

Real-time Elastography of the Breast in Clinical Practice – The Italian experience –

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An Italian multicenter study showed that Real-time Elastography of the breast is accurate and reproducible and may easily and quickly integrate conventional ultrasound and other breast imaging.

Elastography was performed in 784 women (mean age, 52.5 years) who had 874 lesions with a definitive diagnosis (614 benign, 260 malignant) proved with core biopsy or fine needle aspiration. US images were classified according the BI-RADS criteria for US[®]; Elastography images were assigned an elastographic score (1 to 5) according a new proposal of score that modifies the Tsukuba score. The new three-layered score, observed in cystic lesions, is described.

Elastography showed a very high specificity in benign lesions, including BI-RADS 3 lesions. With the best cut-off point between elasticity scores 3 and 4 the negative predictive value was 98% for the whole series, 96.3% for all the BI-RADS 3 lesions, and 100% for those with a size ≤ 5 mm.

Elastography scores were insensitive to the thickness and the echogenicity of the breast, and to the depth and the size of the lesion.

Elastography scores interpretation resulted well reproducible. K indexes of intra-observer (0.93) and inter-observer (0.90) agreement resulted to be very good.

Basing on their experience the Italian experts have defined new guidelines for standard acquisition and interpretation of the breast Elastography scores.

Key Words: Breast Ultrasound, Breast Elastography, Elastography, Breast Lesions, BI-RADS

1. Introduction

At 8 Italian institutions high-resolution ultrasound (US) and real-time Elastography were performed with the same technology and procedure.

The patients were studied by L Aiani (Como), S Baldassarre (Ancona), A Bulzacchi (Padua), S Della Sala (Trento), M Locatelli (Gorizia), G Mangialavori (Merano), P Monno (Bari) and G Scaperrotta (Milan) (Fig. 1).

Their research was supervised by well-known breast

imaging experts: C di Maggio (Padua), G M Giuseppetti (Ancona), E Lattanzio (Bari), A Martegani (Como) and G Rizzatto (Gorizia). Statistical analysis was performed by an independent institution (I Floriani, from Mario Negri Institute in Milan).

The research was approved according to the Italian regulations.



Fig. 1 : The Italian group at work

2. Material and Methods

Elastography was performed in 784 women (mean age, 52.5 years) who had 874 lesions with a definitive diagnosis (614 benign, 260 malignant) proved with core biopsy or fine needle aspiration.

The size was ≤ 10 mm in 59% and ≤ 5 mm in 13.2% of the lesions.

US images were classified according the BI-RADS criteria for US¹¹; Elastography images were assigned an elastographic score (1 to 5) according to the distribution and degree of strain induced by light compression. Scores were related both to solid and cystic lesions.

Our classification differs from the Tsukuba Elastography Score proposed by Itoh A et al²¹. In fact the Japanese score is related only to solid lesions while BI-RADS for US consider also non solid lesions; moreover in our preliminary practice we had observed that the cysts showed a typical three-layered pattern (Fig. 2).

This pattern is due to an artifact. With Elastography scanning many elasticity images are obtained by comparing two adjacent frames to evaluate the displacement generated by the probe with continuous compression and relaxation movements. The displacement of these two

adjacent frames is usually small (< 0.5 mm). The echo intensity inside the cyst is extremely low. The displacement at the center is erroneously estimated as almost 0 and is represented as a green band. The 2 areas near the cystic wall have a different displacement value, with a strain that is lower in the front (blue) and higher in the back (red).

We think that our proposed score (Fig. 3) is more consistent with the normal clinical settings of breast imaging.

A score of 1 indicates a three-layered pattern.

A score of 2 indicates a lesion with even elastic pattern (diffuse green).

A score of 3 indicates a lesion with mostly even elastic pattern, but with some areas of no strain (blue areas). Fig. 4 shows a fibroadenoma with a score 3 pattern.

A score of 4 indicates that most of the lesion has no strain.

A score of 5 represents a lesion with no strain; there may be also a blue rim surrounding the lesion as defined by conventional US.

