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REVIEW / *Gastrointestinal imaging*

Liver fibrosis, cirrhosis, and cirrhosis-related nodules: Imaging diagnosis and surveillance

C. Aubé [a,b,*], P. Bazeries [a], J. Lebigot [a], V. Cartier [a], J. Boursier [b,c]

[a] *Department of Radiology, University Hospital of Angers, 4, rue Larrey, 49933 Angers cedex, France*
[b] *HIFIH laboratory, University of Angers, rue Haute-de-Reculée, 49045 Angers, France*
[c] *Department of Gastroenterology and Hepatology, University Hospital of Angers, 4, rue Larrey, 49933 Angers cedex, France*

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Abstract Although biological scores and elastography continue to yield the best results, imaging retains a crucial role in the diagnosis of liver fibrosis and cirrhosis. First, digestive symptoms or biological liver test abnormalities often lead the referring physician to request an abdominal ultrasound, and with an experienced operator, accuracy of ultrasound can reach 85% for the diagnosis of severe fibrosis or cirrhosis. Second, imaging could lead to discovery of non-symptomatic fibrosis or cirrhosis, with an estimated prevalence of 0.5—2.8% in the population. After diagnosis, imaging is central in the follow-up of cirrhosis. It is used to detect worsening of portal hypertension and hepatocellular carcinoma (HCC). Because many nodules are present in a cirrhotic liver, familiarity with the features of HCC can facilitate noninvasive diagnosis and early and accurate treatment.

Liver disease progression is due to histological and hemodynamic changes within the liver. Confirmation of those changes and early diagnosis of liver fibrosis lesions are important to determine disease progression and postpone the advancement of chronic hepatitis into cirrhosis by introducing prompt and specific treatment. The current reference standard for precise and confirmed diagnosis and staging of fibrosis (F1, mild fibrosis; F2, significant fibrosis; F3, severe fibrosis; and F4, cirrhosis) is histopathological examination of

* Corresponding author. Department of radiology, CHU Angers, 49933 Angers cedex, France.
E-mail address: chaube@chu-angers.fr (C. Aubé).

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percutaneous biopsy samples. However, false-negative diagnoses of cirrhosis are possible owing to sampling errors in an estimated mean of 24% in pooled series of blind liver biopsies [1,2]. Moreover, the invasiveness of this procedure and the risk of complications (morbidity 3%, mortality 0.03%) limit the use of liver biopsy in clinical practice [3,4].

Because of the risks of morbidity and the false-negative rate, noninvasive methods for diagnosing fibrosis have been developed. Initially, many studies claimed that the ultrasound was able to provide information about the stage of fibrosis [5]. More recently, biological scores (FibroMetre, FibroTest, etc.) and impulsional elastometry (FibroScan) have taken the lead in the diagnosis of fibrosis, and are commonly used as first-line tools for noninvasive diagnosis of liver cirrhosis or severe fibrosis ($\geq$ F3) [6–10]. Consequently, the need for liver biopsy has been decreasing, because both of these approaches offer reliable methods to diagnose liver cirrhosis. However, these noninvasive tests are usually performed in patients who undergo a hepatologist consultation owing to existing suspicion of liver disease. Given that liver fibrosis can be asymptomatic for a long time, the number of patients receiving diagnoses by these new methods remains relatively low compared to the overall prevalence of liver disease. Because of its common use, imaging has an important role in the diagnosis and screening of liver fibrosis. Once the diagnosis of cirrhosis is confirmed, imaging also has a crucial role in disease follow-up and detection of related complications, especially portal hypertension and hepatocellular carcinoma (HCC).

In this review, we will discuss the imaging features that lead to the diagnosis of liver fibrosis. The use of imaging modalities in the management of liver fibrosis, from screening to surveillance, will also be considered.

Radiologic features of liver fibrosis and cirrhosis

The imaging diagnosis of fibrosis is based on two main groups of signs: those related to a dysmorphic liver and those related to portal hypertension [5,11,12]. These signs are summarized in Table 1.

Table 1 Imaging signs of fibrosis and cirrhosis.

Morphologic signs
Parenchyma heterogeneity — fibrosis
Size of the liver: hyper then hypotrophy
Dysmorphy of the liver
Hypertrophy of the left lobe — hypotrophy of the right lobe
Segment I hypertrophy
Segment IV hypotrophy
Enlargement of hilar periportal space
Right posterior hepatic notch sign
Nodular aspect of the liver surface
Portal hypertension signs
Portal vein diameter > 12 mm
Spleen length > 11.2 cm
Portal velocity max < 18 cm/s, moy < 10 cm/s
Portosystemic collateral vessels
Portal hypertension colitis
Others hemodynamics changes
Arterial hepatic flow changes
Increase in diameter
IR > 0.7, IP > 1.2
Demodulation of hepatic veins Doppler spectrum
Others signs
Ascites
Gallbladder wall thickening
Peribiliary cysts

Signs of dysmorphia

Coarse aspect of parenchyma

A coarse aspect of parenchyma is a common finding of ultrasound examinations. In the case of MRI and especially CT, parenchyma appears more homogeneous. After contrast media injection, heterogeneity is related to inflammation and necrosis rather than fibrosis [13]. Fibrosis is visible on CT and MRI as a linear late enhancement, delineating a large area of nodular regenerative tissue. On MRI, this fibrosis appears as mild hypersignal on T2-weighted images (Fig. 1) [14].

Nodular aspect of the liver surface

A nodular aspect of the liver surface results from the effects of fibrosis and the regenerative nodules on the capsule. This is a reliable sign of fibrosis, though it is subjective. Classification in the following three groups has been suggested: no irregularity, slight surface irregularity, and pronounced surface irregularity [15]. Huet et al. have recently proposed an automatic method to quantify this irregularity of the hepatic contours, with good results [16]. However, their method, based on proprietary software, is unavailable in clinical practice and therefore impractical (Fig. 2).

Hypertrophy and hypotrophy of the liver

In the early stages of liver disease, hypertrophy related to inflammation is common. In metabolic liver disease, fat overload also leads to hypertrophy. However, as the disease progresses, the liver has a tendency to develop hypotrophy, with a clear predominance of hypotrophy of the right lobe together with a mild hypertrophy of the left lobe. At the end stage of decompensated cirrhosis, this progresses to global atrophy.

Segmental dysmorphia

Typically, there is hypertrophy of segment I and hypotrophy of segment IV of the liver. Segment I could be examined differently. Ultrasound is useful in determining the ratio between segment I and the left lobe as measured on a sagittal slice. Segment I is considered abnormal if the ratio of segment I to the left lobe is greater than 0.33. However, this measurement can be an inaccurate determinant of abnormality because the left lobe is frequently enlarged in the case of cirrhosis. Previous studies have suggested bi- or tridimensional measurements that are more effective for the diagnosis of cirrhosis, but these have become uncommon in clinical practice (Fig. 3) [17,18].

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