KARNATAKA RADIOLOGY EDUCATION PROGRAM

ULTRASOUND ELASTOGRAPHY

Ultrasound elastography, also called as sono-elastography, is a modern evolutionary method of sonographic imaging. Techniques include shear wave elastography (also known as transient elastography) and strain elastography (also known as static or compression elastography). These techniques utilize sound waves for assessing the mechanical properties of tissues such as stiffness and elasticity in response to mechanical pressure on tissue. They are used for detecting different pathologies in tissues by using the differences of their aforesaid mechanical properties.

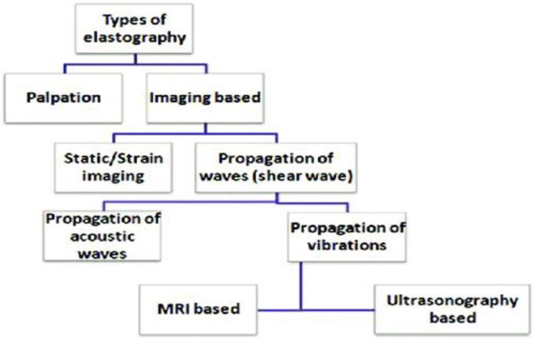
Ultrasound elastography is increasingly used as a non-invasive method to assess the degree of liver fibrosis in chronic liver disease and grade it accordingly because of the prognostic value .

Physics

Tissue stiffness is calculated using a physical property of tissue called Young's modulus or modulus of elasticity. Young's modulus is defined as the ratio of stress (the force placed on a cross-sectional area of a certain material) to strain (i.e. deformation; in this case, tissue deformation). The unit of Young's modulus is Pa(Pascal) or S.I unit of N/m2. Sonographic elastography value is usually in kPa in most clinical settings.

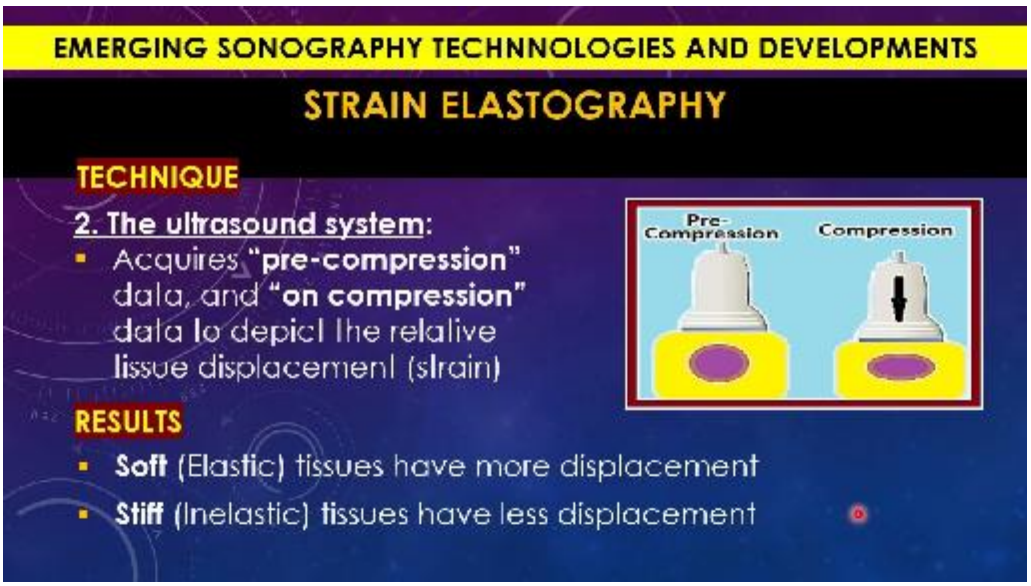
Young's modulus is a relationship between elasticity, strain, and stress:

elasticity x (change in length / original length) = (force / area)
put another way, this is
elasticity x (strain) = stress
or
elasticity = stress / strain
Elasticity is measured in kilopascals (kPa).
This relationship is fundamental to strain elastography and shear wave elastography.
The Young's modulus can be calculated as 1
Young's modulus, E = 3 x tissue density x (shear wave velocity) 2



