Measuring Liver Stiffness on Magnetic Resonance Elastography (MRE)

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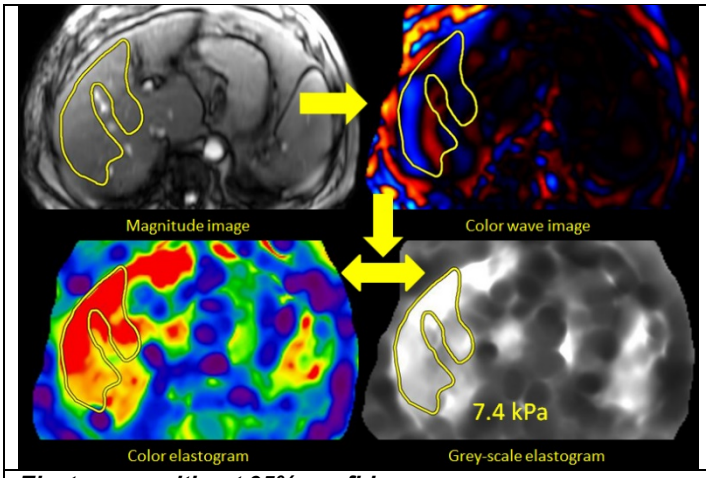
Liver Fibrosis SAR·DFP Society of Abdominal Radiology Disease-Focused Panels

Introduction

Obtaining liver stiffness measurements (LSM) on an MR elastogram is a multi-step process that interpreting radiologists should be comfortable performing. By understanding the MR sequences, drawing the region of interest (ROI) appropriately, and knowing common artifacts and pitfalls, the process can be quick and straightforward. Below we illustrate how to draw the ROI, for systems with 95% confidence maps, and for those without.

General Instructions

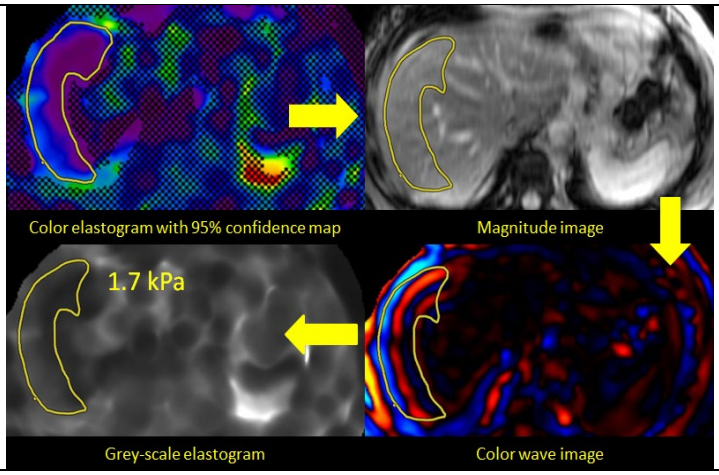
When placing an ROI, either geographic or oval ROIs can be used. Geographic ROIs provide the advantage of a greater volume of sampling and more accurate representation of liver stiffness (LS). Only areas with good waveforms should be sampled. ROIs should not be placed within one-half wavelength (or approximately 1cm) of the liver edge. Additionally, the gallbladder fossa, large vessels, and areas affected by artifact should be excluded. Please see references below for further information.



Elastogram without 95% confidence map.

Measuring LS on an MRE without a confidence map requires attention to make sure good waves are being sampled.

1) Draw an ROI on the magnitude image, avoiding the liver edge and large vascular structures as described above.
2) Copy this ROI to the wave image, with modifications if needed, to exclude areas with artifact or poor waveforms.
3) Copy the ROI (with modifications if any) to the color or grey scale elastogram to obtain the LSM.



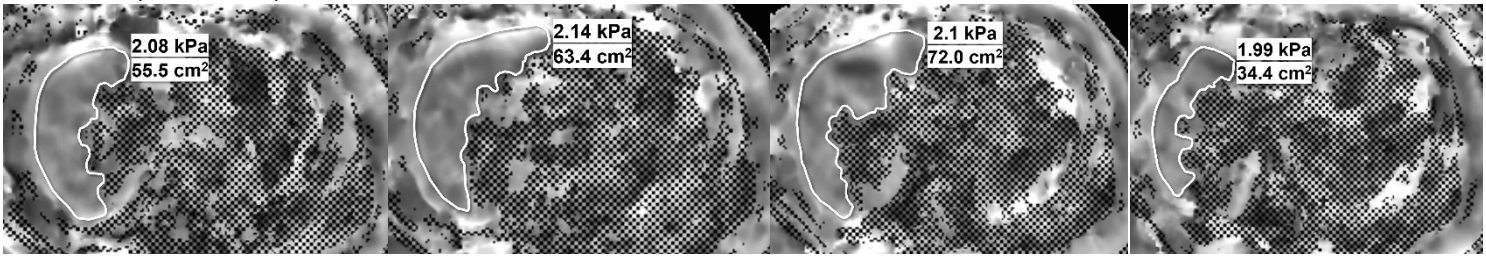
Elastogram with 95% confidence map

To measure LS on an MRE with a 95% confidence map:

1) On the confidence map, draw an ROI on the non-hashed out region representing the region of valid LSM.
2) Copy this ROI to the magnitude image, where adjustments can be made to exclude the liver edge, large vessels, etc.
3) Transfer the modified ROI to the color wave image to ensure the confidence map includes only good quality waves.
4) Copy the ROI to the grey scale elastogram to obtain the LSM.

Obtaining the mean LSM value

The above process is repeated for all four slices of the MRE as shown below.



The overall mean liver stiffness is the **weighted arithmetic mean** which reflects the relative contribution of the area of the liver measured in each slice. Report the weighted arithmetic mean along with the range of values (all rounded to the nearest tenth decimal).

A generic formula for calculating the weighted arithmetic mean of the mean liver stiffness values ("m") obtained from the ROIs drawn in 4 slices, each having a region of interest size of "w" pixels would be:

Weighted arithmetic mean = (m1w1 + m2w2 + m3w3 + m4w4) ÷ (w1 + w2 + w3 + w4)

For the exam above, the weighted mean LSM is calculated as follows: [(2.08 x 55.5) + (2.14 x 63.4) + (2.1 x 72.0) + (1.99 x 34.4)] ÷ (55.5 + 63.4 + 72.0 + 34.4) = 2.1 kPa. Thus, for this exam the "mean liver stiffness" to report would be 2.1 kPa (range 2.0–2.1 kPa).

The interpretation chart below can be used to correlate with fibrosis stage.

Interpretation of MRE Results. Mean LSM:
- <2.5 kPa = Normal
- 2.5 to 3.0 kPa = Normal or inflammation

Increased liver stiffness, in the appropriate clinical setting, is compatible with liver fibrosis as below:
- 3.0 to 3.5 kPa = Stage 1-2 fibrosis
- 3.5 to 4.0 kPa = Stage 2-3 fibrosis
- 4.0 to 5.0 kPa = Stage 3-4 fibrosis
- >5.0 kPa = Stage 4 fibrosis or cirrhosis

References:

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