Epidemiology and Anatomical Histopathological Features of Hydatid Cyst

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Abstract: Hydatidosis (cystic echinococcosis) are formed by members of the genus echinococcus. It is the most widespread parasitic zoonosis. It is known that carnivores are definitive (final) hosts and intermediate hosts are different domestic animals including human. Hydatid cysts are of two types; which are unilocular hydatid cyst and alveolar hydatid cysts. These hydatid cysts contain thousands of scolices. The intermediate hosts acquire hydatid cyst by ingesting echinococcus granulosus eggs that are passed in the feces of definitive (final) hosts especially dogs. Basic knowledge of geographic distribution, prevalence and factors associated with survival and transmission of the parasite in normal host is essential in understanding the potential public health threat it posed to individuals who live in regions where cystic echinococcosis is endemic. Although the distribution of E.granulosus is considered worldwide, it is higher at developing countries, especially in rural communities where there is close contact between dogs and various domestic animals. Growth of the hydatid is slow, maturity being reached in 6-12 months. In the liver and lungs the cyst may have a diameter of 20cm while unrestricted growth is possible in the abdominal cavity. The pathogenic effect of cystic echinococcosis is mainly in the intermediate host. Symptoms can be produced by mass effect or complications of the cyst. As the matter of this fact, this paper is aimed to inform the public, especially the veterinarians, to understand the anatomic and histopathologic appearance of the hydatid cyst/cystic echinococcosis for the identification of the cyst from other cyst like abnormalities. In addition the society should be informed about the nature of the cyst and organs affected by it to create awareness. Every individual that leaves in the rural area should be aware about the host range involved as intermediate and final host to reduce the occurrence of the disease.

Key words: Histopathology • Hydatidosis • Zoonosis • Pathogeniceffect

INTRODUCTION

Hydatid cyst is a large fluid filled cyst lined with germinal epithelium from which are produced invaginated scolices which lie free or in bunches, surrounded by germinal epithelium (brood capsules). The contents of the cysts other than the fluid, i.e. scolices and brood capsules are frequently described as hydatid sand. Occasionally, also daughter cysts complete with cuticle germinal layer are formed endogenously or, if the cyst wall ruptures, exogenously [1].

Hydatid cysts are formed by a member of the genus Echinococcus and are of two types; unilocular hydatid cysts and alveolar hydatids, both of which often contain thousands of scolices. Usually one taenia onchosphere develops into only one bladder worm. However, in the case of taenia crassiceps, asexual multiplication (budding) results in many cysticerci surrounded by a single host tissue capsule. Such a structure may easily be mistaken for a hydatid cyst by the unaware observer [2]. The intermediate hosts acquire the infection (Hydatid cyst) by ingesting E.granulosus eggs that passed in the feces of infected carnivores (final host). Human being is infected by in advertently ingesting these eggs. Cystic echinococcosis occurs in all major continents of the world causing severe economic loss and public hazards. The disease is particularly important in developing countries where many rural inhabitants live under poor sanitary conditions and in close proximity to their domestic animals [3]. It is endemic in sheep and cattle rearing areas of South America, Turkey, Yemen, India, Kenya, Swaziland, Ethiopia, Uganda and other African countries. On average, three or four people die annually in England and Wales and one in Scotland [4].
Occurrence of cystic echinococcosis in human is much more common in the rural areas of Ethiopia where dogs and domestic animals live in very close association. The pathogenesity of cystic echinococcosis heavily depends on the extent and severity of infection; and the organ in which it is situated. Although control program resulting in marked decrease in the incidence of the disease have been carried out in some countries, little effect has been achieved worldwide. There is some evidence that the disease is spreading because of a lack of meat control, dog management and appropriate legislation [5, 6]. Therefore, knowing the anatomical and histopathological features of the cyst is of great importance. Therefore, the objective of this study is to enable readers to understand the general anatomic and histopathologic features of the hydatid cyst during appreciating the cyst, to put some information for veterinarians about the general feature of the cyst and to inform the public to know the host range involved and organs involved for further studying and future awareness.

**Epidemiology:** Basic knowledge of geographic distribution, prevalence and factors associated with survival and transmission of the parasite in normal host is essential in understanding the potential public health threat it posed to individuals who live in regions where cystic echinococcosis is endemic and also to establish very well control programs in these areas. The *E. granulosus* is found in the small intestine of carnivores (particularly the dog) and the metacestode (hydatid cyst) is found in a wide variety of ungulates and man. The parasite has a cosmopolitan distribution and the eggs are the only found in feces not proglottids [3].

