Fat-containing lesions of the liver: What do we need to know about them?

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Learning objectives

-To review the different types of hepatic lesions that can contain fat.

-To establish a relation between their histologic characteristics and the radiological findings, depending on the different imaging techniques.

-To try to reach a differential diagnosis as accurate as possible, based on the existence of intralesional fat.

Background

A wide variety of hepatic lesions, both benign and malignant, can contain macroscopic or intracellular fat. They are a heterogeneous group with different histological, radiological and clinical characteristics. Identification of fat within a liver lesion can help radiologists to reach a more accurate differential diagnosis

Findings and procedure details

Benign lesions include angiomyolipoma, lipoma, focal or geographic fatty change, focal nodular hyperplasia, hepatic adrenal rest tumor, adenoma, hydatid cysts, teratoma, xanthomatous lesions in Langerhans cell histiocytosis and extramedullary hematopoiesis. Malignant liver lesions that can contain fat include metastases, liposarcoma and hepatocellular carcinoma.

Fat has a characteristic appearance with each of the imaging techniques. On ultrasounds it is usually seen as hyperechoic although in some cases it may be appear as hypoechoic. On CT fat has a low attenuation (between -10 and -100 HU). On MRI we have several imaging sequences to identify the fat: it is characteristic its high signal on T1-weighted images and the loss of signal on fat suppression sequences and opposed-phase gradient-echo sequences.

ANGIOMYOLIPOMA

Angiomyolipoma is an uncommon benign mass containing three elements: blood vessel, smooth muscle and mature adipose tissue. It is more common in kidneys, hepatic angiomyolipoma is rare. It is associated with tuberous sclerosis in 6% of patients (20% in renal angiomyolipoma). It is more common in the right hepatic lobe.

The characteristic finding on any imaging technique is the presence of fat and prominent central vessels. However it can have various appearances due to the variant content of the three components.

On ultrasound they usually appear as a hetero or homogeneous echogenic mass commonly in right hepatic lobe.

On CT they appear as a well-defined mass with heterogeneous attenuation due to presence of the three components. They are usually hypodense. They present significant enhancement in arterial phase. The presence of central vessels within the lesions may be a characteristic feature of angiomyolipoma as in other hypervascular lesions (carcinoma hepatocellular, focal nodular hyperplasia) the vessels are usually located in the periphery of the nodules.

On MRI the lesions with high proportion of fat tissue show high signal intensity on T1 and T2-weighted images with a loss of signal on fat suppress sequences. They present enhancement of vascular component in arterial phase.

However 50% of hepatic angiomyolipoma lack considerable fat content so it is difficult to make an acute radiological diagnosis with the other hepatic tumors.

LIPOMA

Hepatic lipomas are a rare benign lesion of the liver. These lesions are composed of mature adipose tissue. On ultrasounds they appear as well-defined hyperechoic lesions. On CT lipomas are homogenous and show fat attenuation (-20 to -70 HU) without contrast enhancement. On MRI lipomas show typical characteristics of a fatty lesion (high signal on T1-weighted images and fat suppression on fat suppressed sequences).

FOCAL OR GEOGRAPHIC FATTY CHANGE

Hepatic steatosis can be diffuse or focal. Focal hepatic steatosis is easily recognized on the typical areas (adjacent to the falciform ligament, along the gallbladder o along the porta) but out of these areas it can mimic metastasis.

The combination of in-phase and out-of-phase T1-weighted gradient-echo imaging is an excellent technique to differentiate focal hepatic steatosis from metastases. Focal hepatic steatosis is isointense or hyperintense to liver on in-phase and loses signal on out-of-phase images.

FOCAL NODULAR HYPERPLASIA

Focal nodular hyperplasia is a benign mass of the liver. It is the second in frequency following the hemangioma. They are more common in young women and they are often found incidentally.

On ultrasounds they are typically isoechoic to liver parenchyma. In 20% of cases they have the characteristic “spoke-wheel” pattern of prominent arterial flow on Color and Power Doppler examination.

