Elastography in the detection of lesions in thyroid and breast

The audience at the Samsung-sponsored symposium on elastography at last year’s RSNA meeting were treated to an expert presentation from Dr V Cantisani of the underlying theory of strain elastography as well as examples of the practical applications in thyroid and breast using Samsung’s elastography system Elastoscan. The article below summarizes the presentation.

Prof Dr. Cantisani began his talk by pointing out that elastography is currently considered a useful and additional tool to US, originating date as far back as 1991 when Ophir’s group from the University of Texas described an imaging technique whereby “local axial tissue strains can be estimated from differential ultrasonic speckle displacement. These displacements are generated by a unique quasi-static stress field, with the resultant strain image being known as an elastogram”.

The challenge raised by this first observation then became how best to exploit the potential of the technique. In practice, this has been done over the years by carrying out many experimental studies with relatively large patient populations, followed by the encapsulation of such experience in guidelines. In Europe, guidelines have been drawn by a panel (of which he is a member) of specialists from the European Federation of Societies of Ultrasound in Medicine and Biology (EFSUMB). These guidelines are available for free download on the EFSUMB web site (www.efsumb.org/guidelines/guidelines-elastography.asp) and are composed of two parts, one describing the basic principles and technology and the second describing the clinical applications.

**PRINCIPLE OF US STRAIN ELASTOGRAPHY.**

Basically the technique involves the taking of two ultrasound images, one before and one after tissue compression; this latter can be carried out either via the probe, or by using internal vibration such as cardiac or carotid pulsation. The tracking of the tissue displacement can then be presented in the form of a multi-colored map, with different colors representing areas of tissues with different stiffness. Hence the name “strain elastography” where strain can be considered as the deformation in a body which has been compressed by an external source.

The underlying physics is defined by Hooke’s law which indeed describes the strain as a function of the softness or hardness of the tissue. In practice, as mentioned already, the representation of the tissue is by color, e.g. green for soft and red for stiff tissue, although this can vary depending on the specific equipment used. In addition to the color representation, data can be expressed semi-quantitatively using an index such as the elasticity contrast index (ECI). To date more than 200 papers have been published on elastography showing the importance of the technique.

The EFSUMB guidelines specify that elastography does not replace ultrasound, instead it should be considered as an additional tool, especially useful for example for the follow-up and monitoring of thyroid lesions that have already been biopsied by needle aspiration whose results suggest they are benign. There are however some limitations of the technique, the most important of which is that strain elastography is still a complex procedure.

The Elastoscan system from Samsung Medison simplifies the process and is a steady-state quasi-static physiological excitation technique which uses carotid pulsation to create internal vibration to obtain strain evaluation. [Figure 1].

**EXPERIENCE AT LA SAPIENZA, ROME, ITALY**

A Thyroid

By now we have accumulated a good experience with the system, and have had time to evaluate how the system works in practice, how we can efficiently get the best out of it and what is the accuracy of the system. The results of our experience with the system for the examination of thyroid lesions are summarized below. The system uses carotid pulsation to create internal vibration to obtain strain evaluation.

**FIGURE 1.** The principle of the Elastoscan system from Samsung Medison is shown above. No compression is necessary: the system uses carotid pulsation to create internal vibration to obtain strain evaluation.
tion of thyroid nodules have recently been published (Cantisani V, et al. Diagnostic accuracy and interobserver agreement of Quasistatic Ultrasound Elastography in the diagnosis of thyroid nodules. Ultraschall Med. 2015; 3600:162). In this study we investigated several aspects: we tried to determine the optimal plane, either axial or longitudinal; the effect of having the Region of Interest (ROI) within the nodule or outside; we also evaluated the overall diagnostic accuracy and inter-observer variability.

The conclusions were clear and positive: the use of the Elastoscan technique resulted in an increase of 20% in ultrasound accuracy. As regards inter-observer variability there was some difference between our observers, but these differences were lower than the cut-off, so overall the variability was acceptable. A typical clinical finding using the Elastoscan, in this case a papillary carcinoma, is shown in Figure 2.

We have recently had the possibility to test a new ultrasound system, the RS80A from Samsung which incorporates the most up-to-date elastography modules from Samsung and our recent efforts have been directed to determining just how accurate the new system could be.

The new system incorporates a tool, the S-Detect which was developed primarily for the examination of breast lesions, but we are also investigating its applicability in thyroid particularly because of its usefulness in helping to delineate the boundary of a lesion. The S-Detect can result in more effective diagnosis by reducing unnecessary biopsies and saving time through simplified procedures. The user simply touches a seed point on the touch screen and the S-Detect automatically sets the lesion’s boundary, providing multiple images. In breast tissue the system can provide an automatic BI-RADS evaluation which is the classification system based on different ultrasound features such as shape, margin, hyperechogenicity, presence of micro-calcifications, presence of vascularization, etc.

An understanding of the basic principles of the Elastoscan system is necessary to avoid potential limitations. For example, it should be taken in mind that, since the compression is generated by pulsations from the carotid artery, any differences in the carotid might affect ECI results, depending on the age of the patient atherosclerosis and/or hypertension.

B. Breast.

As mentioned above the Breast Imaging Reporting and Data System (BI-RADS) system is useful for classification of breast lesions. Analogous to the mammographic BI-RADS classification system the Ultrasound version (US BI-RADS) is a system to facilitate standardization of image interpretation and reporting and to improve communication among radiologists, referring physicians, and surgeons.

As described in the EFSUMB guidelines (Part 2 Clinical Applications: Breast), elastography is now considered as a representing a considerable quality advance in breast ultrasound. In particular elastography is of especial interest in the borderline BI-RADS classes, e.g. BI-RADS 3 or 4, where it is not clear whether to biopsy or not. If, on elastography the lesion appears stiff, the patient should be referred for biopsy. Using E-Breast, users can obtain automatically calculated strain ratio between a target area and reference area by selecting only one region-of-interest (ROI) on a breast ElastoScan image. Simple ROI selection and automatic calculation make breast diagnosis more efficient and intuitive. Although E-Breast is automatic, it has to be configured for optimal performance with the patient. Figure 3 is an example of the application of Elastoscan in the breast, showing a hyper-echoic lesion that was classified as BI-RADS 3 or 4a. Using the Elastoscan it could be seen that the lesion is almost completely blue, i.e. soft, and so probably benign. Eventually MRI confirmed that it was indeed a corpuscolated cystic lesion.

CONCLUSION.

The EFSUMB guidelines now acknowledge that US elastography techniques, including E-Breast can be considered as an additional tool for differentiating breast nodules. Useful to upgrade but not down grade.

S-Detect is a useful tool to aid BI-RADS evaluation but should be interpreted by an expert operator; it does not substitute for radiological evaluation.

Further evaluation in multicenter prospective trials is warranted for its role in the work-up of these patients.