The hydatid cyst is usually unilocular and is composed of a fairly thick outer concentrically laminated membrane and within this is a granular germinal membrane. From this, brood capsules, each containing protoscolices, develop about five months after infection. At this time the cyst is infective for the definitive host. The brood capsules may become detached and float free in the cyst fluid, being called hydatid sand. Occasionally daughter cysts develop within the hydatid cyst and if a cyst is ruptured, protoscolices and brood capsules can develop into other external cysts. Not all hydatid cysts produce brood capsules or protoscolices. Thus they may be sterile. For instance, 27% of horse hydatid cysts and 51% of sheep hydatid cysts should be sterile [7].

From the epidemiological point of view, it might be useful to differentiate hosts, which play a role in the perpetuation of the cycle and aberrant or accidental hosts which represent “blind alley for the parasite as the latter are not involved in disease transmission. This may be because metacestode stages do not become fertile in these hosts or because such hosts do not interact in the transmission cycle. With a few rare exceptions; humans belong to the group as “aberrant hosts” [8].

Although the distribution of *E. granulosus* is considered world wide, it is higher at developing countries in tropics and sub tropics especially in rural communities where there is close contact between dogs and domestic animals [9]. In humans, disease consequence may include poor quality of life, costs of medical treatment, lost opportunity for income generation and mortality in some cases [10]. Where in animals there is reduced productivity and monetary losses due to abattoir condemnation of organs [11].

**Host Range:** It is likely that *E. granulosus* originally completed its life cycle among wild animals in a sylvatic cycle that involved, for example, wolves and cervids or lions and warthogs. It has now adapted: into domestic cycle, however, commonly involving dogs and sheep [12, 13]. As *E. granulosus* has little host specificity with regard to intermediate hosts, hydatid cysts have been seen in a wide range of mammals including domestic ruminants, camels, pigs, equines and humans [12, 14].

**Organs Involved:** The organs most commonly affected by hydatid cyst are liver and lungs, but others like kidneys, spleen, heart and brain can also be affected. The cyst has different features in different organs [13].

**Anatomical Features of Hydatid Cyst:** The metacestode, hydatid cyst basically consists of a bladder with an outer a cellular laminated layer and an inner nucleated germinal layer, which may give rise by asexual budding to brood capsules. Protoscolices arise from the inner wall of the brood capsules. If the scolices separate from the inner lining of the capsules, they are called hydatid sand. The structure and development of the metacestode differs among the four species of *Echinococcus* [15].

**Intermediate and Aberrant (Accidental) Hosts:** The intermediate hosts, represented by a wide range of mammals acquire the infection by the ingestion of eggs. Following the action of enzymes in the stomach and small intestine, the oncosphere is released from the keratinized embryophose [2]. Bile assists in activating the oncosphere, which penetrates the wall of the small intestine. Penetration is then aided by the hook movements and possibly by secretion of the oncosphere.
Table 1: The host range of adult and larval stage of echinococcus in definitive and intermediate hosts

<table>
<thead>
<tr>
<th>Species</th>
<th>Definitive host</th>
<th>Intermediate host</th>
<th>Site for the adult</th>
<th>Site for the cyst</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. granulosus</td>
<td>Dogs/cats red fox being resistant</td>
<td>Ruminants, pigs, horse and man (donkeys are resistant)</td>
<td>Small intestine</td>
<td>Liver and lung</td>
</tr>
</tbody>
</table>

Source: Soulsby, 1982

The oncosphere is passively transported to the liver, lungs and a few may be transported further to the kidneys, spleen, muscles and brain or other organs. All mammals (including man) in which metacestode of echinococcus species develop after infection with eggs are being referred to as intermediate hosts[16].

The Cystic Echinococcosis in Different Intermediate Hosts

Cystic Echinococcosis in Sheep, Goats and Cattle: Ruminant animals become infected when they swallow eggs from contaminated pasture. When hydatid eggs are swallowed by an intermediate host (sheep, cattle, or humans), they migrate through the stomach wall into the bloodstream. They are then carried to various internal organs, usually the liver and lungs, but sometimes the brain. A watery hydatid cyst then forms in these soft tissues [17]. Sheep are typically infected with multiple pleomorphic E. granulosus cysts mainly localized in the liver and lungs but spleen, heart, kidney, omentum and other organs can also be affected. In sheep, however, most cysts are viable and continue to grow throughout the life of the animal. Older sheep in particular may have very large cysts. Cysts contain many capsules, with each capsule containing up to 40 hydatid heads. Each head is capable of developing into an adult tapeworm in the intestine of a dog. Sheep, therefore, act as the most important source of infestation for dogs, however the effect on the sheep is minimal; few noticeable signs of infection will be seen in sheep with hydatid cysts [18].

