Personalized Breast Ultrasound Case Studies

Tissue strain analytics for breast lesions

Cases courtesy of Dirk-André Clevert, M.D., Grosshadern, Munich, Germany

The clinical overlay is not that of the individual pictured. It was modified for better visualization.

Breast cancer is the most common cause of cancer among women[1]. The heterogenous nature of breast cancer leads to a wide variation in presentation, behavior and therapeutic response. Personalized Ultrasound helps to match the right patient to the right tool at the right time to support improved patient outcome.

Siemens Healthineers proprietary suite of strain technologies

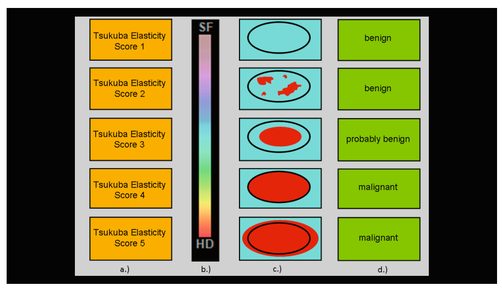
Conventional ultrasound criteria such as irregular margins, shadowing, microlobulations, echogenicity and shape can be applied to help distinguish benign from malignant breast lesions. In addition, the compressibility of a breast lesion can be used as a further criterion, as in general, breast cancer tissue is more stiff and less deformable than the adjacent normal breast tissue. Based on the diagnosis of breast tumor by tissue elasticity images, Dr. Itoh et al. constituted scores of malignancy, which is referred to as the Tsukuba elasticity score, by categorizing patterns of elasticity images of breast tumors into five classes from benign to malignancy as shown below.

eSie Touch elasticity imaging
eSie Touch™ elasticity imaging uses gentle compression to provide a high resolution elastogram depicting relative tissue stiffness. It forms the elastogram by computing relative tissue deformation globally and displaying the information within a user-defined region of interest. Axial detection pulses are continuously transmitted throughout the field of view to provide information about the state of tissue deformation along one axial line at a specific point in time. The deformation (strain) is less in hard tissue than in softer tissue. Using this technique, stiff and soft tissue may be differentiated even when the tissues appear isoechoic on the B-mode exam.

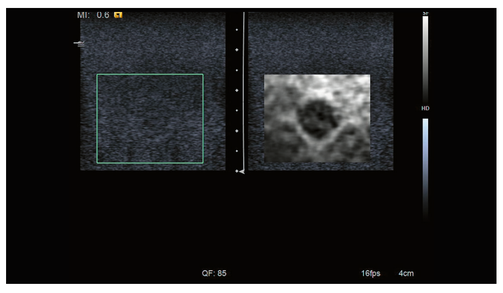
Virtual Touch imaging
Virtual Touch™ imaging provides a qualitative grayscale map (elastogram) of relative stiffness for a user-defined region of interest. A Virtual Touch image is acquired through a series of acoustic push pulse/detection pulse sequences. The process may be summed up into three basic steps:
1. Baseline image is acquired.
2. Acoustic push pulse is transmitted to compress tissue.
3. Detection pulses are used to track the amount of compression.

Virtual Touch quantification
Virtual Touch™ quantification provides a quantitative assessment of tissue stiffness through measurement of shear wave speed. This technology uses an acoustic push pulse followed by detection pulses to calculate shear wave speed:
1. Anatomical location for measurement defined by region of interest (ROI) placement.
2. Acoustic push pulse applied adjacent to ROI.
3. Time between the generation of the shear wave and the passing of shear wave peak at an adjacent location is used to compute the shear wave velocity.

