The role of sonoelastography for the diagnosis of breast cancer

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Abstract

Sonoelastography is a new imagistic method helpful in the diagnosis of breast cancer. Generally, breast cancer is harder than the adjacent normal tissue and this property constitutes the basis for elastography. The principle of sonoelastography is that the tissue compression produces strain within the tissue and that the strain is variable depending on tissue stiffness. Measuring the tissue strain we can estimate tissue hardness which may be useful for differentiating malignant from benign masses. The tissue elasticity distribution is converted in a image called elastogram, the scale ranged from red (for components with greatest strain) to blue (for those with no strain). For characterization of breast lesions we use an elasticity score on a five-point scale developed by Itoh and Ueno. The 1 to 3 scores are suggestive for benign lesions and 4 or, particularly , 5 scores indicate malignant tumors. Real-time sonoelastography can improve the sensivity and the specificity of conventional US, particularly for BI-RADS 3 and 4 lesions; as well can provide information which is difficult to achieve with conventional US.

Keywords: *breast, cancer, sonoelastography*

Introduction

Unfortunately, the breast cancer continues to represent the most common malignant tumor of the woman and the first cause of death by cancer. In the absence of effective preventive measures, early diagnosis and treatment of breast cancer is currently a major desideratum, therefore, a new technique for diagnosing breast cancer has been developed and added to the conventional methods like mammography and ultrasound: **breast sonoelastography** in real time. This is a quick and rapid method which enhances the sensibility and specificity of conventional ultrasound, especially in the case of tumor formations which fall into the BIRADS 3 and 4 category[1].

The operating principle

In comparison with the adjacent glandular breast tissue, breast cancer is much tougher and rigid, a propriety which can be very useful in detecting it both by palpation and also by elastography. The operating principle of sonoelastography is based on the fact that, applying pressure on a region of the breast results in a variable displacement of underlying tissue in the axis, according to their hardness: if the breast tissue is harder, then the deformation will have less of an impact. Thus, measuring the amplitude of the deforming tissue after applying a mild compression with transducer, we can estimate

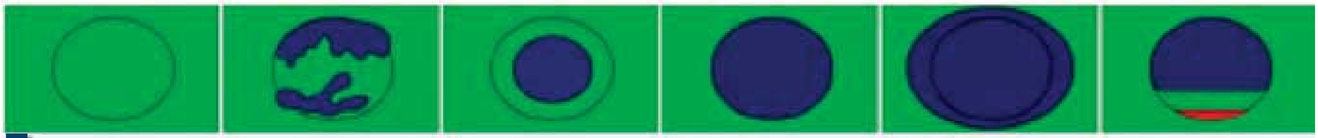

Figure 1

its hardness, an useful information for diagnosis of breast cancer[2].

Measurement in real time requires a high speed algorithm, capable of rapidly and accurately estimate the elasticity of breast tissue. There are three methods of measuring tissue elasticity:

- **the spatial correlation method**: can determine in two dimensions (longitudinaland lateral) tissue deformation induced by static compression, but is slow and thus interferes with real-time evaluation;
- **the phase-shift tracking method**: it uses the Doppler signals. It is a fast and accurate method for evaluating tissue deformation in the longitudinal direction, but it generates errors when assessing a large portion of tissue;
- **the combined autocorrelation method (CAM)**: determining the elastic properties of tissue is based on observing how the pulsating excitations propagate in the tissue. It is fast, accurate and eliminates the disadvantages of the first two methods[3].

Necessary equipment

To practice sonoelastography, you need a conventional ultrasound with an integrated module especially for elastography and also, a dedicated software with a complex algorithm for rapid estimation of tissue elasticity. Ultrasound probe used is a linear electronic probe with a frequency of 7.5 MHz[4].