On CT and MRI focal nodular hyperplasia shows intense contrast enhancement except the central scar which is unenhanced in the arterial phase. In the portal phase, the lesion undergoes rapid washout of contrast material, becoming isodense/isointense to liver. The central scar may show enhancement on delayed scans.

The presence of fat in focal nodular hyperplasia is uncommon and is usually patchy. Intratumoral steatosis may be or not associated with diffuse steatosis and is better observed on MRI.

HEPATIC ADRENAL REST TUMOR

Hepatic adrenal rest tumor is an ectopic collection of adrenocortical cells in the liver. The presence of fat components is the most characteristic imaging feature. They are typically subcapsular and can show hypervascularity and foci of calcification.

ADENOMA

Hepatic adenoma is a primary benign tumor, well-circumscribed and more common in patients taking oral contraceptives or anabolic steroids. Adenoma is composed of hepatocytes with increased amounts of glycogen and fat. The present of glycogen and fat is the responsible for the high signal on T1-weighted images. Chemical shift MR imaging can confirm the presence of fat by showing a loss signal on out-of-phase imaging. On dynamic gadolinium-enhanced MR images, adenomas show early arterial enhancement and become nearly isointense relative to liver on delayed images.

HYDATID CYSTS

Hydatid infections is commonly seen in the liver. Mendez Montero et al suggested that fat-fluid levels inside hydatid cysts derives from the lipid elements in bile caused by a communicating rupture in the cyst wall.

TERATOMA

Teratomas are germ cell tumors derived from the three embryological layers: endoderm, ectoderm and mesoderm. Liver teratomas are extremely rare, it is more common the hepatic invasion from the intraperitoneal or retroperitoneal location. The presence of a mass containing calcification, fluid and fat is almost pathognomonic of this pathology.

XANTHOMATOUS LESIONS IN LANGERHANS CELLS HISTIOCYTOSIS

Langerhans cell histiocytosis is a multisystemic disorder characterized by uncontrolled monoclonal proliferation of Langerhan cells (distinctive cells of monocyte-macrophage lineage).

Hepatic involvement is uncommon, the lesions in the liver may be seen as hyperechoic on ultrasound with imaging features of fat on CT and MRI.

EXTRAMEDULLARY HEMATOPOIESIS

There are few cases of focal intrahepatic extramedullary hematopoiesis described in the literature with inespecific imaging features, being hypo or hyperdense on CT with heterogeneous or nor enhancement after the administration of contrast.

METASTASES

In general, liver metastases do not contain fat. They usually represent the histotype of the primary neoplasm. Fat-containing primary tumors such as teratoma, liposarcoma, Wilms' tumor, and renal cell carcinoma which are high in signal intensity on T1-weighted images can metastasize to the liver.

LIPOSARCOMA

Liposarcoma is a rare malignant mesenchymal tumor, which usually originates in the extremities or retroperitoneum. Hepatic involvement may be from metastases although isolated cases of primary hepatic liposarcomas have been reported.

HEPATOCELLULAR CARCINOMA

Hepatocellular carcinoma (HCC) is the most common primary malignant neoplasm of the liver. Large tumors can show fatty metamorphosis. The hyperintensity of HCC on T1-weighted images is caused by the fatty metamorphosis but also by the presence of subacute hemorrhage, glycogen or excessive copper accumulation. The signal intensity drop on chemical shift images could be very useful in the detection of lipomatous nodules in cirrhotic liver; however benign regenerative nodules can also contain fat.

Conclusion

Fat can appear in many lesions of the liver. However, its presence can help us to make a more accurate differential diagnosis.

Although the presence of fat can be observed with ultrasound or CT, MRI is the most specific imaging technique for the study of the microscopic and macroscopic fat content of the lesions.

