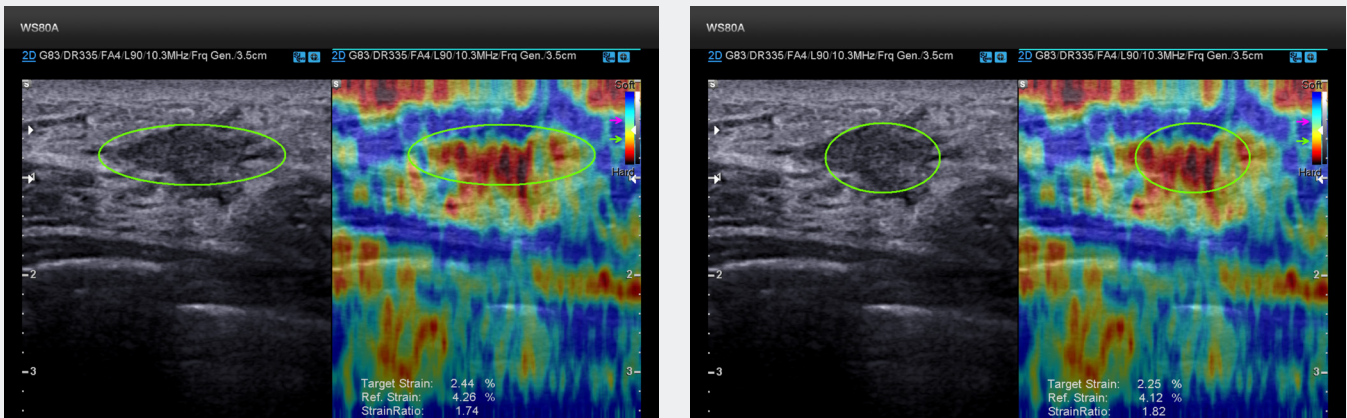


An improved quantification tool for breast ElastoScan™ : E-Breast™

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" E-Breast™ is a complementary diagnostic ultrasound technology improving classification and characterization of benign and malignant breast masses. "

Introduction

Elastography has proven to be effective in assessment of lesions and for its many benefits, it has become an integral part of breast imaging, in particular². According to a study by Wojcinski et al., out of 208 members of the working group for breast ultrasound of the German Society of Ultrasound in Medicine (DEGUM), 21% of the group already is practicing this method. Also, it revealed that the majority of non-users would like to do so in the future⁹. As a result of its importance being emphasized in various literature, the European Federation of Societies for Ultrasound in Medicine and Biology (EFSUMB) has issued guidelines for elastography^{1,4}. This method was then also included in the newest issue of the BI-RADS® (Breast Imaging – Reporting And Data System) of the American College of Radiology (ACR)⁵.

Background

Although there are various techniques for elastography, the ultimate goal for this method is to map the elasticity and/or compressibility of tissues in interest. The most common method is to compare the high strain values which are typically generated from a soft region such as fatty tissues, to the lower strain values produced by harder tumor tissues. These results then are assigned to single or multiple-colored scales. The resulting elastogram is usually displayed with conventional ultrasound B-mode image for direct correlation.

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Early in the development of breast elastography, a method based on the recurrent patterns, called the "Tsukuba Score", was used⁷. The method classifies the elastographic images into 5 imaging patterns under the assumption that an increase in tissue stiffness resulted in a higher probability of the tissue being malignant. However, this method does not describe any strain values, but it rather considers certain distribution patterns of hard and soft regions within the breast tissue for evaluation.

In contrast, the Fifth edition of the BI-RADS® uses only a three-level classification of "soft", "moderate", and "hard" in elasticity assessment category. The vagueness of this classification raises several questions. The definition of borderlines between soft/moderate and moderate/hard is not clear. Also, "soft, moderate, and hard" classifications are objective terms which are difficult to represent in measured values.

