Introduction

Hydatid cyst is commonly caused by the larval stage of the tapeworm *Echinococcus granulosus*. The life cycle of the worm involves two hosts. The definitive host is a dog and rarely some other carnivore. The adult worm lives in the proximal small bowel of the definitive host. Its ova are passed in the feces of the infected animal. Sheep ingests the ova by grazing on the contaminated grass and is the usual intermediate host. The humans get infected by contact with the dog or by ingestion of contaminated water and vegetables. The ovum releases the larva called oncosphere in the duodenum, which enters the portal circulation by passing through the intestinal wall. Thus, it reaches the liver where it grows into a cyst.

The hydatid cyst has three layers: (i) The outer pericyst which consists of modified host cells that form a dense fibrous protective layer; (ii) the middle laminated layer which is acellular and impervious to bacteria, but allows the passage of nutrients; and (iii) the inner germinal layer where the scolices and laminated membrane are produced [Figure 1]. The middle laminated layer and the germinal layer form the true wall of the cyst and are usually referred to as the endocyst.[2] The thickness of these layers depends on the tissue in which the cyst is present. The layers tend to be thick in the liver, are less developed in muscle, and are absent in bone.[3]

Hydatid disease involves the liver in approximately 75% of the cases, the lung in 15% of the cases, and other anatomic locations in 10% of the cases.[1] Based on the radiological appearance, hydatid cysts are classified into four types:

- **Type I- Simple cyst with no internal architecture with or without hydatid sand or septae**
- **Type II- Cysts with daughter cysts and matrix**
  - **IIa- Round daughter cysts arranged at the periphery**

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Malik, et al. Imaging appearances of atypical hydatid cysts

IIb- Irregularly shaped daughter cysts occupying the entire mother cyst
IIc- High attenuation oval or round mass with scattered calcification and occasional daughter cysts
Type III- Dead cyst with total calcification
Type IV- Complicated cyst with rupture and superinfection.

Sites of Involvement

Liver
Ultrasound is the screening method of choice for hepatic hydatid cyst. Computed tomography (CT) has high sensitivity and specificity and is an important diagnostic tool to recognize complications. A hydatid cyst is typically seen as a round or ovoid lesion with type I or II appearance [Figure 2]. It has water density and a high attenuation wall on unenhanced CT. Enhancement of the septae or cyst wall may be seen following contrast injection. There may be partial calcification of the cyst wall or internal matrix. This does not indicate death of the parasite. Later, dense complete calcification may occur and such a cyst is assumed to be inactive. Magnetic resonance imaging (MRI) is the best modality to demonstrate the cystic component and biliary tree involvement. The cystic part is hypointense on T1-weighted images and markedly hyperintense on T2-weighted images. Presence of hypointense rim on T2-weighted magnetic resonance images is considered a characteristic sign of hydatid cyst. It probably represents pericyst which is rich in collagen. Daughter cysts are seen as cystic structures which are hypointense relative to the intracystic fluid on T1-weighted images and hyperintense on T2 images. Irregularity of the cyst wall represents incipient detachment of the membranes.

Complications of hepatic hydatid cyst are: (a) Infection, (b) rupture, (c) exophytic growth, and (d) portal vein involvement.

(a) Infection manifests on CT as hypodense mass with typical enhancing rim like any other hepatic abscess. Gas or air-fluid level may also be seen.

(b) Three types of cyst rupture have been described: Contained, communicating, or direct.

Contained- Endocyst ruptures, but the pericyst remains intact. Detached endocyst is seen as serpentine linear membranes within the cyst. When there is complete detachment, crumpled endocyst floats freely in the cyst fluid, giving rise to the “water lily sign.”

Communicating- Passage of cyst contents into the biliary radicles that have been incorporated into the pericyst.

Direct- Spillage of hydatid material into the peritoneal or pleural cavity, abdominal wall, hollow viscera, etc.

Communicating rupture is indicated by direct and indirect signs. Direct sign is visible communication between the cyst and the biliary tree [Figure 3]. Indirect signs include deformity of the cyst indicated by loss of smooth round or oval shape, defect in the wall, and presence of beak-like projection extending from the cyst wall. Intraductal areas...
of low signal intensity due to cyst material may also be seen on MRI.

Presence of fatty material, air-fluid level, and fat-fluid level in the hydatid cyst also suggests communication with biliary tree. The fat is thought to arise from the lipid content of the bile [Figure 4].

(c) Complications may also arise due to exophytic growth of cyst. The most common routes are the bare area of liver and the gastrohepatic ligament. Involvement of diaphragm [Figure 5] and thoracic cavity may result. CT scan may reveal adherence to diaphragm, thickening and lobulation of cysts, rupture into the pleural cavity or pulmonary parenchyma, and chronic pleural fistula.

(d) Portal vein involvement is very rare. It is due to compression by the cyst followed by thrombosis and cavernoma formation.

