PHILIPS

Ultrasound

ElastQ Imaging

Introducing next-generation **shear wave elastography for breast**

Philips ElastQ Imaging

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Tissue stiffness has long provided important information about presence or absence of disease. Physicians have used palpation for centuries, noting that abnormal tissue is often more stiff than healthy tissue. Elastography is a way to visualize, record and document tissue stiffness parameters.

Philips strain elastography features quasistatic compression and estimates qualitatively resulting tissue deformation or strain.[1] With the introduction of Philips ElastQ Imaging shear wave elastography, users can experience greater confidence in quantification, increased reproducibility and less operator dependency. Philips now offers a full elastography solution that combines the benefit of strain elastography and shear wave elastography on a clinically enhanced PureWave transducer.

The importance of breast lesion assessment

Current elastography systems have demonstrated their utility to distinguish BI-RADS category 3 and BI-RADS 4a lesions with better specificity and decrease unnecessary, painful and costly biopsies.[4]

Elastography in breast lesions assessment

Shear wave has proven valuable in further characterizing breast masses as benign or malignant, minimizing the need for costly and potentially painful biopsies in some patients. ElastQ Imaging provides a technique that is not only noninvasive and easy to use, but also offers clinicians additional confidence in the reliability and the reproducibility of measurements.[2,3]

Quantitative vs qualitative assessment

Strain elastography imaging relies on physiological motion to generate a relative qualitative display of tissue stiffness (Figure 1). In contrast, shear wave imaging techniques such as ElastQ Imaging use Acoustic Radiation Force Impulse (ARFI) to “push” tissue, causing it to move by a few micrometers. This movement generates a transverse (shear) wave in tissue, where the velocity is detected, providing a quantitative assessment of tissue stiffness.[5]

ElastQ Imaging features a large, resizable, color-coded Region of Interest (ROI). Unlike strain elastography, the shear wave technique provides quantitative stiffness analysis, which increases the reproducibility of measurements and provides the ability to refer to a confidence map to assure the reliability of the measurements (Figure 2).

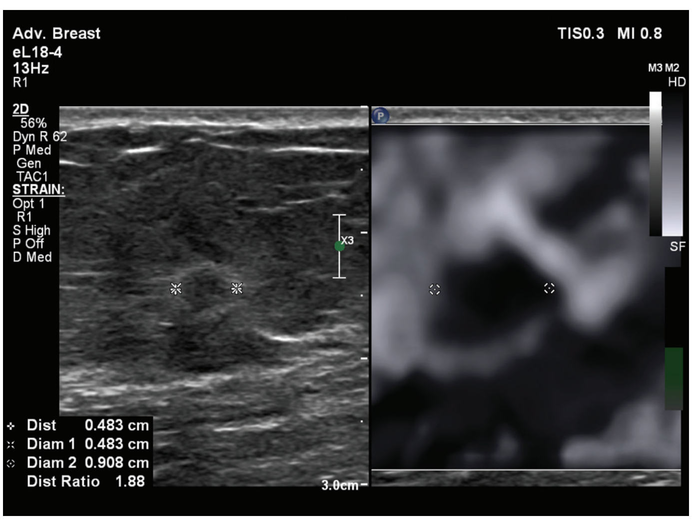


Figure 1. Strain elastography (qualitative technique) allows the user to see the relative stiffness of a questionable lesion compared to the surrounding tissue.

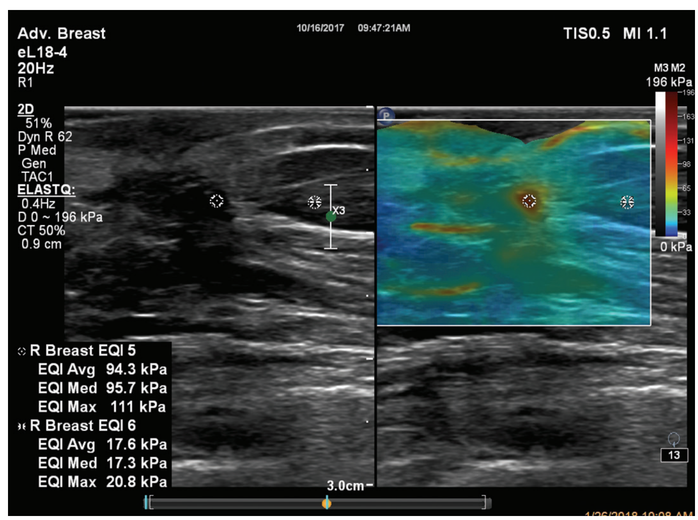


Figure 2. ElastQ Imaging (quantitative technique) features a color-coded Region of Interest box that provides quantitative stiffness analysis, which increases the reproducibility of measurements.