Therefore, another elastography method that evaluates images quantitatively with reference and target strain values as well as a strain ratio was implemented. Previously for this method, there were studies using fibroglandular tissues to calculate reference strain values, but currently it is usually calculated from fatty tissues surrounding the lesion of interest. This reference value is then compared to the target strain value extracted from the lesion of interest to produce a non-dimensional ratio. This is known as the fat/lesion ratio³. Higher strain ratios indicate harder lesions while lower strain ratios indicate softer lesions. However, in order to calculate this ratio, a ROI indicator must be placed on the lesion and on the surrounding fatty tissue manually. This can potentially cause inter-/intra- observer variability and thus can only be called as semi-quantitative.

This semi-quantitative procedure was expected to establish a suggested cut-off level of strain ratio for determination of malignancy/benignity of the lesion. If a lesion shows strain ratio under the cut-off level, then it was hoped that further assessments can be omitted. If it is over the cut-off level, then it gives a rationale to further examine the lesion. However, while it is reasonable to do additional assessment for suspicious lesions, it would be impossible to rule out further assessment of a lesion just based on the strain ratio below the suggested cut-off level. Nevertheless, there are still several studies that suggest cut-off levels of ratio around 2 mentioned in the literature^{6,8}.

The elastographic examinations presented here were performed with E-Breast™, an elastography method that does not require a manual selection of reference ROI, was explored.

E-Breast™

E-Breast™ (ElastoScan™ for Breast), the semi-quantification technique by Samsung, calculates the target strain value by selecting ROI in the lesion from a conventional B-mode image. While the reference ROI was manually picked by the examiner in conventional methods, with E-Breast™, this process is not necessary. E-Breast™ The system automatically calculates the mean strain value of fatty tissues in breast as a reference strain. The reference and target strain values as well as the resulting strain ratio are then displayed on the image for convenience. The elastographic examinations presented in this study were performed using E-Breast™ which is available on Samsung's RS80A and WS80A ultrasound systems.

Cases with low strain ratio

- Lymph nodes which remained uniform in size and structure over several years showed strain ratio of 1.35 to 1.95 (figure 1).
- Scar tissues after breast-conserving therapy showed even lower ratio of 1.26 to 1.38 (figure 2).
- A fibroadenoma with little variance in size over multiple years also showed a low ratio of 1.37 (figure 3).

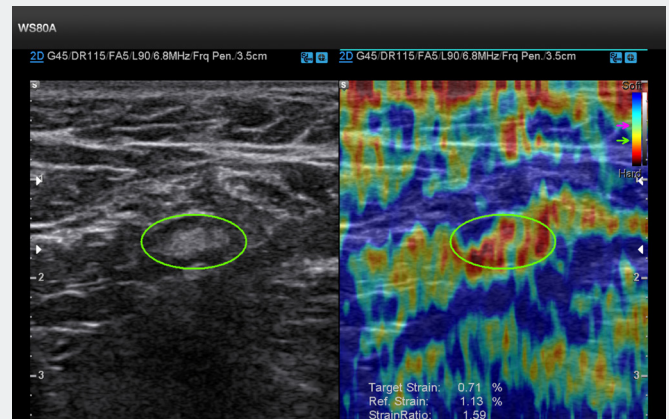


Figure 1. Normal lymph node with no variance in size and structure over the years