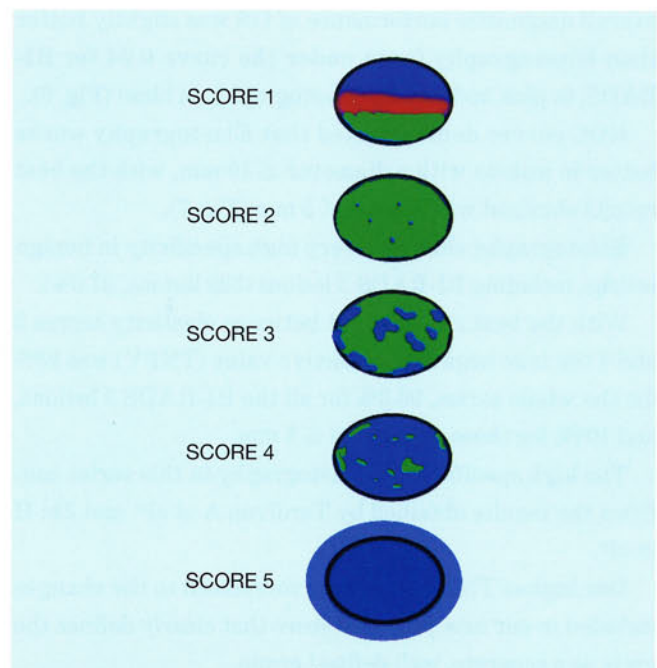


Fig. 3 : The proposed Italian Elastography score

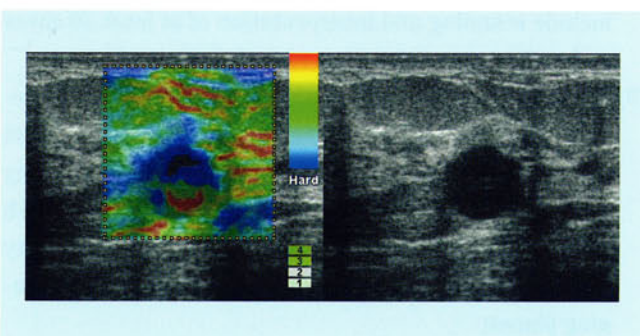


Fig. 2 : Cysts always exhibit a typical three-layered pattern (score 1)

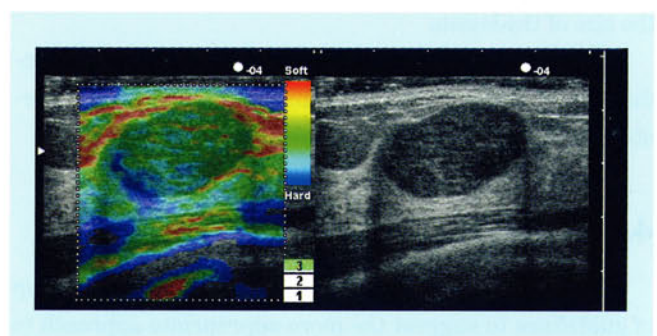


Fig. 4 : Fibroadenoma with a score 3 pattern

Fig. 5 shows a 7 mm medullary carcinoma with a clear acoustic distal enhancement in B-mode but with a Elastography score 5.

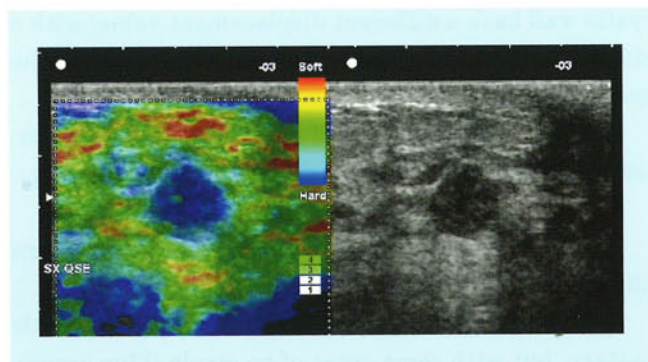


Fig. 5 : Medullary carcinoma with distal acoustic enhancement but a clear score 5 pattern

3. Results

Considering the receiver operating curves (ROC) the overall diagnostic performance of US was slightly better than Elastography (area under the curve 0.94 for BI-RADS, in pink and 0.90 for Elastography, in blue) (Fig. 6).