ElastQ Imaging

Available on the Philips EPIQ ultrasound system, ElastQ Imaging features an adjustable large ROI for quantitative assessment of tissue stiffness. ElastQ Imaging provides a color-coded stiffness/velocity map allowing the assessment of breast tissue stiffness using real-time feedback.

ElastQ Imaging allows measurements in kPa (pressure) or m/s (velocity). A unique confidence map uses intelligent analysis to highlight areas of optimal shear wave propagation (Figure 3). Post-acquisition tools include the ability to make retrospective measurements on stored cineloops. Strain and shear wave elastography techniques can be displayed side by side for complementary clinical assessment.

Measurement flexibility

Every color pixel displayed within the ElastQ Imaging ROI has a discrete value. These values can be assessed pixel by pixel or through a user-defined measurement caliper. Users also have the option to draw a measurement area or measure over the entire ROI.

Acquisition technique[6,7]

The patient is examined in the standard position for a breast ultrasound exam. The patient should lie supine with the ipsilateral hand either above the head or on the hip with the elbow pointed back.

Since a unique pulsing scheme is directly generated from the transducer, it is very important to keep the angle of the transducer perpendicular to the skin and the transducer lightly touching the skin while maintaining minimal compression.

Excessive compression may produce artifactual stiffness.

Using adequate amount of gel and having the patient hold her/his breath may be effective to mitigate motion artifacts.

Placement and sizing of the color-coded ROI box is important and it should cover the lesion and sufficient surrounding tissue to allow comparison between two different areas of tissue.

For lesions close to the skin, the use of a standoff pad is recommended as the skin interface produces reverberation artifacts.

Sampling strategy

With ElastQ Imaging, B-mode frame rate of 20 to 30 fps allows for survey in real time to identify the ideal plane for stiffness measurement of lesions. For most breast applications, it is recommended to place two sampling calipers: the first one in the stiffest area of the lesion or margins, and the second in the surrounding soft tissue to obtain a baseline measurement. Normal stiffness values for breast tissue have been previously established to be between 3 and 9 kPa in fatty tissue, and between 11 and 50 kPa in fibroglandular tissue.[8]

Confidence map

ElastQ Imaging provides a large color-coded ROI box in real time for assessing changes in tissue stiffness surrounding a lesion. Discrete readings can be acquired anywhere within the ROI, enhancing confidence in the reliability of measurements. When performing ElastQ Imaging, a confidence map is also generated within the ROI using smart analysis of echo and shear wave signals based on a multi-parametric algorithm. The color-coded confidence map reflects a value for each pixel, providing an indication of quality across the stiffness value map. This assists the user in obtaining measurements from the areas with the highest shear wave quality.

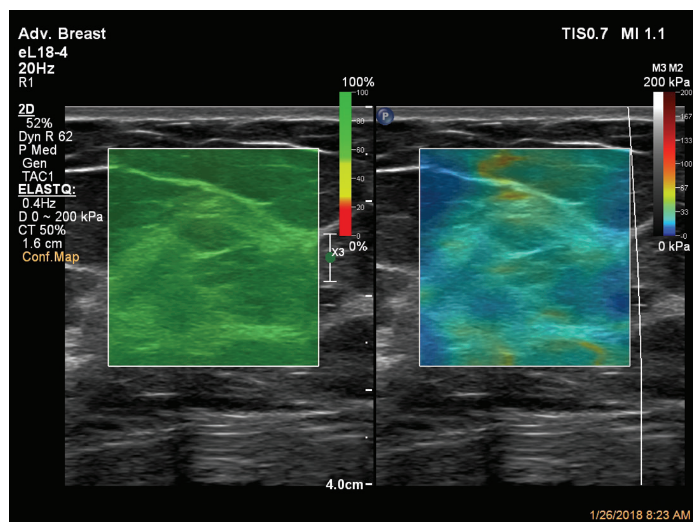


Figure 3. Intelligent analysis highlights areas of optimal shear wave propagation, displayed in the confidence map (left).

Every pixel in the ROI is assigned a confidence value from 0 to 100 and a corresponding color between red and green. Low values (red) indicate that the stiffness value for a given pixel is less reliable. High values (green) indicate that the stiffness value for a given pixel is more reliable (Figure 4).

Several factors can lower the confidence value: tissue areas with blood flow (vessels), low echogenicity (such as cysts), low shear wave strength (as when scanning close to the chest wall), or with large tissue motion (as with no breath pause or cardiac pulsation).

