembling, opisthotonos or circling. Abortion, metritis and the birth of premature, can occur but seem to be rare.Ocular signs are common and may include generalized retinitis or irregular reddish, dark or pale retinal foci;. Chronic lowgrade infections may cause glaucoma, corneal opacity and panophthalmitis.

Diagnosis

The diagnosis is mainly carried out by Microscopic examination, Culture or animal inoculation, Serological test and Polymerase Chain Reaction (PCR).

The detection of Toxoplasma-specific antibodies is the primary diagnostic method to determine infection with Toxoplasma. Antibodies are detected by numerous serologic tests and most of the test kits are commercially available to detect T. gondii specific IgG, IgM , IgA or IgE antibodies. The Sabin-Feldman dye test (DT),indirect fluorescent antibody test (IFAT), indirect haemagglutination test (IHAT), latex agglutination test (LAT), direct agglutination test (DAT), and enzyme linked immunosorbent assay (ELISA) are some of the tests used to detect T. gondii antibodies. Although the DT is the most specific test, it is rarely used now because it uses live virulent T. gondii (Singh, 2003).

Public health importance

Persons at high risk are pregnant women, cat owners, veterinarians, abattoir workers, children, cooks, butchers. There is no significant difference between the prevalence in men or in women. High prevalence of infection is in pregnant women of child bearing age (Singh and Neutiyal, 1991). Prevalence of infection in vegetarians and non-vegetarians was similar (Rawal, 1959).Infection is asymptomatic in 80-90% of non-pregnant, immunocompetant individuals and usually causes mild disease. Toxoplasmosis is a serious and often lifethreatening disease in immunodeficient patients. Epidemiologic studies from various parts of world indicate that the ingestion of undercooked meat is an important means of transmission of T. gondii. Similarly, cancer patients are also at risk of developing clinical toxoplasmosis. Toxoplasmosis is one of the opportunistic infections that AIDS patients develop Toxoplasmosis is more severe in infants whose mothers become infectedduring the first trimester than those during the third trimester. Although most congenitally infected children are asymptomatic at birth, they will develop some symptoms later in life.

Treatment in human

Antibiotics may be used in pregnant women, immunocompromised patients with organ involvement, congenitally infected infants or individuals with ocular disease. Antibiotics cannot destroy tissue cysts and may not be able to eradicate actively dividing parasites If the presence of acute T. gondii infection in a pregnant woman is confirmed, treatment with spiramycin (Rovamycine) can be initiated in an effort to prevent transmission to the fetus. If fetal infection is confirmed through amniocentesis, the woman may be switched to pyrimethamine (Daraprim) and sulfadiazine after the first trimester (Daffos et al., 1988). Folinic acid

(leucovorin) is given with pyrimethamine and sulfadiazine to protect bone marrow from the suppressive effects of pyrimethamine.Trimethoprim-sulfamethoxazole (100 mg/kg/d) should be given in chronic infections.

Treatment in animals

Antibiotics and supportive therapy are used to treat clinical disease. Antibiotics do not destroy the bradyzoites, and do not eliminate infections. Pyrimethamine with triple sulpha drugs has given good results. Frankel (1975) reported that oocyst shedding in toxoplasma infected cats was reduced with combination of Pyrimethamine (1 mg/kg) and sulphadiazine (120 mg/kg). Oocyst shedding was much reduced following administration of 2-sulphamoyl-1-4,4-diaminodiphenylsulphone (SDDS) (160-1000 mg/kg) three to four days after infection, Prevention and control:

(A) Prevention: Feed/ration of the animals should not have access to cats which will help in avoiding feed contamination from cat faeces. Preventive medication is to be given to young cats as they shed more oocytes in faeces. To prevent toxoplasmosis and other food-borne illnesses, food should be cooked to a safe temperature (71.1°C [160°F]). Fruits and vegetables should be peeled or thoroughly washed before they are eaten. Pregnant women should wear gloves when they are gardening or touching soil or sand, because of the possible presence of cat feces. Afterwards, they should wash their hands thoroughly Pregnant women should avoid nourishing the cats as well as avoid contact with cats and raw meat.Raw milk should not be drunk (Narladkar et al., 2006).

(B) Mass education: Education of pet owners, consumers of meat and milk about possible risk of toxoplasma infection and care to be taken for protection.

(C) Toxovax: The vaccine consists of tissue culture grown live attenuated S48 tachyzoites.after around 3000 passages twice weekly it was shown to have lost its ability to develop tissue cyst and has been used to control toxoplasmosis in ewes in New Zealand only one injection 3 weeks before mating is recommended. (Reddy, 2006).