ROC curves demonstrated that Elastography works better in lesions with a diameter ≤ 15 mm, with the best results obtained with lesions < 5 mm (Fig. 7).

Elastography showed a very high specificity in benign lesions, including BI-RADS 3 lesions (329 lesions, 37.6%).

With the best cut-off point between elasticity scores 3 and 4 the true negative predictive value (TNPV) was 98% for the whole series, 96.3% for all the BI-RADS 3 lesions, and 100% for those with a size ≤ 5 mm.

The high specificity of Elastography in this series confirms the results obtained by Tardivon A et al³⁾ and Zhi H et al⁴⁾.

Our higher TNPV is strictly correlated to the changes included in our new proposed score that clearly defines the cysts as a separate, well defined group.

Elastography scores were insensitive to the thickness and the echogenicity of the breast, and to the depth and the size of the lesion.

Elastography scores interpretation resulted well reproducible. K indexes of intra-observer (0.93) and inter-observer (0.90) agreement resulted to be very good.

4. Guidelines

The Italian Elastography experts have defined a group of guidelines to suggest the more appropriate approach to Elastography scanning and interpretation.

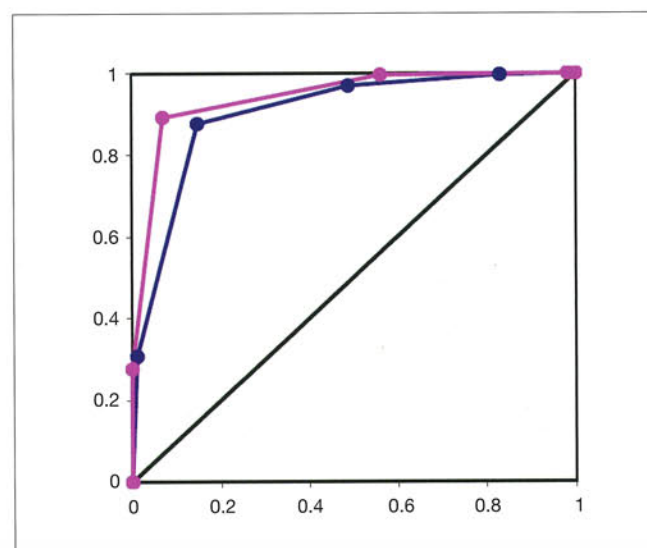


Fig. 6 : ROC curves for all the lesions

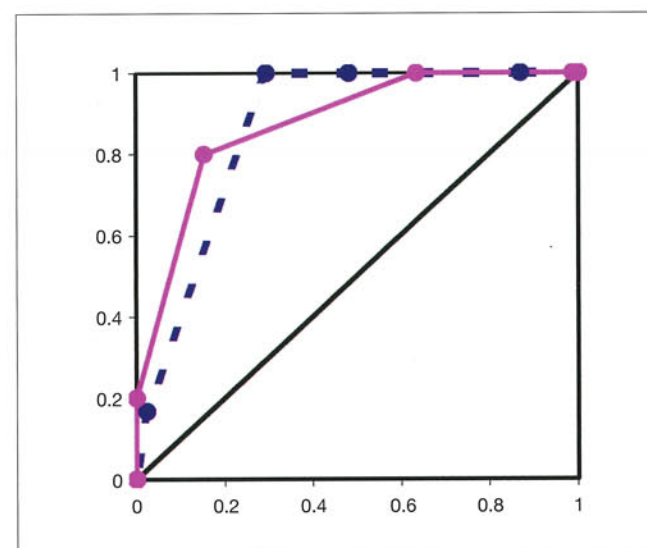


Fig. 7 : ROC curves for lesions with a size ≤ 5 mm

- (1) Elastography may increase the specificity of US in the evaluation of focal breast lesions. It is not indicated for surgical scars, diffuse lesions or lesions larger than the transducer field of view;
- (2) Elastography interpretation requires a global experience in breast imaging with evaluation of all the available images. There is a learning curve; training must include scanning and interpretation of at least 30 cases under the supervision of an expert;
- (3) At least 2 Elastography correct acquisitions of 5 seconds must be obtained for each lesion. The lesion must be in the centre of the scanning area; the Elastography area should cover almost all the field of view. With lesions with mixed texture on B-mode, 2 Elastography scores must be acquired through perpendicular scanning planes;
