Hepatic hemangiomas: Typical and atypical imaging findings, pitfalls and differential diagnosis.

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Learning objectives

Hemangiomas are common focal liver lesions, usually detected in the work up of asymptomatic patients.

In this poster we illustrate the spectrum of imaging findings of liver hemangioma emphasizing key diagnostic features in ultrasound (US), computed tomography (CT) and magnetic resonance imaging (MRI) and theirs histopathological correlation.

We describe typical and atypical imaging features of hemangioma, but also other liver abnormalities that associated with hemangiomas could mimic aggressive lesions.

And we refer some pitfalls in US, CT and MR imaging as well as describe other liver lesions that should be considered in the differential diagnosis.

Background

Liver hemangiomas have an estimated prevalence of 0.4 to 20%. Being devoid of malignant potential, they are usually discovered between that fourth and fifth decade of life during an abdominal imaging workup.¹

Hemangiomas have been classified according to pathology into three varieties: capillary hemangioma, cavernous hemangioma, and mixed type hemangioma.²

Most liver hemangiomas in adults are cavernous hemangiomas.³ Their imaging features are well known, as their pathological examination (Fig.1) that reveals a characteristic focal tender mass formed by multiple vascular channels limited by a single layer of endothelial cells within a thin fibrous stroma. In general, the blood circulation within these tumor vessels is slow.

Morphologically, it is a well-defined lesion possessing round or lobulated margins. Although it may occur anywhere in the liver parenchyma, it is more commonly seen at peripheral and sub-capsular locations, mostly in the posterior segments of the right lobe.⁶, ⁷, ⁹

Their size usually remains stable and can vary from a few millimeters to more than 20 cm, a feature that has been used for its classification into small (<15 mm), medium (15-50 mm) and large hemangiomas (>50 mm).⁷
Large hemangiomas may be associated with complications in 4.5 to 19.7% of cases, consisting of bleeding, compressive effect on adjacent structures and torsion if pedunculated.

Liver hemangiomas have specific imaging features, allowing its confident diagnose with cross-sectional imaging techniques. There is, however, a wide range of findings that fall out of their typical description, which are, essentially, due to modifications of the tumor structure or flow dynamics. Current state-of-the-art imaging techniques are more prone to demonstrating these findings, thus, increasing their diagnostic confidence level.

**Images for this section:**

![Histology of cavernous hemangioma (H&E staining 40x): Multiple vascular spaces limited by a single layer of endothelial cells within a thin fibrous stroma. It is a well-defined non-capsulated tumour.](image)

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Findings and procedure details

1) Common imaging findings

1.1) Ultrasound:

The most common sonographic pattern of hemangiomas (Fig. 2) consists of homogeneous hyperechoic liver nodule, with discrete posterior acoustic enhancement, devoided of Doppler signal both on colour-coded and spectral examination.

Multiple interfaces between the walls of the sinuses and the blood within them account for the typical hyperechogenicity seen at US.

Because hemangiomas may undergo various changes such as internal hemorrhage with necrosis, thrombosis, myxomatous change, fibrosis, and rarely calcification as they become larger\(^1,4\), atypical US features are frequently seen in larger ones.

1.2) CT:

CT (Fig.3) usually shows a hypodense well-defined lesion, with an internal density similar to vessels, that is a characteristic feature of blood pool lesions.

Dynamic studies performed after the administration of non-specific extracellular iodine compounds exhibits early nodular peripheral enhancement (puddling), since its feeding vessels originate from the hepatic artery.

Subsequent phases of liver enhancement reveal a progressive slow centripetal fill-in, with iso or even slight hyperdensity on delayed phase as compared to the normal liver parenchyma. This classical presentation is diagnostic with a high level of confidence.

Late intra-tumoural accumulation of contrast can be explained by the slow flowing blood within its vascular channels as well as absence of noticeable washout on the latter phases of the dynamic study determine iso/hyperdensity. However, delayed homogeneity due to complete contrast filling of the tumor should not be regularly expected, especially for large tumors, and, thus, should not be used as mandatory diagnostic criteria.

Small hemangiomas may appear to enhance to a lesser extent but this may result from partial volume averaging.

