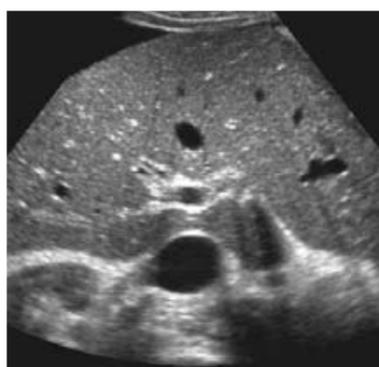


ULTRA-SOUND



RADIOLOGY: THE BASIC MODALITIES
Part Three: Ultrasound

How It Works. Ultrasound is a sound wave with a frequency higher than the range audible by the human ear. The frequency used in diagnostic radiology is in the range of approximately 1 to 10 megahertz; audible sound is about 20 hertz to 20 kilohertz.

Ultrasonography has many medical applications in which a machine is used to create these high-frequency sound waves. The machine has a hand-held wand (or transducer), which is placed directly on the patient's skin. The sound waves emanate

from the face of the transducer, which is a few inches long, relatively thin, and shaped like an electric shaver.

The sound waves are transmitted through the patient's body, so the area that is imaged consists of the skin under the transducer and everything below it. In other words, when you place the transducer on the patient, the image shown on the screen will be a "slice" of the body below the spot where you place it.

How the Images Are Made

Depending on the ability of the tissue to transmit sound, the sound wave will either penetrate through the tissue or bounce back and hit the transducer. A substance such as water is a very good transmitter of sound; as a result, when ultrasound waves are aimed at water, very little bounces back. However, substances such as fat, air, and bone do not transmit sound well, so the waves bounce back to the transducer.

The ultrasound machine then records the sound waves that return to the transducer. It can calculate from where the waves are coming, based on the frequency of the sound. The machine then creates a grayscale "map" of the information it received. Areas from which a lot of sound bounces back appear white (such as fat, bone, or air); areas with no sound return (such as water) appear black. A liquified gel is always placed between the transducer and the patient's skin to eliminate any air between them.



**PROS
CONS**

SOME PROS AND CONS OF ULTRASOUND

Advantages

- Cheap
- Fast
- "Real-time" imaging allows examiner to see motion of tissues*
- No radiation (as a result, used often in children)**
- Can distinguish simple cysts from solid masses reliably
- "Real-time" imaging useful to guide biopsies
- Can evaluate blood flow****

Disadvantages

- Quality of images depends on expertise of operator
- Anatomic detail is poor because of low resolution
- Cannot evaluate bone, lungs, or bowel***
- Images are poor in obese patients***
- Images are poor when air or gas is present
- Small field of view

* Ultrasound images are extremely easy and fast to create; as a result, ultrasound is a "real-time" exam. In other words, when the transducer is placed on the skin, the image of the tissues below it appears almost immediately on the ultrasound screen. This allows the examiner to move the wand back and forth and see the actual movement of tissues in the body as it happens.

** There is absolutely no ionizing radiation associated with ultrasound. The only documented potential adverse effect is that, when used for long periods of time at high intensities, it can cause slight heating of the tissues.

*** Ultrasound cannot be used to evaluate hard structures, such as bone and metal, or structures with a lot of air, such as the lungs or bowel. Sound waves cannot transmit through these tissues, so they will bounce right off the surface. On the ultrasound image, this appears as a rim of white (the surface off which the ultrasound waves bounced) and then pure blackness behind it (an area that the sound waves cannot reach), an effect termed "shadowing." In addition, because fat is a poor transmitter of sound, patients with a lot of subcutaneous fat tissue are difficult to image with ultrasound.

**** "Doppler ultrasound" can be used to evaluate flow in blood vessels, as well as blood flow in solid organs or masses.

**COMMON
USES**

Ultrasound's Most Common Uses

Head and Neck:

- The brain, in newborn infants (the fontanelle is used as an opening to see through)
- The thyroid gland

Chest:

- The motion of the heart (echocardiography) – this can be done through the skin (conventional) or through the esophagus (transesophageal)
- Masses in the breast previously seen on mammography or felt by patient or doctor

Abdomen/Pelvis:

- The uterus and ovaries – the transducer can be placed on the skin (transabdominal) or in the vagina (transvaginal)
- Fetuses – good because there is no radiation and the imager can see motion
- The solid abdominal organs (liver, spleen, pancreas), for masses or biliary dilatation (*Note: The pancreas is often difficult to see because of overlying bowel gas*)
- The gallbladder, for stones and inflammation
- The kidneys, for mass or hydronephrosis
- The appendix, for inflammation (usually in children)
- The prostate gland (transrectal ultrasound, with the transducer placed in the rectum)

Other Uses:

- The testicles
- Lymph nodes
- Masses anywhere in the body, to determine if they are simple cysts
- Arteries and veins (to look for thrombus, atherosclerosis, or aneurysm)
- To guide biopsies in any of the above places

More Advanced Uses:

- Intravenous ultrasound – to evaluate the inside of blood vessels
- Ultrasound therapy – powerful ultrasound produces heating, which is often used in physical therapy
- Focused ultrasound surgery – for treatment of some tumors, such as uterine fibroids