LIVER ELASTOGRAPHY ULTRASOUND PROTOCOL

BILLING CODES:
ULIVELAST – Includes RUQ and Elastography
UELAST – Elastography only

PATIENT PREP: NPO 4 HOURS

EQUIPMENT: C5-1 with ElastQ preset

****This is not an urgent exam and should be done only during routine hours (M- F, 8a-4pm).**

IMAGES TO OBTAIN

RUQ PROTOCOL IMAGES

If only elastography was requested, always include images of both lobes of the liver. These help in the interpretation of elastography and are used in comparison imaging.

ELASTOGRAPHY- 10 cine clips and 10 ROI measurements with SWE.

Note: if you have made 20 attempts without obtaining 10 quality measurements, you do not need to continue to acquire additional samples. This should be discussed with the radiologist to determine whether to use a smaller number of samples or if the exam will be considered insufficient.

For each set of images:

a. Obtain a cine clip of at least 3 seconds of the elastography 2d SWE with patient in neutral breath hold. This allows the image to stabilize.
b. Save the cine clip.
c. Scroll the cine clip back to the best image with most uniform area and take one ROI measurement. IQR/med should be less than 30% when reported in kPa.
d. Save the still image with ROI measurement.

ELASTOGRAPHY SPECIFICATIONS

PATIENT POSITIONING:

1. Patient should be in **supine** position. If this is not possible, LLD up to 30 degrees can be used.
2. Bed should be flat without any elevation of the head.
3. Patient's right arm should be extended above head.
4. Breathing: Measurements should be taken with a breath hold using neutral breathing. Have the patient stop breathing mid breath, not w deep inhale.

SAMPLE CRITERIA AND SELECTION:

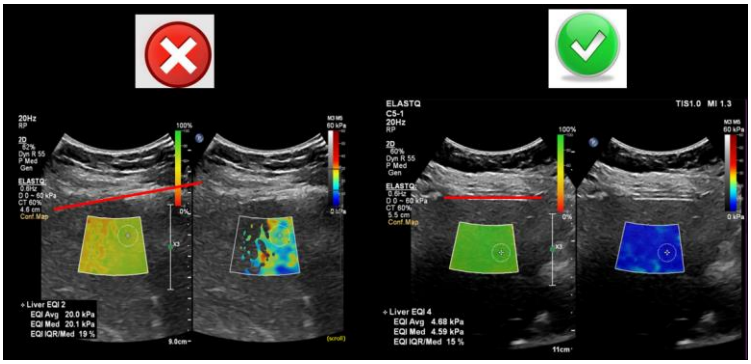
1. Measurements should be taken of the right lobe only, in an intercostal space.
2. There should be no more than 10 mm of ascites in front of the liver.
3. Avoid having blood vessels, ducts and rib shadows that may be in the sample box when acquiring your data.

PHILIPS ELASTOGRAHY SETTINGS:

1. Only the **C5-1 probe** should be used
2. Go to the **ELASTQ** exam preset. Do not stay in Abdomen Gen.
3. Select **Elasto** from the touch screen.
4. Turn on **Confidence Map**.
5. Leave **Confidence Threshold at 60%.**

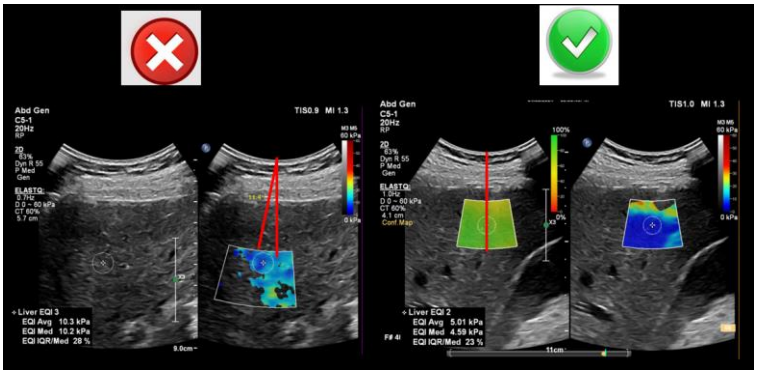
ELASTOGRAPHY ACQUISTION TECHNIQUE:

1. **Probe and liver capsule should be parallel.**

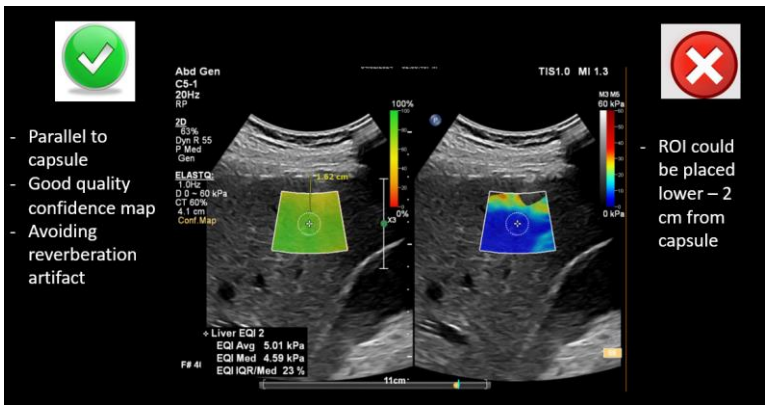


2. **SWE color box should also be parallel**.

Do not swing the color box to the right or left, it needs to remain centered.

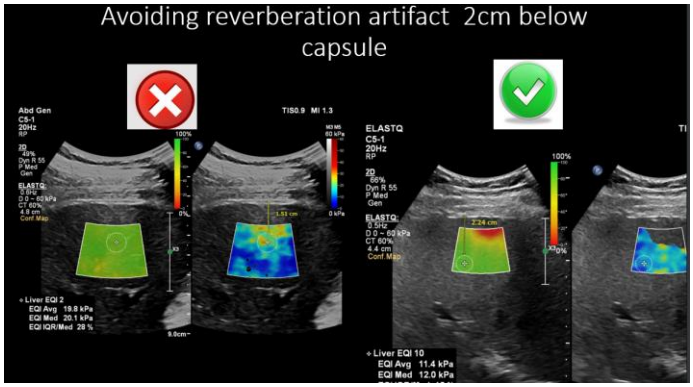


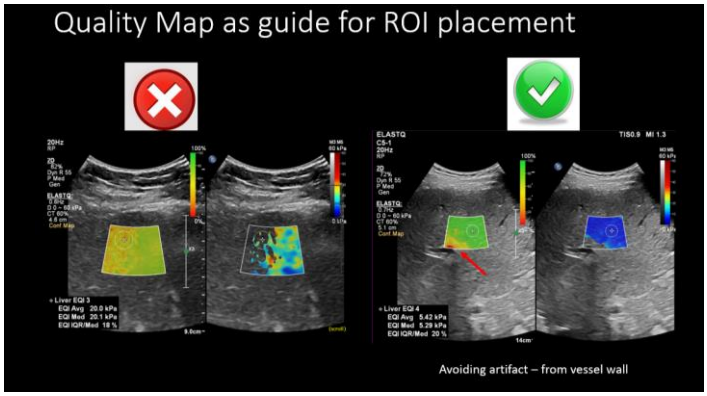
3. **ROI sample should be placed at least 20 mm below the *liver capsule* and no more than 60 mm from the *skin line***. The ideal location for obtaining the 2D SWE ROI measurement is 40- 45 mm.



Note: These are ideal scenarios. If a patient is obese, still attempt even if the sample must be greater than 60 mm from the skin line. If a patient is thin, and you can't move the color box that deep, make sure your actual ROI measurement is at least 20mm from the capsule instead as in the image to left. In both scenarios, the radiologist will state it was not ideal circumstances.

4. **Use Confidence map to avoid reverberation artifact and areas of low confidence**. Green=good confidence, sample here; Red=low confidence, avoid these areas.