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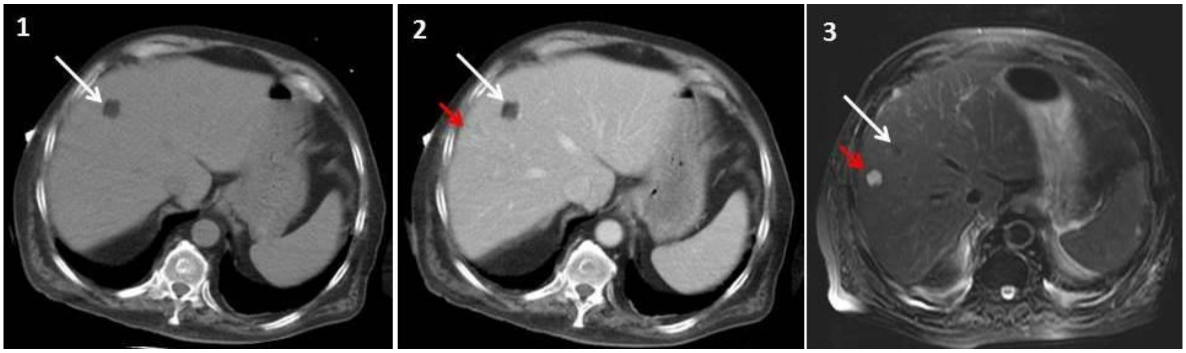

Fig. 1: Unehanced axial CT (1), enhanced axial CT (2) and fast spin-echo T2-weighted MR image demonstrates a 1.5-cm lipoma (white arrow) with an attenuation value of -30 HU without contrast enhancement in the right hepatic lobe on CT. On MRI it shows the typical features of low signal intensity on the fat-suppressed image. An hemangioma is also seen (red arrow)

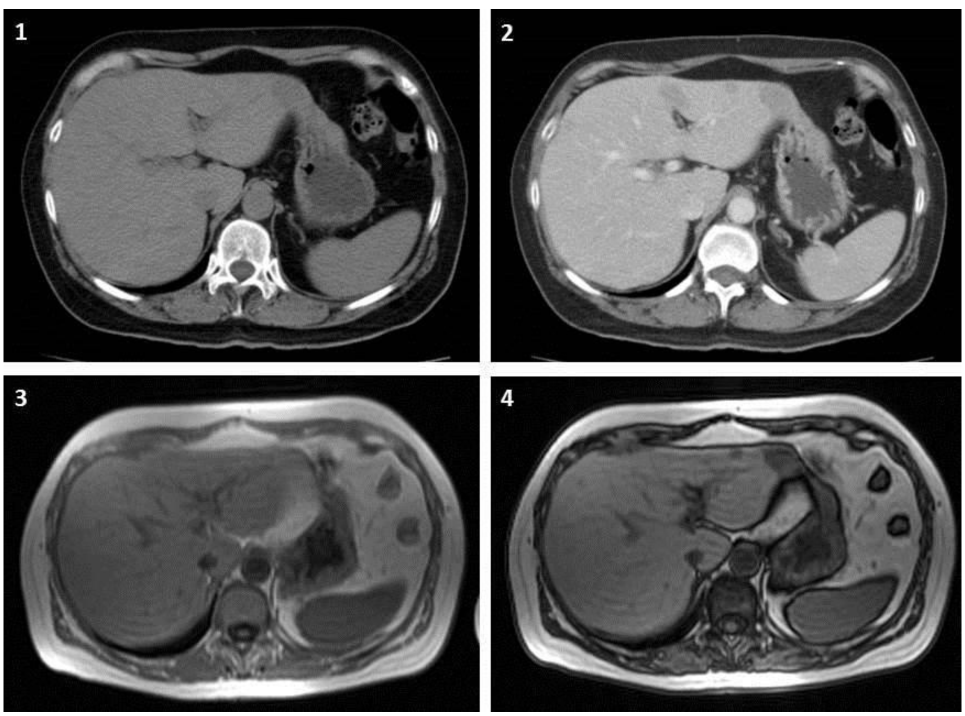

Fig. 2: Focal fatty changes: Unenhanced axial CT (1), enhanced axial CT (2), axial T1-weighted in-phase MRI (3), axial T1-weighted out-of-phase MRI (4). CT images show various focal regions of low attenuation in the liver, a finding consistent with focal geographic fatty infiltration. Marked signal loss confirms presence of focal fatty changes on MR images.

