



1434 Surgery remains the treatment of choice for complicated *E. granulosus* cysts (e.g., those communicating with the biliary tract), for most thoracic and intracranial cysts, and for areas where PAIR is not possible. For *E. granulosus* of the liver, the preferred surgical approach is pericystectomy, in which the entire cyst and the surrounding fibrous tissue are removed. The risks posed by leakage of fluid during surgery or PAIR include anaphylaxis and dissemination of infectious protoscolices. The latter complication has been minimized by careful attention to the prevention of spillage of the cyst and by soaking of the drapes with hypertonic saline. Infusion of scolical agents is no longer recommended because of problems with hypernatremia, intoxication, or sclerosing cholangitis. Albendazole, which is active against *Echinococcus*, should be administered adjunctively, beginning several days before resection of the liver and continuing for several weeks for *E. granulosus*. Praziquantel (50 mg/kg daily for 2 weeks) may hasten the death of the protoscolices. Medical therapy with albendazole alone for 12 weeks to 6 months results in cure in ~30% of cases and in improvement in another 50%. In many instances of treatment failure, *E. granulosus* infections are subsequently treated successfully with PAIR or additional courses of medical therapy. Response to treatment is best assessed by serial imaging studies, with attention to cyst size and consistency. Some cysts may not demonstrate complete radiologic resolution even though no viable protoscolices are present. Some of these cysts with partial radiologic resolution (e.g., CE4 or CE5) can be managed with observation only.

Surgical resection remains the treatment of choice for *E. multilocularis* infection. Complete removal of the parasite continues to offer the best chance for cure. Ongoing therapy with albendazole for at least 2 years after presumptively curative surgery is recommended. Positron emission tomography can be used to follow disease activity. Most cases are diagnosed at a stage at which complete resection is not possible; in these cases, albendazole treatment should be continued indefinitely, with careful monitoring. In some cases, liver transplantation has been used because of the size of the necessary liver resection. However, continuous immunosuppression favors the proliferation of *E. multilocularis* larvae and reinfection of the transplant. Thus, indefinite treatment with albendazole is required.

 **Prevention** In endemic areas, echinococcosis can be prevented by administering praziquantel to infected dogs, by denying dogs access to infected animals, or by vaccinating sheep. Limitation of the number of stray dogs is helpful in reducing the prevalence of infection among humans. In Europe, *E. multilocularis* infection has been associated with gardening; gloves should be used when working with soil.

HYMENOLEPIASIS NANA

 Infection with *Hymenolepis nana*, the dwarf tapeworm, is the most common of all the cestode infections. *H. nana* is endemic in both temperate and tropical regions of the world. Infection is spread by fecal/oral contamination and is common among institutionalized children.

Etiology and Pathogenesis *H. nana* is the only cestode of humans that does not require an intermediate host. Both the larval and adult phases of the life cycle take place in the human. The adult—the smallest tapeworm parasitizing humans—is ~2 cm long and dwells in the proximal ileum. Proglottids, which are small and rarely seen in the stool, release spherical eggs 30–44 μm in diameter, each of which contains an oncosphere with six hooklets. The eggs are immediately infective and are unable to survive for >10 days in the external environment. When the egg is ingested by a new host, the oncosphere is freed and penetrates the intestinal villi, becoming a cysticercoid larva. Larvae migrate back into the intestinal lumen, attach to the mucosa, and mature into adult worms over 10–12 days. Eggs may also hatch before passing into the stool, causing internal autoinfection with increasing numbers of intestinal worms. Although the life span of adult *H. nana* worms is only ~4–10 weeks, the autoinfection cycle perpetuates the infection.

Clinical Manifestations *H. nana* infection, even with many intestinal worms, is usually asymptomatic. When infection is intense, anorexia, abdominal pain, and diarrhea develop.

Diagnosis Infection is diagnosed by the finding of eggs in the stool.

TREATMENT HYMENOLEPIASIS NANA


Praziquantel (25 mg/kg once) is the treatment of choice, because it acts against both the adult worms and the cysticercoids in the intestinal villi. Nitazoxanide (500 mg bid for 3 days) may be used as an alternative.

Prevention Good personal hygiene and improved sanitation can eradicate the disease. Epidemics have been controlled by mass chemotherapy coupled with improved hygiene.

HYMENOLEPIASIS DIMINUTA


Hymenolepis diminuta, a cestode of rodents, occasionally infects small children, who ingest the larvae in uncooked cereal foods contaminated by fleas and other insects in which larvae develop. Infection is usually asymptomatic and is diagnosed by the detection of eggs in the stool. Treatment with praziquantel results in cure in most cases.

DIPHYLLOBOTHRIASIS

 *Diphyllobothrium latum* and other *Diphyllobothrium* species are found in the lakes, rivers, and deltas of the Northern Hemisphere, central Africa, and South America.

Etiology and Pathogenesis The adult worm—the longest tapeworm (up to 25 m)—attaches to the ileal and occasionally to the jejunal mucosa by its suckers, which are located on its elongated scolex. The adult worm has 3000–4000 proglottids, which release ~1 million eggs daily into the feces. If an egg reaches water, it hatches and releases a free-swimming embryo that can be eaten by small freshwater crustaceans (*Cyclops* or *Diatomus* species). After an infected crustacean containing a developed proceroid is swallowed by a fish, the larva migrates into the fish's flesh and grows into a plerocercoid, or sparganum larva. Humans acquire the infection by ingesting infected raw or smoked fish. Within 3–5 weeks, the tapeworm matures into an adult in the human intestine.

Clinical Manifestations Most *D. latum* infections are asymptomatic, although manifestations may include transient abdominal discomfort, diarrhea, vomiting, weakness, and weight loss. Occasionally, infection can cause acute abdominal pain and intestinal obstruction; in rare cases, cholangitis or cholecystitis may be produced by migrating proglottids.

 Because the tapeworm absorbs large quantities of vitamin B₁₂ and interferes with ileal B₁₂ absorption, vitamin B₁₂ deficiency can develop, but this effect has been noted only in Scandinavia, where up to 2% of infected patients, especially the elderly, have megaloblastic anemia resembling pernicious anemia and may exhibit neurologic sequelae of B₁₂ deficiency.

Diagnosis The diagnosis is made readily by the detection of the characteristic eggs in the stool. The eggs possess a single shell with an operculum at one end and a knob at the other. Mild to moderate eosinophilia may be detected.

TREATMENT DIPHYLLOBOTHRIASIS

Praziquantel (5–10 mg/kg once) is highly effective. Parenteral vitamin B₁₂ should be given if B₁₂ deficiency is manifest.

Prevention Infection can be prevented by heating fish to 54°C for 5 min or by freezing it at –18°C for 24 h. Placing fish in brine with a high salt concentration for long periods kills the eggs.