White Paper

QElaXto 2D
Liver Fibrosis Assessment

esaote


"According to the guidelines and the latest upda Consensus Statement: 2D SWE, how to assess the

Prof. Carlo Filice - US in Infectious Diseases - University of Pavia - San Matteo Hospital, Pavia, Italy

Background

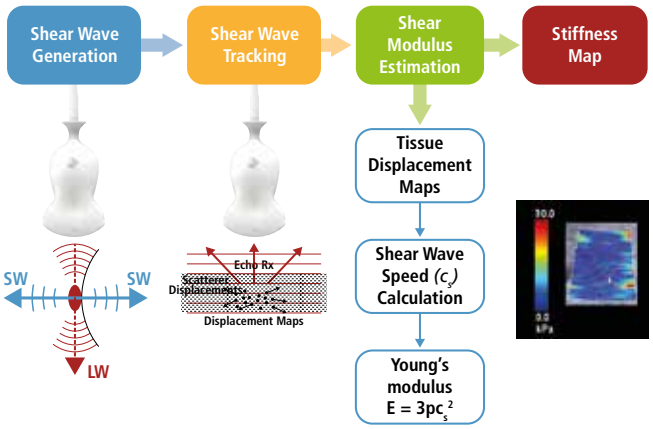
Chronic liver disease is nowadays a worldwide problem and may result from different etiologies: the most important are viral infection of the liver, NAFLD (non alcoholic fatty liver disease), ALD (alcoholic liver disease), cholestatic liver disease, and AIH (Autoimmune hepatitis). All these factors may cause an abnormal increase in collagen deposition and other components of the extracellular matrix in the liver leading to a liver cirrhosis which may develop into portal hypertension, impaired liver function, decompensated liver cirrhosis (ascites, encephalophaty, variceal hemorrhage, jaundice) and hepatocellular carcinoma.

In the past years liver biopsy was the only test available for an accurate assessment of the severity of the inflammation of the liver and the degree of fibrosis, and was the only test which could determine the risk of disease progression, the need for therapy or the need for new therapy after a treatment failure. However, liver biopsy has several limitations: it analyzes only a very small part of the liver; it has an interobserver variability; it is costly, invasive and carries a risk of rare but potentially life-threatening complications, it is not always well accepted by the patients, and of course it is not easily repeatable. For these reasons, in the last two decades, elastographic techniques are rapidly becoming the method of choice for the assessment of liver fibrosis, replacing liver biopsy for diagnosis, evaluation, longitudinal safe monitoring of the disease and treatment monitoring.

Ultrasound 2D-SWE technique is:

- a non-invasive method
- an ultrasound guided-imaging technique
- complementary to a B-mode liver evaluation
- less expensive than MRI Elastography
- more available than MRI Elastography
- a repeatable technique

Fig. 1 - Basic physics of SWE. In the first step of the process, shear waves are generated using an energetic RF pulse; they propagate perpendicularly to the primary US wave at a lower velocity. In the second step, tissue displacement is calculated, and finally tissue displacements are used to calculate shear wave velocity (Cs)



Findings and procedure details

Esaote QElaXto 2D Technology

QElaXto 2D is a SWE Technique from Esaote (S.p.A., Genoa, Italy) that alternates multiple perturbations and reading phases, enabling an image of the stiffness for a small tissue sample. The system creates multiple shocks beside the box that will induce some shear waves. Then it tracks the radio frequency (RF) signal of the tissue displacement on different sample stripes inside the box and measures the shear wave velocity for each strip. Secondly, the velocity is associated with a color map and then QElaXto 2D codes each strip with color pixels in order to enable a colored representation of the stiffness in the sample (Fig. 1). Then, clinicians have to perform five valid measurements inside the box to get a quantitative assessment, placing the ROI in an area free from vessels, bile ducts and artefacts. QElaXto 2D can provide the following measurements to clinicians:

- Median (MED) in kPa or m/s
- IQR/MED in %

Beside these, the software also gives additional measurements such as:

- Average (AVG) in kPA or m/s
- Standard Deviation (SD) in kPpa or m/s
- Interquartile Range (IQR) in kPa or m/s

When QElaXto 2D is active, a dedicated menu is displayed on the touchscreen to facilitate the workflow, optimizing the user interface that is also fully customizable to simplify the acquisitions.