Displaying side-by-side strain elastography and ElastQ Imaging[6]

Both strain and shear wave elastography techniques help to further characterize breast lesions. As no study has suggested one technique is superior to the other, performing both strain and shear wave techniques on a patient may improve confidence in the results and provide additional tissue characterization information. Philips full solution elastography allows the capability of acquiring a strain elastography image and displaying it side by side with live ElastQ Imaging for ease of documentation (Figure 5).

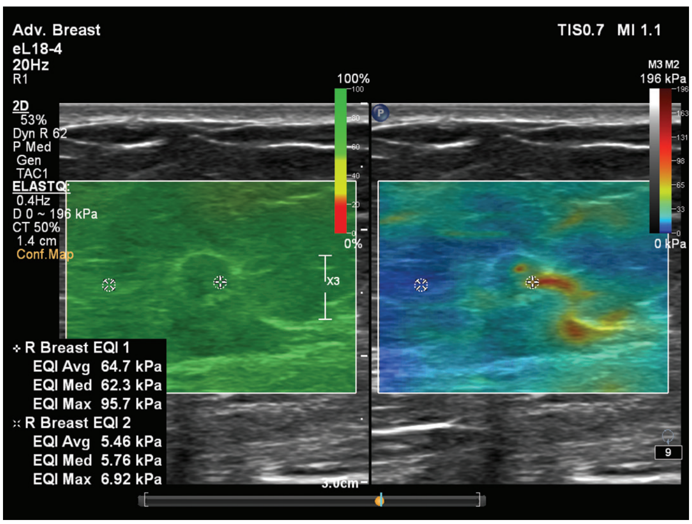


Figure 4. The amount of green in this ElastQ Imaging confidence map (left) demonstrates that the shear wave quality is very high.

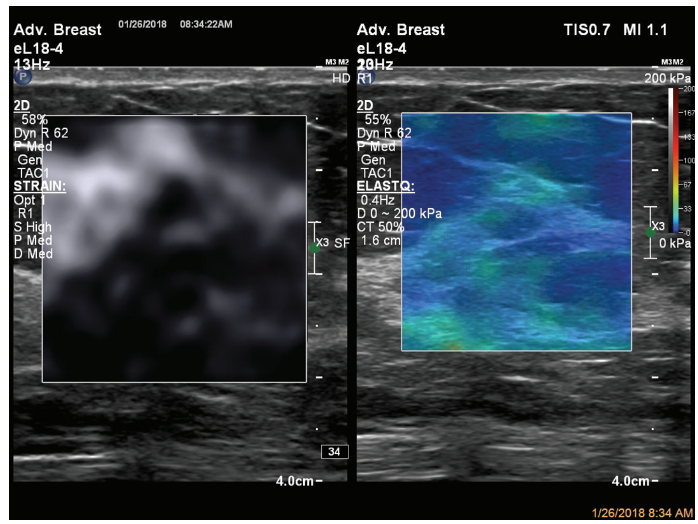


Figure 5. Strain elastography (left) and ElastQ Imaging (right) displayed side by side for ease of documentation.

Clinical utilization of strain elastography and ElastQ Imaging[9, 10]

When using strain elastography, three methods exist in the literature to differentiate benign and malignant masses: Size Compare ratio, strain ratio and the Tsukuba score. For instance, it has been demonstrated that the size of a lesion varies consistently from the strain image to the B-mode image. The size variation is correlated to the type of masses: benign lesions are smaller with strain elastography than the corresponding B-mode image, while malignant lesions are larger. With that in mind, a quality criterion has been defined to differentiate benign or malignant masses as follows: the ratio of the lesion size on strain elastography to the B-mode image via Size Compare ratio < 1.0 as benign and ≥ 1.0 as malignant. When using ElastQ Imaging, increased stiffness values indicate a higher risk of malignancy.