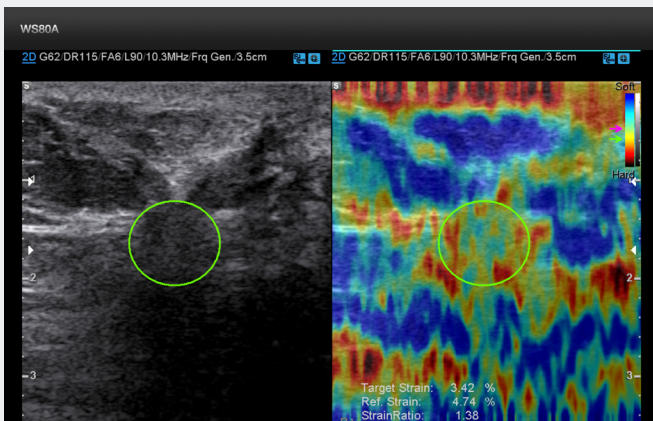


Figure 2. Scar after breast-conserving tumor surgery

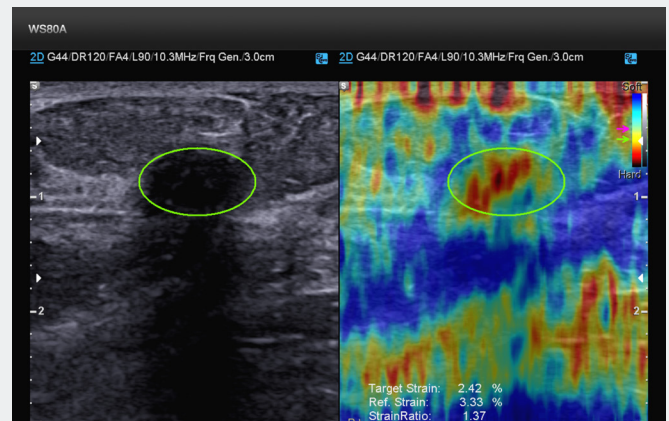


Figure 3. A fibroadenoma with constant size in the course and obtained through punch biopsy

Cases with high strain ratio

- In accordance with many studies suggesting a strain ratio above 2 for malignancy, breast cancer tissues analyzed with E-Breast™ also showed ratios above 2 ranging from 2.20 to 2.63. (figure 4, 5)

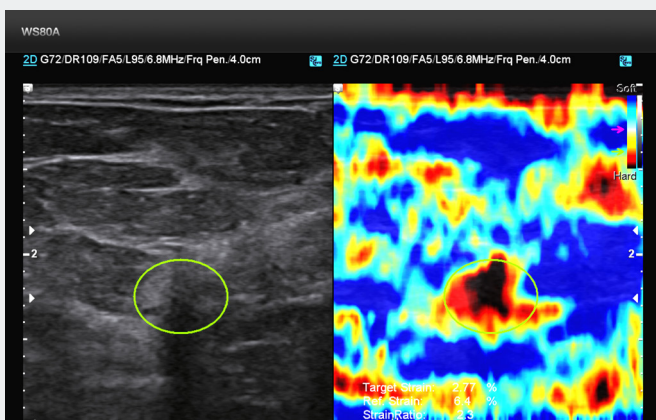


Figure 4. Small invasive breast cancer (G1) including the echo-dense borders in the ROI

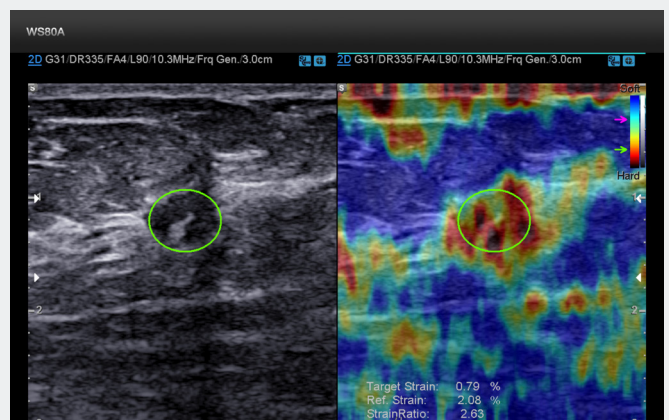


Figure 5. Invasive breast cancer (G2) where the ROI was solely placed on the echo-low lesion

Cases with moderate strain ratio

- A papillomatosis, which is a risk lesion according to pathologists, showed an average ratio of less than 2, ranging between 1.74 and 1.82 (figure 6a, 6b).

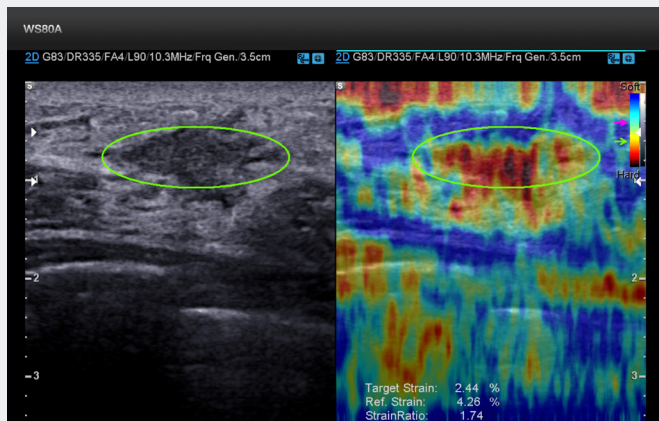


Figure 6a. Area of papillomatosis in which an attempt was made to include the finger-shaped protuberances at least in part in the ROI