Examining technique

Initially, breast examination is done with conventional ultrasound - the B mode. After setting the area of interest (identifying an injury), you must use sonoelastography. Basically, using the same ultrasound probe,

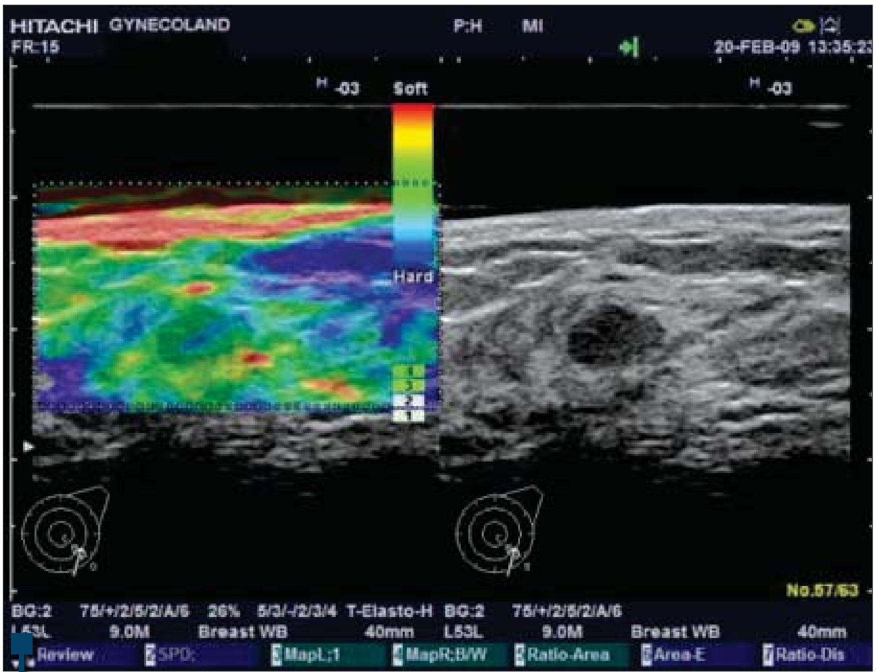

Figure 2

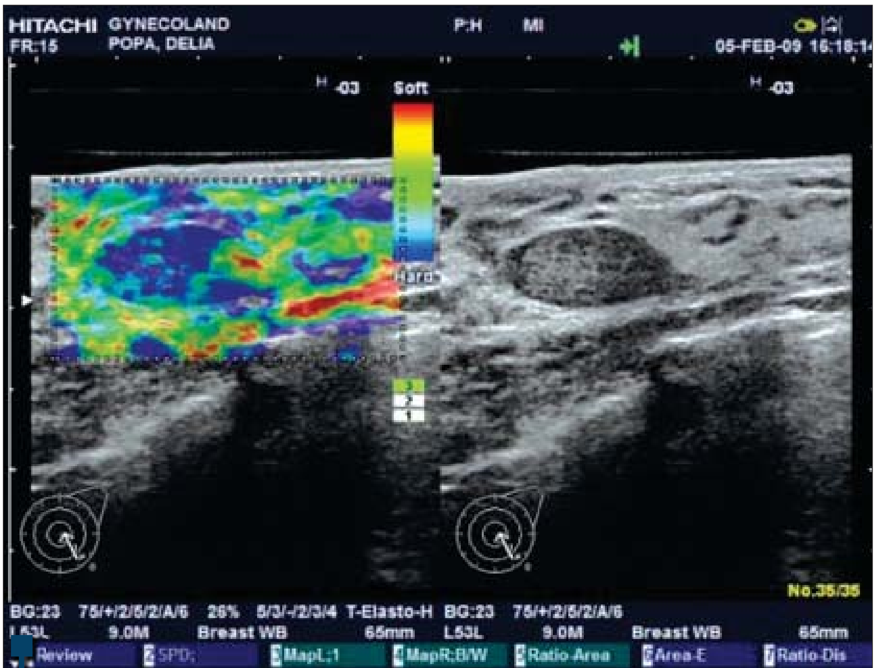

Figure 3

