TABLE 3B Assessment and grading of steatosis based on the percent of hepatocytes affected

Degree of steatosis			
0 (Normal or minimal)	1 (Mild)	2 (Moderate)	3 (Severe)
< 5%	5%-33%	34%-66%	> 66%

Note: Based on Brunt et al.[20] and Kleiner et al.[21]

imaging features that allow for diagnosis of cirrhosis or PHTN include a coarse or heterogenous nodular liver, dilated portal vein (> 12 mm) or presence of collaterals, recanalization of the umbilical vein, ascites, and splenomegaly (most frequently defined as ≥ 13 cm but varies depending on patient sex, size, and morphology of the spleen).

US-based elastography

Transient elastography (TE, or vibration-controlled TE) uses M-mode US to track the speed of propagation of a mild amplitude and low-frequency (50 Hz) elastic wave produced by a mechanical vibrator included in the probe. The liver shear wave speed is expressed as the elastic modulus or liver stiffness measurement (LSM) within a range of 2.5-75 kPa. The faster the shear wave propagates through the liver, the higher the LSM, indirectly indicating a greater degree of fibrosis. The total area of tissue that is evaluated with this technique is approximately 3 cm^3, corresponding to a liver volume at least 100 times larger than a standard liver biopsy specimen. At least 10 valid measurements with an interquartile range (IQR) < 30% of the median value is required for reliable results.[30] Two probes have been developed for adults (M and XL probe), along with one for pediatric use (S probe, which has two settings, S1 and S2, based on thoracic circumference of < 45 cm and 45-75 cm, respectively).[31–33] The M probe is designed to assess patients with a skin-to-(liver) capsule distance (SCD) < 25 mm, and it quantifies stiffness at a distance of 25-65 mm from the skin, whereas the XL probe quantifies stiffness at depths of 35-75 mm from the skin. The XL probe in patients with obesity is successful in LSM in over 95% of patients with body mass index (BMI) ≥ 40 kg/m^2. A more recent study, however, suggested obtaining LSM with the XL probe in all patients with a BMI ≥ 32 kg/m^2, given the high frequency (78%) of SCD ≥ 25 mm in this group.[32] Of note, the XL probe yields lower LSM values than the M probe when tested on the same patient, although no adjustment in the cutoff values has been recommended given that TE yields higher LSM values in patients with obesity for whom the XL probe is normally used, thus potentially counterbalancing any between-probe differences.[31,34,35] TE is unreliable in the presence of ascites and is confounded by other factors (Table 6A and 6B).

Acoustic radiation force impulse (ARFI) techniques assess liver stiffness based on tissue displacement from acoustic compression pulses.[58] The regions of interest (ROIs) are selected with real-time grayscale US imaging and are not limited to the right intercostal area. ARFI encompasses two related techniques: point shear wave elastography (pSWE), which assesses ROIs measuring 10 × 5 mm^2, and two-dimensional shear wave elastography (2D-SWE), which interrogates more than one ROI in rapid succession to decrease sampling error. The 2D-SWE assesses a larger field of analysis than TE-LSM and pSWE because the size of the ROI can be modified by the operator. The recommended depth to locate the ROIs is 4-8 cm from transducer surface for both pSWE and 2D-SWE, and results are expressed in m/s with a range of 0.5-4.4[59] or kPa with ranges as high as 300, depending on the manufacturer.[58]

Conceptually, pSWE and 2D-SWE are similar to TE, with reliable performance standards including an acquisition success rate ≥ 60% (ratio of valid/total acquisitions) and an IQR of 30% or less of the median value. The major difference is the method for generating the elastic modulus (i.e., stiffness estimation), as TE uses vibration to generate a propagation shear wave, whereas ARFI relies on the shear waves generated during tissue absorption of an acoustic pulse. As a result, ARFI results are less affected by ascites or obesity because the shear waves are generated inside the liver.[36,60] The ROIs for the 2D-SWE and pSWE are much larger than that from TE, and ROIs can be moved to avoid interrogating regions with large vessels or masses. A limitation of shear wave elastography (SWE) is the need for technical expertise, including proper selection of ROI within the liver parenchyma (i.e., right lobe, at proper depth, in an area devoid of vascular/biliary structures and without exerting mechanical tissue compression). pSWE/2D-SWE are affected by many similar factors as TE (Table 6A). Finally, liver stiffness cutoff values for pSWE and 2D-SWE are unique to each vendor-specific machine and must be interpreted accordingly. Although TE may not provide as much anatomic information as pSWE and 2D-SWE, it offers a standardized platform to allow for more uniform thresholds for varying levels of fibrosis.

Magnetic resonance (MR)-based elastography

Magnetic resonance elastography (MRE) uses propagating mechanical shear waves generated with an acoustic passive plastic driver placed over the right