1.3) MRI:
Magnetic resonance imaging is the imaging method of choice to diagnose hemangiomas (Fig.4)\textsuperscript{5,6}. On T1-weighted (-w) images, hemangiomas display low signal intensity and on T2-w, they are strikingly homogeneous, clearly demarcated from the adjacent parenchyma, with very high signal intensity, similar to cerebrospinal fluid (CSF), due to the long T2 relaxation time of its blood-filled vascular channels, a feature that has been coined as the bulb-light sign.

On diffusion MR images hemangiomas show restricted diffusion because of the long T2-relaxation time rather than the limited mobility of the water protons (T2 shine-through). So we will find areas demonstrating substantial restriction on diffusion images and high diffusivity on the ADC map.

The enhancement in dynamic study is equivalent to that seen at CT, with complete filling of the lesion.

2) Uncommon presentations of hemangiomas:

Although the prevalence of atypical hemangioma has not been precisely determined, it seems that approximately 20-40% of hemangiomas are of this kind.

Less typical imaging findings can result from one of three main causes: altered morphology or structure, unusual flow pattern or associated liver abnormalities. Although these aspects do not preclude in all instances the correct diagnosis, they may be misleading and, therefore, should be known by radiologists in order to avoid other potentially more invasive diagnostic tests. Whenever the diagnosis is doubtful, especially in oncologic patients, even after a multimodality imaging approach, a percutaneous biopsy could be sought, with considerable evidence concerning its safety.

2.1) Uncommon morphology/structure

2.1.1.) Hemangioma with Echoic Border or with Central Scar:

On grey-scale US, atypical hemangiomas can show an internal iso/hypoechoic texture with a peripheral hyperechoic border (Fig.5), which has been associated with internal thrombosis and scarring.

Large hemangiomas are frequently heterogeneous and may display a central scar (Fig.5), which does not enhance on the late interstitial phases of the dynamic studies.
On pathology, the scar is formed by myxomatous degeneration, thrombosis, fibrosis or necrosis.

The T2-w images are frequently unable to determine its exact composition, as seen on pathological studies, because a central fluid-like hyper-intensity can be displayed, even in cases of myxomatous degeneration.

2.1.2.) Hemangioma with internal septations:

Other atypical morphological features consist of the presence of internal septations (Fig.6), exhibiting low signal intensity on T1- and T2-w images related to the presence of a fibrotic component.

2.1.3.) Giant hemangioma:

Large hemangiomas are often heterogeneous\(^1\). They are termed giant hemangiomas when they exceed 4 cm in diameter.

Large hemangiomas may be responsible for liver enlargement and abdominal discomfort.

At US, large hemangiomas often appear heterogeneous.

On nonenhanced CT scans, lesions appear hypoattenuating and heterogeneous with marked central areas of low attenuation (Fig 2, A).

After intravenous administration of contrast material, the typical early, peripheral, globular enhancement is observed (Fig 2, B). However, during the venous and delayed phases, the progressive centripetal enhancement of the lesion, although present, does not lead to complete filling (Fig 2, C).

At MR imaging, T1-weighted sequences show a sharply marginated, hypointense mass with a cleftlike area of lower intensity and sometimes with hypointense internal septa (Fig 7). T2-weighted images show a markedly hyperintense cleftlike area and some hypointense internal septa within a hyperintense mass\(^7\). The enhancement is equivalent to that seen at CT, with incomplete filling of the lesion; the cleftlike area remains hypointense, as do the internal septa\(^1\).

2.1.4.) Pedunculated hemangioma:

Pedunculated hemangiomas are rare. They can be asymptomatic or complicated by subacute torsion and infarction.
Sometimes the liver origin of the lesion may be difficult to recognize, as lesion can be attached to the liver by a thin pedicle, which is nearly undetectable at imaging. For this reason it has been described as mimicking other abdominal abnormalities, such as hypervascular gastric or adrenal tumors.

Multiplanar reconstruction of CT scans on coronal or sagittal MR imaging can be helpful showing the origin of the lesion and signal intensity and enhancement pattern are usually consistent with the diagnosis demonstrating the typical enhancement pattern and the typical signal intensities on both T1- and T2-weighted images. Pathologic examination either through percutaneous biopsy or surgical resection is usually not required.

Complicated pedunculated hemangiomas must be resected immediately. However, clear surgical indications as well as prognostic factors predicting a high risk of spontaneous bleeding were not mentioned in the reports identified in our literature review. Further investigations about the natural course and operative indications for pedunculated hepatic hemangioma are needed.

