SERIAL FEATURE

Algorithms in the Diagnosis and Management of Exotic Diseases.
X. Echinococcosis

D. I. Grove, K. S. Warren, and A. A. F. Mahmoud

Echinococcosis (hydatid disease) in humans is caused by the larval stage of the canine tapeworm *Echinococcus granulosus*. The infection is a zoonosis, with man being an incidental host to the natural cycle of transmission between carnivores and various herbivorous animals.

Human infection is characterized by space-occupying hydatid cysts found mostly in the liver and lungs but also in other organs. Man is an intermediate host for *E. granulosus*, and the growing cysts contain multiplying larvae; this parasite is therefore one of the few helminths that replicate within the human body. The adult tapeworms are found in canines, usually dogs and wolves.

*E. granulosus* is worldwide in distribution but is most frequently found in the sheep- and cattle-raising areas of Australasia, South America, South Africa, the Soviet Union, and the Mediterranean littoral. The infection is relatively uncommon in the United States, but both imported and autochthonous cases have been reported. Indigenously acquired cases have been described in 15 states, and the complete cycle of transmission involving sheep, dogs, and humans has been found in California and Utah [1]. Echinococcosis is also endemic in Alaska but has a different epidemiological pattern [2].

**Life Cycle**

The adult *Echinococcus*, found in the small intestine of dogs and wolves, is a small tapeworm 3–6 mm long, consisting of a head (scolex) armed with hooklets and suckers, a neck, and three segments. Rupture of the terminal gravid segment releases up to 500 eggs, which are discharged in the feces.

On ingestion by intermediate hosts such as sheep or humans, the embryos escape from the eggs in the duodenum, penetrate the mucosa, and pass via the portal veins to the liver, where most of them are trapped. Those that pass through the liver are usually arrested in the lungs, but some embryos may reach the systemic circulation, where they may seed any organ. Wherever the parasites lodge, they either are destroyed by an inflammatory reaction or develop into hydatid cysts. The embryo undergoes central vesiculation, increases in size, and differentiates into an outer laminated membrane and an inner germinal layer. From this inner layer buds develop, which again vesiculate to form brood capsules. Larval scolices (rudimentary heads) arise on the inner surface of the brood capsule by further internal budding and may be released into the hydatid fluid if the brood capsule ruptures. Sometimes the brood capsules develop an outer laminated layer, thus becoming daughter cysts within the parent cyst. The mature hydatid cyst, which is usually spherical, grows slowly over many years and may reach 20 cm in diameter. When bones are involved, the dense tissues do not permit the parasite to assume its normal spherical shape, the fibrous capsule is absent, and naked excrescences penetrate the bone cavities to form multiple outpouchings containing little fluid.

After the death of the intermediate host, the larval hydatid may be eaten by a dog or another definitive host, whereupon the released scolices attach to the small intestinal mucosa and mature into multiple adult worms over a period of six to eight weeks.
Echinoceccosis

Epidemiology

The prevalence of human echinococcosis is dependent upon the association of man with infected canines. There are two epidemiological patterns, domestic and sylvatic, in both of which members of the canine family are the definitive hosts of the adult worms. The more important cycle is adapted to domesticated dogs, which are infected when they eat the contaminated viscera of sheep, cattle, or pigs; the cycle of transmission continues when the eggs passed in the dogs' feces are eaten by the herbivorous intermediate hosts. Echinococcosis is most frequently reported in regions of the world where livestock is a major industry. It is especially common in the sheep-raising areas where dogs are fed uncooked offal. Surveys in several parts of the United States, including California, Utah, and Mississippi, have revealed that 1%–5% of sheep, cattle, and pigs are infected with *E. granulosus*. Man is infected most frequently by direct contact with infected dogs but also by ingestion of contaminated soil, vegetables, or water.

A sylvatic epidemiological cycle is seen in the zones of tundra and northern coniferous forest of Alaska and Canada, where a strain which has sometimes been called *E. granulosus* var. *canadensis* also occurs. The adult form is found in the wolf, and the larval stage is adapted to large deer such as moose, reindeer, and caribou.

Disease Syndromes

The majority of infections with *E. granulosus* are asymptomatic. Many infections are detected during a routine chest X ray, during the investigation of an unrelated condition, or at autopsy. Since almost any organ can be invaded, the symptoms and signs which may be encountered are protean. The anatomical distribution of cysts may vary with geographical area, but an indication is given by the following distribution of 1,802 cysts recorded in the Australasian Hydatid Registry: liver, 63%; lung, 25%; muscles, 5%; bone, 3%; kidney, 2%; spleen and brain, 1%; and heart, thyroid, breast, prostate, parotid, and pancreas, all <1%. Multiple cysts are found in approximately 20% of patients.

Patients with symptomatic infections usually present with the features of a space-occupying lesion. Since the liver is a large organ of uniform function in a distensible area of the body, hepatic cysts usually become quite large before producing symptoms, unless they are located in a strategic site such as the porta hepatitis. Some patients may complain of abdominal discomfort or epigastric pain; others may have enlargement of the liver, especially of the right lobe. Many cysts, however, are revealed only by calcification seen on an abdominal radiograph. In view of the years required for symptoms to appear or calcification to develop, hepatic hydatids are seen most frequently in middle-aged or elderly patients.

