Listen to the associated podcast episodes available at theradiologyreview.com or on your favorite podcast directory.

What is the cause of ultrasound reverberation artifact?

The cause of reverberation artifact is having two echogenic structures in close proximity causing the sound wave to bounce back and forth between the echogenic structures. A key feature of reverberation artifact is that the length between each reverberation is equal throughout the visualized image.

What is comet tail artifact and can you name a few anatomic structures/substances that commonly show comet tail artifact?

Comet tail artifact is reverberation artifact that occurs within cholesterol (such as adenomyomatosis in the gallbladder) or colloid (such as in the thyroid/colloid cyst). In comet tail artifact you see one continuous line instead of multiple separate line as the reverberation artifact is not resolved as multiple separate lines (due to the very small interfaces within the cholesterol or colloid). Make sure to look this up if you don't know what it looks like.

What is ring down artifact?

Ring down artifact commonly happens in water with air bubbles and results from the sound waves resonating between the air bubbles. This is a form of comet tail artifact but results from air bubbles in fluid rather than reverberation in cholesterol/colloid as in comet tail artifact and unlike comet tail artifact you will usually see actual reflections in the beam that are in a variable pattern (unlike reverberation artifact where the reverberated waves manifest as multiple lines that are equal in distance or comet tail artifact where the lines cannot be separated).

What is mirror image artifact and what is a classic cause of this?

Mirror image artifact results from a double reflection that tricks the ultrasound system into thinking something is deeper than it is. This commonly may result from a double reflection of the soundwaves between the diaphragm with air above it and liver beneath it. Interestingly, if you lose that air on the side of the diaphragm (such as with a pleural effusion) you would no longer see the mirror image artifact.

What is the assumed speed in meters per second that an ultrasound machine assumes the sound waves travel through tissue?

The assumed speed that an ultrasound beam through tissues—also known as the propagation speed—is 1540 meters per second.

What are some factors that influence how fast ultrasound waves will propagate through tissue?

A major factor I would remember is that tissue density greatly influences how fast an ultrasound wave will propagate through tissue. Tissue elasticity also is a major factor of the speed of ultrasound through tissue.

True or false—as tissue density decreases, the speed of ultrasound propagation through the tissue increases.

Listen to the associated podcast episodes available at theradiologyreview.com or on your favorite podcast directory.

False—as tissue density increases, propagation speed of ultrasound also increases. For example, the speed of ultrasound waves through bone is approximately 4080 meters per second whereas the speed through air is about 330 meters per second. The speed of ultrasound waves through tissues like fat, water, blood, muscle, and solid organs like the kidneys and liver vary much less as the densities are more similar than bone compared to air (range is about 1450-1580 meters per second). Therefore, 1540 meters per second is a compromise that is in the general range of tissues like fat, water, solid organs, blood and muscle.

What is the name of the major artifact that occurs when ultrasound waves pass through tissues that have different intrinsic propagation speeds?

Speed displacement artifact. This will result because the ultrasound machine will assume the sound waves are traveling at 1540 meters per second whereas the ultrasound beam may have actually been traveling at 330 meters per second, for example, if imaging through air in the lungs or imaging through the liver when there is hepatic steatosis surrounded by focal fatty sparing. Speed displacement artifact will display a structure, or a portion of a structure, at an incorrect depth.

What is refraction artifact on ultrasound and how might this be shown on images?

Refraction artifact results when imaging through structures which first refract the beam, and then reflect the beam, causing the ultrasound system to believe an object is directly in front of the probe when, in fact, the beam was refracted and subsequently reflected back to the probe by another structure. Common scenarios that are tested are seeing multiple gestational sacs when imaging through the muscle in a single plane or multiple aortas when imaging the aorta through the rectus abnominus musculature. To confirm whether there is aortic duplication, or twin gestation, you would image in different planes to confirm artifact vs surprise findings.

What is the cause of acoustic enhancement on ultrasound?

Acoustic enhancement results when the ultrasound beam passes through structures that transmit the sound better than the surrounding tissues, such as simple cysts on a breast ultrasound, or the distended gallbladder. Another way to say this is that acoustic enhancement occurs when there is less attenuation of the ultrasound beam in fluid filled structures compared to surrounding solid tissues/fat. Why this can appear brighter is that the time gain compensation (the purpose of TGC is to account for attenuation by making deeper structures brighter) overcompensates causing the deeper structures behind the fluid filled structure to be presented as brighter on the image. Since there is less attenuation through the fluid filled structure compared to the tissues surrounding the fluid filled structure, these will appear brighter as there is a uniform time gain compensation throughout the image.

What is the cause of acoustic shadowing on ultrasound?

Acoustic shadowing results when you have structures, such as calcified masses, dense calcifications, or malignancies with many irregular interfaces, that absorb and/or reflect the ultrasound waves thereby leaving a void of signal (a shadow) behind the structure.

Listen to the associated podcast episodes available at theradiologyreview.com or on your favorite podcast directory.

What is the twinkle artifact and what is this characteristic of?