2.1.5.) Hemangioma associated with bile duct dilatation:

Sometimes, bile duct dilatation may occur as consequence of large hemangiomas centrally located within the liver. Although bile duct dilatation occur more often associated with intra-hepatic cholangiocarcinoma, all intra or extra-hepatic lesions with mass effect especially around segment IV and near the liver hilum could result in this feature.

Therefore, bile duct dilatation does not preclude hemangioma diagnosis.

2.1.6.) Hemangioma with calcifications:

Calcifications in hemangiomas can be found with a central or peripheral location, with multiple foci usually representing phlebolites (Fig.9). They are better depicted on CT as tiny dense nodules or as low signal intensity foci within the hyperintense tumor on T2-w images. (Fig.10).

2.1.7.) Cystic and multilocular hemangioma:

Cystic and multilocular hemangiomas containing a large central cavity are extremely rare. On MRI, this atypical feature is represented by a single or multiple intra-tumoural cavities, possessing long T1 and T2 relaxation times related to thrombosis and old hemorrhage. Nevertheless, peripheral enhancement with puddling can still occur.
2.1.8.) Hemangioma with fluid-fluid level:

Fluid-fluid levels within hemangiomas are very rare. A fluid-fluid level may be depicted inside the hemangioma, which is thought to represent stagnant or slow flowing blood with sedimentation of red blood cells on the dependent portion. The superior fluid layer consists of serum and the inferior layer contains unclotted sedimentary red blood cells.

US shows a hyperechoic or hypoechoic pattern. This fluid-fluid level is not seen at US.

CT and especially MR imaging can easily demonstrate this feature. The superior layer is hypoattenuating on CT scans, isointense to muscle on T1-weighted MR images, and markedly hyperintense on T2-weighted MR images. The inferior layer is of higher attenuation on CT scans, hyperintense to muscle on T1-weighted images, and slightly hyperintense on T2-weighted images.

Nevertheless, fluid-fluid levels in hepatic lesions do not indicate a specific diagnosis and can be observed in both malignant and benign conditions. Some authors have suggested that fluid-fluid levels that are clearly demonstrated with CT or MR imaging but not visible at US could be suggestive of hemangioma.

2.2) Uncommon enhancement patterns

2.2.1.) Rapidly Filling Hemangioma

Rapidly filling hemangiomas are not very frequent (16% of all hemangiomas).

Their pathological examination corresponds to a capillary hemangioma which presents small vascular spaces and extensive connective tissue (Fig.10).

The so-called flash-filling pattern is mostly seen in small tumors under 2 cm and show fast, intense and uniform enhancement on the arterial phase of the dynamic study, typically, paralleling aortic enhancement (Fig.11). These hemodynamic differences are probably related to the size of the vascular channels composing the hemangioma, with hyperdynamic flow in those containing small-sized vessels.

Since these tumors may also display colour spots on Doppler examination, differentiation from other hypervascular tumors may be problematic.

So hemangioma show immediate homogeneous enhancement at arterial-phase CT or contrast-enhanced T1-weighted MR imaging (Fig 10, B), and remain hyperattenuating or hyperintense in delayed-phase CT or MR imaging, whereas hypervascular metastases
do not. A key point resides on the evaluation of the late interstitial phase of the dynamic study, where flash-filling hemangiomas should not reveal contrast washout or fading.

Another important finding in diagnosis of hemangioma is an attenuation equivalent to that of the aorta during all phases of CT.

We should consider clinical context as small fibrotic scars in cirrhotic livers can also enhance in a similar pattern.

2.2.2.) Hyalinised or sclerosed hemangioma

Hyalinised or sclerosed hemangioma is rather unusual and is believed to represent the end stage of a hemangioma involution. The replacement of the vascular spaces by hyalinised fibrotic tissue leads to marked modifications of its imaging features, with loss of the typical globular enhancement on contrast-enhanced studies and of its high signal intensity on T2-w images on MRI (Fig.12). Since it is virtually impossible to propose a definitive diagnosis in such a case, pathologic proof may be necessary, which discloses extensive fibrotic tissue and obliteration of the vascular channels. A reasonable exception to need for pathological evaluation is when a past imaging exam displays a typical hemangioma in the same location of the present sclerosed hemangioma.

Differential diagnosis should include hypovascular tumors, such as metastases.

