The temporal lobe on the left side of the brain shows less blood flow than the right

- This type of scanning is also useful in diagnosing stress fractures in the spine (spondylolysis), blood deprived (ischemic) areas of brain following a stroke, and tumors.

Ultrasonography

The term ultrasound refers to acoustical waves above the range of human hearing (frequencies higher than 20.000 Hz). Medical ultrasound systems operate at frequencies of up to 10 MHz or more.

An ultrasonic wave is acoustical. Ultrasonic imaging is used in medicine, engineering, geology, and other scientific areas. Radio signals are electromagnetic waves, while medical ultrasound signals are acoustical.

- Ultrasound is a non-invasive diagnostic tool used to complement other imaging modalities.
- The degree to which the ultrasound beam penetrates the patient and the image resolution obtained depend on the frequency of the transducer used.
- Artifacts can be beneficial or detrimental to image interpretation
- Ultrasonography is the use of high-frequency sound waves to generate an image. Because ultrasonography is relatively safe and non-invasive, it has become a useful diagnostic tool in veterinary medicine.[1] Veterinary technicians, especially those who wish to learn how to perform ultrasound examinations, should have a basic understanding of ultrasonography: how sound waves are produced and interact with tissue, what types of images can be obtained, how to get the best image, and how to identify common artifacts.
- Ultrasound examinations complement other imaging modalities, such as radiography, and allow more definitive diagnostic tests to be conducted. However, ultrasonography is limited by the fact that it is user dependent.
- This means that the quality of the images obtained and their accurate interpretation depend on the experience and knowledge of the sonographer

Ultrasound

Physical Properties

- Sound is a wave of energy that, unlike x-rays, must be transmitted through a medium. Sound waves can be described by their frequency, wavelength, and velocity. The frequency is the number of cycles or waves that are completed every second, and the wavelength is the distance needed to complete one wave cycle. The frequency of the sound waves used in ultrasonography is well above the limit of the human ear (20,000 kHz) — usually in the range of 2 to 12 MHz (2 to 12 million Hz).
- An inverse relationship exists between the frequency and the wavelength of a sound wave: the higher the frequency, the shorter the wavelength. This relationship affects the choice of frequency used in each patient undergoing ultrasonography. Higher-frequency ultrasound waves create higher-resolution images, but their shorter wavelength makes them unable to penetrate deeper tissues. Lower-frequency waves have better penetrating power, but because of their longer wavelengths, their resolution is lower. Weighing the need for higher resolution versus more penetrating power is always a consideration when selecting a transducer frequency.
- The velocity of an ultrasound wave is independent of the frequency. However, it changes depending on the medium through which the wave is traveling

Image Production

- Two basic principles need to be understood regarding how ultrasound is generated and an image is formed. The first is the **piezoelectric effect**, which explains how ultrasound is generated from ceramic crystals in the transducer. An electric current pass through a cable to the transducer and is applied to the crystals, causing them to deform and vibrate. This vibration produces the ultrasound beam. The frequency of the ultrasound waves produced is predetermined by the crystals in the transducer.

- The second key principle is the **pulse-echo principle**, which explains how the image isgenerated. Ultrasound waves are produced in pulses, not continuously, because the same crystals are used to generate and receive sound waves, and they cannot do both at the same time. In the time between the pulses, the ultrasound beam enters the patient and is bounced or reflected back to the transducer. These reflected sound waves, or echoes, cause the crystals in the transducer to deform again and produce an electrical signal that is then converted into an image displayed on the monitor. The transducer generally emits ultrasound only 1% of the time; the rest of the time is spent receiving the returning echoes

Interaction with Tissue

Ultrasound produced by the transducer interacts with different tissues in a variety of ways that may help or hinder image formation. Attenuation and refraction are the two major types of tissue interaction.

Attenuationis the gradual weakening of the ultrasound beam as it passes through tissue. Attenuation can be caused by reflection, scattering, or absorption of the sound waves and is compensated for by use of specific controls, discussed below.

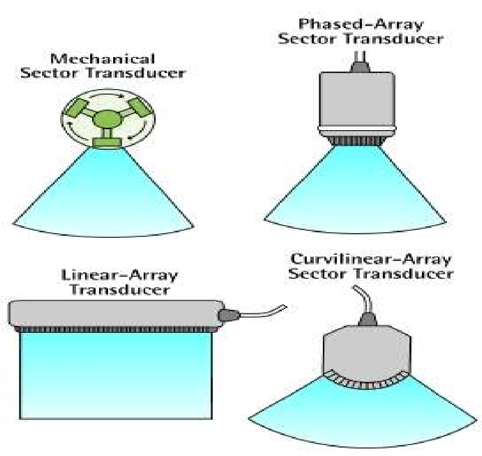
Reflectiontakes place when ultrasound waves are bounced back to the transducer for image generation. The portion of the ultrasound beam that is reflected is determined by the difference in acoustic impedance between adjacent structures.[5] Acoustic impedance is the product of a tissue's density and the velocity of the sound waves passing through it; therefore, the denser the tissue, the greater the acoustic impedance. The large differences in density and sound velocity between air, bone, and soft tissue create a correspondingly large difference in acoustic impedance, causing almost all of the sound waves to be reflected at soft tissue-bone and soft tissue-air interfaces. On the other hand, because there is little difference in acoustic impedance between soft tissue structures, relatively few echoes are reflected to the transducer from these areas.

