Taenia Infection

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Background: Of 32 recognized species of *Taenia*, only *Taenia solium* and *Taenia saginata* are medically important. However, recent epidemiologic studies in Southeast Asia have identified a third *Taenia* species in humans known as the Asian species. Cysticercosis is the development of extraintestinal encysted larval forms of *T solium* in various organs (see Cysticercosis). The central nervous system (CNS) is involved in 60-90% of cases; this condition is termed neurocysticercosis (NCC) (see Neurocysticercosis).

Cysticercosis caused by *T saginata* (also called the cattle or beef tapeworm) is rare; *T saginata* has far lower impact on human health than *T solium*. Differentiating between *T solium* and *T saginata* infections is important because both infections are endemic in Southeast Asia, Africa, Europe, and Central and South America. Infection in children usually goes unrecognized.

Pathophysiology: Adult tapeworms live in the human small intestine. Humans pass gravid eggs in feces; these mature eggs contaminate pastures and barnyards, where cattle and pigs ingest them. Upon reaching the alimentary canal of infected animals, the embryos are released, penetrate the gut wall, and enter the circulation. The embryos filter from the circulation and encyst in muscular tissue. Larvae (ie, cysticerci) become infectious within 2-3 months. Humans develop a tapeworm infection by eating raw or undercooked beef or pork. The cysticercus becomes activated, attaches to the wall of the small intestine by the scolex, and becomes a mature tapeworm. This maturation process takes 10-12 weeks for *T saginata* and 5-12 weeks for *T solium*. A single tapeworm produces an average of 50,000 eggs per day and may live 25 years.

Humans can also act as an intermediate host for *T solium*. Cysticercosis results from human ingestion of *T solium* eggs through fecal contamination, reverse peristalsis of gravid proglottids, or autoinfection. The cysticerci may develop in any organ, and their effects depend entirely upon the location of the cysticerci.

A coenurus is the larval stage of *Taenia multiceps*, *Taenia*
serialis, and *Taenia brauni*. Adult tapeworms develop in dogs or other canids that ingest coenurus larvae in the tissues of various intermediate hosts. These hosts include sheep, goats, hares, rabbits, and other herbivores for *T. multiceps*; hares, rabbits, and other rodents for *T. serialis*; and gerbils for *T. brauni*. Each protoscolex within a coenurus can mature into an adult tapeworm after ingestion by a canid host. Adult worms produce eggs, which are passed in feces; these eggs are morphologically similar to taeniid eggs. Ingestion of eggs by an appropriate intermediate host or by humans leads to development of coenurus. Coenuri are cysts that contain many protoscolices attached in rows on the internal membrane of the cyst.

**Frequency:**

- **In the US:** Cysticercosis is primarily an imported disease. Approximately 1000 cases are diagnosed each year. Most occur in persons who have immigrated to the United States, primarily from Latin America. Cysticercosis has also developed following close contact with recently immigrated, infected individuals. Although some patients with NCC are born in the United States, many have traveled to rural areas in countries where the condition is endemic. Locally acquired infections have been confirmed in Los Angeles, New York, Chicago, and elsewhere. Although *T. saginata* infection occurs worldwide, prevalence in the United States is less than 1% because most US cattle are free of the parasite.

- **Internationally:** Approximately 50 million people worldwide are infected by *T. saginata* or *T. solium*. Approximately 50,000 people die annually of cysticercosis. *T. saginata* is common in cattle-breeding regions. Areas with the highest (ie, >10%) prevalence are central Asia, the Near East, and central and eastern Africa. Areas with low (ie, 1%) prevalence are Southeast Asia, Europe, and Central and South America.

*T. solium* is endemic in Central and South America, Southeast Asia, India, the Philippines, Africa, Eastern Europe, and China. Areas of highest prevalence include Latin America and Africa. In some regions of Mexico, prevalence may reach 3.6% of the general population.
*T. multiceps* has been reported from the Americas and parts of Europe and Africa.

*T. serialis* infections occur in the United States and Canada.

*T. brauni* has been reported in Africa.

**Mortality/Morbidity:** Most intestinal taeniid infections are asymptomatic. When symptoms occur, they usually are mild and involve abdominal pain, anorexia, weight loss, or malaise. Cysticercosis causes a mass effect in various vital organs (e.g., brain, eye, heart). The mortality rate for cysticercosis is low and is generally caused by complications such as encephalitis, increased intracranial pressure secondary to edema and/or hydrocephalus, and stroke.