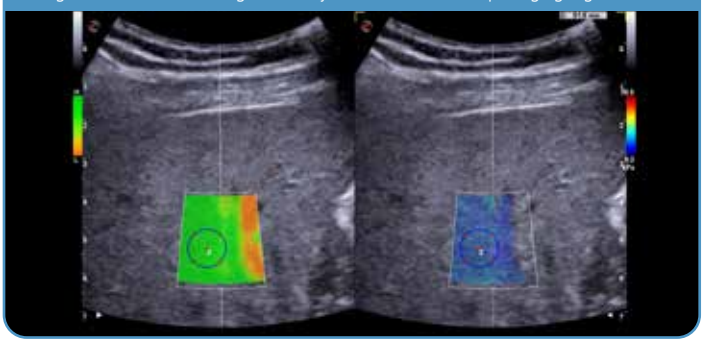
- The acquisitions can be continuous or one-shot
- Possible to save images automatically after each measurement
- Automatic export in the report at the end of each session
- Dedicated report and worksheet
- Advanced algorithm to reject false measurements
- Possibility to delete previous measurements in the current session

To help help clinicians obtain reliable measurements, QElaXto 2D offers some further tools, namely the dispersion map and the rejection parameter. The dispersion map is the computation of the standard deviation of the value of each pixel in comparison with the surrounding ones.

- Green means that the reliability is good
- Orange means that the reliability is weak

It can be enabled beside the stiffness imaging in a dual mode visualization. The rejection parameter indicates to the algorithm the rejection level for the artefacts, vessels and weak shear waves. With rejection activated, the algorithm won't include the pixels coming from the rejected areas in the computation of the values (Fig. 2).

Fig. 2 - QElaXto 2D Technology - dispersion map and stiffness map - Dual mode visualization to enable the dispersion map (left side), the orange areas indicate a low reliability while the green ones indicate a high reliability, and the stiffness map imaging (right side)



te to the Society of Radiologists in Ultrasound Liver Elastography severity of liver fibrosis in chronic hepatitis diseases."

Dr. Laura Maiocchi - Infectious Disease - Infectious Disease Department 1 - US in Infectious Diseases - San Matteo Hospital, Pavia, Italy

Acquisition procedure

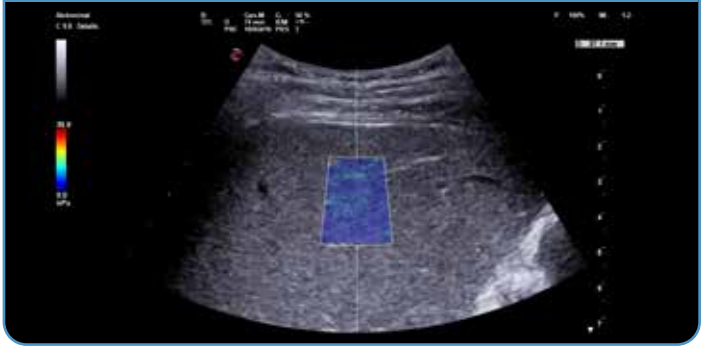
a- Scanning Instructions

- Fasting for 4-6 hours is recommended.
- Right intercostal access has to be used, with the patient in the dorsal decubitus position, examining the right lobe of the liver (VI/VII segments) using the Convex array.
- Put the right arm of the patient above his/her head in order to maximize the intercostal space, as shown in the figure (Fig. 3).

Fig. 3 - Practical aspects - Patient in decubitus position with his/her right arm above his/her head and the convex probe through the intercostal access

- The coupling between probe and liver has to be complete (the whole echo image has to be properly visible) – a correct amount of gel has to be used. Dark areas of the echo image, reverberation artefacts and rib shadows have to be avoided.
- The higher the skin-to-liver distance, the lower the reliability of the measurements.
- The correct gentle pressure must be applied for stability and to ensure proper coupling with the skin over the liver – the pressure should not be excessive in order to not compress the liver.
- No respiration during the acquisition, the patient should be asked to stop breathing just for few seconds in the neutral respiratory phase, without a deep inspiration.

Fig. 4 - Practical aspects - The whole echo image has to be properly visible with enough gel, without rib shadows and reverberation artefacts. At a position on the liver free from vessels or bile ducts, the measurement box should be positioned at least 15-20 mm below the liver capsule



b- Box positioning

- The box has to be positioned in an area free of vessels, bile ducts or nodules.
- The box has to be positioned 1-2 cm below the Glisson capsule to avoid reverberation artefacts. The optimized depth is between 1-5 cm.
- The box has to be positioned in the orthogonal axis to the capsule (Fig. 4).

c- Number of measurements

- According to the guidelines five valid measurements are adequate in the presence of a quality assessment provided by the manufacturer.
- The session (ended after five valid acquisitions) can be considered when IQR/MED < 30% (Fig. 5).

