Parasitic Diseases and their Mimics

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Parasites can be defined as organisms that engage in a symbiotic relationship with another organism while causing some form of harm to its host. There are 2 main classes of parasites that can cause CNS disease in humans: protozoa, and helminths.

With the increase in international travel parasitic disease, although previously rare outside developing countries, is now occasionally seen worldwide.

Protozoa

Protozoa are microscopic, one-celled organisms that are mobile. They can be free-living or parasitic in nature. They are able to multiply in humans, which contributes to their survival and also permits serious infections to develop from just a single organism. Transmission of protozoa that live in a human intestine to another human typically occurs through a fecal-oral route (for example, contaminated food or water or person-to-person contact). Protozoa that live in the blood or tissue of humans are transmitted to other humans by an arthropod vector (for example, through the bite of a mosquito or sand fly).

Entamoeba histolytica is a protozoan. A microscope is necessary to view this parasite.
http://www.dpd.cdc.gov/dpdx/HTML/ImageLibrary/Amebiasis_il.htm

Examples of CNS human diseases caused by protozoa include: Malaria, Amoebiasis, Toxoplasmosis, Trichomoniasis, Trypanosomiasis
Development and terminology

Some protozoa have life stages alternating between proliferative stages in which they are called trophozoites and dormant stage in which they are termed bradyzoite cysts. These dormant cysts are usually in infected muscle or brain tissue. As cysts, protozoa can survive harsh conditions, such as exposure to extreme temperatures or harmful chemicals, or long periods without access to nutrients, water, or oxygen for a period of time. Being a cyst enables parasitic species to survive outside of a host, and allows their transmission from one host to another.

Helminths (Worms)

Helminths are worms. They are large and generally visible to the naked eye in their adult stages. They can be free living or parasitic in nature.

_Echinococcus granulosus_ adult, stained with carmine.

Close-up of the scolex (head) of _E. granulosus_

http://www.dpd.cdc.gov/dpdx/HTML/ImageLibrary/Echinococcosis_il.htm

There are 2 main groups that cause CNS infection in humans:

**Flatworms** – these include the flukes and give rise to schistosomiasis, paragonimiasis and the tapeworms which cause cystericosis, echinococcus and sparganosis.
Roundworms – cause toxocariasis, trichinosis and gnathostomiasis

Infestations

Man can be the definitive host if the adult worm residues in the body; often in intestines, blood or skin. e.g intestine cysterciosis. Humans are intermediary hosts if they harbor the parasite only for a short transition period. This is often as the parasite transfers from egg to a juvenile form, larva, which are usually found in muscles or other organs. For example in Trichinella spiralis, the roundworm that causes trichinosis, a host has both reproductive adults in its digestive tract and immature juveniles in its muscles, and is therefore considered both the definitive and intermediary host.

If not important in sustaining the life cycle of the parasites, humans may be infected as accidental intermediary hosts - e.g echinococcus where contact with eggs in soil, dirt, animal hair may lead to cyst formation in the brain.

Terminology and Developmental Phases: Worms

The head of the worm is known as the scolex. The scolex has suckers that allow attachment to membranes. The body segments of the worm (see below) that can lay eggs are called, proglottids. Eggs containing embryos are called oncospheres. Hatched eggs develop into larva. Larva is a juvenile form of the adult and often becomes encysted in muscle or other organs.

Echinococcus granulosus. Adults range from 3-6 mm in length and usually consist of a scolex and three proglottids. The third (terminal) proglottid is gravid (contains eggs) and is longer than wide. The scolex contains four suckers and a rostellum with 25-50 hooks.

http://www.dpd.cdc.gov/dpdx/HTML/ImageLibrary/Echinococcosis_il.htm
Clinical profile

Clinical symptomatology varies with organism, development stage and host immune response. Parasitic disease can involve the CNS with multiple clinical presentations. This includes seizures, headache, fever, or symptoms associated with a space occupying lesion.

Prevalence

Infestations can be divided into common, less common and rare. This will vary depending on the country considered. The most common parasitic infection is cystericosis. Less common infections are: toxoplasmosis, echinococcus and malaria. Rare infections: schistosomiasis, sparganosis, paragonimiasis, amoebiasis, toxocara, African and American trypanosomiasis, trichinosis and gnathostomiasis.

Infective organism and mode of spread to humans and endemic regions

Cystericosis - Tape worm Taenia solum.

- Infection acquired through in gestation of eggs from a tapeworm carrier. (fecal -oral contamination). Man becomes definitive host by in gestation of encysted larva is undercooked pork.

- Central and South America, India, Africa, East Asia and Eastern Europe

Toxoplasmosis - protozoa Toxoplasma gondii

- Transmission by oral ingestion of infectious oocysts oral ingestion of tissue cysts. The third type of transmission can occur vertically through passing on of tachyzoites transplacentally. Cat is definitive host.

- Ubiquitous. Disease caused by reactivation in immunosuppressed host.

Echinococcus - Tapeworm Echinococcus granulosus and less commonly E multilocularis

- Definitive host, dogs. Sheep intermediary host. Transmission by ingestion of food or water contaminated by parasitic eggs.

- Australia, New Zealand, Middle East and South America.

Malaria - protozoa, plasmodium falciparum

- Transmission of parasite by mosquitoes

- Africa, much of Southeast Asia, Indonesia, many of the islands of the western Pacific and in areas of the Amazon Basin of South America.
**Schistosomiasis** - Flat worm, flukes S. japonica most common in brain.