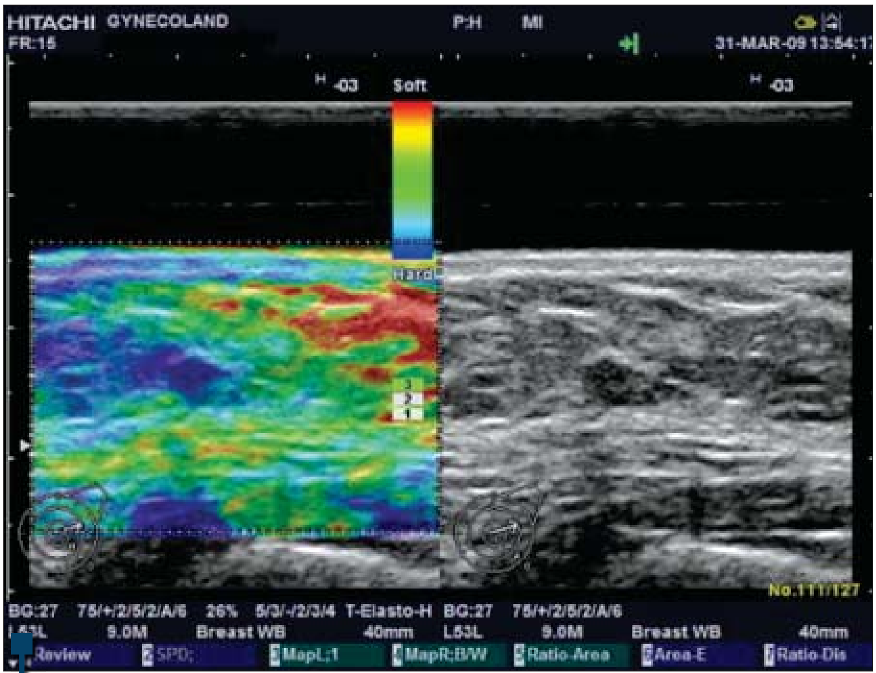

Figure 4

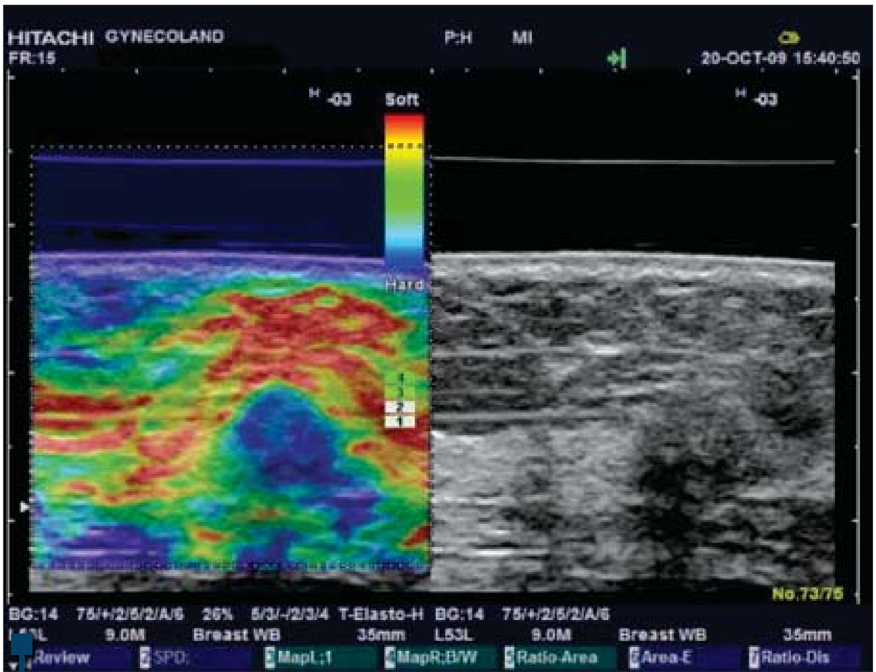

Figure 5

the monitor will display the breast image region of interest in two windows: the first shows the elastography, and the second, the conventional ultrasound appearance. For elastography image to be accurate for analysis, we have to respect a series of rules.