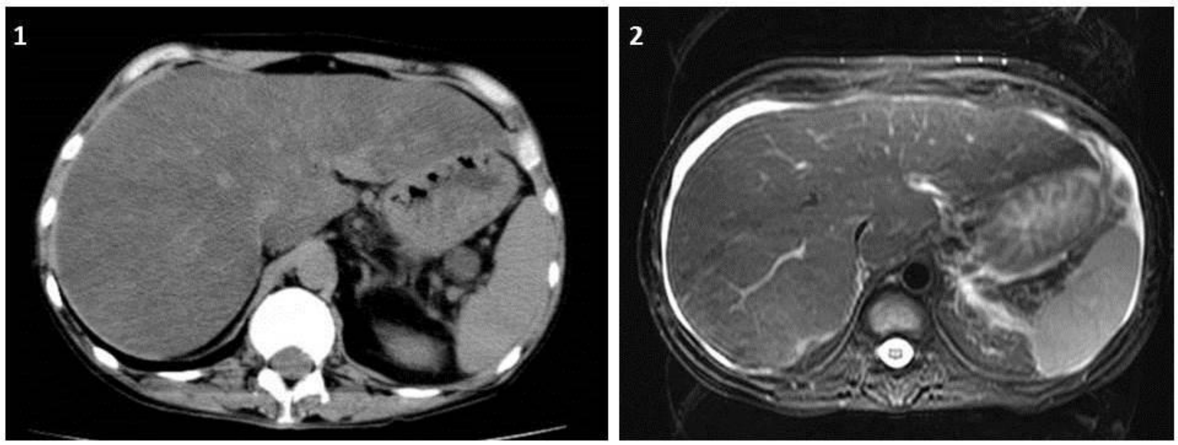

Fig. 3: Unenhanced CT scan (1) and axial fat-suppressed T2-weighted image (2). CT shows a low-attenuation change of the hepatic parenchyma caused by severe hepatic steatosis. MRI demonstrates the low-intensity with fat suppression.

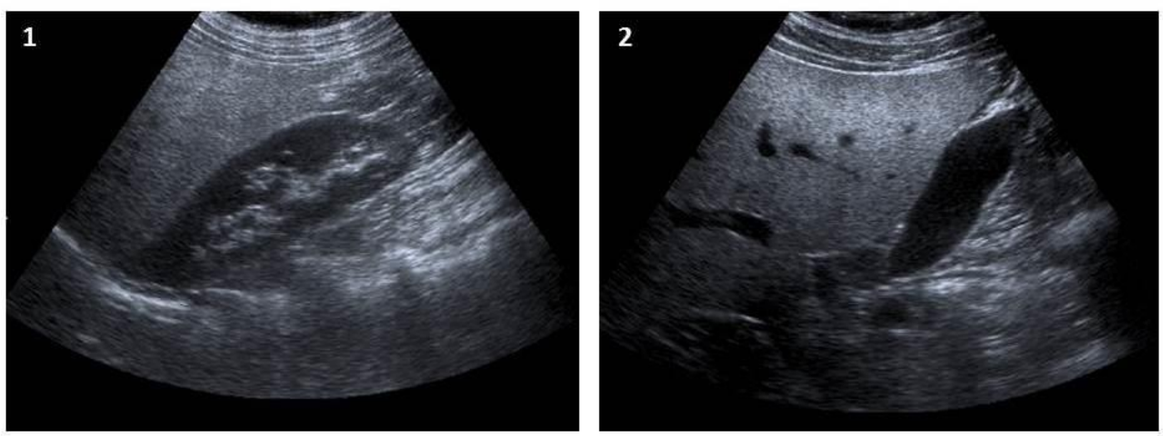

Fig. 4: Ultrasound images in hepatic steatosis. The steatotic liver is hyper-echoic, compared to the cortex of the right kidney