Similarly, in goats the liver and the lung are the main sites of predilection. In cattle cysts are often multiple and unilocular and the liver and lung are the organs most commonly affected [19, 20]. Hydatid cysts are generally 5-15cm in diameter and numerous cysts can be found in the viscera of affected animals [21].

If cattle are infected with the cattle strain, cysts are predominantly located in the lungs. Less frequently, cysts have been recorded in the spleen, heart, brain and the marrow cavity of bones. In cattle, approximately 10% of hydatid cysts are viable and these cysts usually die within a few months [17].

Cystic Echinococcosis in Horses: In horses, cysts may grow slowly so that fertile cysts do not exceed four centimeters in diameter in horses 11-16 years old and not induce symptoms. However, large cysts in horses may also remain asymptomatic. The liver is the organ most commonly affected, but cysts have also been recovered from the lungs, heart, pericardium, pleura, spleen, kidney and uterus. The strain that infects horses is considered to be less of a potential problem in human than are some other strains, e.g., those infecting sheep [22]. It is uncommon for the lung to be the only organ affected.

In one case reported from Switzerland a nine years old Irish horse was heavily infected with hundreds of hepatic and pulmonary cysts (1-8 cm in diameter). It also showed massive enlargement of the liver (about 6.5 times), increased serum concentration of liver enzymes, liver function, disturbances and hyper bête globulinaemia, anorexia, symptoms of chronic obstructive lung disease, intermittent colic and emaciation [23].

Cystic Echinococcosis in Pigs: In pigs the liver is most commonly affected but cysts can also be found in the lungs, kidney, spleen, heart, skeletal muscles and occasionally the testes [24]. The regional occurrence of cystic echinococcosis in slaughtered pig from Slovakia was studied in the period of 2000-2008, along with the quantitative parameters associated with the establishment of cysts (intensity of infection, fertility, size). From 103 pig livers collected from abattoirs in 35 sites Slovakia as suspected for Echinococcus infection, 63 were positive for cystic echinococcosis. Fertile cysts with echinococcal protoscolecetes were recorded in 25.4 % of positive pigs, with the 8.9 % fertility rate and the intensity of infection reaching value of 5.9 cysts per liver. The average size of fertile cysts was more than three times larger than diameter of sterile cysts (diameters of 4.67 cm vs. 1.37 cm, respectively). No significant differences in relative amounts of fertile and sterile cysts were found among countries (P = 0.15). The annual prevalence of E. granulosus in pigs in 2000 - 2 008 has ranged from 0.02 % to 0.13 % (average rate 0.08 %), with the decreasing tendency over the period, especially after 2005. The most heavily affected areas with cystic echinococcosis over 2006 – 2008 were indicated in Prešov (eastern Slovakia, 0.68 % prevalence) and Komárno districts (south western Slovakia, 0.26 % prevalence) [25].

Cystic Echinococcosis in Dromedary (Camels): Local bred camels (Camelus dromedaries) harbor. Hydatid cysts of Echinococcus granulosus. Prevalence in males is higher, in females the occurrence is lower and overall
prevalence rate is not high. Infection was higher in age group 1 <3 years than others. The most commonly infected organs were lungs 46% followed by liver 24%, both liver and lungs constituted 30% of infection. Hydatid cysts of lungs had a higher fertility rate (85.77%) than those of liver (14.23%). The mean number of cysts in infected liver was 1 to 15 and in infected lung were 1 to 17 cysts. Intensity of infection increased with increasing age. Cysts size varied from 1-8 cm in diameter [26]. Camels were proclaimed to be one of intermediate hosts that harbour high percentages of fertile cysts, enabling their meat to be important source of infection [19]. This work was designed to assess the present status of Echinococcosis in camel’s population of Iraq, particularly in Najaf governoreate and their neighborhood, with an emphasis on the morphometry, lesion distribution and the percentage of fertile hydatid cysts in these desert animals [27].

Cystic Echinococcosis in Humans: Echinococcus granulosus and Echinococcus multilocularis occur simultaneuously in large endemic areas; mixed infection of cystic echinococcosis and alveolar echinococcosis in human are apparently rare with regard to the mode of information, there are Primary and Secondary echinococcosis known in human [28].