Fig. 5 - Practical aspects - At the end of the examinations, after 5 valid measurements (top left), you can view the following measurements (bottom left): Median, IQR/MED, Average (AVG), Standard Deviation and IQR.

Descriptions of the quality parameters

- SD < 30% of Med value
- IQR/M of the 5 measurements < 30%
- Rejection parameter
- Dispersion map
- To position the ROI in the most reliable area. Indeed, the orange areas mean that the reliability is low in case of artefacts, low coupling between the probe and the liver or even the presence of vessels.
- To help the clinicians obtain more reliable values in the liver assessment and to reduce the time of acquisition per session.

Pitfalls

- Low echogenicity and thick abdominal wall could result in weak shear waves.
- Modification of the acquisition liver window between the different acquisitions.
- Box axis not perpendicular to the Glisson capsule.
- Artefacts could impact the values if not rejected.
- Liver stiffness value must be interpreted on the basis of clinical and laboratory data.
- Some conditions can over-estimate the liver stiffness value: food intake, acute viral hepatitis, transaminase flares, congestive heart failure, extrahepatic cholestasis, infiltrative diseases.

Guidelines and latest update to the Society of Radiologists in Ultrasound Liver Elastography Consensus Statement

As suggested by the latest guidelines, the evaluation of the progression of liver diseases and the staging of liver diseases are the most important factors for evaluating the prognosis, for surveillance and treatment indication, because fibrosis is a dynamic process and the patients with a higher stage of liver fibrosis (F3-F4) are at higher risk of clinical complications.
Based on literature data and on the steps of the "rule of five" (5, 10, 15, 20 kPa) from the "Baveno VI Consensus Conference for the staging of liver fibrosis with vibration-controlled transient elastography (Fibroscan)", a consensus panel recently suggested the "rule of four" (5, 9, 13, 17 kPa) for the energetic RF pulse techniques for viral etiologies and for NAFLD as described in the table below. For the other etiologies, such as alcoholic hepatitis, primary biliary cirrhosis, Wilson disease, autoimmune hepatitis, sclerosing cholangitis, and drug-induced liver disease, there is as yet insufficient data to give the same indication.

Liver stiffness	Recommendation
≤ 5 kPa (1.3 m/sec)	High probability of being normal (Fig. 6)
< 9kPa (1.7 m/sec)	Without other clinical signs, rules out cACLD. In presence of clinical signs, may need further test for confirmation (Fig. 7)
9-13 kPa (1.7-2.1 m/sec)	Suggestive of cACLD but needs further test for confirmation (Fig. 8)
> 13 kPa (2.1 m/sec)	Rules in cACLD (Fig. 9)
> 17 kPa (2.4 m/sec)	Suggestive of CSPH (Fig. 10)

Note: cACLD = compensated advanced chronic liver disease, CSPH = clinically significant portal hypertension

Fig. 6 - Stiffness ≤ 5 kPa (1.3 m/sec)

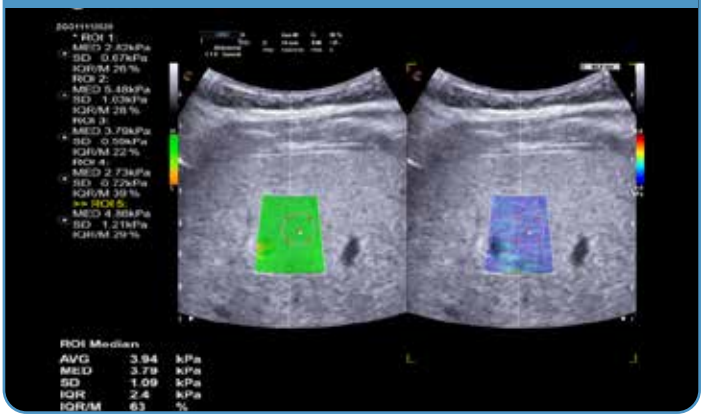


Fig. 7 - Stiffness < 9 kPa (1.7 m/sec)