The probe must be applied perpendicular to the chest wall, with a slight pressure - enough to keep the probe in contact with the skin, the probe must print a slight rhythmic movement vertically, alternating upper and lower, with lower amplitude. Basically, depending on the volume of breast lesion size and location, compression/decompression movement must have an amplitude of 0.4 mm to 1-2 mm and a frequency of 1-2/sec. Usually, the monitor shows a compression intensity scale from 1 to 5 (which must be maintained between 3 and 4)[5].

Also, setting the mammary region of interest is very important. Investigated damage will always be placed in the center of the image. Elastography window should include subcutaneous fat above and below the pectoral muscle without coastal springs, lateral edges should be set at least 5 mm of the lesion boundaries to include enough surrounding breast tissue.

In the region of interest, selected breast tissue elasticity distribution is reconstructed as an image called elastograme, the scale of colors ranging from red (for tissues with maximum compressibility to blue (for incompressible or slightly compressible tissue). Green indicates the presence of tissue with average elasticity. By applying an appropriate pressure, subcutaneous fat appears as a mosaic of green and red, glandular breast tissue occurs in various shades of green and pectoral muscle in blue. This color image of tissue elasticity (elastograme) is superimposed on B mode ultrasound image so that it can be very easy related between conventional ultrasound appearance of a particular injury and its elasticity[6].

The overt

In practice, the elasticity evaluation of breast lesions is usually done by setting the UENO elasticity score and, respectively, by calculating the strain ratio (SR).

Elasticity score UENO

It makes a classification of breast lesions elasticity in five categories; assigning a particular score is made by assessing the appearance and distribution of color image both within elastograme identified breast lesion by the ultrasound (which appears to be isoechoic against hypoecoic or subcutaneous fat) and the surrounding breast tissue (Figure 1).

Score 1 indicates that the entire hypoecoic lesion is elastic (appears uniformly colored green) - Figure 2.

Score 2 indicates a lesion with increased flexibility in most, but also associates rigid portions (lesion appears as a mosaic of green and blue) - Figure 3.

Score 3 is assigned to lesions showing peripheral elasticity and central stiffness (hipoecoic lesion appears colored in blue, the most having a green peripheral delimitation) - Figure 3.

Score 4 indicates a lesion without elasticity (the entire hypoecoic lesion is colored in blue, the adjacent tissue being normal) - Figure 5.

Score 5 indicates the lack of elasticity in the entire lesion, and also around it (hypoecoic lesion and also its surrounding area appear colored in blue) - Figure 6.

Cystic breast lesions takes a particular sonoelastografic look in 3 layers blue-green-red (BGR: blue-green-red) - Figure 7[7].

The probability of breast cancer increases with the increase of the UENO score; in general, a score of 1 to 3 corresponds most often to a benign lesion, while the score 4 or above 5 suggests the presence of a malignant tumor.

Strain ratio (SR)

It is a ratio between the elasticity of the lesion and the elasticity of the adjacent normal breast tissue (Figure 8). In general, a ratio ≥ 5 raises the suspicion of breast cancer.

Diagnostic value of sonoelastography

A number of studies have attempted to analyze the importance of diagnosis and the place of such methods in other means of imaging evaluation of the breast.

The best known study was conducted at Tsukuba University Hospital in Japan during March 2002 - September 2003. It included 111 patients with lesions of the breast diagnosed by conventional ultrasound which were included in the BI-RADS 2.5 category and were subsequently pathological verified.