**Race:** All races are affected equally.

**Sex:** Both sexes are affected equally.

**Age:** All ages are susceptible to infection. The age at which raw meat consumption begins is the primary determinant. *T. solium* taeniasis has been reported in children older than 2 years in certain rural communities of Mexico.

**History:**

- Taeniasis
  
  - Most individuals with taeniasis are either asymptomatic or have mild-to-moderate complaints.
  
  - The most common complaint is passage (active or passive) of proglottids, which is associated with slight discomfort. Other symptoms include the following:
    - Colicky abdominal pain (more common in children)
    - Nausea
    - Weakness
    - Loss of appetite
Increased appetite
Headache
Constipation
Dizziness
Diarrhea
Pruritus ani
Hyperexcitability

- Abdominal pain and nausea reportedly are more common in the morning and characteristically are relieved by eating small amounts of food. Children are more symptomatic than adults and often manifest change of appetite, both increased and decreased. Symptoms in infants are more pronounced and consist of vomiting, diarrhea, fever, weight loss, and irritability.

- The most common serious complication of adult tapeworm infection is appendicitis. Other reported complications include obstruction of bile ducts, pancreatic duct and tapeworm growth in ectopic locations (eg, middle ear, adenoid tissue, uterine cavity). A mild eosinophilia of 5-15% may occur in 5-45% of patients; higher levels occur infrequently.

- Cysticercosis and neurocysticercosis

  - In cysticercosis, the cysticerci are most often located in subcutaneous and intermuscular tissues, followed by the eye and then the brain. The CNS is involved in 60-90% of patients (ie, NCC). Most patients have more than one cyst; as many as 200 cysts have been reported.

  - NCC symptoms include 3 characteristic syndromes: convulsions and/or seizures, intracranial hypertension, and psychiatric disturbances, which may occur separately or combined. Onset can be insidious (eg, elevated intracranial pressure) or abrupt (eg, floating cysticerci suddenly block cerebrospinal fluid [CSF]).
    - Convulsions and/or seizures: Seizures are caused by the localization of cysticerci in brain parenchyma. Children most often
present with seizures, which are focal with acute onset. Cysticercosis is the most common cause of epilepsy in endemic areas and is the sole manifestation in as many as one third of patients.

- Intracranial hypertension: This is caused by obstruction of CSF by intraventricular brain cysts. Symptoms include headache, nausea, vomiting, vertigo, and papilledema.
- Psychiatric disturbances: While changes in personality and mental status occur more often in adults than in children, behavioral changes and learning disabilities were reported in a study of 25 affected children.

- Other possible infections
  - Ocular cysticercosis: The subretinal space, vitreous, and conjunctiva are the most frequent sites of infection. Common manifestations of infection include severe pain and blurred or lost vision.
  - Muscular and dermatologic cysticercosis: Cysticerci in muscles often are associated with NCC. Any muscle mass may be involved and appear as acute myositis. However, most patients are asymptomatic. Subcutaneous nodules may be evident.
  - Coenurosis: Clinical manifestations are determined by the site of the coenurus larvae. Patients with cerebral coenurosis can present with seizure or intracranial hypertension. Ocular coenurosis manifests as a red and painful eye.

**Physical:** Most children with intestinal taeniasis appear healthy. Physical findings may include the following:

- Weight loss, caused by loss of appetite, is more pronounced in infants than in adults.
- Subcutaneous nodules are less common in children than in adults.
Neurologic abnormalities in some children with NCC may manifest as hemiparesis, sensory disturbances, and papilledema.

Intraocular larva may be evident.

Muscular pseudohypertrophy may occur.

**Causes:** Taeniasis is caused by ingesting inadequately cooked beef or pork that contains the larvae or cysticerci of *T. saginata* or *T. solium*. Cysticercosis, which is caused by ingesting eggs of *T. solium*, occurs when larvae are deposited in skeletal muscle, brain, eyes, and other organs. Taeniasis is endemic in countries where both *T. saginata* and *T. solium* are common and public hygiene is poor. A species of *Taenia* recently identified in many Southeast Asian countries resembles *T. saginata* at the molecular level, and its ingestion in inadequately cooked pork causes an intestinal infection. This close relationship with *T. saginata* has led to the assumption that it does not cause human cysticercosis because human cysticercosis is caused almost exclusively by *T. solium*.