2.3) Associated liver abnormalities

2.3.1.) Hemangioma with capsular retraction:

Liver capsule retraction is not a frequent finding, thought it should not preclude the diagnosis of hemangioma, since it may be seen as a consequence of peripheral fibrotic changes. A possible mechanism could be fibrous degeneration.

In this case, other benign and malign entities should be ruled out, such as cirrhosis, intra-hepatic cholangiocarcinoma, epithelioid hemangioendothelioma or, even, metastases with a fibrotic component.

This entity is rare and most of time is diagnosed through surgical biopsy.

2.3.2.) Hemangioma in Fatty Liver Infiltration
Diffuse fatty infiltration of the liver is a common finding and may change the typical appearances of lesions, making them more difficult to characterize due to the decreased liver-lesion contrast, which, in severe steatosis, may even be reversed in both imaging modalities, with the hemangioma being hypoechoic and denser, respectively, when compared to the adjacent fatty liver.

At US, a hemangioma may appear slightly hyperechoic, isoechoic, or hypoechoic relative to a fatty liver\textsuperscript{11}. Posterior acoustic enhancement is usually observed.

At nonenhanced CT, the lesion may be hyperattenuating relative to the liver or may not be seen. Contrast-enhanced CT shows peripheral enhancement and delayed filling, an appearance similar to that of a hemangioma in a normal liver. However, at arterial-phase imaging, the hemangioma may be isoattenuating relative to the liver.

Sometimes, in CT studies, a peripheral dense halo may be seen surrounding the hemangioma. This corresponds to spared non-fatty parenchyma, as a consequence of the preferential arterial inflow and/or decreased portal flow around the lesion due to compression phenomena\textsuperscript{12}.

MR imaging is more helpful than CT and allows reliable detection and differentiation of hemangiomas from other hepatic masses\textsuperscript{13}.

MRI may be preferable in this setting, especially using in-phase and out-of-phase gradient-echo sequences. The high signal intensity on T2-w images and the enhancement features are preserved, thus, endering the diagnosis relatively straightforward.

2.3.3.) Hemangioma in cirrhotic liver

Hemangioma in cirrhotic liver is rare, with an incidence estimated to be about 1.7% at pathologic examination and 0.6% at CT, which is clearly lower than the frequency in unselected autopsy series or at CT in non-cirrhotic patients\textsuperscript{11}.

Despite the stiffening of the liver parenchyma, hemangiomas generally retain their characteristic findings, both on T2-w images and the enhancement pattern. In rare cases, however, mostly in advanced cirrhosis, they can lose their typical imaging features due to the development of fibrosis, determining lower volume and lower signal intensity on T2-w images\textsuperscript{11}.

2.3.4.) Hemangioma with Arterial-Portal Venous Shunt
Arterial-portal venous shunts are mainly associated with hepatic malignancy, but can also be seen in benign liver masses\textsuperscript{8,9}, in particular hemangiomas. This entity is usually asymptomatic.

An arterial-portal venous shunt can be detected with helical CT or dynamic contrast-enhanced MR imaging (Fig 15). The findings consist of early parenchymal enhancement associated with early filling of the portal vein.

Peri-lesional enhancement is seen in 19-25% of cases and manifests itself as transient hepatic attenuation differences (THAD), corresponding to staining areas seen on the arterial phase of liver enhancement, fading away on the subsequent phases of the dynamic study\textsuperscript{6,7}. Pathological explanation resides in arterio-venous shunting related to their hyperdynamic status.

Although THAD is mostly seen in cases of small flash-filling hemangiomas, larger tumors can also show the same perfusion abnormalities due to portal vein compression and compensatory arterial inflow, determining a peri-tumoral area of parenchymal enhancement\textsuperscript{6} (Fig.14). It must be stressed that peri-lesional THADs have been described in association with a variety of focal liver lesions, such as metastases, abscesses and hepatocellular carcinoma\textsuperscript{8}.

\textbf{2.3.3.) Nodular hyperplasia surrounding hemangioma}

Hemangioma has been reported in approximately 20% of cases of patients having a concomitant FNH (Fig.16), a prevalence that is higher than that observed in the general population. A common physiopathological mechanism may explain this association, which is believed to result from a focal disturbance of the liver blood supply facilitating a hyperplastic response and subsequent development of these benign tumours\textsuperscript{12}.