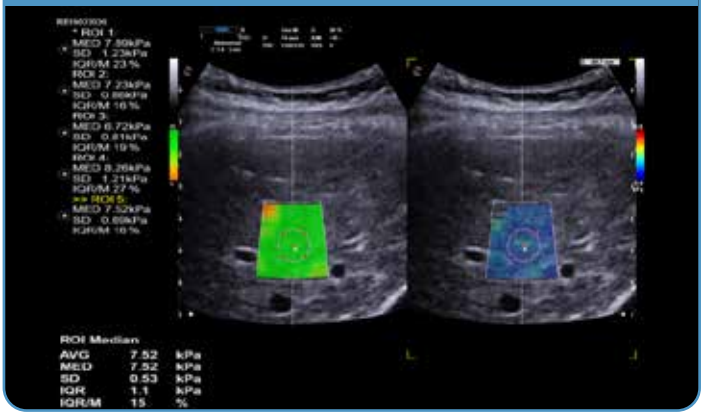


Fig. 8 - Stiffness ≤ 9-13 kPa (1.7-2.1 m/sec)

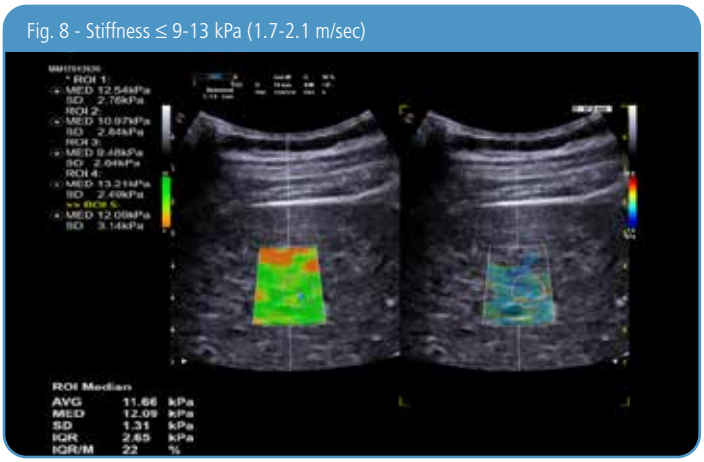


Fig. 9 - Stiffness > 13 kPa (2.1 m/sec)

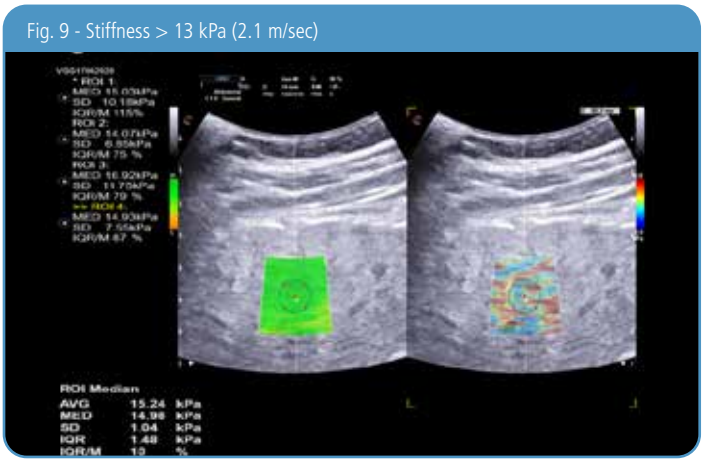
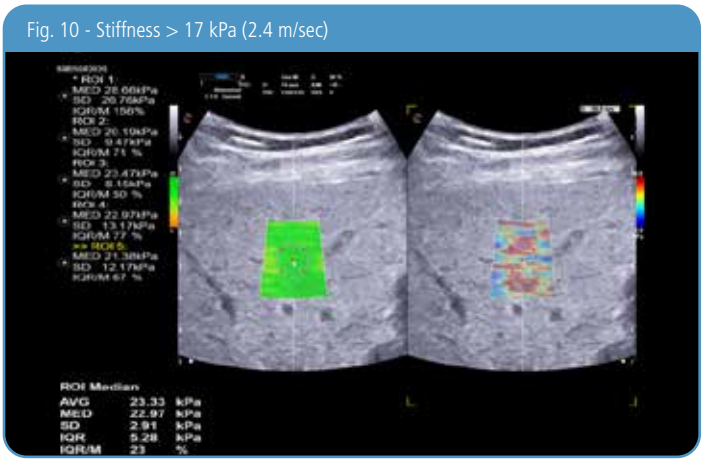


Fig. 10 - Stiffness > 17 kPa (2.4 m/sec)



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QIBA - Quantitative Imaging Biomarkers Alliance Guidelines for liver shearwwaves techniques 2020

Esaote S.p.A. - sole-shareholder company

Via Enrico Melen 77, 16152 Genova, ITALY, Tel. +39 010 6547 1, Fax +39 010 6547 275, info@esaote.com

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