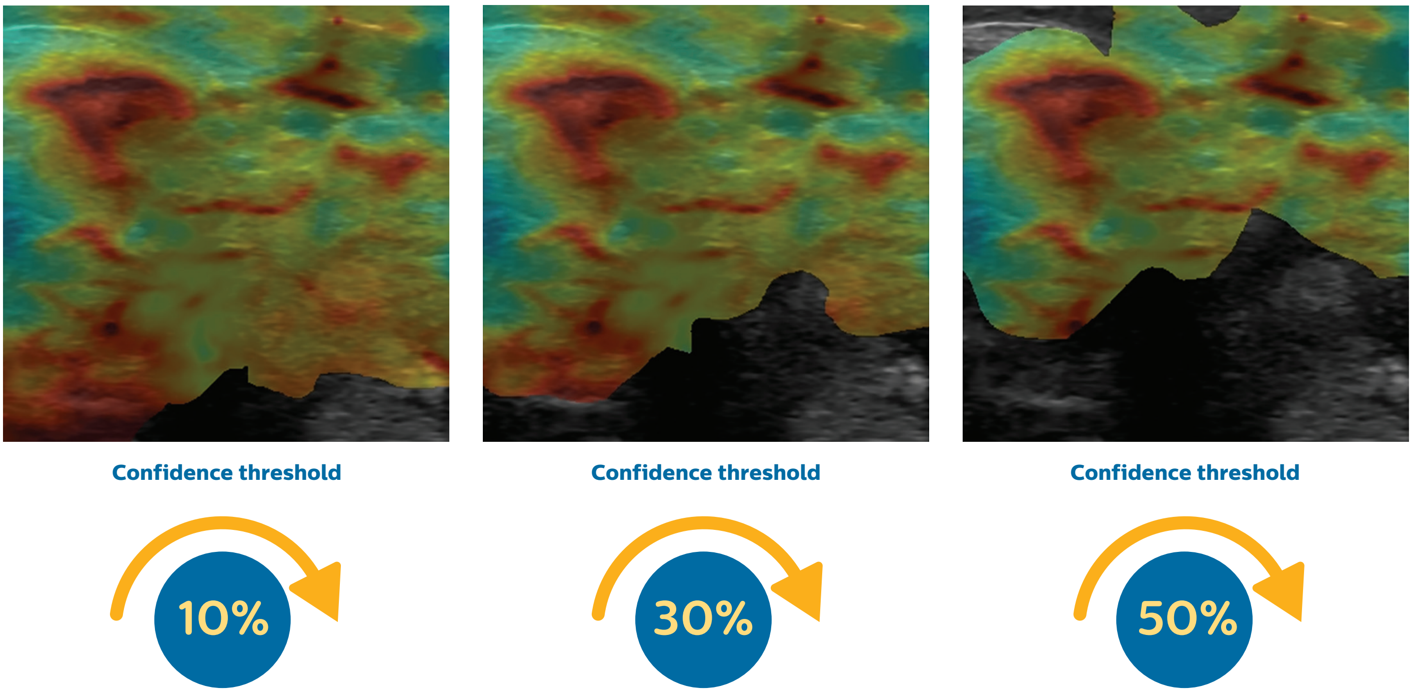
A single stiffness scale for breast application

The system has been designed to support a scale from 0 to 200 kPa (0 to 8.2 m/s). This single scale supports shear wave elastography in breast clinical applications (Figure 6).

Using the confidence threshold

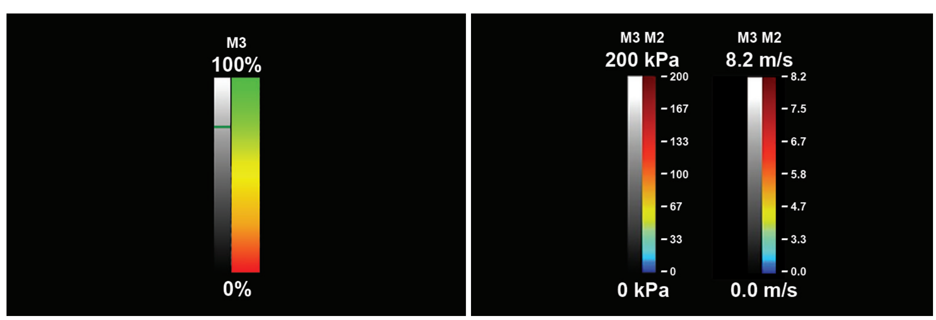
The confidence threshold sets those areas of a stiffness/velocity map with lower confidence as transparent. For example, setting the confidence threshold to 40% will set areas of a stiffness/velocity map with a confidence value of less than 40% as transparent. The transparent areas will not be measured. For breast lesions, as it is important to target the stiffest area, lowering the confidence threshold to 40% increases the visibility of the shear wave map especially in deeper areas of the ROI. Changing the confidence threshold will not change the confidence map.

Adjusting the confidence threshold



Use of the confidence map can enhance the exam if the scan technique is proficient, but it cannot overcome suboptimal scanning technique. Examples of suboptimal scanning technique are placing the ROI on or near the skin (producing a reverberation artifact) or placing the ROI on or near the pectoral muscle.