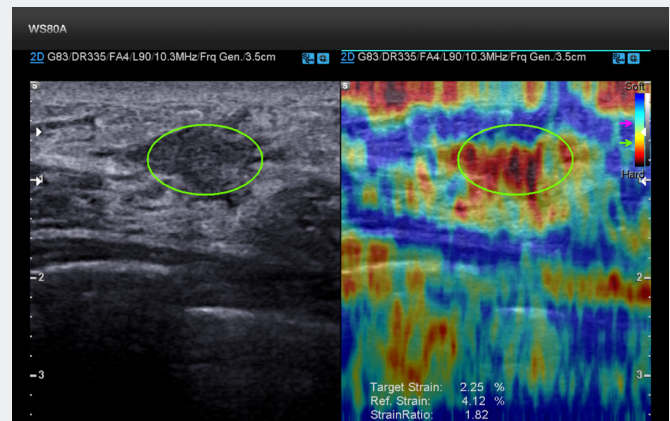


Figure 6b. The same area of papillomatosis, but now excluding the protuberances in the placement of the ROI

- A carcinoma tissue after neoadjuvant chemotherapy showed comparable strain ratio of 1.63 (figure 7).

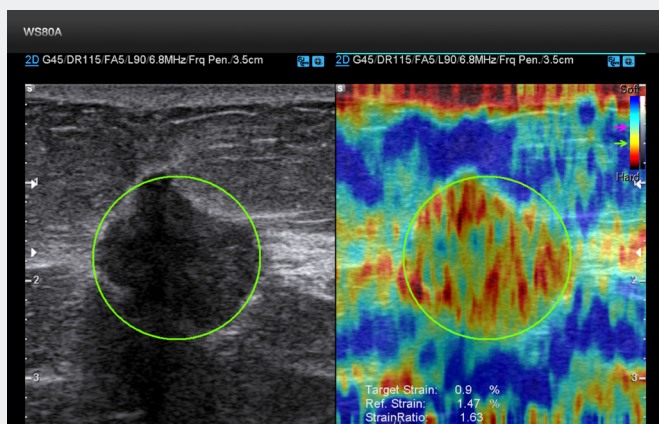


Figure 7. Carcinoma with centrally necrotic softening after pre-surgical chemotherapy

Cases with local relapses and lymph node metastases

- In a patient with two local relapses after breast conserving therapy, a smaller lesion showed a significantly higher strain ratio of 1.90 (figure 8a) compared to the larger one with a strain ratio of only 1.44 (figure 8b). This was later explained as being the result of extensive necrosis which was not possible to be detected in the B-mode images.