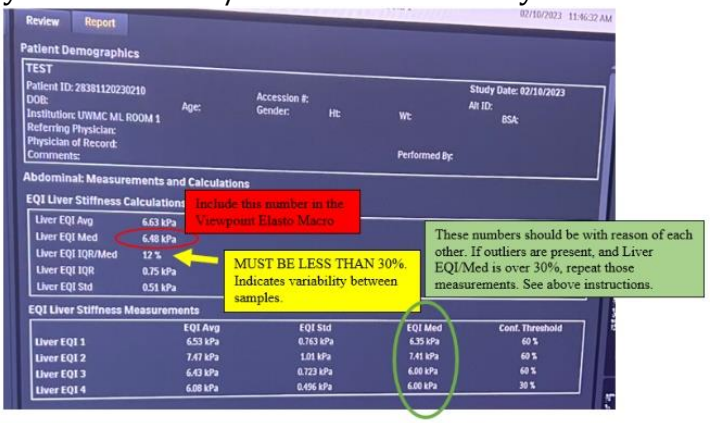




EVALUATING ELASTOGRAPHY SAMPLES:

1. Each measurement taken should have an EQI IQR/Med of less than 30% reported on the image when reported in kPa.

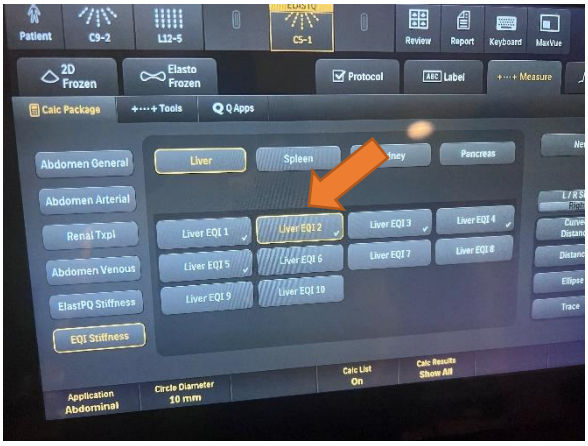
2. Each of the 10 images should have relatively close kPa or m/sec for low variability between samples.



3. The variability between samples taken can be found on the report page and is also listed as Liver EQI IQR/Med (yellow arrow.) This percentage of variability should be less than 30% but does not need to be included on the Viewpoint report.

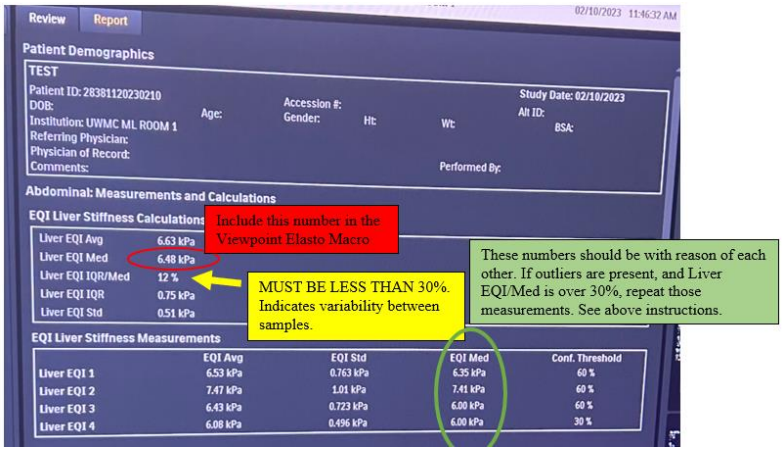
4. Go to the Report and see if the Liver EQI IQR/Med is less than 30%. If it is not, compare the kPa values for the set of samples (circled in green on the example). Find the outliers and replace those measurements with a new one that matches the set better before capturing an image of the report.

TO REPLACE AN OUTLYING MEAUREMENT:



- Return to the ElastQ page
- Repeat the steps outlined above to obtain new measurement.
- Once the sample has been obtained, use the touch screen to select the sample you would like to replace. (This can also be done with the pointer on the image screen.)
- Return to the Report to verify it was replaced. If it is a measurement more consistent with the others, the Liver EQI IQR/Med should be lower.
- Repeat with any other outlying measurements until Liver EQI IQR/Med is less than 30%.

DOCUMENTATION OF MEASUREMENTS:



- Once 10 quality measurements are obtained and the Liver EQI IQR/Med is less than 30%, print screen for both pages of the report.

