UNIT V

PRINCIPLE & APPLICATIONS OF SOUND IN MEDICINE

5.4 ULTRASOUND IMAGE FORMATION

Principle

Ultrasound Imaging (sonography) uses a probe containing multiple acoustic transducers to send pulses of sound into a material. Whenever a sound wave encounters a material with a different density (acoustical impedance), part of the sound wave is reflected back to the probe and is detected as an echo

Working

Modern ultrasound equipment creates an ultrasound image by sending multiple sound pulses from the transducer at slightly different directions and analyzing returning echoes received by the crystals.

Tissues that are strong reflectors of the ultrasound beam, such as bone or air will result in a strong electric current generated by the piezoelectric crystals which will appear as a hyperechoic image on the monitor

On the other hand, weak reflectors of ultrasound beam, such as fluid or soft tissue, will result in a weak current, which will appear as a hypoechoic or anechoic image on the monitor

The ultrasound image is thus created from a sophisticated analysis of returning

echoes in a grey scale format The ultrasound beam travels in a longitudinal format in order to get the best possible image.

• Keep the angle of incidence of the ultrasound beam perpendicular to the object of interest, as the angle of incidence is equal to the angle of reflection

SCANNING METHODS

Several modes of ultrasound are used in medical imaging and major modes are

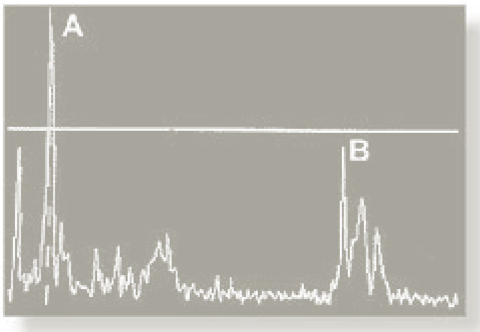
1. A-mode
2. B-mode
3. M-mode
4. Doppler mode

1. A-mode (Amplitude-mode)

A-mode scan also called as 1-D is the oldest ultrasound technique and it was invented in 1930. The transducer sends a single pulse of ultrasound into the medium.

Consequently, a one-dimensional simplest ultrasound image is created on which a series of vertical peaks is generated after ultrasound beams encounter the boundary of the different tissue.

The distance between the echoed spikes can be calculated by dividing the speed of ultrasound in the tissue (1540 m/s) by half the elapsed time, but it provides little information on the spatial relationship of imaged structures.



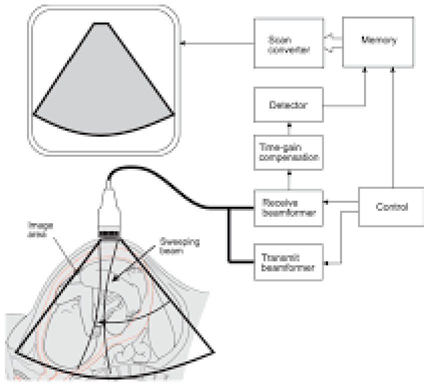
2. B-mode (Brightness-mode)

The B-mode scan is a two-dimensional (2D) image of the area that is simultaneously scanned by a linear array of 100-300 piezoelectric elements rather than a single one as in A-mode.

The amplitude of the echo from a series of A-scans is converted into dots of
different brightness in B-mode imaging.

The horizontal and vertical directions represent real distances in tissue, whereas the intensity of the grayscale indicates echo strength. B-mode can provide an image of a cross section through the area of interest. In brief, B- mode ultrasound (Brightness-mode) is the display of a 2D-map of B-mode data.n a grey scale, high reflectivity (bone) is white; low reflectivity (muscle) is grey and no reflection (water) is black. Deeper structures are displayed on the lower part of the screen and superficial structures on the upper part .While this mode is useful to accurately represent the 2-

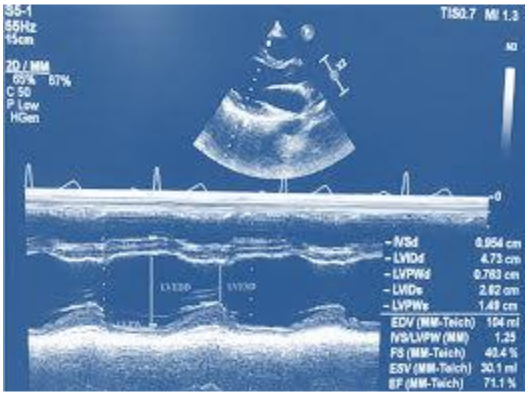
dimensional structure of the tissues, it does not resolve rapid movements well and may misrepresent the 3-dimensional nature of structures.



3. M-mode (Motion mode)

In M-mode (motion mode) ultrasound, pulses are emitted in quick succession each time, either an A-mode or B-mode image is taken. Over time, this is equivalent to recording a video in ultrasound.

As the organ boundaries that produce reflections move relative to the probe, this can be used to determine the velocity of specific organ structures. This represents movement of structures over time.



• Initially a 2-D image is acquired and a single scan line is placed along the area of interest. The M-mode will then show how the structures intersected by that line move toward or away from the probe over time.

The M-mode has good temporal resolution, so it is useful in detecting and recording rapid movements.