**General Principle of Ultrasound Elastography**

Step 1: Perturb the tissue using a quasi-static, harmonic, or transient mechanical source

Step 2: Measure the resulting mechanical response (displacement, strain or amplitude and phase of vibration)

Step 3: Infer the biomechanical properties of the underlying tissue

**Main Applications of Elastography**

**Liver Elastography**

- Liver disease is the 12th leading cause of death worldwide.
- If caught early, certain liver disease can be corrected and the liver can be stabilized.

**Elastography & Liver Disease**

- Helps diagnose liver disease.
- With the use of transient elastography, there is a 90-93% accuracy in diagnosing cirrhosis with Hepatitis B & C.
- Helps with prognosis and treatment plans.
- “Patients with higher hepatic elastography were much more likely to develop liver cancer, portal hypertension, gastric and esophageal varices or hemorrhage, hepatic decompensation, and mortality.”
- Non-invasive study.
- Biopsies are invasive procedures that enable “the analysis of only a small portion of the liver, about 1/50,000th of the total parenchyma, introducing sampling variability and possible diagnostic errors.”
- Patient follow up allows us to track the extent of the disease and the progression.

**Thyroid Elastography**

- Main use: evaluation of thyroid nodules.
- Evaluates malignant potential.
- Aids in diagnosis/monitoring of thyroid disease.

**Case Study: Papillary Carcinoma**

- Gross scale image (left) shows an ill-defined, hypoechoic, 12 mm thyroid nodule. It has microcalcifications showing malignant potential.
- Elastogram (right) indicates stiffness supporting lesion malignancy.

**Breast Elastography**

- Evaluates malignant potential.
- Stiffer masses have more malignant potential.

**Accuracy of Reading Breast Lesions**

- Strain elastography – 95% accurate.
- Shear wave elastography – 85% accurate.

Future Application

Elastography has a promising future for prostate evaluation.

Prostate cancer is the third leading cause of cancer related death in men throughout the United States. Data has shown that there is an association with a five-year survival if the cancer is detected early enough and properly managed. Generally, a prostate needle biopsy is considered the gold standard in proper diagnosis, however it doesn’t come without pitfalls. Though efficient, prostate biopsies are often found to be invasive, costly and often susceptible to infection. Couldn’t there be a better way?

A study was conducted in 2017 investigating various elastography techniques for prostate cancer detection, characterization and its use in needle biopsy procedures. The study was completed testing both strain and shear wave elastography in five different patients. These individuals all had confirmed adenocarcinoma of the prostate and were scanned two weeks prior to a radical prostatectomy. Following surgery, the specimens were sectioned, stained and evaluated by a pathologist to visually localize the malignancies. After mathematical application, all images taken were then compared side by side for evaluation. See Image A (right).

The study proved successful with both tumor detection and constancy in the methods that were tested. “On average, 76% ± 28% of the tumor regions were detected based on the proposed method and its counterpart estimated from the gold standard findings of histopathology” (r² = 0.71). This implies that YM images reconstructed using the proposed method are capable of estimating the extent of prostate cancer reasonably accurately.

In summary, the results obtained in this study suggest that with more research, this may be a promising potential method for detection and localization of prostate lesions as well as quantification of the disease extent. There may soon be other options to combat the invasive and costly nature of prostate biopsy procedures. While elastography is a newer variation of ultrasound technology, it is being hypothesized that this science could have a larger scope of practice than initially thought. Only the future will be able to tell.