Coenurosis results when humans accidentally ingest mature *T. multiceps* or *T. serialis* eggs, usually in contaminated fruits or vegetables. Approximately 100 cases of coenurosis have been reported, primarily in tropical Africa, with the remainder in North and South America and South Africa. Interestingly, the cases in central Africa rarely involved the CNS, whereas more than 75% of the cases elsewhere had CNS involvement. Larvae of these species may be inoculated directly into a child's conjunctiva and skin as the child plays on contaminated ground.
Tuberculosis

Other Problems to be Considered:

Pancreatitis
Brain abscess
Encephalitis
Periorbital infections
Brain neoplasm
Lipoma
Fibroma

Lab Studies:

- Intestinal taeniasis
  - Complete blood count detects eosinophilia in no more than 45% of patients.
  - Examine 3 consecutive stool samples (direct and concentrated stool preparations) from patients and contacts.
    - Determination of species on the basis of ova examination is difficult because the eggs of *T solium* and *T saginata* are identical.
    - Examining the gravid proglottids helps identify the species; count the main uterine branches after injection with India ink (ie, 7-13 branches for *T solium*, 15-20 for *T saginata*).
    - Examining the scolex helps differentiate the species because a *T solium* scolex has 4 suckers and an armed rostellum.

- Neurocysticercosis
  - Examine stool samples as described above.
  - Perform a lumbar puncture.
    - CSF findings are abnormal in 50-90% of patients with NCC.
    - Protein levels are elevated.
    - Glucose levels are mildly to moderately depressed.
    - A predominantly mononuclear pleocytosis is common.
    - Cell counts rarely exceed 300/mm³.
    - Eosinophils in the CSF are a common but nonspecific finding. Giemsa or Wright stains should be performed to detect their presence.
- Enzyme-linked immunotransfer blot (EITB) assay
  - An EITB assay is the test of choice to confirm the diagnosis of NCC indicated by clinical and radiologic findings.
  - Test specificity is 100% and sensitivity is 90% with more than 2 lesions; sensitivity declines to 50-70% with a solitary lesion. Therefore, EITB assay may have limited value for children because most present with a single lesion.
  - A serum immunoblot assay is more sensitive than the assay using CSF, thus obtaining CSF solely for that purpose is unnecessary.

- Enzyme-linked immunosorbent assay (ELISA)
  - While an ELISA can be performed on both CSF and serum, CSF provides better reliability.
  - ELISA may provide either false-positive or false-negative results.
  - ELISA provides a reported sensitivity of 75%.
  - ELISA can aid in diagnosis in patients with few CNS lesions and relatively mild disease.

Imaging Studies:

- Radiography
  - Plain films of the chest, neck, arms, and thighs can depict calcified cysticerci, although calcification takes approximately 3 years, and sometimes longer, to occur.
  - A central calcified scolex surrounded by a calcified cyst wall is pathognomonic.

- Computed tomography
  - Perform computed tomography (CT) in all children presenting with new-onset focal seizures.
  - While CT is superior to magnetic resonance imaging (MRI) to detect intracerebral calcification, calcification occurs less frequently in children than in adults.
  - CT reveals both cysts and granuloma. Cysts, which may be single or multiple, are approximately 5-20 mm in diameter. Most children (ie, 75%) have a single cyst, usually located in the cortex or at the junction of gray and white matter.
  - CT can also detect edema associated with dead worms. The dead worms appear as spherical hypodensities, often with the parasite's protoscolex appearing as an eccentric dot of calcium (ie, mural nodule).
CT with contrast shows a ring-enhancing image. Later obliteration of the cyst may produce a solid-enhanced image.

- MRI
  - MRI is superior to CT to detect intraventricular and subarachnoid cysts.
  - MRI may reveal a mural nodule within the cyst, which is pathognomonic for NCC.

Other Tests:
- Ocular cysticercosis
  - Funduscopic examination may show freely floating cysticerci in the anterior chamber and vitreous chamber and may provide visual identification of the movements and morphology of larval forms. Larvae may be found adhering to subretinal tissues.
  - Subretinal cysts are associated with vasculitis and edema.
  - Cysts in vitreous are associated with chorioretinitis and retinal detachment.

Procedures:
- Excise or perform biopsy of subcutaneous nodules.
- For skeletal cysticercosis, conduct a biopsy or excision of the nodule and histologic examination of the cysticerci.
- For neurocysticercosis, perform a lumbar puncture (see Lab Studies).