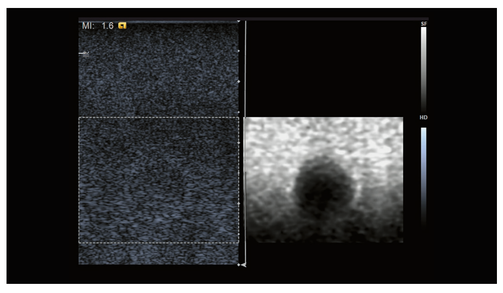
Case 1: Breast phantom



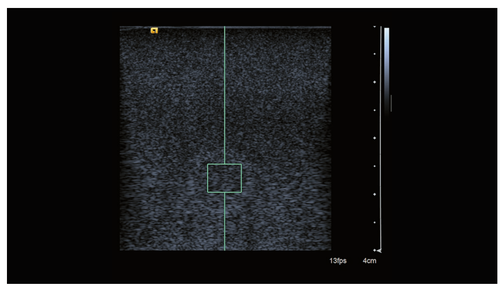
Schematic view of Tsukuba Elasticity Score (a), (b) stiffness coded in color from purple (soft tissue) to red (hard tissue). Relation of the tumor margins in comparison to elasticity size (c) and entity (d).



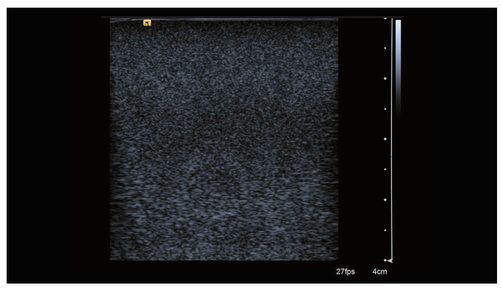
Grayscale eSie Touch Elasticity Imaging demonstrates a lesion which is more stiff (black) than the surrounding tissue. The conventional B-mode ultrasound is the same as displayed in the previous image.



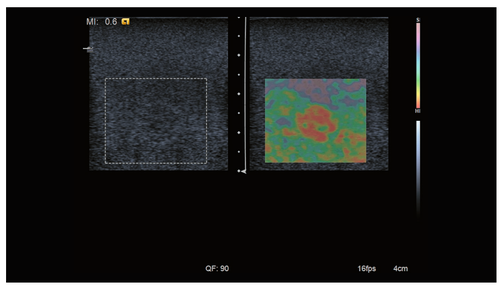
Grayscale Virtual Touch Tissue Imaging demonstrates a lesion which is more stiff (black) than the surrounding tissue.



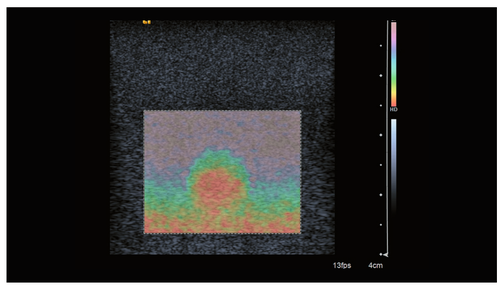
With Virtual Touch Tissue Quantification, the shear wave speed in the center of the phantom lesion measured (Vs = 3.05 m/s). This value is related to tissue stiffness at the user-defined anatomical region localized using a conventional ultrasound image.



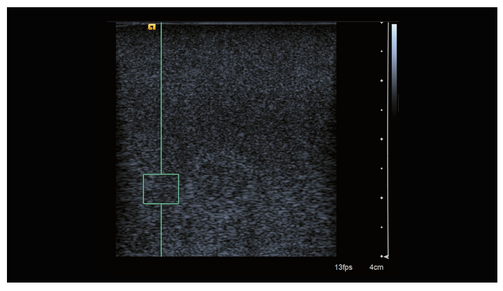
In the breast phantom, the lesion is hardly visible on the conventional ultrasound image.



Color scale eSie Touch Elasticity Imaging demonstrates a lesion which is more stiff (red) than the surrounding tissue.

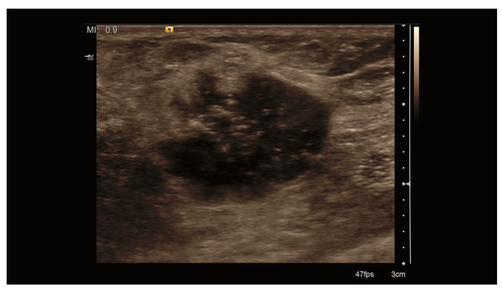


Color scale Virtual Touch Tissue Imaging demonstrates a lesion which is more stiff (red) than the surrounding tissue.