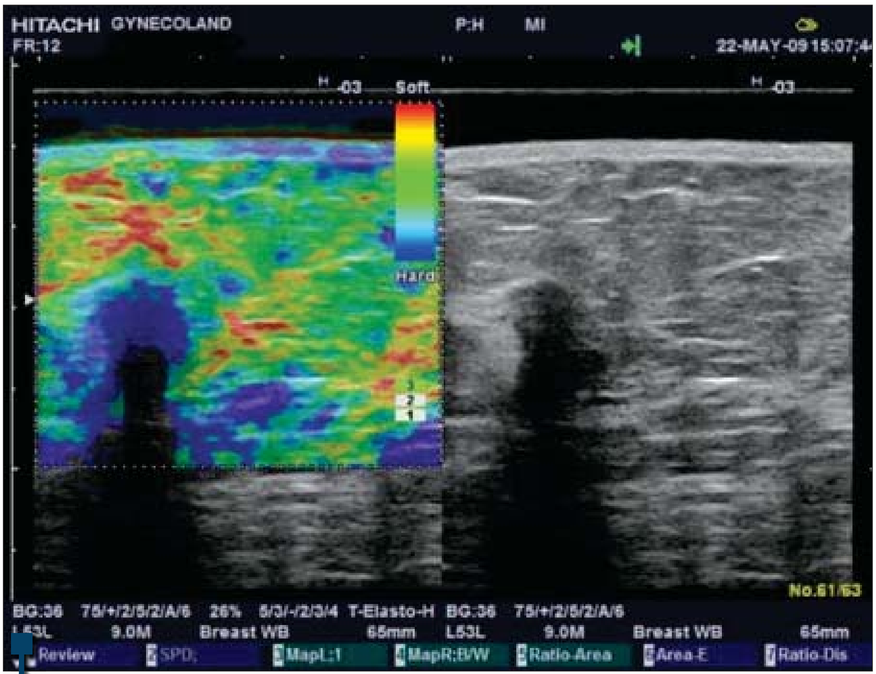

Figure 6

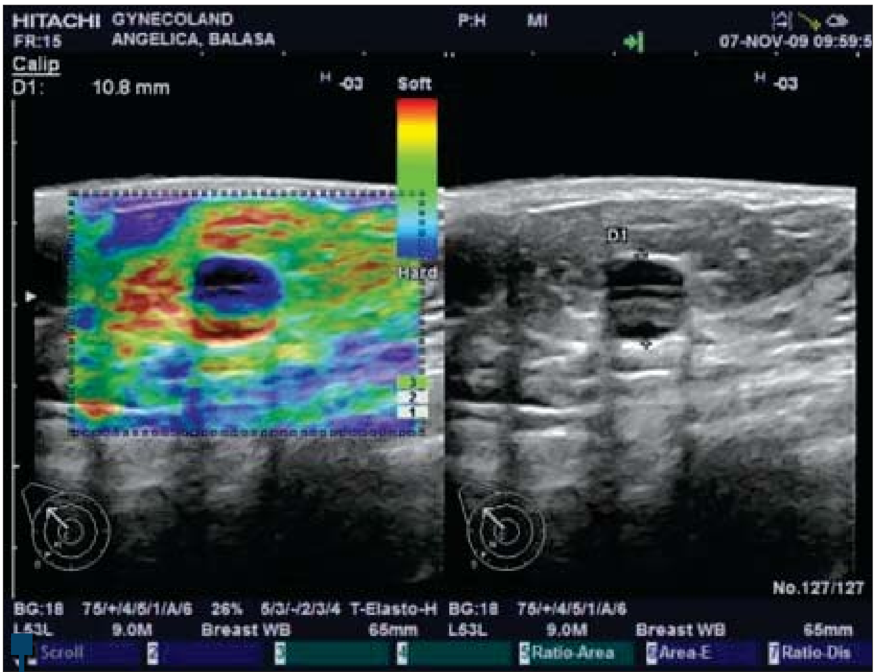

Figure 7

The study showed that the average score for elasticity was significantly higher for malignant lesions (4.2 ± 0.9) compared with the benign (2.1 ± 1.0). Setting a cutoff value of elasticity in the UENO score from 3-4, it was observed that sonoelastography has a sensitivity of 86.5% and a specificity of 89.8% (higher than conventional ultrasound for lesions assigned BI-RADS 3.4 ≈ 62%).

