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Using Imaging Studies to Differentiate Among Benign Liver Tumors

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G&H What are the most common types of benign liver tumors?

BM There are 4 common benign hepatic lesions: cysts, hemangiomas, focal nodular hyperplasia (FNH), and hepatic adenoma. Biliary cystadenomas and peliosis hepatis are rare entities and will not be detailed in this review.

G&H What are the key features of hepatic cysts?

BM The prevalence of hepatic cysts is approximately 2.5% in the general population. These cysts are asymptomatic and are more common in women. They may be isolated or multiple, and are completely benign. Hepatic cysts may or may not be associated with syndromes, or they may be infectious. The most concerning possibility is that these cysts may be of hydatid origin, meaning caused by a parasite. The thickness of the walls, the presence or absence of calcifications, plus the occurrence of internal daughter cysts in a patient from endemic regions, helps to determine whether or not these cysts are hydatid.

G&H What do various imaging techniques show about these cysts?

BM When detected with sonograms, simple hepatic cysts have sharply defined margins with acoustic enhancement with or without delicate septations. With computed tomography (CT) scans without enhancement following iodine infusion, these cysts have smoothly marginated borders and attenuation values of -20 to +20 Hounsfield units (HU). Using magnetic resonance imaging (MRI), hepatic cysts are characterized by low signal intensity (SI) on T1-weighted sequences and by high SI on T2-weighted sequences, and they are also devoid of enhancement when imaged on postgadolinium MRI.

G&H What is FNH?

BM The FNH lesion is the hepatic response to a preexisting arteriovenous malformation. Its internal matrix has a central scar that radiates to the periphery of the lesion. This scar contains hypertrophied hepatic arteries, disorganized bile ducts, Kupffer cells, and inflammatory infiltrates, but is devoid of portal branches or fat. The venous drainage of this hyperplastic lesion is accomplished via hepatic veins. This lesion is unencapsulated, which can be appreciated by its lobulated contours on imaging studies and histopathologic specimens. Calcifications are rarely if ever present on FNH.

In 80% of cases, FNH has these typical features. In the remaining 20%, these lesions show an absence of central scars, may be telangiectatic, and exhibit a more heterogeneous enhancement on imaging surveillance.

G&H What are the challenges associated with diagnosing a benign liver tumor as FNH?

BM The greatest challenges to the imaging diagnosis of FNH result from its similarity to normal hepatic parenchyma, which precludes detection when their size is small on sonograms. Relative to the hepatic parenchyma, FNH may be isoechoic, hypoechoic, or hyperechoic. Unenhanced CT shows FNH to have similar attenuation to the hepatic parenchyma.

G&H What imaging techniques help distinguish between hepatic parenchyma and FNH?

BM Color/power Doppler can distinguish between FNH and normal hepatic parenchyma because arterial signals are present in the scar that have low resistance to flow (high diastolic flow). Ultrasound contrast agents that are available elsewhere in the world might also distinguish between the two, but at present we have no experience with this approach.

When FNH occurs in the presence of diffuse hepatic steatosis, it becomes perceptible as an area of normal hepatic attenuation because it does not become infiltrated by the steatosis. During triple-phase studies with CT, FNH enhances homogeneously on early arterial phase, exhibits a centrifugal pattern of enhancement along radiating septa, remains enhanced on late arterial phase with better perception of its scar, and becomes isodense to the hepatic parenchyma on portal venous phase.

Because MRI can distinguish between different soft tissues, it can detect the central scar of FNH with 78% better sensitivity than CT. The lesion and its scar exhibit low SI on T1-weighted sequences and high SI on T2-weighted sequences. Gadolinium-enhanced studies such as contrast-enhanced CT demonstrate centrifugal enhancement from the central FNH hypertrophied hepatic artery to its periphery. FNH retains contrast and becomes isointense to the hepatic parenchyma on portal-venous phase sequences.

G&H What causes hepatic adenomas?

BM There is a confirmed association between hepatic adenomas and the use of either estrogen- or androgen-based products. However, current evidence suggests that numerous factors contribute to the development of these benign tumors. Potential causes include diminished portal flow, diabetes mellitus, genetic predisposition, and type I glycogen storage disease.

G&H Are there any dangers associated with hepatic adenomas?

BM Adenomas do not contain normally functioning hepatocytes or biliary ducts, and they lack a strong connective tissue matrix, the latter predisposing them to hemorrhages.

G&H How are hepatic adenomas identified?

BM The presence of intralesional fat, whether detected histologically or through imaging studies, is associated with hepatic adenoma. With CT scans, lipids are characterized by attenuation values of less than -10 HU. With MRI, fat is indicated by a decrease in SI with fat-suppressed sequences and in particular with out-of-phase sequences.