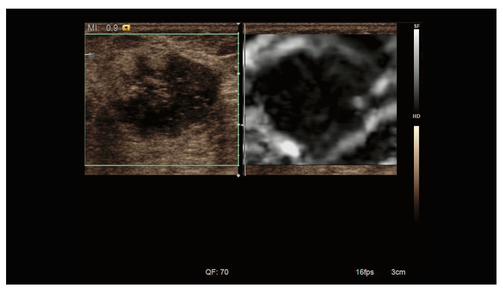


Virtual Touch Tissue Quantification measured shear wave speed next to phantom lesion as (Vs = 2.27 m/s). The results of eSie Touch and Virtual Touch Imaging confirmed the findings, that the surrounding tissue is softer than the lesion and the velocity of shear waves are slower in softer tissue.

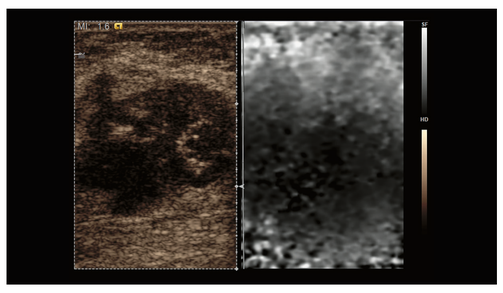
Case 2: Biopsy-proven invasive ductal carcinoma of the breast



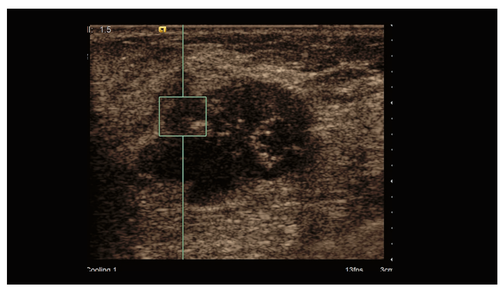
81-year-old patient. Grayscale ultrasound detected a breast lesion (16 x 20 mm) with ill-defined irregular edges and an inhomogeneous echo structure.



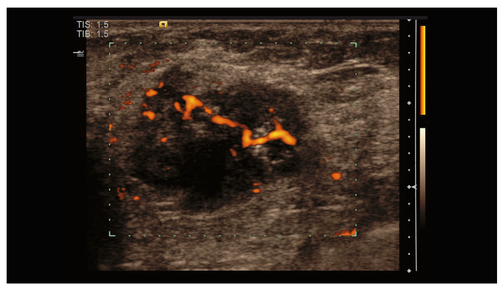
Grayscale eSie Touch Elasticity Imaging demonstrates a lesion which is more stiff (black) than the surrounding tissue and appears larger in elastogram than in grayscale image. Tsukuba Elasticity Score 5.



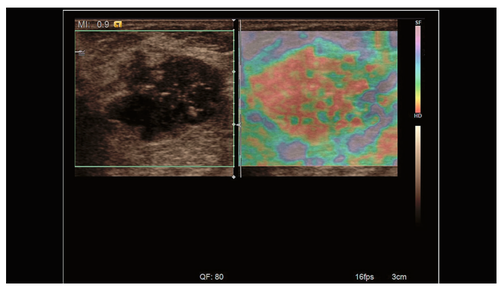
Grayscale Virtual Touch Tissue Imaging confirmed the finding of conventional elastogram. The lesion is more stiff (black) than the surrounding tissue and appears larger. Tsukuba Elasticity Score 5.



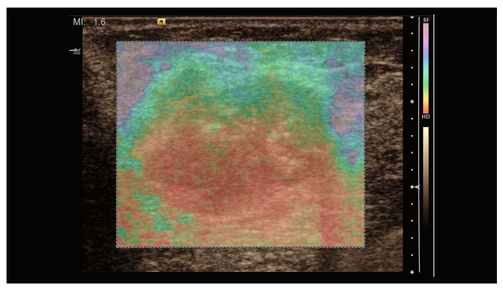
Using Virtual Touch Tissue Quantification, the shear wave speed in the center of the cancer measured (Vs = 1.97 m/s).