Such a method is the Sonoelastography, which increases the specificity and accuracy of conventional ultrasound in differentiating benign/malign lesions especially

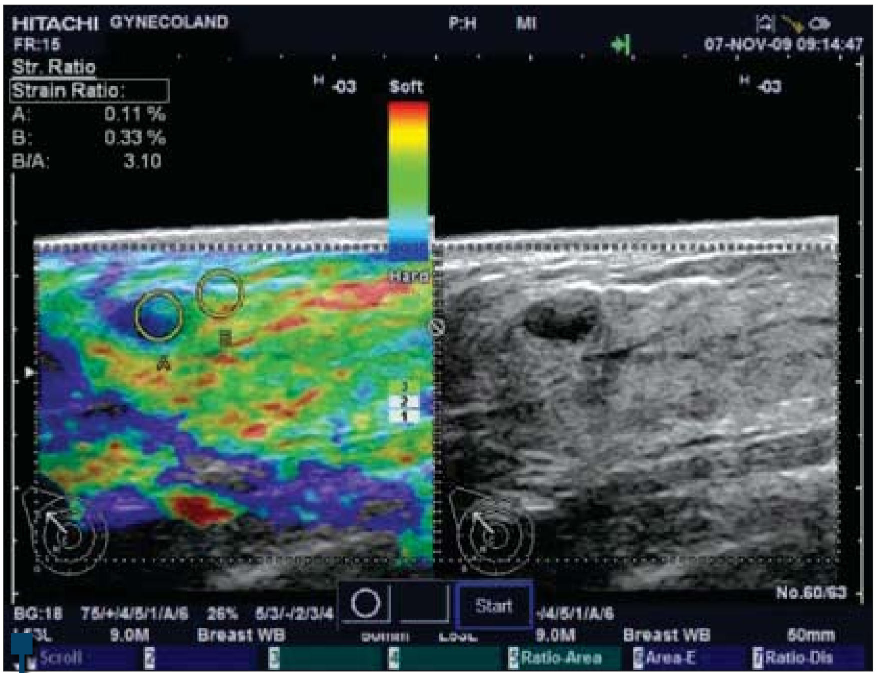

Figure 8. Strain ratio

if they were placed in the category BI-RADS 3-4. At the same time, it is especially valuable in the diagnosis of carcinomas "atypical" in conventional ultrasound (which appear to be hyperecoic or are having posterior acoustic reinforcement) or are very small in size. In addition, through sonoelastography it is very important for diagnosis complex cysts containing impurities; they can not be differentiated from solid formations by conventional ultrasound[8].

Method limits

False-negative results of the sonoelastography (breast carcinoma which seems to have a elastography benign look, falling in the Ueno score ranging from 1 to 3) may be in relation to histopathological type (undifferentiated invasive ductal or papillary carcinoma, inflammatory carcinoma, peudochistic carcinoma), tumor size (very small formations located deep or lesions which are larger than 3 cm) or with incorrect technique (putting too much pressure with the ultrasound probe)[9].

False-positive results may be caused by some hyalinized or calcified fibro adenomas or sclersosing adenosis, cytosteatonecrosis[10].

Conclusions

Sonoelastography is a non-invasive diagnostic method, relatively simple, providing a range of important information in diagnosing benign and malignant lesions of the breast. It supplements and increases the diagnostic accuracy of conventional ultrasound, particularly for BI-RADS 3-4 lesions; further reducing unnecessary biopsies or subsequent reevaluation[11].

Although this method is not yet widespread in Romania, thanks to the advantages mentioned above, we believe that sonoelastography will become in a relatively short time an usual method for assessing breast pathology. ■

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