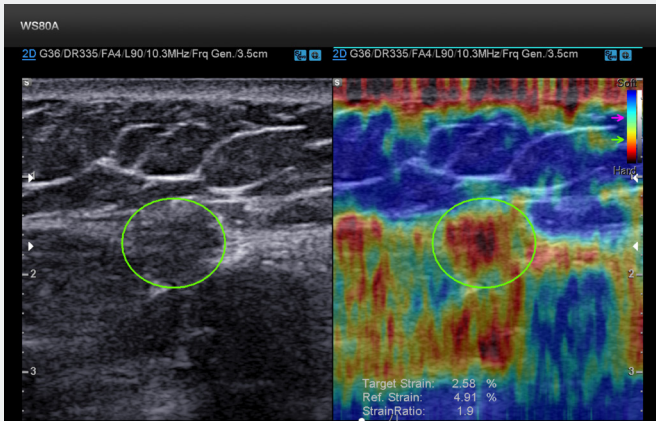


Figure 8a. Small local relapse of breast cancer

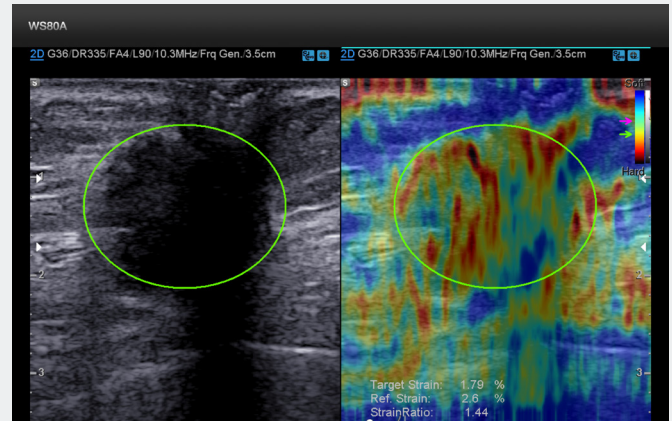


Figure 8b. The larger local relapse located 2.5 cm from the lesion shown in fig. 8a is significantly softer

- Similarly, in another patient with two lymph node metastases showed remarkably different ratios of 2.67 (figure 9a) and 1.37 (figure 9b) while their appearances on the B-mode image didn't have a remarkable difference. This difference in ratio was caused by the different responses to the pre-surgical chemotherapy administered to the patient as was found in a pathohistological assessment.

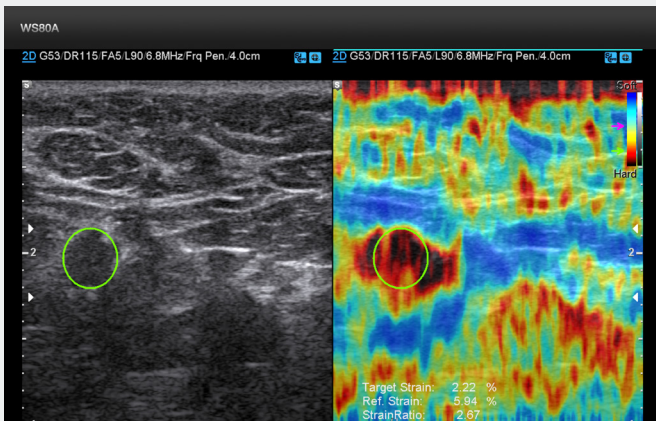


Figure 9a. An axillary lymph node metastasis that was found to be significantly hardened in a breast cancer patient after pre-surgical chemotherapy due to histologically proven fibrosis

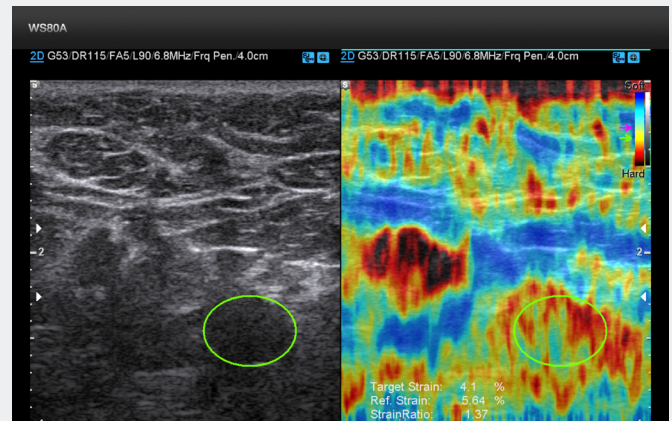


Figure 9b. A second lymph node metastasis with a similar appearance on the B-mode image of the same patient is significantly softer in the elastogram, similarly to the case shown in Fig. 8b caused by histologically proven necrosis

Conclusion

Although it would be difficult to classify the dignity of breast lesions and its malignancy with a single numerical value calculated from the strain ratio as their appearances can vary widely, E-Breast™ still offered a valuable assistance in characterizing a variety of breast lesions and overcome the issues of other elastography techniques.

While E-Breast™ was helpful for categorization of different lesions, it still remains a rough estimation of lesions. Therefore, it would be important not to evaluate a lesion from an isolated manner with strain ratio generated from E-Breast™, but rather always include within the context of the generated elastograms.

Supported Systems

- RS80A
- WS80A
- Accuvix A30

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