- Include the Liver EQI Med kPa in the Viewpoint Elastography Macro, you do not need to report the Liver EQI IQR/Med %

- The liver section of the Viewport report should say the following:

  Liver stiffness measurements were obtained using a Philips EPIQ machine using a C5-1 probe following the SRU guidelines. Ten valid measurements were obtained using 2D SWE method. The IQR to median ratio was less than 30% suggesting a good quality data set. The liver stiffness was (xxx) kPa.

- The impression section to be completed by the radiologist should use the following stiffness values and recommendations:

Table 2: Recommendation for Interpretation of Liver Stiffness Values Obtained with ARFI Techniques in Patients with Viral Hepatitis and NAFLD

Liver Stiffness Value	Recommendation
≤5 kPa (1.3 m/sec)	High probability of being normal
<9 kPa (1.7 m/sec)	In the absence of other known clinical signs, rules out cACLD. If there are known clinical signs, may need further test for confirmation
9–13 kPa (1.7–2.1 m/sec)	Suggestive of cACLD but need further test for confirmation
>13 kPa (2.1 m/sec)	Rules in cACLD
>17 kPa (2.4 m/sec)	Suggestive of CSPH

Note.—ARFI = acoustic radiation force impulse, cACLD = compensated advanced chronic liver disease, CSPH = clinically significant portal hypertension, NAFLD = non-alcoholic fatty liver disease.

ELASTOGRAPHY GUIDELINES AND REFERENCES:

Table 1: Recommendations for Performing Liver Stiffness Measurements with the ARFI Technique

Recommendations
1. Patients should fast at least 4 hours before the examination
2. Measurement should be taken at an intercostal space with the patient in the supine or slight lateral decubitus (30°) position with right arm in extension
3. Measurements should be taken at neutral breathing during a breath hold
4. Measurement should be taken at least 15–20 mm below liver capsule in pSWE
5. The 2D SWE region of interest can be positioned closer to the liver capsule, if reverberation artifacts are avoided; however, the measurement box should be positioned at least 15–20 mm below the liver capsule
6. Results can be reported in meters per second or in kilopascals
7. In most systems, the maximum ARFI push pulse is at 4–4.5 cm from the transducer, which is the optimal location for obtaining measurements. In most systems, the ARFI push pulse is attenuated by 6–7 cm, limiting adequate shear wave generation
8. Major potential confounding factors include liver severe inflammation indicated by AST and/or ALT elevation greater than five times upper normal limits, obstructive cholestasis, liver congestion, acute hepatitis, and infiltrative liver disease (these all lead to overestimation of the stage of fibrosis)
9. Ten measurements should be obtained with pSWE, and the final result should be expressed as the median together with the IQR/M
10. Fewer than 10 measurements with pSWE can be obtained (at least five); however, the IQR/M should be within the recommended range
11. For 2D SWE, five measurements should be obtained when the manufacturer's quality criteria are available, and the final result should be expressed as the median together with the IQR/M
12. The most important reliability criterion is an IQR/M of ≤30% of the 10 measurements (pSWE) or five measurements (2D SWE) for kilopascals and ≤15% for measurements in velocity (in meters per second)
13. Adequate B-mode liver imaging is a prerequisite for point and 2D SWE as shear waves are tracked with B-mode

Note.—ALT = alanine aminotransferase, ARFI = acoustic radiation force impulse, AST = aspartate aminotransaminase, IQR/M = interquartile range–to-median ratio, pSWE = point SWE, SWE = shear-wave elastography, 2D = two-dimensional.