\textbf{3. Pitfalls in US, CT and MRI}

\textbf{3.1) Not all hyperechoic liver lesion on ultrasound are hemangioma.}

A \textit{hyperechoic liver lesion} on ultrasound is not pathognomonic of hemangioma, it can arise from a number of entities, both benign and malignant.

Examples of \textbf{benign lesions} are focal hepatic steatosis, hepatic adenoma with high fat content (Fig.17), focal nodular hyperplasia, focal hepatic steatosis, and inflammatory pseudotumour of the liver.
Examples of **malignant lesions** are hepatic metastases (colorectal carcinoma (up to 50% of hyperechoic liver metastases), treated breast cancer, endocrine tumors of the pancreas, renal cell carcinoma, thyroid carcinoma, melanoma, some sarcomas, choriocarcinoma), hepatocellular carcinoma or cholangiocarcinoma.

3.2) **In arterial phase, hemangioma typically show discontinuous, nodular, peripheral enhancement.**

Periphery **continuous enhancement** is not typical of liver hemangioma and you should consider another differential diagnosis as metastases, abscess, cholangiocarcinoma, hepatocarcinoma (Fig.19) in cirrhotic liver or treated lesions.

3.3) **Hemangioma is a hypervascular liver lesion that always have attenuation / signal equivalent to that of the aorta during all phases.**

A hypervascular liver lesion that demonstrate fading or wash out in venous phase or delayed-phase images are not a hemangioma. In this case we should consider nodular hyperplasia focal, adenoma or metastases, (Fig.20) and hepatocarcinoma as differential diagnosis. MRI is the most useful tool to make a correct differential diagnosis.

3.4) **Not all giant liver lesions with central scar are giant hemangiomas.**

As principal differential diagnosis we should consider fibrolamellar HCC (Fig.21), metastases with central necrosis, and FHN.

3.5) **Not all liver lesions with early nodular peripheral enhancement in arterial phase are hemangiomas. We should always consider all phases in dynamic study.**

In arterial phase, liver lesion with discontinuous, nodular enhancement could not be hemangioma, we should always consider the clinical context. In our department we observed some cases of liver lesions with nodular periphery enhancement that was an HCC treated by hepatic embolization, and remain with a halo of tumoral tissue that enhances contrast.
3.6) Not all liver lesions with blood pool are hemangiomas, we should also consider as differential diagnosis peliosis hepatic (Fig. 22, 23), hemagioendothelioma and liver angiosarcoma.

3.7) Not all hypointensity liver lesion during late dynamic phase with hepatocyte-specific contrast agents means wash out.

Differentiation of hepatic hemangiomas and metastatic lesions is a common clinical problem and can influence treatment. MRI is frequently used to characterize liver lesions, and findings on T2-weighted and gadolinium-enhanced MR images have been found to play a key role in differentiation of hemangioma and metastasis.

Gadoxetate acid or its salt, gadoxetate disodium is a hepatobiliary contrast agent and is preferentially taken up by hepatocytes. It has extended persistence in the liver. It has shown dose-independent renal (41.6-51.2%) and biliary (43.1-53.2%) elimination and an enterohepatic recirculation rate of approximately 4%. Because the effect of recirculated contrast material might be less in gadoxetate disodium-enhanced MRI than in gadopentetate dimeglumine-enhanced MRI, the bright dot sign and the minimal enhancement observed in hemangiomas during the late dynamic phase are minimized on gadoxetate disodium-enhanced MR images. In addition, because the signal intensity of the liver continues to increase with time, these delicate enhancement findings might be obscured. Another explanation for difficulty with hemangiomas, besides the lower gadolinium dose and effect of recirculated contrast material, is more rapid removal of the contrast agent from the vascular space.

For these reasons, hemangioma demonstrate avid arterial enhancement and then, because of rapid progressive hepatic parenchymal enhancement, become hypointense to normal liver as early as 3 minutes after injection, simulating washout. This recently reported phenomenon was described as "pseudo washout" \(^{16}\) (Fig.24).

Because of these issues, we do not recommend the use of gadoxetic acid for the routine imaging of known or suspected hemangiomas.