Scatteringrefers to the redirection of ultrasound waves as they interact with small, rough, or uneven structures.This tissue interaction occurs in the parenchyma of organs, where there is little difference in acoustic impedance, and is responsible for producing the texture of the organ seen on the monitor. Scattering increases with higher-frequency transducers, thus providing better detail or resolution.

Absorptionoccurs when the energy of the ultrasound beam is converted to heat. This occurs at the molecular level as the beam passes through the tissues.[5]

Refractionoccurs when the ultrasound beam hits a structure at an oblique angle. The change in tissue density produces a change in velocity, and this change in velocity causes the beam to bend, or *refract*.This type of tissue interaction can also cause artifacts that need to be recognized by the sonographer.

Display Modes



▲ Diagrams of different transducer types.

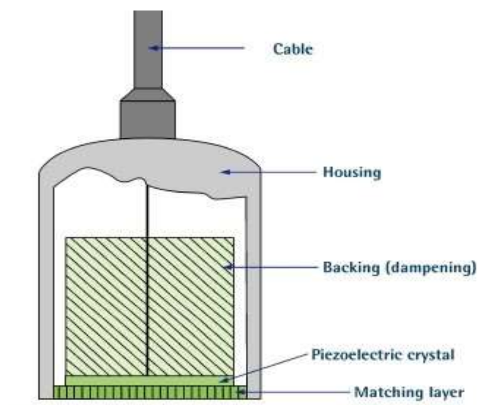
A (Amplitude) Mode

In A mode, the returning echoes are displayed on the monitor as spikes originating from a single vertical or horizontal baseline.[5] The depth of the echo is determined by the position of the spike on the axis, with the top or left side of the monitor being the most superficial and the bottom or right side being farther away. The height of the spike correlates to the amplitude of the echo. This mode is not frequently used other than in ophthalmology.

B (Brightness) Mode

In B mode, echoes are represented by dots on a line that form the basis of a two-dimensional image. The brightness of each dot indicates the amplitude of the returning echo. Its location relative to the transducer is displayed along the vertical axis of the monitor, with the top of the monitor representing the transducer. The returning echo's location along the axis is based on the amount of time it takes for the ultrasound wave to be transmitted from the transducer and reflected back. Echoes arising from structures in the near field (close to the transducer) take less time than those coming from the far field (farther away from the transducer) because they travel a shorter distance.

Real-time B mode ultrasonography allows a complete, two-dimensional, cross-sectional image to be generated by using multiple B-mode lines.[5] In real-time B mode, the transducer sweeps the ultrasound beam through the patient many times a second. With each pass of the ultrasound beam, multiple lines of dots are generated on the monitor, producing a complete image. These B-mode lines remain on the monitor until the next sweep of the ultrasound beam. Because several beam sweeps are performed per second, a moving, changing, "real-time" image is generated. This is the mode most commonly used in veterinary practice.



▲ Components of an ultrasound transducer.

M (Motion) Mode

M mode is used in echocardiography and allows the sonographer to measure the heart to assess cardiac function and chamber size. M mode uses a single B-mode line, with the amplitude of the echoes indicated by the brightness of the displayed dots. The difference is that the information obtained from that single line is constantly swept across the monitor so that the motion of the body part being investigated is displayed along the horizontal axis.

Image Optimization

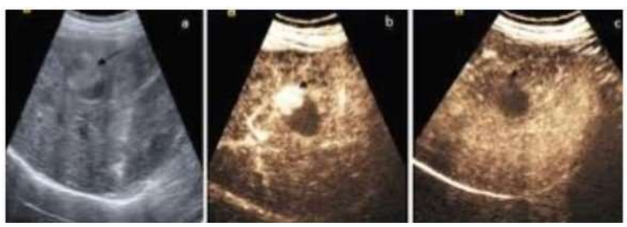
To obtain good-quality images, the sonographer must know what type and size of transducer to use and how to use the available ultrasound controls. There are many transducers or probes from which to choose, and selection of the appropriate one depends on the location of structures to be imaged and the size of the patient.

Transducers

Transducers are first classified as *linear* or *sector*, according to the arrangement (array) of the crystals and the shape of the imaging field produced on the monitor. In a linear transducer, the crystals are oriented in a straight line, producing a rectangular image in which both the near and far fields are wide. Linear transducers provide superior resolution of near-field structures and therefore are commonly used in equine reproduction and tendon examinations.[5] However, their large footprint can limit their use in cardiac and abdominal studies, where it may be difficult to fit the probe between the ribs.

▲ An ultrasound console showing the time gain compensation sliders and the depth and gain controls. Names and locations of ultrasound controls vary from unit to unit.

Ultrasonography of Kidney



Gray Sclae i

Endoscopy

- Endoscopy is a nonsurgical procedure used to examine a person's digestive tract.
- Using an endoscope, a flexible tube with a light and camera attached to it, your doctor can view pictures of your digestive tract on a colour TV monitor.
- Endoscopy is the insertion of a long, thin tube directly into the body to observe an internal organ or tissue in detail. It can also be used to carry out other tasks including imaging and minor surgery.
- Endoscopes are minimally invasive and can be inserted into the openings of the body such as the mouth or anus.
- Alternatively, they can be inserted into small incisions, for instance, in the knee or abdomen. Surgery completed through a small incision and assisted with special instruments, such as the endoscope, is called keyhole surgery.
- Because modern endoscopy has relatively few risks, delivers detailed images, and is quick to carry out.