Shear wave elasticity imaging (ARFI, VTIQ mode ®): a new technique for breast lesion characterization?

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Purpose

To determine the input of Shear Wave Imaging elastography by using Acoustic Radiation Force Impulse®, Virtual Touch Imaging and Quantification®, Siemens (ARFI, VTIQ mode®) in addition to conventional ultrasound to improve breast lesion characterization.

To correlate conventional B mode imaging, shear wave imaging and pathology with a focus on BI-RADS category.

Background

It is well known that breast cancer tissue is harder than adjacent normal breast tissue. This property is commonly used in physical examination (palpation) of the breast to assess whether the lesion is benign or malignant as well as for elastography.

The basic principle of elastography is that compression produces displacement within the tissue which is smaller in harder structures than in softer ones. Another characteristic derived from tissue stiffness is that ultrasound pulse velocity within a malignant lesion would be significantly higher than the one within the surrounding tissue.

Methods and Materials

The study was approved by the ethical and scientific review board of our institution. Oral informed consent was obtained from all participating women.

Patients:

This prospective study was set between March 2012 and July 2012. Both conventional ultrasound (US) and elastography (EI) were used for all participating women (110) who underwent evaluation for breast lesions (48 benign lesions and 62 malignant lesions) at 'Institut de Cancérologie Gustave Roussy', Villejuif, France, in our one stop shop breast unit. All the lesions were detected by conventional B-mode US and categorised as BI-Rads 2-5 according to the Breast Imaging Recording and Data System (BI-RADS) criteria for US. Consecutively, we performed US elastography for all lesions.
Our one stop shop breast unit is a specialized care unit dedicated to breast cancer. It involves a multidisciplinary staff including 2 breast surgeons, 2 radiologists subspecialized in breast imaging, 1 pathologist and 2 oncologists, who see one patient at a time, establish a diagnosis and make a decision on further investigations and followup.

The pathologic diagnosis was obtained by means of fine needle aspiration (FNA)* with cytological examination for cystic lesions or ultrasound core biopsy followed by histologic evaluation for solid ones.

* Due to family background or the patient's anxiety, Birads 2 and 3 lesions were followed by FNA in our one stop shop breast unit even if there was no suspicion for malignancy on conventional US or elastography.

_Side bar: benign/malignant lesions: percentage

**Equipement:**

Conventional US was performed using a standard 10-15 MHz transducer. A new mode of shear wave elastography with a 9L4 transducer (Acoustic Radiation Force Impulse®, Virtual Touch Imaging and Quantification®, Siemens) was used for elastography. This new shear-wave elastography mode was available on a S3000® ultrasound machine (Siemens®). The software (SN Software Version by Siemens: 400.0.016, System SN: 205605) is based on colour coded maps (Qualitative elasticity map) with a colour scale as follows: stiffness of the tissue varies between red and green where red is the hardest and green the softest. This mode includes also a quality map of shear-waves (green image for high quality, yellow map for low quality) and a colour map illustrating tissue displacement induced by shear-waves (dark blue for low displacement, light blue for high displacement).

_Sidebar: pic US machine

Conventional US:

Both examinations (Conventional US and elastography) were performed by a radiologist with at least 15 years of experience in breast imaging.

Images were assigned to one of five categories according to BIRADS criteria for US (1, 2, 3 4a/b/c, 5). Mammogram results or clinical findings were already known at the time of the examination. We divided the lesions by US appearance in two groups: cysts (simple, complex, poorly defined) and solid (smooth, well defined; irregular, poorly defined; shadowing).
We also evaluated the size of the lesion and whether the lesion is palpable or not.

Elastography parameters (colour coded maps):

We evaluated 3 parameters as follows: 1. The stiffness of the tumour versus the one of the surrounding tissue (harder/softer/isoelastic). 2. The displacement in the lesion versus surrounding tissue (high/low/same). 3. The velocity in the lesion versus surrounding tissue (Vlesion/Vsurrounding tissue). A fourth image quality (colour coded) parameter was evaluated (good-green, marginal-yellow, poor-red).

Results

We evaluated 110 breast lesions of which 48 were benign (44%) and 62 were malignant (56%). 56 lesions were palpable (51%) and the rest of 54 had no clinical expression, with dimensions varying between 4mm and 44 mm (median of 12mm).

The best parameters correlated with malignancy were the following: harder than surrounding tissue (76 % of cases, n=80 lesions), low displacement (75%, n=77), tumour velocity > 4 m/s (min=1.3 max=8.4 mean=3.7 p<0.0001) and surrounding tissue velocity > 3 m/s (min=0.08 max=7.1 mean=1.6 p<0.02) with the tumour-tissue velocity differential > 4 m/s (mean 2.0 p<0.0001). The cut-off value for velocity was 3.4 m/s, corresponding to Se and Sp values of 78% with an AUC of 84%.

The best parameters correlated with benignity were: isoelastic (100% of cases, n=24), softer than surrounding tissue (80%, n= 5), same displacement in the tumour tissue and surrounding tissue (96%, n= 26).

Conventional US alone showed a very good diagnostic performance with a sensibility of 94% and a specificity of 96%, with a threshold of 0.78 and p<.0001 ; The AUC (Area Under the Curve) was estimated at 96%.

The ROC curves show that elastography does not increase the specificity nor the sensibility of conventional US alone. (fig.5.)

Images for this section:
Fig. 1: Typical elastography appearance of a cyst

Fig. 2: Typical appearance of a Fibroadenoma on elastography
Fig. 3: Typical appearance of an ILC

Fig. 4: Typical appearance of an IDC
**Fig. 5:** ROC curves for US and EI parameters.
Conclusion

The predictive pattern for malignancy of shear wave elasticity imaging can provide additional information that could upgrade a breast lesion to a higher BIRADS category. Therefore this procedure brings an added diagnostic benefit for lesions previously assessed as BIRADS 3.

References


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