Focal liver lesions detected by MRI: A daily challenge for radiologists

Diego Páez Granda, Sebastián Rivadeneira Rojas.

Abstract

The differential diagnosis of focal liver lesion (FLL) is a daily challenge for radiologists. The advances in new imaging technologies permitted the detection of these lesions with greater frequency and a more efficient characterization of them; however, the differentiation is not always evident. There are essential aspects that radiologists need to know to distinguish between the different pathologies: knowing the groups of patients with a higher risk of presenting each type of lesion, being able to recognize the appearance or aspect of the lesions at different sequences of magnetic resonance imaging (MRI), and becoming familiar with the evolution of the lesion after intravenous contrast administration. The purpose of this essay is to summarize the basic differences between the main focal hepatic lesions in magnetic resonance imaging, and to help junior radio-
principales lesiones focales hepáticas y relacionar al residente en formación con las características distintivas de cada una.

**Palabras clave:** Lesión ocupante de espacio, hígado, Resonancia Magnética.

**Key words:** Focal lesion, liver, Magnetic Resonance.

**Imaging findings**

Hepatic metastases are malignant lesions that are more frequently detected in the hepatic parenchyma. There has to be a suspicion that the lesion observed is a metastasis, especially in patients with a history of neoplasia. Primary tumors that spread to the liver with greater frequency are those of the digestive tract, especially from the colon (1). Metastases are generally hypointense in T1 and hyperintense in T2 (2) (Figures 1 and 2). An exception to this rule are the ones that originate in melanomas or tumors made up of lipid components, such as liposarcoma (2). Due to their content of melanin and fat, these lesions are generally hyperintense in T1 (2). In some occasions, the central portion of the lesion has a darker aspect. This finding known as “doughnut sign” is characteristic by metastasis that originates from colon cancer (3). Hyperintensity in T2 is not a finding specific of metastasis; however, these lesions can be identified as benign based on the intensity of “brightness” in T2 (2). Generally, cysts and hemangiomas have a higher and homogeneous intensity in T2 compared with malignant lesions (2). An exception to this rule is metastasis from mucinous or hypervascular tumors (2). As regards enhancement after intravenous contrast injection, the behavior varies depending on the hypervascular or hypovascular structure of the lesion. Hypervascular metastases are generally originated from endocrine tumors, carcinoid tumors and carcinoma of renal cells (4). These have a contrast uptake in the arterial phase, where smaller metastases are homogeneously enhanced and metastases measuring more than 3 cm are heterogeneously enhanced. Hypovascular metastases secondary to colon carcinoma present a slight peripheral enhancement (3) (Figure 3). The behavior in the venous phase of the exploration varies greatly; some lesions are isointense with respect to the parenchyma, others have a peripheral halo of enhancement that is more evident in arterial phases, or they can present a diffuse enhancement (2) (Figure 4).

Hepatocellular carcinoma (HCC) is the most frequent primary tumor of the liver (1). More than 90% of the cases originate in cirrhotic livers; therefore, we should consider this diagnosis in patients with a history of cirrhosis (5). In the progression from a nodule of hepatic regeneration to a dysplastic nodule and later an hepatocellular carcinoma, the lesion loses portal irrigation and acquires an arterial flow depending mainly on the hepatic artery (6). Their aspect in MRI varies greatly and depends on the evolution of the lesion. In T1-weighted sequences they are often hypointense; however, they frequently adopt an isointense or hyperintense aspect (2) (Figure 5). A great percentage of hepatocellular carcinomas have microscopic fat and they will lose signal in images of opposed phase (7). T2-weighted sequences do not present specific characteristics; hypervascular, isointense or hypointense lesions can be seen (2). Hypointensity or isointensity in T2 are related with well-differentiated tumors (2) (Figure 6). A nodule in a cirrhotic liver with enhancement in arterial phase and disappearance in venous phase is specific of HCC. The absence of either characteristic permits a dismissal of the diagnosis with a high level of certainty (2). However, and due to the gradual
process of progression from a nodule to HCC (as mentioned above), the behavior with the intravenous contrast injection can be very different between different HCC. In general, established HCC of small size are intensely and homogenously enhanced in arterial phase, while those of greater size are heterogeneously enhanced (2) (Figure 7). In venous phases, they are generally seen as isointense or hypointense lesions with respect to the surrounding parenchyma (2) after intravenous contrast injection (Figure 8). A characteristic that permits the differentiation in some cases of hepatocellular carcinomas of other lesions is the presence of a fibrotic capsule that is hypointense in T1 and T2, with enhancement in late portal venous phases after the intravenous contrast injection (8) (Figures 7 and 8).

**Figure 1. MR T1-weighted hepatic image, axial view.**  
45-year-old female patient with a history of colon neoplasia. Hypointense rounded lesion is observed in segment 8. Metastatic lesions, with few exceptions, are hypointense in T1.

