Clinical Utility of Breast Elastography

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**What is elastography?**

Ultrason is an imaging modality used to characterize the anatomy of a breast lesion since Stavros introduced his criteria. These criteria have been incorporated into the BI-RADS classification. Elastography is an ultrasound technique that defines tissue stiffness, rather than anatomy. Different types of tissue can be color-coded with red as stiff and blue as soft.

**Shear wave elastography vs. strain elastography**

Shear wave imaging is performed using a high collapse load ultrasound technique, whereas strain elastography is performed by imaging surrounding tissue with a low-frequency strong ultrasound pulse. Strain elastography has unique properties where benign lesions have a lower stiffness that malignant lesions.

**How it works**

When an ultrasound pulse contacts tissue, it can be reflected or absorbed or can transfer momentum to surrounding tissues. Acoustic Radiation Force Impulse (ARFI) is an ultrasound technique that propagates pulses to tissues using a low-frequency strong ultrasound pulse. The movement of the tissue can be measured directly using strain imaging or the speed of the wave can be measured through shear wave imaging.

**Strain elastography**

Strain elastography evaluates the stiffness or softness of a lesion; the higher, the softer the lesion. This is a qualitative method; it determines the relative stiffness of a lesion to surrounding tissues. Breast lesions have a unique property where benign lesions are appear smaller and malignant lesions appear larger on elastography. Strain elastography is interpreted by measuring the size change between the B-mode image and the elastogram (E/B-mode ratio) or the ratio of the lesion stiffness to that of the lesion ratio or FLR. In a large multicenter trial, using an E/B ratio of >1 for benign lesions and <1 for malignant lesions had a sensitivity of 99% and specificity of 87%.

**Intraductal papilloma**

The patient is a 37-year-old woman presenting with a palpable right retroareolar mass and occasional white discharge. The site of the palpable abnormality demonstrates an isoechoic, well-circumscribed, wider than tall lesion (a). On strain imaging, the lesion is softer than surrounding tissue with an E/B ratio of 0.98 (b). On shear wave imaging (c), the lesion has increased stiffness to surrounding breast tissue with a Vs of 2.4 m/s suggestive of benignity.

**Lipoma**

A 49-year-old patient presents with a palpable mass in her right breast. On mammography, the mass of the palpable mass is only dat density and was classified as BI-RADS 3. The referring doctor ordered a diagnostic ultrasound for further evaluation. On B-mode imaging (a), the lesion is circumscribed mass. No blood flow was identified on color Doppler imaging. On strain elastography, the lesion is very soft (white) and softer than the underlying glandular tissue. On shear wave imaging (c), the lesion consistent with fatty tissue similar to the adjacent fatty tissue.

**Simple cyst**

A 23-year-old woman presents with a new palpable mass in the right breast. Ultrasound was requested as initial imaging. The palpable mass is a 2.5 cm well-circumscribed oval, wider than taller, heterogeneous hypoechoic mass. The lesion demonstrates posterior acoustic shadowing, the E/B ratio is 0.94 suggestive of a benign lesion. On shear wave imaging (c), the lesions has a Vs of 3.3 m/s consistent with a benign lesion.

**Surgical scar**

This is a 59-year-old woman with 1.5 cm mass noted in right breast on CT scan of the chest for chest pain. B-mode image (a) of a mass identified on CT. The mass is anechoic, homogeneous, well-circumscribed, and no internal echogenicity. Strain elastogram (b) demonstrates “bull’s eye” appearance characterized by the central white area, which occurs when the contents are freely movable. Cysts do not support shear waves on elastography (c) so the majority of the cyst does not color code. Some bleeding of the anterior portion of the cyst that may occur.

**Atypical ductal hyperplasia**

A 67-year-old female with a history of invasive ductal carcinoma in her right breast status post lumpectomy and radiation 5 years ago presents for her yearly routine mammography. The mammogram demonstrated new suspicious calcifications on the mass in her left breast and was classified as BI-RADS 4C. Ultrasound was recommended for further evaluation. On B-mode imaging, an 8 mm isoechoic, ill-defined mass is associated with microcalcifications (a). The mass is softer than surrounding glandular tissue and has an E/B ratio of 1.2 (b). On SWE, the mass has a maximum shear wave velocity of 4.22 m/s.

**Lymphoma**

A 90-year-old female with a history of multiple malignancies and recent screening mammography was categorized as BI-RADS 4. Ultrasound was performed. On shear wave imaging (b), the mass is only dat density and was classified as BI-RADS 4. The lesion is not recommended. If a BIRADS 3 lesions has an E/B ratio of 1.1 suggestive of a malignancy. On shear wave imaging (c), the lesion has a Vs of >7.7 m/s, highly suggestive of a malignancy.

**Infiltrative lobular carcinoma**

A 67-year-old female presented with a palpable, non-mobile mass, the lesion is wider extended into the adjacent skin. Strain imaging was not performed. On shear wave imaging (b), the mass and the surrounding skin have a markedly elevated Vs of >7 m/s.

**Discussion**

A benign lesion has the potential to downgrade a biopsy. Further investigation, but downgrading a 4B, 4C or 5 lesion is not recommended. If a BIRADS 3 lesions has characteristics of malignancy on strain or SWE, the lesion should be upgraded to a BIRADS 4 biopsy performed.

The addition of elastography can improve the sensitivity and specificity of breast lesion characterization. This leads to a decrease number of benign biopsies and better lesion characterization prior to surgery. It is unknown if the size changes noted on elastography (malignant lesions appear larger) should be considered for larger resection at the time of surgery.

**Conclusion**

Both strain and shear wave elastography are useful adjuncts in characterizing breast lesions as benign versus malignant.

**References**