Figure 6. ElastQ Imaging displays the stiffness or velocity map and the confidence map.



Confidence map (0-100%) **Stiffness/velocity map**

Effectively using ElastQ Imaging[6]

- Patient in supine position with the ipsilateral hand either above the head or on the hip with the elbow pointed back
- Ensure good transducer contact with adequate gel
- Obtain a good B-mode image
- Keep the angle of the transducer perpendicular to the skin
- Position the ROI box in the center of the image
- Size the ROI box to include the target area and surrounding tissue for optimal breast lesion assessment
- Avoid placing the ROI box on or near the skin or the pectoral muscle; for imaging very superficial target area (< 5 mm depth), a standoff pad may be required
- Maintain minimal compression, as higher pre-compression may elevate tissue stiffness values
- Breath hold may be required for some patients to mitigate tissue motion
- Wait several seconds for the ROI box to completely fill with color by decreasing the confidence threshold if necessary
- Freeze when a consistent stiffness pattern develops
- Scroll back to ensure representative image with consistent stiffness pattern
- Place the first circle caliper, with default size of 1 mm, in the ROI on the stiffest areas of the lesion or margins
- Place the second caliper of the same size in surrounding tissue of the breast to obtain a baseline measurement
- Refer to EQI Med for both measurements
- If retrospective measurements are desired, acquire a cineloop with 3 to 5 consistent ElastQ Imaging frames

Documenting the results

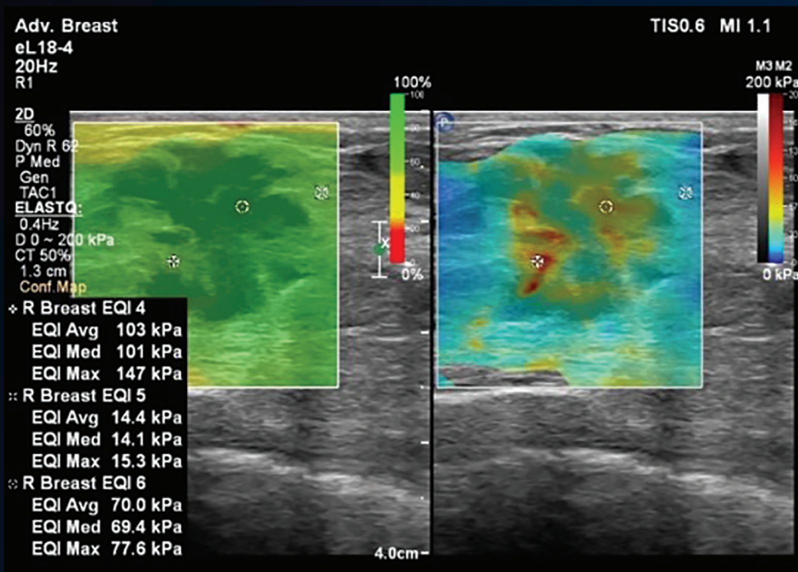
The post-acquisition tools and quantification capability of ElastQ Imaging allow adjustment of the overlay, blending and confidence thresholds in review.

An evolution that's more of a revolution

Philips EPIQ ultrasound system offers an ultimate ultrasound solution for breast assessment, treatment planning and monitoring.

- ElastQ Imaging utilizes a unique pulsing scheme to generate and detect the propagation speed of shear waves, providing an absolute measure of breast tissue stiffness
- PureWave transducer technology offers exceptional breast imaging, even on challenging patients
- Precision biopsy capabilities reduce needle-blind zones and enhance the display of needle reflections, elevating confidence during interventional procedures
- Anatomical Intelligence for Breast visually maps areas of screened anatomy for full coverage of the breast during the acquisition phase, for enhanced workflow and documentation (Figure 7)

Figure 7. Anatomical Intelligence for Breast featuring automated annotations and color mapping of breast tissue coverage.



ElastQ Imaging at a glance

- ROI of 6 cm x 5 cm allows for a robust estimate of breast tissue stiffness, as well as confident visualization and comparison of stiffness between lesions and normal tissue
- B-mode frame rate of 20 to 30 fps provides a real-time survey to identify the ideal plane for stiffness measurement
- Real-time shear wave confidence map offers smart analysis of shear wave fidelity at every pixel
- Every stiffness image has a corresponding confidence image
- Side-by-side display of strain elastography and ElastQ Imaging improves confidence in the findings[6]
- Post-acquisition tools and quantification capability allow for calculation of new stiffness measurements on stored cineloops after the patient visit, or retrieved from a PACS

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