**Figure 2. MR T2-weighted hepatic image of the same patient, sagittal view.**  
The same rounded lesion in segment 8 is hyperintense. Metastases are hyperintense in T2-weighted images. Brightness intensity is less, compared with benign lesions.
Figure 3. MR hepatic image after intravenous contrast injection of the same patient, early arterial phase, axial view.
Slight peripheral enhancement of the lesion. Hepatic metastases of colon neoplasia are hypovascular; therefore, if they show enhancement, it is slight and peripheral.

Figure 4. MR hepatic image after intravenous contrast injection of the same patient, portal venous phase, axial view.
Peripheral enhancement is more evident. Hypovascular metastases capture contrast in the form of a ring, which is a finding that is more evident in venous phases.

Figure 5. MR T1-weighted hepatic image, axial view.
56-year-old male patient with a history of alcoholic cirrhosis. Liver of cirrhotic aspect, with irregular edges. Multiple hyperintense lesions in T1. The bigger lesion is located in segment 4. Hyperintensity of hepatocellular carcinoma lesions in T1 is related with the presence of iron, proteins, lipids and/or glycogen.
Figure 6. MR T2-weighted hepatic image of the same patient, axial view.
In this sequence, lesions are isointense with respect to the surrounding tissue. Isointensity or hypointensity in T2-weighted sequences is related to well-differentiated hepatocellular carcinoma.

Figure 7. MR hepatic image after intravenous contrast injection, early arterial phase, axial views.
Same patient as before. Lesions have a good and homogeneous contrast uptake. The lesion in segment 4 shows a hypointense peripheral fibrotic capsule that does not have a good contrast uptake in early arterial phases. The behavior in dynamic phases after intravenous contrast injection of HCC varies depending on the stage of the evolution of the lesion. However, a lesion that has a good contrast uptake in the arterial phase over a cirrhotic liver will be, most certainly, an hepatocellular carcinoma. The finding of a hypointense capsule in the arterial phases is useful to differentiate this lesion from others in doubtful cases.

Figure 8. MR hepatic image after intravenous contrast injection, portal venous phase, axial view.
Same patient as before. Lesions are isointense with respect to the parenchyma. The peripheral capsule has a slight contrast uptake. In venous phases, enhancement also varies greatly; however, it is often less than in the arterial phase.
Hepatic hemangiomas are the most frequent benign hepatic lesions observed (1). Diagnosis is generally made after incidental findings in imaging tests performed for other reasons (9). They have variable sizes and when they reach a diameter of 6 cm or greater they are considered giant (2) (Figure 9). In T1-weighted sequences, they are hypointense, whereas in T2-weighted sequences they are seen as lesions with a great hyperintensity (2) (Figure 10 and 11). The “brightness” observed in T2 is greater and more homogeneous than the brightness of metastasis, which permits the differentiation (2). Without a doubt, the behavior of these lesions in dynamic phases after intravenous contrast injection is the most useful characteristic in the differentiation of hemangiomas of other hepatic FFLs. In early phases of intravenous contrast injection, there is an incomplete peripheral nodular enhancement (2) (Figures 12 and 13). It is important to differentiate this type of contrast uptake from the complete annular aspect that malignant lesions acquire, especially metastases. Smaller lesions can adopt a homogeneous aspect (2). In late venous phases, the nodular contrast progresses centripetally without completely filling the interior of the lesion (2) (Figures 14-18).

Focal nodular hyperplasia (FNH) is the second most frequent benign hepatic lesion and is often present in young women who do not have symptoms (2). In MRI, they are seen as isointense / slightly hypointense lesions in T1-weighted images, and isointense / slightly hyperintense in T2-weighted images (10) (Figures 19 and 20). After intravenous contrast injection, they behave like hypervascular lesions, with good and homogeneous contrast uptake in arterial phases (2) (Figure 21). In early venous phases, the lesion is isointense with respect to the hepatic parenchyma, and in later phases it presents a slight homogeneous enhancement (2) (Figure 22). In up to 70% of the cases, a central scar can be seen, which is hypointense in T1 and hyperintense in T2 (Figures 24 and 25). This finding is not enhanced in arterial phases and has a slight contrast uptake in late venous phases (2, 11) (Figures 26 and 27).

Figure 9. MR hepatic image after intravenous contrast injection, early arterial phase.
39-year-old patient with a history of recurring epigastric pain. The image shows a hypointense lesion with incomplete and slight peripheral enhancement. In a young female patient with almost no symptoms and with a lesion of these morphological characteristics we should consider the diagnosis of giant hemangioma.
Figure 10. **MR T1-weighted hepatic image, axial view.**
29-year-old female patient with no symptoms. The image shows a hypointense lesion in the left hepatic lobe.

Figure 11. **MR T2-weighted hepatic image, axial view.**
Same patient as before. The lesion in the left hepatic lobe has a great homogeneous hyperintensity. For now, findings are unspecific. However, the intensity of brightness in T2 allows us to consider a lesion of benign etiology.