Twinkle artifact results when imaging with color Doppler imaging and you see the appearance of alternating colors (which would be typical otherwise for turbulent blood flow) when using color Doppler imaging on a highly reflective object such as a calculus. This is kind of like the comet tail artifact equivalent when imaging with color doppler imaging. On board exams twinkle artifact would be most classic for something like renal stones.

What is the cause of a side lobe artifact?

We assume that ultrasound beams leave the transducer almost in a straight uniform line but in reality, you have the primary beam and secondary beams that surround the primary beam that come off of the transducer in a radial pattern. If this "side lobe" beams get reflected back to the transducer you can see a side lobe artifact which typically appear echogenic and curvilinear. Look this up to see examples of how this can manifest on images.

What is anisotropy and why is this a potential problem for musculoskeletal ultrasound?

Anisotropy can occur if uniform rope-like structures like a tendon reflect the incident ultrasound wave away from the transducer. The transducer then doesn't receive the echo and will make that area look hypoechoic which can mimic a tendon tear or other tendon pathology. To check for this, change the ultrasound angle slightly and see if the artifact goes away and you now see an echogenic tendon. If you change the angle and see the tendon in the region that previously looked like a tear, you have confirmed that what you were seeing was artifact from anisotropy and not a true tendon tear.

How do you prevent color flash artifact?

Color flash artifact results from motion of tissue in the ultrasound beam or motion of the transducer over tissue that causes a flash of color when using color Doppler imaging. A good example is flashes of color on a breast ultrasound when a patient is talking, due to movement of the chest tissues from respiration/vibration from talking. To prevent this artifact, take measures to prevent motion of the ultrasound probe or motion of the patient while imaging with color Doppler imaging. Another strategy is to reduce the color gain to make this flash artifact less likely to occur.

True or false: Ultrasound velocity is independent of the frequency of the emitted soundwaves.

True. Velocity of the sound wave is determined only by the type of material the sound wave is passing through. This is calculated as the inverse of the square root of the compressibility of the material. Less compressible materials have higher sound wave velocities. Ultrasound waves travel faster through bone and slower through air.

What is acoustic impedance?

Acoustic impedance is an intrinsic property of a material that is the product of the density of the material and the velocity of sound within the material. Differences in acoustic impedance between materials determine how much energy is reflected at the interface of the materials. Interfaces between low acoustic impedance and high acoustic impedance materials will reflect the most energy. Examples of

Listen to the associated podcast episodes available at theradiologyreview.com or on your favorite podcast directory.

highly reflective interfaces are bone/soft tissue and soft tissue/air interfaces. An ultrasound image is essentially an acoustic impedance map.

What is the difference between non-specular and specular reflections?

Specular reflections are from large smooth surfaces and reflect a lot of soundwaves back to the transducer. Nonspecular reflections are from rough, irregular materials that scatter rather than reflect a lot of the soundwaves. The echoes from specular reflections are the primary component of ultrasound images.

What does ultrasound gel do to improve the image quality of an ultrasound system?

The gel displaces air between the ultrasound transducer and the patient's soft tissues, thereby getting rid of the large difference in acoustic impedance that would otherwise occur if air existed between the transducer and patient's skin—this promotes transmission of ultrasound into the patient's body and reduces reflection of ultrasound beams by air outside of the patient's body.

If a surface being imaged is larger than the wavelength of an ultrasound beam does this promote reflection or scatter of the ultrasound beam?

Large surfaces promote reflection of the ultrasound beam. In general, if the surface is larger than the wavelength of ultrasound, reflection will occur. If a surface is smaller than the wavelength of ultrasound, scatter will occur.

Does increased scatter increase or decrease the echogenicity of a structure?

Increases in scatter increase the echogenicity on an image. ECHOgenicity literally has "echo" in the name and this is because the echogenicity is related to the degree of echoes from a tissue. This is why cysts are anechoic—because they transmit the ultrasound wave without scatter and they are therefore "anechoic" or another way of saying this is "without scatter".

What are two major factors that increase attenuation of ultrasound in the body?

Absorption and scatter of the ultrasound beam.

What is the primary determinant of the frequency of an ultrasound probe?

The thickness of the piezoelectric crystal determines the frequency. Higher frequency probes are thinner/have thinner crystals and lower frequency probes are thicker/have wider crystals. In general, smaller frequency probes give more detailed images. Lower frequencies have better depth penetration.

What is the pulse repetition frequency and how does changing the pulse repetition frequency affect an ultrasound image?

The pulse repetition frequency (PRF) is a measure of how many soundwaves are transmitted per unit time. In general, an ultrasound system listens about 100x longer than it transmits and the longer you listen (the lower the pulse repetition frequency) the more time sound beam has to penetrate tissue and reflect back to the probe (thereby obtaining deeper echoes). So lower frequencies and lower pulse

Listen to the associated podcast episodes available at theradiologyreview.com or on your favorite podcast directory.

repetition frequencies result in increased depth penetration with tradeoffs of lower spatial and temporal resolution.