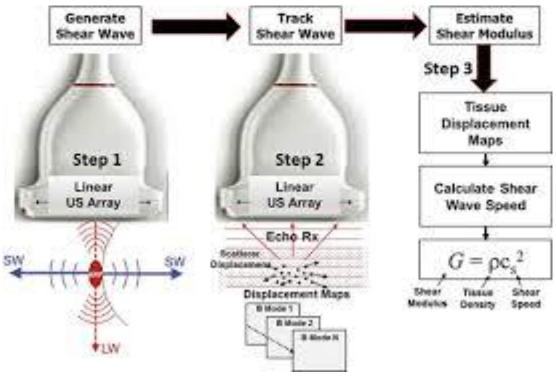
Strain elastography (also known as tissue strain elastography/static elastography/compression elastography) is a developing form of ultrasound that assesses tissues' macroscopic structure through the strain modulus. This is different from normal B-mode grayscale ultrasound which characterizes a tissue's elasticity but at a microscopic level.

Strain elastography relies on Young's modulus to detect strain in the axial dimension. The characteristics of an ultrasound beam through tissue before and after compression are compared. In some systems, the strain of tissues is measured in a semi-quantitative way, relying on Young's modulus, but not directly calculating it.



Shear wave elastography is a developing variation of ultrasound imaging.

The concept is similar to strain elastography, but instead of using transducer pressure to compare a shift in an ultrasound A-line (thereby measuring changes in strain), a higher intensity pulse is transmitted to produce shear waves, which extend laterally from the insonated structure. The shear waves may then be tracked with low intensity pulses to find the shear velocity and this velocity is related to Young's modulus.

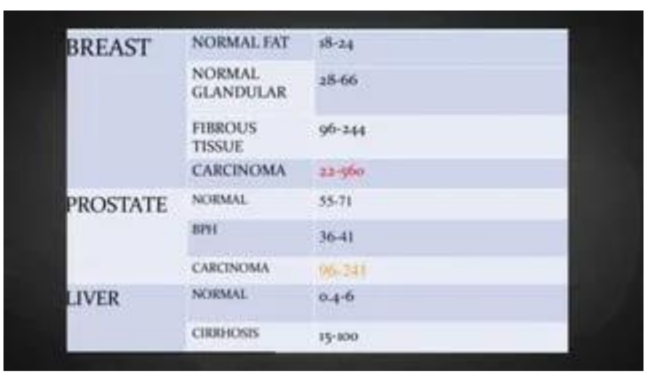


Types

1. **Point shear wave elastography (pSWE) : Point shear wave elastography (pSWE) is a type of shear wave elastography using ultrasound machine where an acoustic radiation force impulse (ARFI) is used to generate shear waves in targeted area of liver tissue.**
2. **2D-shear wave elastography (2D-SWE)**

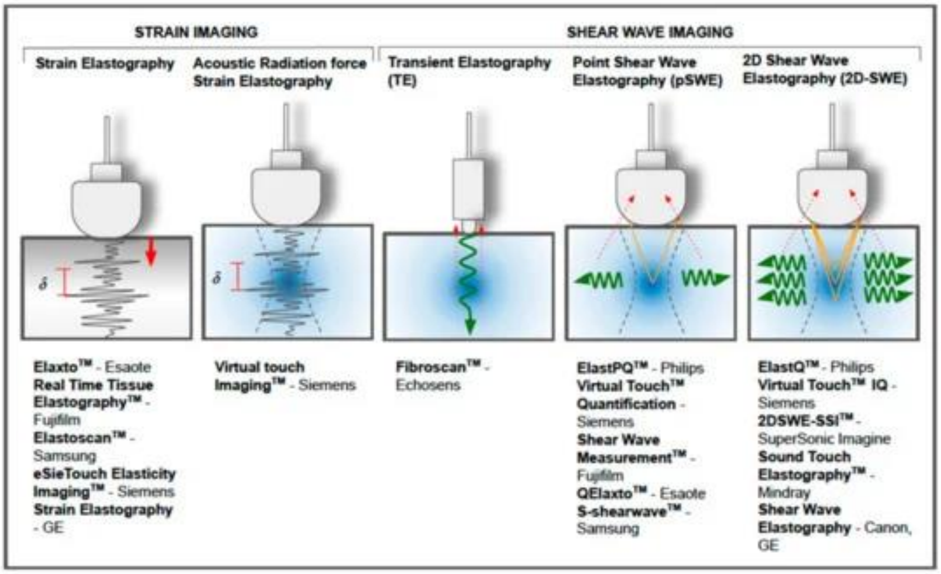
Aims of Elastography:

1. **Excitation – transmission of stress in a tissue[mechanical/vibrational]**
2. **Acquisition – recording the signal induced by deformation of tissue due to stress**
3. **Analysis – analysis of tissue strain induced by propagation of stress.**



BREAST	NORMAL FAT	18-24
	NORMAL GLANDULAR	28-66
	FIBROUS TISSUE	96-244
	CARCINOMA	22-560
PROSTATE	NORMAL	55-71
	BPH	36-41
	CARCINOMA	96-241
LIVER	NORMAL	0.4-6
	CIRRHOSIS	15-100

Transient elastography most often refers to a type of elastography which relies on a mechanical pulse generated by an external probe.



Harmonic imaging is a technique in ultrasonography that provides images of better quality as compared with conventional ultrasound technique.

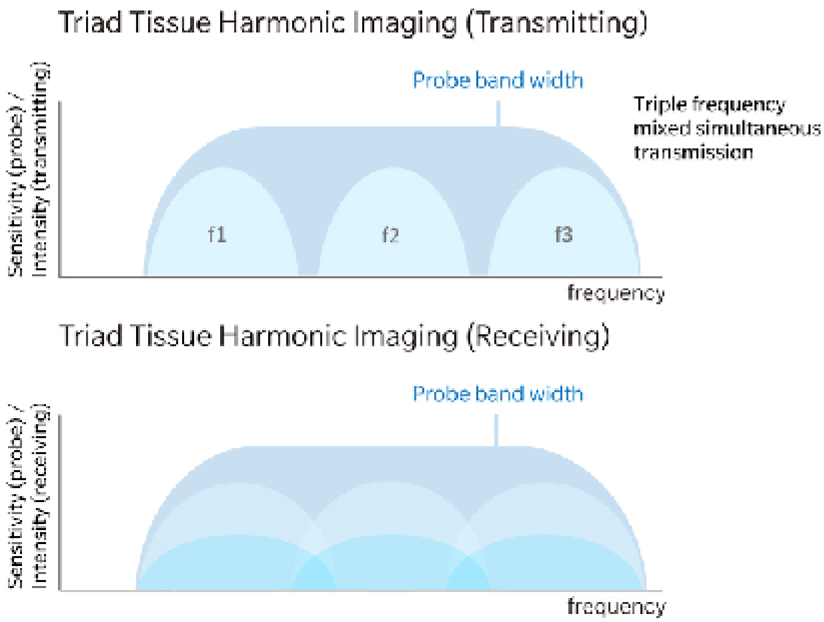
Physics

Harmonic imaging exploits non-linear propagation of ultrasound through the body tissues. The high pressure portion of the wave travels faster than the low pressure portion resulting in distortion of the shape of the wave. This change in waveform leads to the generation of harmonics (multiples of the fundamental or transmitted frequency) from a tissue. At present, the second harmonic, (which is twice the fundamental frequency or first harmonic) is being used to produce the image because the subsequent harmonics are of decreasing amplitude and insufficient to generate a proper image.

These harmonic waves that are generated within the tissue, increase with depth to a point of maximum intensity and then decrease with further depth due to attenuation. Hence there is an optimum depth below the surface at which maximum intensity is achieved.

Advantages over conventional ultrasound

- **decreased reverberation and side lobe artifacts**
- **increased lateral resolution (but decreased axial resolution)**
- **cyst clearing**
- **increased signal to noise ratio**
- **improved resolution in patients with large body habitus**



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