Histologic Findings: Mature cysticerci are ellipsoidal, translucent, fluid-filled cysts, 1-2 cm in diameter. Younger cysticerci are smaller. A single dense white body can be seen through the membrane. The spiral canal of the cyst wall, which has a wavy appearance in most tissue preparations, is most frequently observed in biopsy specimens. The wall, which is 100-200 micrometers wide, is characterized by an internal parenchymal layer of longitudinal and circular muscle, a middle layer of pseudoepithelial cells, and an outer cuticular layer composed of a dentate membrane with a microvillus projection that interfaces with host tissues. The scolex region is thickened and more organized. Cross sections of the scolex appear as several layers of folded smooth muscles, which may contain parts of the suckers or hooklets.

The parasite is surrounded by an adventitia of host tissue reaction. A scant local cellular reaction that consists of some eosinophils and macrophages surrounds
that consists of the entire spectrum of inflammatory cells, including multinucleated giant macrophages.

**Medical Care:** Most patients with intestinal taeniid infection are asymptomatic or mildly symptomatic. If adult tapeworms are detected in the stools, anthelmintic therapy usually suffices. Asymptomatic cysticercosis requires no treatment. Treatment for symptomatic NCC is controversial. If anthelmintic therapy is chosen, albendazole or praziquantel is the drug of choice. Because these agents provoke an anti-inflammatory response in the CNS, start the patient on high-dose glucocorticosteroids. Ocular, ventricular, and spinal lesions may require surgical treatment because treatment with anthelmintic drugs can provoke irreversible drug-induced inflammation.

**Surgical Care:**

- Surgery may be needed if intestinal taeniid infection causes complications such as acute surgical abdomen, appendicitis, or obstructed bile or pancreatic ducts.

- Surgical intervention may also be required for cysticercosis and NCC (see Cysticercosis, Neurocysticercosis).

- Surgical excision of ocular cysticercosis is the preferred method of treatment.

**Consultations:**

- Consult with an infectious diseases specialist for help with a questionable diagnosis, help eradicating the organism, and information on public health issues.

- Consult a neurologist for the management of NCC manifestations.

- Consult an ophthalmologist for cases involving ocular cysticercosis.

**Diet:** Other than adequately cooking pork and beef products to prevent reinfection, taeniid infections require no specific diet.

**Activity:** No activity restrictions are necessary.
Drug Category: *Anthelmintics* -- Treatment of both tapeworm infections is similar; praziquantel is considered the drug of choice. Niclosamide can also be used. Both are administered as single-dose therapy. With *T solium* infection, start treatment immediately because of the possibility of cysticercosis via autoinfection.

<table>
<thead>
<tr>
<th>Drug Name</th>
<th>Praziquantel (Biltricide) -- DOC for <em>Taenia</em> infection. Increases cell membrane permeability in susceptible worms, resulting in loss of intracellular calcium, massive contractions, and paralysis of musculature.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult Dose</td>
<td>5-10 mg/kg PO once Cysticercosis: 50 mg/kg/d PO divided q8h for at least 15-30 d</td>
</tr>
<tr>
<td>Pediatric Dose</td>
<td>&lt;4 years: Not established &gt;4 years: Administer as in adults</td>
</tr>
<tr>
<td>Contraindications</td>
<td>Documented hypersensitivity; ocular cysticercosis</td>
</tr>
<tr>
<td>Interactions</td>
<td>Hydantoins may reduce serum concentration, possibly leading to treatment failures</td>
</tr>
<tr>
<td>Pregnancy</td>
<td>B - Usually safe but benefits must outweigh the risks.</td>
</tr>
<tr>
<td>Precautions</td>
<td>Mild and transient adverse effects include dizziness, headache, abdominal pain, fatigue, malaise, and limb pain; patients should not drive during and 1 d after therapy because of dizziness; avoid in pregnancy when possible</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drug Name</th>
<th>Niclosamide (Niclide) -- Acts by causing necrosis of head and adjoining segments of tapeworm. Worm loses hold and is eliminated in pieces or intact with feces. Available as 500-mg tab. Should be chewed to fine pulp before swallowing with a little water or crushed in liquid and then swallowed.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult Dose</td>
<td>2000 mg (4 tab) PO as single dose</td>
</tr>
<tr>
<td>Pediatric Dose</td>
<td>&lt;2 years: 500 mg (1 tab) PO as single dose 2-6 years: 1000 mg (2 tab) PO as single dose</td>
</tr>
</tbody>
</table>
### Drug Name

**Albendazole (Albenza)** -- Decreases ATP production in worm, causing energy depletion, immobilization, and finally death. To avoid inflammatory response in CNS, patient must also be started on anticonvulsants and high-dose glucocorticosteroids.