Table 4: Summary of Recommendations

Protocol for acquisition: As reported in Table 1, the most important criterion is IQR/M ≤30% for values in kilopascals and 15% for values in meters per second. In pediatric patients, the same protocol must be used
Protocol for 2D SWE acquisition in children who are unable to hold their breath: The consensus panel suggests recording a 2D SWE cine loop for up to 30 seconds if real-time 2D SWE is available, reviewing it, and choosing the image that demonstrates the most stable pattern for the stiffness measurement. No more than one image should be chosen in each recorded cine loop
Cut-off values: "rule of four" (5, 9, 13, 17 kPa) for the ARFI techniques for viral causes and NAFLD (Table 2)
NAFLD and rare diseases in pediatric patients: The number of published pediatric studies of NAFLD remains low, and the cutoff values for staging liver fibrosis varies between studies. It is expert opinion that each patient becomes his or her own control, using the stiffness delta changes over time to evaluate the efficacy of the treatment or the progression of disease—remembering that the measurement reflects stiffness and not fibrosis
Follow-up: The use the delta changes of LS values over time should be used instead of the absolute values. In patients with chronic viral hepatitis who are successfully treated, the baseline LS stiffness should be that obtained after viral eradication or suppression. A clinically significant change should be considered when the delta change is greater than 10%. Applying this rule, LS assessment can be suitable for evaluating all clinical conditions leading to an increase of LS, independent of the disease cause including nonfibrotic causes of LS increase (eg, congestive heart failure)
Spleen stiffness: It appears that spleen stiffness is better correlated with portal pressure than LS. However, there are differences in cut-off values between studies and the level of evidence is still low to recommend spleen stiffness in the diagnostic work-up of patients with cirrhosis
Reporting: The report should include the system vendor name, the SWE technique (pSWE or 2D SWE), the probe used, the number of acquisitions, the IQR/M, and conclusions (Fig 5)

Note.—ARFI = acoustic radiation force impulse, IQR/M = interquartile range–to-median ratio, LS = liver stiffness, NAFLD = non-alcoholic fatty liver disease, pSWE = point SWE, SWE = shear-wave elastography, 2D = two-dimensional.

REFERENCES: https://pubs.rsna.org/doi/full/10.1148/radiol.2020192437

ELASTOGRAPHY IMAGE LIST

IMAGE REQUIREMENTS	**MODE**
ALL RUQ IMAGE requirements, or Liver images if only Elasto was ordered	2D
10 three second cine sweeps with confidence map on	Elasto
10 ROI measurements, one from each sweep	Elasto
Print both pages of report	Report
PATIENT POSITION	
SUPINE *LLD can be used if needed up to 30 degrees*	
Bed should be flat	
Arm should be extended over head	
Neutral breath hold, stop mid breath	
SAMPLE SELECTION	
RHL only	
Intercostal only	
Avoid rib and vessels	
PHILIPS SETTINGS	
C5-1 probe only	
Go to ELASTQ preset	
Turn on ElastQ	
Turn on Confidence Map	
Leave Confidence Threshold at 60%	
REQUIREMENTS	
Probe, liver capsule, and color box need to be parallel to each other	
ROI should be between 20 mm from capsule, but not more than 60 mm from the skin line	
Sample should be placed in areas of green on the confidence map, not any areas of red.	
SAMPLE QUALITY	
<30% IQR/Med for each sample in kPa	
EQI IQR/Med is <30% between samples	

LIVER ELASTOGRAPHY PROTOCOL HISTORY

	Date	Changes made	By whom
Updated	9/9/2022		Becky Marion Manjiri Dighe
Updated	6/8/2022	Changed requirement to 5 ROIs w IQR/med <15% from 10 at <30% Short Cine clip of each set to be taken in addition Clarification - RUQ protocol is required in addition due to bundled charge	Renee Betit Fitzgerald Manjiri Dighe
Updated	2/10/2023	-Changed requirement to 5 ROIs w IQR/med at <30% for each image and individual data set AND <30% variability between samples which is reflected on report page as Liver EQI IQR/Med. -For VOD patients unable to hold breath, get cine clips and report that unable to obtain reliable ROI. -kPa to be reported, not m/sec -Philips EPIQ only to be used at this time, GE settings will be evaluated for future use	Renee Betit Fitzgerald Manjiri Dighe Shaun Bornemeier
Changed	2/28/2024	-Changed to 10 samples from 5 -60mm from the skin line, not the liver capsule -Not required for VOD patients any longer	M. Dhyani, G. Cunha, M. Dighe, M. Jagtiani, S Bornemeier, R. Betit Fitz
Updated	4/18/2024	Updates to images Moved contents around. No protocol changes.	M. Dhyani, G. Cunha, M. Dighe, M. Jagtiani, S Bornemeier, R. Betit Fitz