4. Differential Diagnosis

During previous discussion we reviewed the most common differential diagnosis. A summary table of imaging features of principal differential diagnosis follows.
Fig. 25: Differential Diagnosis. The (+) sign indicates the frequency of the findings: (+++) very common finding, (++) less common finding, (+) rare finding; (a) extremely rare finding; (b) lesion > 2cm in a cirrhotic liver; HF= homogeneous with fading pattern; HP = homogeneous and persisting pattern; HW = homogeneous with "washout" pattern; HYPO = hypoenhancing lesion on hepatobiliary phase; ISO/HYPER = iso/hyperenhancing lesion on hepatobiliary phase; MOSAIC = mosaic pattern; PUD = "puddling" pattern; RF = fading ring pattern; RW = ring with "peripheral washout" pattern; SCAR = central scar.

References: - Vila Nova de Gaia/PT The (+) sign indicates the frequency of the findings: (+++) very common finding, (++) less common finding, (+) rare finding; (a) extremely rare finding; (b) lesion > 2cm in a cirrhotic liver; HF= homogeneous with fading pattern; HP = homogeneous and persisting pattern; HW = homogeneous with "washout" pattern; HYPO = hypoenhancing lesion on hepatobiliary phase; ISO/HYPER = iso/hyperenhancing lesion on hepatobiliary phase; MOSAIC = mosaic pattern; PUD = "puddling" pattern; RF = fading ring pattern; RW = ring with "peripheral washout" pattern; SCAR = central scar.

5. Hepatic hemangiomas diagnosis - How to do it right?

In order to achieve the correct diagnosis, there are some points that you should always consider:

1. Medical history: Age and gender of patient, risk factor for acute/chronic hepatopathy, history of previous neoplasm or chemoembolization, use of oral contraceptive or anabolic steroids.

2. Clinical and laboratory abnormalities: anemia, fever, weight loss.

3. Dynamic studies including all phases.

4. Do not use gadoxetic acid for the routine imaging of known or suspected hemangiomas.
5. Typical and atypical features of hemangioma, so if you do not have certain diagnosis you should call it as an indeterminate lesion, and never diagnose it as an atypical hemangioma.

6. The most common pitfalls and knowledge on how to avoid them.

7. The principal differential diagnosis.

8. Review previous exams regardless of timeline.

9. If you are in doubt about diagnosis, you must recommend pathological examination.

Images for this section:

Fig. 3: Axial CT images of typical hepatic hemangioma. The CT findings shows a hypoattenuating lesion on nonenhanced images (A). After intravenous administration of contrast material, arterial-phase CT shows early, peripheral, globular enhancement of the lesion (B). The attenuation of the peripheral nodules is equal to that of the adjacent aorta. Venous-phase CT shows centripetal enhancement that progresses to uniform filling (C). This enhancement persists on delayed-phase images (not shown). This pattern is seen in lesions with "blood pool" and the enhancement must equal the attenuation of the aorta during the different phases of the dynamic study, a finding of most diagnostic importance.

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Fig. 4: Axial MR images of typical hepatic hemangioma in segment VI. On T1-weighted (T1-w) images hemangioma displays low signal intensity (A) and on T2-w, it is strikingly homogeneous, clearly demarcated from the adjacent parenchyma, with very high signal intensity, similar to cerebrospinal fluid (CSF), showing the bulb-light sign (D). During arterial-phase (C) shows early, peripheral, globular enhancement of the lesion and centripetal enhancement that progresses to uniform filling during the venous and delayed phase (B). Hemangioma demonstrates substantial restriction on diffusion images (C) and high diffusivity on the ADC map (F), T2 shine-through.

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Fig. 5: Atypical hemangioma on ultrasound. Hepatic mass on grey-scale US showing an internal isoechoic texture with an hypoechoic central portion and border, which has been associated with internal thrombosis and scarring on pathology study.

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**Fig. 6:** Hemangioma with internal septations and fibrosis. Axial MR images show a solid lesion located in the right hepatic lobe that is hyperintense in T2 (-W)* (E) and hypointense in T1 (-W) (A) relative to hepatic parenchyma. On axial unenhanced T2-weighted gradient echo image this lesion shows some tiny septations and focal hypointense areas suggesting fibrotic areas. On opposed phase T1-weighted sequences (F) reveals an hyperintense halo perilesional of focal fatty sparing. In dynamic study we see early, peripheral, globular enhancement of the lesion (C,G), suggestive of hemangioma. The diagnosis was proved with biopsy. *Note the hypointense linear elements, which correspond to internal septa.