**Spleen**

Splenic hydatidosis is the third most common after the liver and lungs. It is usually secondary to systemic dissemination or due to intraperitoneal spread from the ruptured hepatic hydatid cyst. The imaging characteristics are similar to those of hepatic cysts [Figure 6]. Identification of daughter cysts and detached floating membranes if present helps in the diagnosis. The differential diagnosis includes epidermoid cyst, pseudocyst, and lymphangioma.

**Peritoneum**

Peritoneal hydatid cysts are almost always secondary to hepatic hydatidosis. These are generally multiple and can occur anywhere in the peritoneal cavity. Presence of hepatic hydatid, multiple lesions in the peritoneum, and characteristic appearance of daughter cysts allow the diagnosis [Figure 7]. However, unilocular type I cysts are difficult to differentiate from mesenteric cyst and intestinal duplication cyst.

**Retroperitoneum**

Retroperitoneal hydatid is rare, usually secondary to involvement of other organs, especially liver. The infection reaches the retroperitoneum by spontaneous rupture or by inoculation during surgery. Visualization of daughter cysts helps in the diagnosis. However, other appearances like unilocular cyst, cyst with detached membranes, partially or totally calcified cyst may be seen [Figure 8]. This needs to be differentiated from lymphangioma which appears as a large, thin-walled cystic mass that may involve more than one compartment of retroperitoneum. Other entities like mucinous cystadenoma, cystic teratoma, and pseudocyst can be differentiated based on age and other findings in the abdomen.
Lung

Lung involvement is seen in 0.5-4% of cases. Spine, pelvis, femur, tibia, humerus, skull, and ribs are the frequent sites involved. Due to lack of pericyst formation, aggressive proliferation causes replacement of medulla, cortical destruction, and extension into soft tissues. Extraosseous cysts may calcify. The radiological appearance consists of areas of osteolysis with expansion, thinning, and destruction of cortex and extension into soft tissues [Figures 10-12]. Complications include

Bone

Bone involvement is seen in 0.5-4% of cases. Spine, pelvis, femur, tibia, humerus, skull, and ribs are the frequent sites involved. Due to lack of pericyst formation, aggressive proliferation causes replacement of medulla, cortical destruction, and extension into soft tissues. Extraosseous cysts may calcify. The radiological appearance consists of areas of osteolysis with expansion, thinning, and destruction of cortex and extension into soft tissues [Figures 10-12]. Complications include...
deformity, pathological fracture, secondary infection, neurological deficit, compression of adjacent structures, and transarticular extension.\textsuperscript{15}

Muscle
Skeletal muscle is a rare site as it does not favor the growth of hydatid cyst because of its contractility and high lactic acid level.\textsuperscript{16} Muscles of the neck, trunk, thigh, or upper extremities and around the hip are generally involved, but any part can be involved.\textsuperscript{16} Ultrasound done as part of initial workup of suspected soft tissue lesion may reveal findings typical of hydatid cyst. These vary from unilocular cyst to cyst with daughter vesicles, detached membranes, and water lily sign (Figures 13 and 14). CT is helpful in the detection of osseous extension and cyst wall calcification.\textsuperscript{17} Complicated cysts may simulate abscess, hematoma, metastases, or soft tissue tumors like myxoid liposarcoma. CT and MRI show rim enhancement in an abscess and variable enhancement in metastases and soft tissue tumors. Blood products are seen in hematoma on MRI.

Brain
Involvement of brain is extremely rare. Hydatid cyst is mostly located in the middle cerebral arterial territory.\textsuperscript{18} On CT scan, it is seen as unilocular cyst with attenuation similar to the cerebrospinal fluid (Figure 15). Fine peripheral enhancement may be seen. Edema is absent. There may be erosion of adjacent calvarium. Atypical findings include edema, irregularity of cyst wall, multiple locules, heterogeneity of cyst content, and calcification.\textsuperscript{19}

Breast
Breast hydatid cyst is very rare. Diagnosis is difficult unless ultrasound reveals membranes or fluid level due to debris in the cyst (Figure 16). Ring-shaped structures within a dense, well-circumscribed lesion on mammography are also suggestive of hydatid.\textsuperscript{18} Presence of hydatid cysts in other organs adds to the diagnostic confidence.
Hydatid cyst can occur in other anatomic sites also. These include the heart, pericardium, orbit, mediastinum, kidney, adrenal glands, and subcutaneous space. Involvement of kidney is seen in about 3% and that of orbit in less than 1% of cases. It is even rarer in other locations. Imaging appearances are similar to those described for other organs. The orbital hydatid is typically unilocular, may be extra or intraconal. Thus, hydatid cyst should be included in the differential diagnosis of cystic masses of a specific organ, even when the typical appearance of cyst with multiple daughter cysts is not seen. This is particularly important if the patient belongs to an endemic region and has cystic lesions in the liver or lung.

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References

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