Catch the Wave

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A new ultrasound technology called Shear Wave Elastography has been developed that provides not only exceptional gray scale or B-mode imaging, but quantitative real-time ultrasound elastography as well. Shear Wave Elastography adds important information by quantitatively measuring soft tissue stiffness in real time.\(^1\) The technique can capture ultrasound shear wave propagation in tissue, which was, until now, undetectable. The speed of the shear wave is directly related to the stiffness of the tissue. By generating, capturing, and quantifying shear wave propagation speed, this technology can produce an objective assessment of tissue stiffness or elasticity. Knowing tissue elasticity is an important step in the diagnostic process as tissue elasticity is related to pathology. Shear Wave Elastography is regarded by many practitioners and sonographers as the next generation of ultrasound technology, which promises significant clinical and imaging management benefits. It has followed major advances, all of which have increased imaging specificity such as color Doppler, harmonics, and compound imaging, and is expected by many to be adopted in ultrasound systems as a key technology alongside these predecessors. Its clinical and economic value cannot be underestimated.

Using Shear Waves to Identify Tissue Stiffness

Shear waves are waves that move in a perpendicular manner to the direction of the tissue shear displacement. Shear waves travel faster in harder tissues. Shear Wave Elastography generates low-frequency shear waves in the body by employing focalized beams of acoustic energy using conventional transducers. As shear waves travel through the body they are altered by changes in tissue stiffness. If a shear wave passes through stiffer tissue, the propagation speed increases. The speed of the propagation of a shear wave in tissue is directly related to tissue elasticity (Young's Modulus) and therefore quantitative results can be obtained in kilopascals (kPa). Shear Wave Elastography has the potential to improve cost-effectiveness and enhance clinical workflow by improving soft tissue characterization. More information in the diagnostic process may lead to earlier detection and may avoid additional costly tests such as CT or MRI.

Strain Elastography Versus Shear Wave Elastography

With conventional ultrasound elastography, a region of tissue is subjected to manual compression (called stress) and the degree to which it distorts the underlying soft tissue (known as strain) is assessed. Disadvantages are that the exam is operator dependent, not reproducible, and qualitative not quantitative.

Shear Wave Elastography is different in that the technique is operator independent and does not require manual compression on the tissue being imaged, therefore it is user-skil independent. The exams performed with this technique are quantitative and reproducible and can be used over time to monitor tissue changes. The fact that it is operator
independent, allowing for different people to provide the same result, and examinations are reproducible has important implications for diagnostic confidence as data over time is comparable. Training time is also significantly reduced, providing additional economic and clinical management benefits. Shear Wave Elastography offers a new level of information and diagnostic confidence to the user, and its simplicity in use fits well into the clinical workflow pattern. Shear wave elastography offers four major innovations: its quantitative aspect, its high spatial resolution, its real-time capabilities, and its reproducibility.

**Better Breast Lesion Detection**

Ultrasound has proven its value in breast imaging and has been shown to detect lesions missed by mammography. But ultrasound is not very specific. It finds both benign and malignant lesions, and often biopsy is required to make a diagnosis. Over the years, a variety of ultrasound techniques have been used to improve ultrasound specificity and avoid breast biopsies, including color and power Doppler, harmonics, and compound imaging. Shear Wave Elastography is the newest addition in this continuing development. In general, normal breast tissues are soft and breast cancers are hard. Benign and malignant lesions may look alike on gray scale ultrasound, but they behave differently with elastography. Shear Wave Elastography offers the ability to visualize breast lesions smaller than 5 mm, and it may be possible to differentiate cancer from benign lesions based on tissue elasticity, one goal of an ongoing multicenter international study of more than 2,000 patients. If the study data are supportive, the increased specificity attributable to elastography may help to reduce or even to avoid the expense and risk of unnecessary biopsy. Elastography's potential to increase the specificity of breast ultrasound is an active area of research for many eminent breast imagers, such as principal investigator Ellen Mendelson, MD, professor of radiology at the Feinberg School of Medicine, Northwestern University. She commented that “This novel technology enables measurements of tissue stiffness to be obtained in seconds, easily and reproducibly using the same transducer to depict gray scale B mode features of benign and malignant breast masses.”