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**Fig. 7:** Giant hemangioma of the right lobe. Axial MR imaging demonstrate a mass that nearly replaced the right hepatic lobe. This mass reveals heterogeneous high signal intensity on T2-weighted images (D) and low signal intensity on T1 (-w) imaging (A). Dynamic gadolinium-enhanced imaging show a mass with peripheral slow flame-shaped enhancement with irregular inner margins on 90s (B) and becomes more confluent as it progresses centrally on delayed 5 minutes post-gadolinium SGE image (E).

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Fig. 8: Hemangioma with calcifications in axial and coronal CT images. Unenhanced abdominal CT scan, axial (A) and coronal (B) projections demonstrate a giant cavernous hemangioma with central hypodense area and punctate calcifications. In general, calcifications are due to intra-lesional phlebolites but may be the end result of fibrosis and dystrophic changes.

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Fig. 9: Hemangioma with calcifications in axial MR images. T1-weighted spin-echo MR image shows a markedly hypointense center and some hypointense linear elements within a hypointense lesion (A). T2-weighted spin-echo MR image shows that the lesion
is hyperintense relative to the liver with a markedly hyperintense center (B). Note the hypointense nodular element, which correspond to a nodular calcification.

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**Fig. 10:** Histology of capillary hemangioma. (A) H&E staining 200x: Small vascular spaces, lined by endothelial cells (which appear very similar to normal cells). These interconnected spaces are filled with red blood cells.

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Fig. 11: Rapidly filling hemangioma. Early-phase T1-weighted MR image shows immediate homogeneous enhancement of a small lesion (B). Delayed-phase T1-weighted MR image shows persistent enhancement of the lesion (E). The diagnosis was proved with biopsy.

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Fig. 12: Sclerosed hemangioma. Axial MR images on T1 (-w) (A), T2(-W) (D), dynamic phases at 20 sec and 120 min (B,E), diffusion (C) and ADC map (F). Axial MR images shows a liver nodule in hepatic segment VII, that demonstrates substantial restriction on diffusion images (C), and slowly, peripheral, globular enhancement (B,E), suggesting interstitial fibrosis. The diagnosis was proved with biopsy.

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Fig. 13: Sclerosed hemangioma. Hematoxylin and eosin (H&E) staining 20x showing complete obliteration of the some vascular channels and replacement by fibrous tissue (white arrow). A typical cavernous hemangioma is also seen (black arrow).

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**Fig. 14:** Hyalinised hemangioma. Axial MR images on T1 (-w) (A), T2(-W) (B), dynamic phases at 90 sec and 15 min (C,D), diffusion (E) and ADC map (F). Axial MR images show a large, polilobated lesion in the right hepatic lobe. T2-weighted spin-echo MR image shows that the lesion is heterogeneous and less hyperintense than cerebrospinal fluid (B). On axial enhanced T1-weighted gradient echo image after injection of gad chelates the lesion demonstrates homogeneous and avidly enhancement during the arterial phase (C), which becomes more confluent as it progresses centrally on delayed phase (D). The diagnosis was proved with biopsy. Hyalinised hemangioma. Axial MR images on T1 (-w) (A), T2(-W) (B), dynamic phases at 90 sec and 15 min (C,D), diffusion (E) and ADC map (F). Axial MR images show a large, polilobated lesion in the right hepatic lobe. T2-weighted spin-echo MR image shows that the lesion is heterogeneous and less hyperintense than cerebrospinal fluid (B). On axial enhanced T1-weighted gradient echo image after injection of gad chelates the lesion demonstrates homogeneous and avidly enhancement during the arterial phase (C), which becomes more confluent as it progresses centrally on delayed phase (D). The diagnosis was proved with biopsy.

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Fig. 15: Hemangiomas seen on dynamic CT associated with perfusion abnormalities. (A) Plain image disclosing one hypodense focal lesions at the right liver lobe. (B) Arterial phase image of a dynamic CT study showing a triangular hyperdense area representing arterio-venous shunting. This area corresponds to a transient hepatic attenuation differences (THAD) that is no longer depicted in the portal venous phase (C).