Images of adenomas appear more heterogeneous than other benign liver tumors due to the presence of fat, glycogen, and hemorrhagic products in the lesion. In addition, multiple feeding hepatic arteries can be seen supplying the adenoma from its periphery, unlike FNH, which exhibits a central hepatic artery. In approximately one third of cases, hepatic adenomas exhibit a capsule, which also helps distinguish these tumors from FNH. Finally, with both CT and MRI, hepatic adenomas do not retain contrast, due to the presence of shunting within the lesion, and as a result, they are neither isodense or isointense.

G&H Could you describe hepatic hemangiomas?

BM Hepatic hemangiomas are venous vascular lesions that are completely devoid of hepatic parenchyma, biliary ducts, and specialized reticuloendothelial cells. The prevalence of these lesions ranges from 1–2% (in the general population) to 7.4% (according to autopsy series), and are more common among women than men.

G&H What are the distinguishing pathologic features of these lesions?

BM Hepatic hemangiomas are congenital vascular malformations, which become ecstatic and do not induce cellular proliferation or hyperplasia. On contrast-enhanced imaging studies, hepatic hemangiomas are characterized by their pattern of vascular enhancement. With sonograms, their multiple internal interfaces are the result of their internal composition being that of a tangle of vessels. These vascular structures give these lesions a characteristic appearance of hyperechogenicity, though there are rare cases of atypical hemangiomas when they are hypoechoic on sonograms. This vascular framework results in their hyperintense appearance on T2-weighted sequences and low SI on T1-weighted sequences. With contrast-enhanced studies, hemangiomas display a characteristic discontinuous peripheral nodular enhancement, with a gradual centripetal filling-in towards its center.

The most reliable feature of hemangiomas is retention of iodine and conventional gadolinium on delayed studies (5 minutes after infusion, on average). In larger lesions—those that are 4 cm or more—there may be a scar in the central area (hyalinized) that is devoid of vascularity and is easily seen with sonogram, CT, or MRI.

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G&H Are there atypical hemangiomas that may appear differently?

BM Yes, there are several subtypes of atypical hemangiomas. Of these, the "flash filling" hemangioma often causes concern when seen in imaging studies. Instead of a gradual peripheral discontinuous nodular enhancement, these lesions rapidly enhance during the early arterial phase of contrast delivery. Flash filling hemangiomas retain contrast—and therefore maintain isodensity and isointensity to the vascular pool—which is indicative of their vascular nature without associated shunting.

G&H Are there any potential concerns associated with typical hemangiomas?

BM The venous matrix of hemangiomas may develop small rounded calcifications, secondary to phleboliths. These benign calcifications should be correctly recognized on imaging studies and associated with hemangiomas. Hemangiomas may sequester platelets during surgery or other insults, triggering a bleeding diathesis (Kasabach-Merritt syndrome) and possibly internal bleeding.

G&H What other benign liver tumors are important to be aware of?

BM Individuals with hepatic steatosis, cirrhosis, or Budd-Chiari syndrome may develop focal fatty infiltration and/or sparing, regenerating and dysplastic nodules. Cirrhosis is also associated with arteriovenous shunts.

G&H How do these appear on imaging studies?

BM Focal fatty infiltrations appear as wedge- or flame-shaped lesions that are usually adjacent to the ligamentum teres, hepatic veins, gallbladder fossa, or porta hepatis. These lesions do not exhibit mass-effect with contrast-enhanced imaging studies.

Regenerating nodules and their associated dysplastic nodules are supplied by the portal vein and therefore show enhancement on delayed imaging studies (portal venous phase of CT or MRI), which distinguishes them from the more ominous hepatocellular carcinoma.

As a result of the diminished portal oxygenation associated with cirrhosis, numerous arteriovenous shunts develop that are difficult to distinguish from hepatocellular carcinomas. Characteristic of their vascular nature, these shunts maintain equal enhancement to the vascular pool on triple-phase studies.

G&H What is the advantage of hepatocyte-specific gadolinium products that have been introduced to imaging technology in recent years?

BM Gadoxetic acid (Gd-EOB-DTPA) offers 2 phases of enhancement: an initial vascular phase occurring in the first 5 minutes after infusion and a hepatobiliary phase occurring 5–30 minutes after infusion, when the gadolinium particle is metabolized along the same pathway as bile. Fifty percent of this agent is excreted through the biliary system, and 50% is excreted through the kidneys. Its gadolinium-based nature requires preserved renal function with estimated glomerular filtration rates of at least 30.

Focal liver masses that are devoid of functioning hepatocytes will not retain gadolinium on the hepatobiliary phase of contrast clearance, allowing their greater conspicuity relative to the normally enhanced background of the hepatic parenchyma. Smaller lesions can therefore be perceived and assessment of mass composition ascertained.

G&H What is the greatest challenge in diagnosing benign liver tumors with imaging studies?

BM The greatest challenges in diagnosis by imaging methods stem from the fact that benign liver tumors can coexist with other benign or malignant liver masses, may demonstrate characteristics that may not be too different from their malignant counterparts, and, most importantly, may require expectant and/or surgical management. This review aimed to describe imaging characteristics of benign hepatic masses and to offer clues to the correct identification of these benign hepatic focal lesions.

Suggested Reading

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