Histopathological Feature of Hydatid Cysts
Pathological Feature of Hydatid Cyst in Different Organs of Intermediate Host: Cysts grow slowly and may attain large sizes (sometimes 20cm in diameter) and contain many liters of fluid. Some may contain numerous daughter cysts and fertile cysts contain thousands of protoscolices. In rare sites such as abdominal cavity, where unrestricted growth is possible, cysts may be very large. One or both lungs may be affected causing respiratory symptoms and if several hydatids are present in the liver, there may be gross abdominal distention. Cysts in liver may obstruct the common bile duct and cause jaundice. When hydatid cysts develop in bone, since there is no fibrous wall that forms a sound the cysts, bone fracture may result [13].

Hydatid cyst may also occur in the mediastinum and it may cause cardiac symptoms if cysts are located in the heart [3]. Lesion may be transformed into an abscess of the affected organ. Accidental rupture of the cyst, for example, following a blow, jolt or fall is very serious. Sudden death may occur either due to anaphylactic shock when hydatid fluid spreads throughout the system or due to internal hemorrhage if the cyst is associated with cardiovascular organs. Symptoms can be produced by mass effect or complications of the cyst. Pressure symptoms can take a long time to become evident, except when they involve the brain or eyes. Most cysts causing symptoms are larger than 5cm in diameter. Later as the mass presses on surrounding organs, symptoms become more specific. In the liver, symptoms of obstructive jaundice and abdominal pain can develop. Pressure of the cyst on the biliary tract can cause biliary colic, jaundice and urticaria. Vomiting of hydatid membranes (hydatid emesia) occur rarely [22].

Infection of the cyst results in a range of symptoms from mild fever to full-blown sepsis. The liver is the primary site of infection and the symptoms may closely mimic those of cirrhosis or carcinoma. The clinical picture is one of progressive liver dysfunction leading to liver failure. This can occur over weeks, months or years. Distant metastases are possible and involvement of other organs (for example in the lung, brain and bones) can occur in as many as 13% of the pat. Cerebral echinococcosis is rare. A child with chronic headache and disturbed gait caused by a primary left hemisphere large echinococcal cyst is described [29]. Computed Tomography scan confirmed the presence of a large left hemispheric cystic formation with dilatation of the body of the lateral ventricles cardiovascular hydatid disease is associated with a high risk of potentially lethal complications. Unless a cyst is located in a critical anatomic site, the patients can remain asymptomatic for years, although they are under a continuous threat of rupture. Signs and symptoms are extremely variable, although chest pain is the most frequent.

Intraperitoneal HD accounts for 13% of all abdominal hydatidosis. The cysts develop secondary to spontaneous or iatrogenic rupture of hepatic, splenic, or mesenteric cysts and can be located anywhere in the peritoneum. Primary peritoneal involvement is extremely rare. Single and unilocular peritoneal hydatid cysts may not be distinguished from other peritoneal cysts including mesenteric and duplication cysts on the basis of imaging findings alone [30].

Involvement of the spleen is relatively rare and is the third most common site after the liver and lungs. The incidence of splenic involvement has been reported to be from 0.9% to 8%. Primary splenic Hydatidosis is quite rare and accounts for less than 2%. It develops secondary to systemic dissemination or intraperitoneal spread from ruptured liver hydatid cysts [31].
Fig. 1: A- *Echinococcus granulosus* cysts in pig liver; B – isolated protoscoleces from cysts. Scale bar - 100 µm

Fig. 2: Intraoperative view: Outer side of calcified hydatid cyst tightly attached to the liver

Fig. 3: The outer side of the removed cyst together with the gallbladder and a small part of the liver

Fig. 4: The inner side of the cyst developed entirely extramucosally

Fig. 5: Histopathologic specimen
Source: (Krasniqi *et al.*, 2010)

