

Sonography Tech

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

OVERVIEW

Scope of Practice

- **Ultrasound (s.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 pathology 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 produce less resolution, but image deeper into the body

(NOTE: See page 6 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 (7-18 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 less axial and 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, endorectal 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

Pressure = Force/Area OR $P = F/A$
 Units of measure: Newtons/Area or N/m^2

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 positions)

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

Density = Mass/Volume OR $D = M/V$
 Units of measure: Kg/m^3 , g/cm^3

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

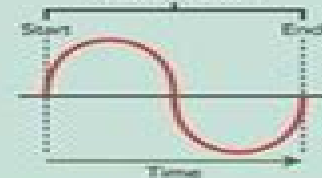
- The seven parameters of sound waves are: period, frequency, amplitude, power, intensity, wavelength and speed
- Period and frequency describe the speed of the wave
- Amplitude, power and intensity describe the strength of the wave (s.k.a., magnitude); these parameters tend to be directly related; when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

- 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 **NOT** adjustable by the sonographer (ultrasound tech) with a particular transducer

Wave Period



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 **NOT** adjustable by the sonographer with a particular transducer

Frequency Spectrum of Sound

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

Wave Frequency



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 (g/cm^3) 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

Betsy J. Shiland



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