(D) Disinfection: T. gondii oocysts are resistant to most disinfectants but can be inactivated by iodine, formalin and ammonia. They are also destroyed within 10 minutes by temperatures greater than 66°C (150°F), and can be killed with boiling water. Tachyzoites and tissue cysts are susceptible to most disinfectants, including l% sodium hypochlorite and 70% ethanol. Tachyzoites are also inactivated at pH < 4.0. Freezing at –15°C for more than three days or –20°C for more than 2 days destroys a high percentage of the cysts.

References

1. Bowerman, R.J.(1991). Seroprevalence of Toxoplasma gondii in rural India: a preliminary study. *Trans Roy Soc Trop Med Hyg* 85:622.
2. Dubey, J.P. (1977). Toxoplasma, Hammondia, Besniotia, Sarcocystis, and other tissue cyst–forming coccidia of man and animals. In Parasitic Protozoa, ed. JP Kreier, 101–237. New York: Academic.
3. Dubey, J. P. (1988). Toxoplasmosis in India. *Perspect Parasitol* 2:131-152.
4. Dubey, J.P; Beattie, C.P. (1988). Toxoplasmosis of Animals and Man. Boca Raton, FL: CRC Press 1:220.
5. Frenkel, J.K. (1973). Toxoplasma in and around us. *Biol. Sci.* 23:343–352.
6. Hokelek, M. (2009). Toxoplasmosis. eMedicine Infectious Diseases 1-24.
7. Jani, R.G.; Bhuva, C. N.; Katara, R. D.; Bhanderi, G. and Vadaliya, D. (2006).Study of Seroprevalence of Toxoplasmosis in workers of Zoological Gardens of Gujarat. *Intas Polivet* 7(2): 452-454.
8. Jeffrey, J. (2003). Congenital Toxoplasmosis. *American Family Physician* 67(10):2131-2138.
9. Narladkar, B. W.; Kulkarni, R. R.; Deshpande, A. R. and Deshpande, P.D. (2006). Toxoplasmosis- Public health significance. *Intas Pollvet* 7(2): 444-451.
10. Nicolle, C. and Manceaux, L. (1908). Toxoplasmosis. *Acad Sci* 147:763-766.
11. Parija, S. C. (1996). Textbook of Medical Parasitology.AIPD.Madras:75-109.
12. Pfefferkorn, E. R.; Pfefferkorn, L. C. and Colby, E. D. (1977). Development of gametes and oocysts in cats fed cysts derived from cloned trophozoites of Toxoplasma gondii. *J Parasitol* 63:158–59.
13. Rawal, B.D. (1959). Toxoplasmosis. A dye test on sera from vegetarians and meat eaters in Bombay. *Trans Roy Soc Trop Med Hyg.* 53:61-63.
14. Ray, H. N. and Rahavanchari, K. (1941). Toxoplasmosis. *Ind J Vet. Sci* 11:28-32.
15. Reddy, P. M. (2006). Toxoplasmosis in domestic animals and man with reference to epidemiology and control. *J Parasitol* 83-86.
16. Slavin, M.A.; Meyers, J. D. and Remington, J. S.(1994). Toxoplasma gondii infection in bone marrow transplant recipient: A 20 year experience. *Bone Marrow Transplant* 13:549-557.
17. Singh, S. (2003). Mother to child transmission and diagnosis of Toxoplasma gondii infection during pregnancy. *Ind J Med Microbiol* 21(2):69-76.
18. Singh, S.; Mahajan, R.C. and Dubey, J.P. (1997). Toxoplasmosis in India. Published by Pragati Publishing Company, Gaziabad. India.
19. Singh, S. and Nautiyal, B.L. (1991). Seroprevalence of Toxoplasmosis in Kumaon region of Uttar Pradesh. Ind *J Med Res* 93:47-49.
20. Tedesco, R. C.; Smith, R.L.; Corte-Real, S. and Calabrese, K. S. (2004). Ocular toxoplasmosis: the role of retinal pigment epitheliummigration in infection. *Parasitol Res* 92: 467–472.
21. Vallochi, A.; Nkamura, M. V; Schlesinger, D.; Martins, M. C.; Silveira, C.; Belfort, R. Jr. and Rizzo, L.V. (2002). Ocular toxoplasmosis: more than just meets the eye. *Scand J Immunol* 55:324–328.