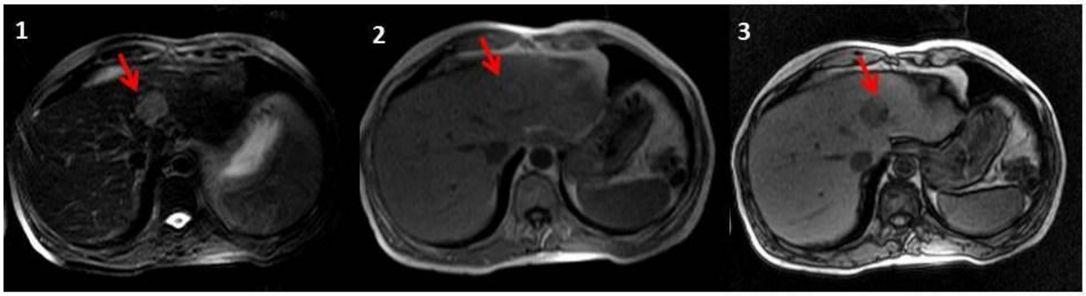

Fig. 5: Focal nodular hyperplasia. Axial fat-suppressed T2-weighted fast spin-echo sequence (1), axial T1-weighted in-phase MRI (2), axial T1-weighted out-of-phase MRI (3). They show a well-circumscribed lesion (arrow) with peripheral foci of low signal intensity which represent focal fat deposits.

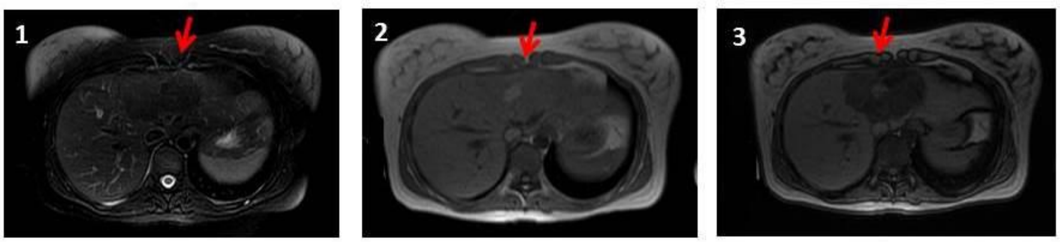

Fig. 6: Hepatic adenoma. Axial fat-suppressd T2-weighted fast spin-echo sequence (1), axial T1-weighted in phase MRI (2), axial T1-weighted out-of-phase MRI (3). They show a large mass in the left hepatic lobe (arrow) hypointense on fat suppression sequence and with a decrease in the signal intensity on opposed-phase sequences.

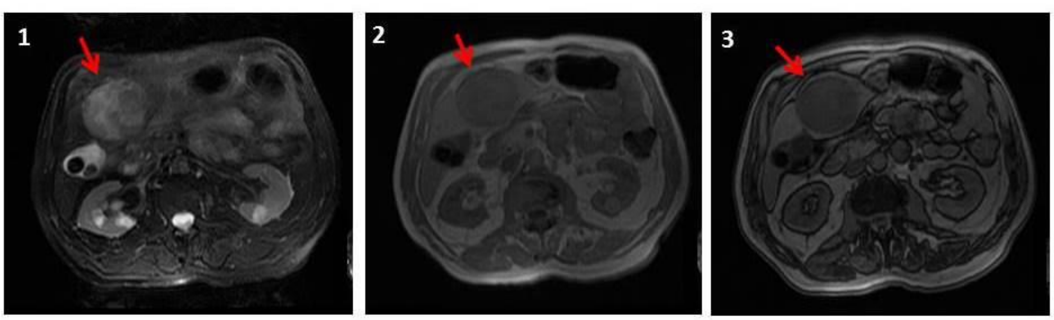

Fig. 7: Hepatocellular carcinoma. Axial fat-suppressed T2-weighted fast spin-echo sequence (1), axial T1-weighted in-phase MRI (2), axial T1-weighted out-of-phase MRI (3). They demonstrate a 4.5-cm mass

with foci of low signal intensity (1) and with a decrease in the signal intensity (2,3) which represents focal fat deposits.