**Histological Feature of Hydatid Cyst in Different Organs of Intermediate Host:** Hydatid disease is a zoonotic infection caused by larval stages of dog tapeworms belonging to the genus *Echinococcus* (family taeniidae) and is also referred to as echinococcosis. Three broad morphological forms of echinococcosis are recognized clinically. Human cystic echinococcosis caused by *E granulosus* is the most common presentation and probably accounts for more than 95% of the estimated 2-3 million annual worldwide cases. Hydatidosis is endemic in Mediterranean countries and other sheep and cattle-raising region. In Kosovo, although there is no exact data about the incidence of human cystic echinococcosis, liver and lung hydatid cysts continue to be a very common pathology of surgical wards. The liver (70-80%) and lungs (15-25%) are the most frequent locations for echinococcal cysts while occurrence in other sites is very rare and the real incidence of extra hepatic cysts is not known. Primary hydatid cyst of the
gallbladder is an extremely rare entity. There are reports of the gallbladder daughter cysts secondary to liver cysts. Patients with primary hydatid cyst of the gallbladder are those with no previous history of hydatid disease and with no other cysts found at the time of surgery. In a recent review of the literature through the Medline database, we found that in the English language only five cases have been reported by Safioleas et al. [32] and Wani et al. [33]. The aim of this case report is to highlight the diagnostic features, routes of dissemination and treatment options of this rare clinical entity.

Differentiation of Hydatid Cyst from Cyst like Abnormalities: It is common that there are so many abnormalities that look like hydatid cyst in their feature. Examples are as follows: liver abscess, pyonephrosis, epidermoid cyst, simple cyst and Neoplasia.

Methods/techniques Used in Cyst Differentiation: Diagnosis is made by a combination of imaging, serological, and molecular techniques. These techniques are as listed below:

- Ultrasound for abdominal cysts with fine needle aspiration, Chest X-ray or Computed Tomography scans for those in the lung. Serological diagnosis is, unusual for parasitic infections, the base for laboratory diagnosis and standard sensitive and specific test exists for cystic echinococcosis antibody detection [36].

Imaging plays a pivotal role in the work-up of patients with suspected liver infections. All cross-sectional techniques allow highly accurate detection of hepatic infections. Computed tomography (CT) is particularly helpful in revealing the presence of calcifications and gas and in detailing the enhancement pattern. In most cases, however, it is difficult to characterize necrotic infections with ultrasonography (US) and CT alone because the imaging findings are often nonspecific and may, therefore, mimic hepatic cysts or necrotic tumors. Magnetic resonance (MR) imaging can help detect liver abscesses at least as well as other cross-sectional methods. In particular, the multiplanar capability and sensitivity to small differences in tissue composition of MR imaging increase its specificity for certain hepatic infections, including hydatid cyst and candidiasis. Nonnecrotic infections also have a varied appearance but may have specific imaging characteristics. In most cases, however, radiologic findings are not sufficiently characteristic to help identify the type of infection and aspiration or biopsy is needed for final diagnosis. In addition, access to epidemiologic and clinical information (e.g., patient age, gender, clinical history, symptoms) remains extremely important for obtaining a more accurate presumptive diagnosis [35].

Indirect hemagglutination tests and ELISA are widely used. However, Serological diagnosis can be difficult from brain and eye cyst fluid samples. Young children produce minimal serological reactions. No standard sensitive and specific test exists for cystic echinococcosis antibody detection [36].

CONCLUSIONS

Hydatid cyst is a large fluid filled cyst lined with germinal epithelium from which are produced invaginated scolexes which lie free or in bunches, surrounded by germinal epithelium (brood capsules). The intermediate hosts acquire the infection (Hydatid cyst) by ingesting E.granulosus eggs that passed in the feces of infected carnivores (final host). Growth of the hydatid is slow, maturity being reached in 6-12 months. The length of the cyst is different in different intermediate hosts. The organs most commonly affected by hydatid cyst are liver and lungs, but others like kidneys, spleen, heart and brain can also be affected. The metacestode, hydatid cyst basically consists of a bladder with an outer a cellular laminated layer and an inner nucleated germinal layer, which may give rise by asexual budding to brood capsules. Protoscolices arise from the inner wall of the brood capsules. The pathogenic effect of cystic echinococcosis is mainly in the intermediate host. The pathogenicity of the hydatid cyst depends on severity of infection, size of the cyst and the organ involved. Differential diagnosis of hydatidosis is done by a combination of imaging, serological and molecular techniques.

Recommendations: In lights of the above conclusion, the following recommendation is forwarded:

The veterinarians and the meat inspectors should be familiar with the anatomic and Histopathological features of the cyst. The public should be informed about the general feature of the cystic Echinococcosis. The society must be informed about the nature of the cyst and organs affected by it to create awareness. Every individual that lives in the rural area should be aware about the host range involved as the intermediate and final host to reduce the occurrence of the diseases. Every veterinarian should know the differential diagnosis of the cyst to
differentiate it from other cyst like abnormalities during histopathologic appreciation of the cyst in different organs of the intermediate host.

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