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Fig. 16: Transverse MR images show hemangioma associated with FNH. T2-weighted fast spin-echo MR image (D) shows mildly hyperintense FNH lesion (*) in the left hepatic lobe. Hemangioma (white arrow) with signal intensity almost as strong as that of the CSF. Gadolinium-enhanced T1-weighted gradient-echo MR image (B) obtained during arterial phase shows strong hyperintensity of FNH lesion to normal liver. Hemangioma shows nodular peripheral enhancement. Gadolinium-enhanced T1-weighted gradient-echo MR image (E) obtained during portal venous phase shows centripetal filling of hemangioma except for the central region, while FNH lesion is isointense to normal liver.

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Fig. 17: Steatotic adenoma. This image shows a small, round nodule in the right lobe of the liver that is predominantly hyperechoic relative to the liver parenchyma. The diagnosis was proved with biopsy.

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**Fig. 18:** Steatotic hepatocellular adenoma on MRI. The lesion is located in segment VII, subcapsular. The lesion is isointense on T2-weighted sequences (D), isointense on in-phase T1-weighted sequences (B) with a strong and homogeneous drop in signal intensity on opposed phase T1-weighted sequences (E), which indicates presence of fat. This lesion enhanced on arterial-phase (90 sec) using non-hepatospecific MRI contrast agents (C) and is hipointense on hepatospecific study (F).

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Fig. 19: Images in a 51-year-old man with HCC related cirrhosis showing a mass (6.2 cm) in the right hepatic lobe: Multiphasic CT technique. There is an hypodense lesion on precontrast CT image (A). Late hepatic arterial phase image shows heterogeneously hyperenhancing mass with periphery continuous enhancement(B). Relative to liver, mass de-enhances on portal venous (D) and 5-minute delayed phase images to become isoattenuating with background parenchyma. Mass has capsule appearance in venous phases, shown to best advantage in delayed phase. Note ascites.

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**Fig. 20:** Axial CT scan images show a solid mass in right hepatic lobe, with heterogeneously hyperenhancing on late hepatic arterial phase (A). It has a confluent, centripetal and progressive enhancement on venous phase (B), and becomes almost isoattenuating with background parenchyma on delayed phase (C). Although this lesion behaves as hypervascular lesion with centripetal enhancement, it does not present internal density similar to vessels (arrows), that is a characteristic feature of blood pool lesions. Biopsy confirmed that it was a cholangiocarcinoma.

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**Fig. 21:** Fibrolamellar hepatocellular carcinoma (HCC) in 18-year-old man. A, Coronal T2 (-w) MR image shows large hypoattenuating mass (white arrow) in right lobe with low-attenuation central scar (*). B, Coronal MR image in portal venous phase shows mass is almost isoattenuating (white arrow) compared with liver, and central scar (*) remains hypoattenuating. C, Axial CT image in delayed phase shows mass is mildly hypoattenuating (white arrow) compared with liver.

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Fig. 22: Peliosis hepatic at multi-sequence MRI with and without gadolinium. T2 weighted axial images demonstrate increased T2W signal within the lesion (D). Arterial enhancing phase images show early enhancement (B). Early and late venous phase contrast enhanced axial images demonstrate avid centrifugal enhancement (B,E). Diffusion weighted axial image demonstrates substantial restriction on diffusion images (C) and high diffusivity on the ADC map (F), T2 shine-through.

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Fig. 23: Peliosis hepatic. Transverse unenhanced CT image shows hypoattenuating lesion within segment VIII/I of liver (A). B, On contrast-enhanced CT during hepatic arterial phase, lesion shows homogeneous contrast enhancement, which have centrifugal progression of contrast enhancement during portal venous phase (C), and tend to become progressively isoattenuating with time (D).

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**Fig. 24:** Axial T1-weighted fat-saturated MR images obtained with fixed window settings before (Pre - A) and at seven intervals (45 seconds (D) and 5 (B) and 20 (E) minutes) after administration of a gadoxetic acid injection show the typical extensive enhancement of liver parenchyma in the hepatocellular phase. A cavernous hemangioma with marked peripheral enhancement during the hepatic arterial phase (D) that becomes less obvious as the liver parenchyma enhances during the hepatocellular phase. At the peak of the hepatocellular phase (20 min), the lesion appears hypointense relative to normal liver, an expected finding in cavernous hemangiomas.

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Conclusion

Hemangiomas are a radiologist's dream lesions because they often allow a confident diagnosis. Dynamic imaging is immensely advantageous over single-phase imaging. Knowledge of atypical features and pitfalls can limit diagnostic error. However if diagnostic criteria are not reunited or doubtful, a biopsy study should be recommended.

Personal information

References