

Sonography Tech

Essentials of Physics & Sound, Image Interpretation, Tools, Techniques, Equipment & Terminology

OVERVIEW

Scope of Practice

- Ultrasound (a.k.a., ultrasonography and/or sonography) involves the following aspects of skills, practice and technology:
 - patient care
 - quality control
 - diagnostic procedures
 - computer data acquisition & processing
- Ultrasound technology is a multidisciplinary field, in which medicine is linked to mathematics and quantitative sciences, including:
 - geometry
 - physics
 - computer technology
- Ultrasound diagnostic imaging technique is used to visualize subcutaneous body structures, for possible pathological or lesions.
 - structures best suited to sonographic imaging include:
 - tendons
 - muscles
 - joints
 - vessels
 - internal organs
- In physics, the term "ultrasound" applies to all acoustic energy with a frequency above human hearing (20,000 hertz (Hz) or 20 kilohertz (kHz)).
 - Typical diagnostic sonographic scanners operate in the frequency range of 2-18 megahertz (MHz), hundreds of times greater than the limit of human hearing.
- However, the choice of frequency is a trade-off between spatial resolution of the image and imaging depth.
 - Lower frequencies provide less resolution, but images deeper into the body.

(NOTE: See page 4 for a Glossary of Sonographic Terminology)

How Ultrasound Works

- Sonography is effective for imaging soft tissues of the body.
- Superficial structures such as muscles, tendons, testes, breast and the neonatal brain are imaged at a higher frequency (2-18 MHz), which provides better axial and lateral resolution.
- Deeper structures such as liver and kidney are imaged at a lower frequency (1-6 MHz), which provides reduced axial/lateral resolution but greater penetration (i.e., increased imaging depth).
- A general-purpose sonographic machine may be used for most imaging purposes; specialty applications may be imaged by use of a specialty transducer.
 - Most ultrasound procedures are done using a transducer on the surface of the body, but improved diagnostic procedures are often possible if a transducer can be placed inside the body.
 - For this purpose, specialty transducers (including endorectal, endovaginal and transesophageal transducers) are commonly employed.

PHYSICS & SOUND

Understanding Sound Waves

- In physics, all waves carry energy from one location to another.
- Sound is a mechanical wave in which particles move (i.e., the molecules vibrate back and forth from a fixed position).
- Sound travels in a straight line and sound waves are longitudinal waves.
- Sound waves are identified by the following acoustic variables: pressure, particle displacement, density and temperature.
- In diagnostic ultrasound, pulses (i.e., sound) travel through tissue.
- Reflections arising from structures in the body return to the transducer and are processed into images.
- To understand exactly how that happens, let's review how sound waves work.

Pressure

- The ratio of force acting on a surface object.
- If there were no forces, or pressure, everything would be in a state of constant rest.
- The Law of Inertia explains that a body in motion will remain in motion; likewise, a body at rest will stay at rest until acted upon by an outside force.
- Ultrasound moves human soft tissue out of its state of rest.

FORMULA

$$\text{Pressure} = \text{Force}/\text{Area} \text{ OR } P = F/A$$

Units of measure: Newtons/area or N/m²

Particle Displacement

- The distance the body has moved after being impinged upon by a force (i.e., how far the particles moved from their equilibrium position).

Density

- The property common to all matter and the one property that makes each type of matter unique.
- Density is defined as mass per unit volume; the more mass confined to a given volume, the greater the density.
- In ultrasound, density is referred to as mass density, which can be defined as the mass of the object divided by its volume.

FORMULA

$$\text{Density} = \text{Mass}/\text{Volume} \text{ OR } D = M/V$$

Units of measure: Kg/m³, g/cm³

Temperature

- The measurement of relative coolness or warmth of an object.
- Temperature in ultrasound becomes important because the speed of sound varies with the temperature of the tissue that is being scanned.

7 Parameters of Sound Waves

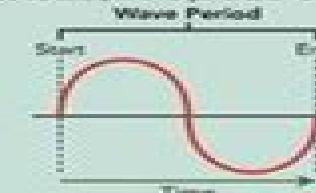
- The seven parameters of sound waves are: period, frequency, amplitude, power, intensity, wavelength and speed.
- Period and frequency describe the speed of the wave.
- Amplitude, power and intensity describe the strength of the wave (i.e., magnitude); these parameters tend to be directly related; when intensity increases so do power and amplitude.

Period

- Time it takes for a wave to vibrate a single cycle (i.e., from the start of one cycle to the start of the next cycle).

Equipment & Terminology

- Reported in units of time (seconds, milliseconds, hours, days).
- The value of period in diagnostic ultrasound is one tenth to one half of a millionth of one second.
- period determined by the sound source only, not by the tissue being scanned.
- period is **INOT** adjustable by the sonographer (ultrasound tools) with a particular transducer.

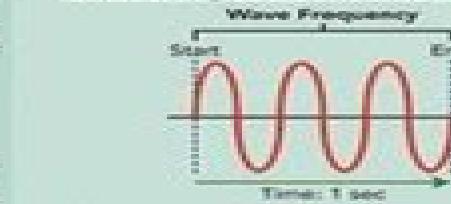


Frequency

- Number of events that occur in a specific duration of time.
- In diagnostic ultrasound, the frequency of a wave is described as the number of cycles occurring in one second.
- Frequency is important in diagnostic ultrasound because it affects penetration and image quality.
- Measured in units per second or Hz (1 cycle/second = 1 Hz).
- Frequency ranges are from 2MHz to 10 MHz (2 million to 10 million per second).
- Frequency determined by the sound source only, not by the tissue being scanned.
- Frequency is **INOT** adjustable by the sonographer with a particular transducer.

Frequency Spectrum of Sound

ultrasound	less than 20 Hz
audible	sound between 20 Hz and 20 kHz
ultrasound	greater than 20 kHz



Amplitude

- Defined as the "bigness" of the wave, it is the difference between the minimum value and the average value of the acoustic variable.
- Measured in units of pressure (pascals), density (kg/cm³) and particle motion (any distance).
- Amplitude is determined by the sound source, but amplitude decreases as it travels through the body.
- Decrease in sound depends on the characteristic of the sound and the body tissue the wave is traveling through.
- The sonographer can alter the initial amplitude on an ultrasound machine.
- Amplitude is measured from the middle value to the maximum value.

Medical Terminology Study Guide Ultrasound

**Agnes Clare Frenay, Rose Maureen
Mahoney**

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