2D SHEAR WAVE ELASTOGRAPHY (2D-SWE)

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Liver Fibrosis

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Introduction to 2D-SWE

2D Shear wave elastography (2D-SWE), is a recently developed technique which uses acoustic radiation force to produce micrometer tissue displacement at multiple points. These tissue displacements result in shear waves that propagate perpendicular to the compressive ultrasound wave. Propagation of the shear wave is measured and depicted as a quantitative elasticity colorized map termed an elastogram. Quantitative elastography data can be presented as the estimated tissue Young's modulus in kilopascals (kPa) or as the estimated shear wave speed in meters per second (m/s). These values are algebraically related as $E=3\rho c_s^2$, in which E, ρ and c_s represent, Young's Modulus, density (kg/m^3) and shear wave speed (m/s) respectively. This technique is available on multiple ultrasound systems including those produced by Siemens, Philips, SuperSonic Imagine, GE Healthcare, Toshiba and others[1].

When and how to use 2D-SWE

2D-SWE is useful in chronic liver disease, where it can be used to stage liver fibrosis and risk stratify patients with hepatitis C virus liver disease and non-alcoholic fatty liver disease. Splenic 2D-SWE may also be used to detect portal hypertension secondary to liver fibrosis. Unlike transient elastography, 2D-SWE can be successfully performed in patients with perihepatic ascites. Higher values are expected at higher stages of liver fibrosis. As in other types of elastography, to get the most reliable shear wave speed values, patients should be positioned in the supine or left lateral decubitus position and the right arm should be elevated above the head. Ten measurements should be obtained from the right lobe of the liver at least 2 cm beneath the liver capsule. When placing the region of interest (ROI), vessels, bile ducts, rib shadows, and focal lesions should be avoided. 2D-SWE imaging is best performed through an intercostal acoustic window, typically the right 7th or 8th intercostal spaces. Measurements should only be obtained after a minimum of four hours of fasting[2].

Accuracy of 2D-SWE

2D-SWE is clinically useful for liver fibrosis staging. In a recent meta-analysis with thirteen studies, the reported area under the receiver operating characteristic curve (AUC) for detecting liver fibrosis stage ≥F2 was 0.87 (CI 0.91-0.95) and for detecting liver fibrosis stage =F4 was 0.94 (CI 0.92-0.96)[3]. Obesity may reduce measurement quality. Confounding factors which increase liver stiffness without fibrosis include hepatic inflammation, congestion, recent food ingestion, and infiltrative disease such as amyloidosis. Operator training is important as probe and acquisition site selection are important success factors when endeavoring to obtain optimal measurements.

Limitations of 2D-SWE

2D-SWE cannot accurately stage patients into individual liver fibrosis stages and should not be used for this purpose.
2D-SWE is more accurate for the diagnosis of cirrhosis than for the intermediate stages of liver fibrosis.
2D-SWE implementations vary across manufacturers. There is presently limited evidence regarding the ability to translate measurements from one vendor to another, limiting comparability of results and seamless disease tracking when using different systems. The correct number of measurements to ensure optimal accuracy is presently unknown, with a variety of different proposed strategies, depending on the vendor and/or expert guidelines selected.
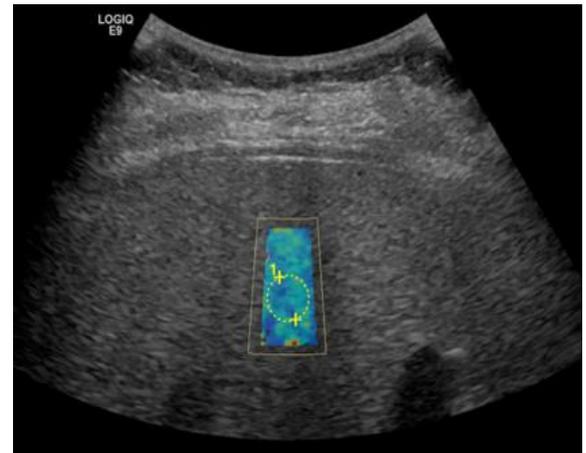
A 2D SWE image performed on the General Electric E9 ultrasound device. Colored map pixels denote estimated shear wave speeds. The ROI selects a given group of pixels for quantitative reporting.

References:
1.   Ozturk, A., Grajo, J. R., Dhyani, M., Anthony, B. W. & Samir, A. E. Principles of ultrasound elastography. *Abdom. Radiol.* **43,** 773–785 (2018).
2.   Barr, R. G. *et al.* Elastography Assessment of Liver Fibrosis: Society of Radiologists in Ultrasound Consensus Conference Statement. *Radiology* **276,** 845–861 (2015).
3.   Jiang, T. N. A. *et al.* Diagnostic accuracy of 2D-shear wave elastography for liver fibrosis severity: A meta-analysis. *PLoS One* **11,** 1–14 (2016).