Pulmonary hydatids are often found in children and younger patients. This fact may be accounted for in part by early discovery of this form in chest X rays for unrelated conditions or during mass surveys. Symptomatic patients may complain of hemoptysis, cough, or dyspnea. Intracranial cysts are likely to be symptomatic early in their development, presenting with the features of a slowly expanding space-occupying lesion. Hydatid disease of bone is often revealed by a spontaneous fracture, while hematuria or loin pain may be the first signs of a renal cyst.

The most important complications of hydatid cysts are rupture or infection. A leaking cyst may give rise to urticaria or precipitate an anaphylactic reaction. Furthermore, dissemination of scolecies may lead to the establishment of secondary hydatid infections elsewhere in the body. Bacterial infection of a cyst resembles an abscess of the liver, lung, or other organ.

Diagnosis

An algorithm for the diagnosis and management of echinococcosis is given in figure 1. The infection may be suspected in an otherwise asymptomatic patient who is found by chance (on routine radiography) to have a lesion in the lungs or calcification in the liver area. Other patients may be noted to have hepatomegaly or may present with hemoptysis, fracture, urticaria, or any of a wide variety of symptoms and signs of a space-occupying lesion in any organ.

A geographic history must be taken. The diagnosis is more likely if the patient has lived in an area of the world where hydatid disease is prevalent. Inquiry should be made concerning intimate
Figure 1. Progression to a definitive diagnosis of echinococciosis.
contact with dogs that may have been exposed to potentially infected offal. The disease is more likely, therefore, in people who have lived on sheep and cattle farms. There are unusual situations, however, such as in Wales, where infection occurs in small towns to which sheep have free access, and in Alaska, where dogs may impinge upon the sylvatic cycle by eating infected deer. Failure to obtain such a history does not exclude the diagnosis but renders it less likely.

All patients should have plain X rays of both the abdomen and the chest, since some have multiple cysts. The abdominal film may show a calcified round or oval cyst rim or spotty calcified densities, usually in the liver area. The chest film usually shows a round, uniformly dense lesion 1–20 cm in diameter, but calcification rarely occurs. There may be surrounding pneumonitis or atelectasis and, occasionally, a fluid level indicating rupture into a bronchus [3]. All patients with both hepatic and extrahepatic lesions should have a liver scan for detection of focal filling defects; cysts on the periphery of the liver often give an appearance of hepatic displacement. A suspicious liver defect may be further investigated by selective visceral angiography, which may demonstrate an avascular mass that is often surrounded by a characteristic halo of dye [4].

When a mass has been demonstrated, immunological tests may help in elucidating its hydatid nature. The Casoni skin test is not reliable, since it has not been standardized and false-positive results are obtained in up to 40% of patients. Sera may be sent to the Mycology and Parasitology Section, Center for Disease Control, Atlanta, Georgia for serological testing. Indirect HA titers of $\geq 1:32$, and bentonite flocculation titers of $\geq 1:5$ are considered positive. Serological tests yield positive results in approximately 85% of patients with liver cysts but in only 40% of patients with pulmonary echinococcosis. False-positive results (usually with low titers) may be found in patients with cirrhosis or collagen diseases and in those with other helminthic infections, especially cysticercosis [5].

Eosinophilia is uncommon, and abnormal results in tests of liver function are neither prominent nor diagnostic. A presumptive diagnosis must be made, therefore, on the basis of probabilities. On no account should an attempt be made to make a parasitological diagnosis by percutaneous needle puncture of a cyst, since this procedure may cause leakage leading to anaphylaxis or spread of the lesions. In patients in whom surgical intervention is appropriate, the definitive diagnosis is made by demonstration of the parasite at surgery.

Management

When the diagnosis is considered probable, the disease must be assessed and the benefits and risks of surgical intervention weighed. Surgery is indicated in all symptomatic patients but carries with it a small risk of death and a moderate incidence of morbidity. If the patient is asymptomatic and the cyst has been discovered by chance, then the location of the lesion, the age and fitness of the patient, and the strain of parasite must be considered. A small ($\leq 5$ cm in diameter), calcified liver hydatid in an asymptomatic patient requires only observation. It is generally agreed that pulmonary cysts warrant operation, even in the asymptomatic patient, to prevent rupture, infection, and the attendant complications. An exception may be made in the case of *E. granulosus* var. *canadensis*, since such patients do not seem to develop complications readily [2]. Many surgical techniques have been used, but, if possible, the cyst should be removed entirely. To prevent spillage and dissemination, the cyst is carefully isolated, about $\frac{1}{2}$ of the fluid is aspirated, an equal volume of 1% aqueous iodine solution is injected and allowed to mix for several minutes, all of the fluid is aspirated, and the cyst is excised. The iodine kills the scolecites within 1 min and probably produces fewer complications than formalin, which has been used in the past. Corticosteroid and antihistamine therapy may be necessary if an anaphylactic reaction occurs as a result of spillage during the operation. Details of the surgical techniques used in hepatic, pulmonary, and bony hydatid disease have been described elsewhere [6–8].

*Infection with Echinococcus multilocularis.* *E. multilocularis* infections are usually found in Europe and in the northern latitudes of Asia and North America but have been reported elsewhere. The adult worm is found in foxes as well as in domestic cats and dogs, while the larval form is found principally in field rodents. When man is infected, there is an aggregation of innumerable
small cysts that multiply by exogenous budding to produce the so-called malignant hydatid; hydatids are usually found in the liver, and the honeycomb lesions may be confused with a malignancy. The prognosis is grave, with portal hypertension and liver failure often developing. Treatment is by surgical excision, if possible.

References