Figure 12. **MR hepatic image after intravenous contrast injection, early arterial phase, axial view.**
Same patient as before. The image shows a characteristic peripheral nodular enhancement. The behavior of hemangiomas after intravenous contrast injection is the most useful characteristic to consider this diagnosis. This patient was diagnosed with hemangioma due to the enhancement of this lesion in this phase and later phases (following images).
Figure 13. MR hepatic image of the patient diagnosed with giant hemangioma that was seen previously.
This image corresponds to later phases after the intravenous contrast injection. There is an incomplete peripheral enhancement. It is important to always distinguish the incomplete enhancement of the hemangioma and the complete annular contrast uptake of malignant lesions.

Figure 14. MR hepatic image after intravenous contrast injection, axial view, early venous phases.
Patient with hepatic hemangioma of the left lobe seen in previous images. There is a slight increase of enhancement in venous phases.

Figure 15. MR hepatic image after intravenous contrast injection, axial view, late venous phases.
Patient with hepatic hemangioma of the left lobe seen in previous images. There is a progressive filling of the lesion.
Figure 16. MR hepatic image after intravenous contrast injection, axial view, late venous phases.
Patient with hepatic hemangioma of the left lobe seen in previous images. There is a progressive filling of the lesion that is incomplete.

Figure 17. MR hepatic image after intravenous contrast injection, axial view, early venous phases.
Patient with giant hemangioma seen in previous images. There is a slight increase of enhancement in venous phases. The incomplete progressive filling is a characteristic of hemangiomas.

Figure 18. MR hepatic image after intravenous contrast injection, axial view, late venous phases.
Patient with giant hemangioma seen in previous images. There is slight increase of enhancement in late phases, without complete filling of the lesion.
Figure 19. MR T1-weighted hepatic image, axial view.
35-year-old female patient with no symptoms. There are no alterations of the hepatic parenchyma (isointense lesion). She was diagnosed with focal nodular hyperplasia based on findings of other MRI sequences (see following images).

Figure 20. MR T2-weighted hepatic image, axial view.
Same patient as before. The image shows a slight hypointense lesion in the right hepatic lobe. For now, findings are unspecific (see following images).

Figure 21. MR hepatic image after intravenous contrast injection, early arterial phase.
Same patient as before. The lesion of the right hepatic lobe has a good contrast uptake. The lesions of the focal nodular hyperplasia have a good contrast uptake in early arterial phases.
**Figure 22. MR hepatic image after intravenous contrast injection, early venous phase.**
Same patient as before. The lesion is isointense with respect to the surrounding parenchyma. Isointensity in early venous phases is a characteristic of FNH.

**Figure 23. MR hepatic image after intravenous contrast injection, late venous phase.**
Same patient as before. The lesion has good contrast uptake in late phases. This typical finding of FNH is secondary to fibrotic composition of the lesion.

**Figure 24. MR T1-weighted hepatic image, axial view.**
32-year-old female patient with no symptoms. Isodense rounded lesion is observed in segment 4. In the central portion there is a hypodense image that can be attributed to central scar. The diagnosis was focal nodular hyperplasia. The central scar is not always present in lesions of FNH; however, its presence allows us to find a diagnosis for these lesions. Their intensity in T1 / T2 and the behavior after intravenous contrast injection allows us to differentiate them from other scar lesions.
**Figure 25.** MR T2-weighted hepatic image, axial view.
Same patient as before. The lesion is slightly hyperintense. The central scar is hyperintense in this sequence.

**Figure 26.** MR hepatic image after intravenous contrast injection, arterial phase.
The lesion has a good contrast uptake. The central scar does not have a good contrast uptake.

**Figure 27.** MR hepatic image after intravenous contrast injection, venous phase.
The lesion is isodense with respect to the surrounding parenchyma. The central scar has a slight contrast uptake.
Conclusion

Bibliographical revision shows that imaging aspect of focal hepatic lesions varies greatly. The differentiation between diverse pathologies starts when the patient is examined, based on their demographic data, age, sex and clinical history. Obtaining clinical data before analyzing the images contributes to reaching a more accurate diagnosis. The characteristics that radiologists have to describe and observe are the aspect of the lesion in T1 and T2-weighted images and the behavior of the lesion in dynamic phases after intravenous contrast injection. Nowadays, different medical centers use hepatospecific contrast means, but the revision goes beyond the scope of this essay. However, it is important to acknowledge that the behavior of the lesion in later phases after the use of contrast means is a characteristic that helps radiologists differentiate between lesions. The adequate use of magnetic Resonance Imaging and its diverse sequences may help radiologists suspect a diagnosis with a high level of certainty, without the need to perform other invasive tests.

Bibliography

4- Del Cura JL, Pedraza S, Gayete A. Radiología Esencial SERAM. Editorial Panamericana, Madrid (España); 2010.