- Man is definitive host. Intermediate host is freshwater snail which release larva. Transmission of disease by larva entering human through skin when swimming in infected water.

- Africa, South America, Middle East, China, Taiwan, Japan and Philippines.

**Sparganosis** - Tapeworm Spirometra mansoni

- Transmission by ingestion of larva contaminated food, snake, fish, frog (intermediary hosts) or water. Definitive hosts are dogs, cats. Man is an accidental host.

- South East Asia, Japan, China, Korea.

**Paragonimiasis** - flat worm, fluke Paragonimus westerman

- Disease caused by ingestion of undercooked crustaceans containing larva. Man is definitive host and eggs hatch in shells in water.

- South East Asia, Japan, China, Korea.

**Amebiasis** - protozoa: Entamoeba histolytica, Naegleria fowleri, Acanthamoeba are most common - transmission from swimming in contaminated freshwater, inhaling dust or soil with amebic cysts. Spread along olfactory tracts or through blood.

- Worldwide distribution and occurs most frequently in tropical areas and during hot summer months.

**Toxocariasis** - Roundworm Taenia canis

- Dog is definitive host. Transmission by ingestion eggs.

- Worldwide.

**Trichinosis** - round worm Trichinella

- Transmission by the consumption of raw or undercooked meat, especially pork, or wild game infected with larvae.

- Europe, Asia, and North America.

**American Trypanosomiasis** (Chagas disease)
Protozoa Trypanosma cruzi
- transmitted by reduviid bugs
- Latin America

**African Trypanosomiasis**
- Protozoa, Trypanosoma brucei rhodesiene, T brucei gambiense
- transmission by tsetse fly
- Africa

**Gnathostomiasis**- Round worm Gnathostoma spinigerum
- transmitted by ingestion of raw, insufficiently cooked intermediate hosts such as fresh water fish, birds or amphibians definitive host for gnathostomiasis includes cats, dogs, tigers, leopards, lions, minks, opossums, and raccoons
- Asia, Mexico, India and parts of South Africa.

**Imaging Features**

**General Features**

The most characteristic appearance of parasitic disease is of an enhancing supratentorial multiloculated mass.

The most characteristic location is supratentorial.

Typical imaging features are listed.

**Cysticercosis:**

Lesions are most common in the cisterns followed by the parenchyma and then ventricles. Imaging varies with development stage and host response. Lesions may be at different stages in same patient. 4 pathologic stages: Vesicular, colloidal vesicular, granular nodular, and nodular calcified. The most characteristic appearance is a cyst with a dot in it, central T2 hyperintensity, dark on DWI and presence of additional calcifications

**Toxoplasmosis**

This is the most common CNS infection in AIDS.

Lesions are typically located in the basal ganglia, corticomedullary junction, thalamus, and cerebellum. They are usually ill defined round, ovoid lesions with edema and rim, nodular or target (enhancing nodule with enhancing rim) enhancement.
**Echinococcosis**

Usually presents as a large uni-or multilocular cyst ± detached germinal membrane, daughter cysts, with no edema and no enhancement. These cysts are most common in the parietal lobe and middle cerebral artery territory.

**Malaria**

Malaria has a predilection for the basal ganglia and cortex with punctate or ring hemorrhages, infarction and edema.

**Schistosomiasis**

May be hemispheric and cerebellar in location. It causes a granulomatous encephalitis, and/or a mass lesion with multiple enhancing nodules and areas of linear enhancement.

**Sparganosis**

The most common finding is multiple conglomerated ring-shaped enhancements. The live worm grows in the brain and is surrounded by a capsule. The” tunnel sign” caused by the undulating motion of the worm as it passes through the brain may aid in making the diagnosis.

**Paragonimiasis**

Conglomerates of multiple ring enhancing lesions, grape like or soap bubble appearance. Tunnel sign may be present.

**Amebiasis**

Meningoencephalitis and cerebral infarctions

**Toxocariasis**

CNS involvement is rare. Meningoencephalitis

**Trichinosis**

Eosinophilic meningoencephalitis, thrombosis and small gray and white matter infarctions.

**American Trypanosomiasis (Chagas Disease)**
Meningoencephalitis plus multiple nodular enhancing lesions in corpus callosum, periventricular white matter, deep white matter, subcortical regions and cerebellum

**African Trypanosomiasis**

Meningeal thickening and enhancement and T2 hyperintensities in deep gray matter, internal capsule, cerebellar peduncles, corpus callosum and cortex.

**Gnathostomiasis**

Meningoencephalitis, hemorrhagic tracks, subarachnoid and parenchymal hemorrhage.

**Differential Diagnosis**

A wide differential diagnosis may exist.

For contrast enhancing disease: Glioblastoma Multiforme, lymphoma, metastases, abscess

For cyst like lesions: Cystic astrocytoma, Arachnoid cyst, Virchow Robin space, porencephalic cyst

Close correlation to history, symptomatology, biochemistry and travel history may aid in the diagnosis. Enzyme linked immunosorbent assay (ELISA) or indirect hemagglutination of serum or CSF may be useful in patients with nonspecific and inconclusive findings.

**Conclusion**

Most parasitic infections are uncommonly encountered in developed countries.

The key to diagnosis is to consider the possibility in the first place.

Although the definitive diagnosis is usually made with histopathology, the clinical diagnosis is generally based on a combination of the ethnicity of the patient, clinical features, serology and characteristic neuroimaging findings.
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