- (4) The pressure applied with the probe must be constant and perpendicular to both the front margin of the lesion

and the thoracic plane. Lateral movements must be avoided because they usually produce artefacts;

- (5) Elastography acquisition should be considered correct when the value of the reference LEDs on the monitor is constant and with a value of at least 2 or 3. Color homogeneity through all the scanning area surrounding the lesion indicates a good technical approach.

5. Conclusions

Elastography scores are accurate and reproducible. Diagnostic scores are acquired in almost all patients in a few minutes and after a short learning curve.

They help conventional US in characterizing small breast lesions. If incorporated in the diagnostic flow chart Elastography scores may avoid the use of biopsy in BI-RADS 3 for US and may postpone to 1 year the follow-up schedule.

Elastography score may also suggest the most appropriate workup for most of the cancers that present with indeterminate or even benign descriptors. Fig. 8 shows a 9 mm, homogeneous solid lesion, with oval shape and lobulated margins; these descriptors and the absence of alterations in the surrounding tissues clearly suggest a benign fibroadenoma. In this case the Elastography score 4 is due to the presence of a lobular carcinoma.

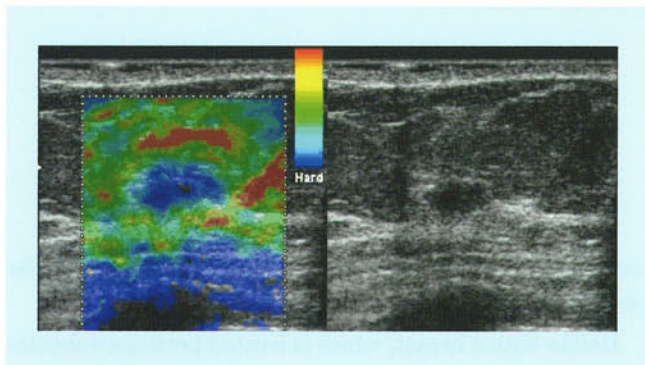


Fig. 8 : Lobular carcinoma showing benign descriptor but with a score 4 pattern

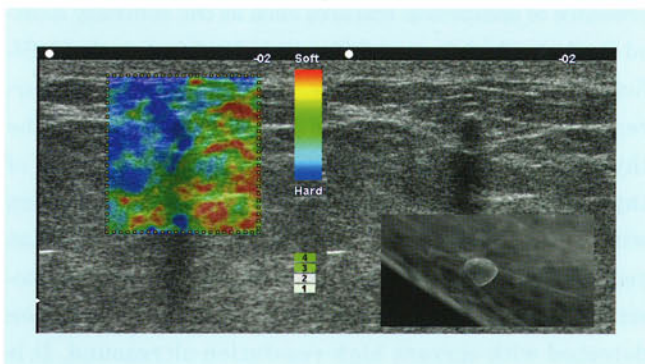


Fig. 9 : Small calcified cyst on mammography shows a clear score 4 pattern

Elastography score cannot work alone; it is only a new descriptor (as margins, type of growth, echo texture, etc) that must be always integrated with all other US and imaging findings. Fig. 9 shows a 4 mm lesion with a Elastography score 5 due to a small cyst with partially calcified walls, as was clearly evident on the mammogram.

References

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