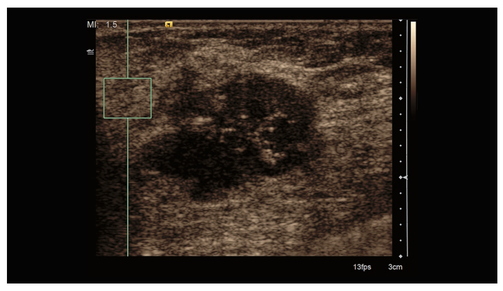
Power Doppler examination depicted central and peripheral vessel feeding vessels.



Color scale eSie Touch Elasticity Imaging demonstrates the same lesion as before, with the lesion is more stiff (red) than the surrounding tissue (purple).

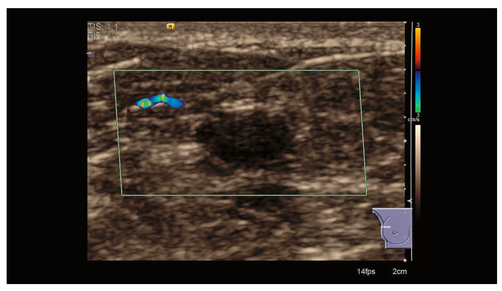


Color scale Virtual Touch Tissue Imaging depicted the lesion as being more stiff (red) than the surrounding tissue.

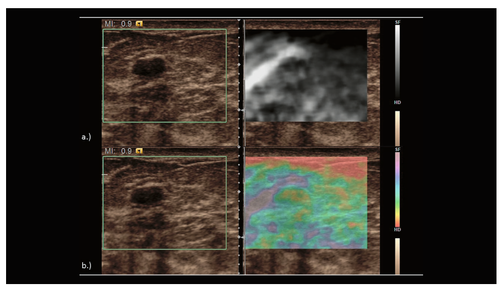


Virtual Touch Tissue Quantification, in tissue adjacent to the cancer, measured (Vs = 1.30 m/s). The results of eSie Touch and Virtual Touch Imaging confirmed the findings, that the surrounding tissue is softer than the cancer and the velocity of shear waves are slower in softer tissue.

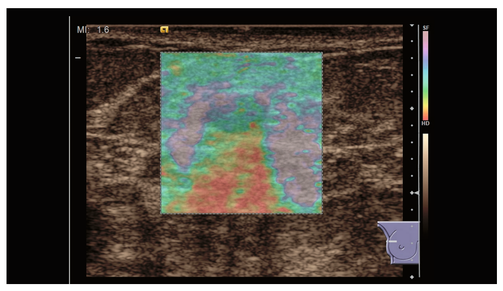
Case 3: Biopsy-proven breast fibroadenoma



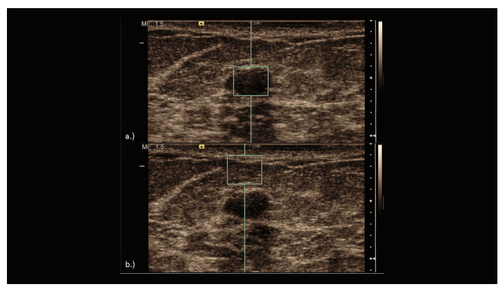
Color Doppler examination depicted a hypoechoic lesion measuring 5 x 8 mm with an irregular border and no major central vessels.



Grayscale (a) and color (b) eSie Touch Elasticity Imaging demonstrated a lesion which is marginally stiffer than the surrounding tissue but doesn't appear larger in elastogram than in grayscale image. Tsukuba Elasticity Score 2.



Color scale Virtual Touch Tissue Imaging visualized the lesion as being of a similar stiffness to the surrounding tissue and confirmed the findings of eSie Touch Elasticity Imaging.



Virtual Touch Tissue Quantification measured the shear wave speed in the center (a) of the fibroadenoma as (Vs = 1.48 m/s), and that adjacent (b) to the lesion (Vs = 1.25 m/s). The results of Virtual Touch Tissue Quantification confirmed a similar stiffness in the lesion and in the surrounding tissue.

[1] *http://www.who.int/cancer/breast_cancer_awareness/en/*

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