### Adult Dose

- **<60 kg:** 15 mg/kg/d PO divided bid for 8-30 d; not to exceed 800 mg/d
- **>60 kg:** 400 mg PO bid for 8-30 d

### Pediatric Dose

- **<2 years:** 200 mg/d for 3 d; repeat in 3 wk prn
- **>2 years:** Administer as in adults

### Contraindications

Documented hypersensitivity

### Interactions

Avoid alcohol during treatment

### Pregnancy

B - Usually safe but benefits must outweigh the risks.

### Precautions

Most adverse effects are mild and transient (eg, vomiting, nausea, abdominal distress)

### Drug Name

**Dexamethasone (Decadron)** -- Adrenocortical steroid. Decreases inflammation by suppressing migration of PMNs and reducing capillary

### Drug Category: Glucocorticoids

Useful in cases of increased intracranial pressure resulting from anthelmintic-induced cyst death and resultant inflammation.
### Adult Dose
Loading dose: 1-2 mg/kg PO/IV/IM initially, followed by 1-1.5 mg/kg/d divided q4-6h for 2-3 d; not to exceed 16 mg/d

### Pediatric Dose
Administer as in adults

### Contraindications
Documented hypersensitivity; active bacterial or fungal infection

### Interactions
Effects decrease with coadministration of barbiturates, phenytoin, or rifampin; decreases effects of salicylates and vaccines used for immunization

### Pregnancy
C - Safety for use during pregnancy has not been established.

### Precautions
Increases risk of multiple complications, including severe infections; monitor adrenal insufficiency when tapering drug; abrupt discontinuation of glucocorticoids may cause adrenal crisis; hyperglycemia, edema, osteonecrosis, myopathy, peptic ulcer disease, hypokalemia, osteoporosis, euphoria, psychosis, myasthenia gravis, growth suppression, and infections are possible complications

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**FOLLOW-UP**

Further Inpatient Care:

- Admit the patient if complications such as intestinal obstruction arise because of intestinal taeniid infection. (See **Cysticercosis**, **Neurocysticercosis** for information on further inpatient care for these diseases.)

Further Outpatient Care:

- Following treatment, patients should carefully examine stools for proglottid elimination during the next 5 weeks for *T solium* infection and for 3 months for *T saginata* infection.

Deterrence/Prevention:

- Individuals should avoid eating inadequately cooked beef or pork.
- Examine the stools of potentially infected individuals for taeniid infection and provide treatment if test results are positive.

**Complications:**
- Appendicitis
- Cholecystitis
- Pancreatitis
- Intestinal obstruction
- Tuboovarian abscess (rare)
- Systemic cysticercosis

**Prognosis:**
- Treatment with praziquantel reportedly provides cure rates of 99-100%.

**Patient Education:**
- Educate patients and families about routes of infection and preventive measures.
- Teach patients and families proper sanitary and personal hygiene measures.

**Medical/Legal Pitfalls:**
- Initially missing the diagnosis of intestinal taeniasis is possible, especially in the United States, where cases are infrequent. Patients whose conditions are misdiagnosed risk major complications, such as cysticercosis and NCC. Obtain a travel history for patients with suggestive lesions.

- Although inappropriate treatment for intestinal taeniasis is less likely to occur than an incorrect diagnosis, it remains a potential issue, even when the diagnosis is correctly made. To help ensure appropriate treatment, consult an infectious diseases specialist for all cases of suggested intestinal taeniasis, cysticercosis, and NCC.

- Adverse reaction to treatment is a potential medicolegal pitfall that can be avoided by following established standards of care and obtaining
proper patient histories. Ascertain whether a patient with a taeniid infection previously received antiparasitic drugs and, if so, whether administration of the drugs caused problems. Failure to do so could result in the patient having an adverse reaction to a prescribed medication.

Special Concerns:

- Patients with taeniid infections may also have other parasitic infections. Many regions where *Taenia* species are endemic also are endemic for other parasites. After treatment for taeniasis, observe patients for symptoms of other parasitic infections.

- To prevent reinfection, identify the source and treat patient contacts.

**BIBLIOGRAPHY**


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