OPTIMIZING YOUR ULTRASOUND IMAGE

A QUICK REFERENCE GUIDE

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THE ULTRASOUND STORE, INC.
EXPERTS IN SOUND

Could my ultrasound images be better? Why am I not seeing what I want? Is that a polar bear in a snowstorm?

If you use ultrasound, you've probably asked yourself these questions. Well, maybe not exactly the polar bear in a snowstorm one, but maybe one like it.

Ultrasound imaging is an indispensable diagnostic tool, is relatively inexpensive and provide quick diagnostic information. Gaining a better understanding of imaging techniques and the system adjustments that can be made, are an essential skill to achieve the best image quality and diagnostic outcomes.

The goal should be to achieve the best possible image quality your system is capable of.

Familiarize yourself with the controls on your particular system and learn how they affect the image. **First and foremost: Always use a sufficient amount of coupling gel or alcohol. It is always best to shave the area to be scanned if you want to produce the best image quality.** If there is any air between the transducer and the patients skin, you will not get a good image!

When viewing your image quality there are important factors to consider: Could a better image may be acquired by using a different probe or selecting another frequency? Would adjusting the way you are manipulating the probe/scanning technique help? Or, could the image be improved with system settings. Ask yourself: Do I have sufficient coupling medium to prevent air between the transducer and skin? Could fat, bone, artifact or tissue density affecting the image? Is there pathology present? Could there be a problem with the ultrasound equipment itself?

HOW IS THE ULTRASOUND IMAGE FORMED

- Simply described, the ultrasound image is produced when the sound beams produced by the transducer, interact with the tissues beneath the transducer. The transducer sends out high frequency sound pulses and this information is reflected and returns to be received by the transducer. It is similar to the sonar used to detect submarines or the depth to the ocean floor, with a bit more information added. The system is timing how long it takes for the sound pulses/echoes to return to the transducer. This determines the depth of the echo and the position on the screen. The amplitude of the returning echo determines how bright that echo should be displayed. At an interface between tissues where there is a large difference in impedance, such as soft tissue and bone, the sound beam is strongly reflected, and this produces a very bright echo on the image, which is described as hyperechoic. If the sound beam encounters a strong reflector like bone, all of the sound energy is reflected back to the transducer and the area beneath the bone shows up as black. An area on the image that has no echo and is black is termed anechoic, whereas an area with a weak or low echo is termed hypoechoic. Fluid is anechoic and shows as black on the screen. If a structure is of equal echogenicity to the adjacent soft tissues, it may be described as isoechoic.

CHOOSING THE BEST TRANSDUCER

SYSTEM ADJUSTMENT

OPERATOR ADJUSTMENTS

CHOOSING THE BEST TRANSDUCER

There are quite a few transducer types available and they are typically model and brand specific. Depending on the application, there are different frequencies, shapes and sizes to best image the structures you want to see. Modern broad bandwidth transducers have variable frequencies that can be selected by the user and allow it to image a greater range of depths. Here are some of the most common used in veterinary:

- Frequency (MHz): High MHz transducers produce better resolution in the near field or close to the skin, but they do not penetrate as well to image deeper structures. Lower frequencies penetrate further, but give up resolution. The rule is to use the highest frequency that still allows you to penetrate to the area of interest. Most systems/transducers can vary the frequency within a given range on each transducer and are changed with an on-screen selector.
- Convex Array Transducers: These probes give you a wide field of view and produce a pie shaped image on the screen. Typically used for abdominal and pelvic imaging in larger patients. Frequencies range typically from 2-6 MHz.
- Micro-Convex Array Transducers: These produce an even wider field off view than convex probes and use higher frequencies typically 3-9 MHz or higher. This is the most versatile transducer for small animal imaging.
- Linear Array: This probe displays a rectangular image and uses high frequencies to produce high resolution images of shallower structures. Frequencies rang from 4-15 MHz or higher. Pro tip: Split/Dual screen, Panoramic View and Trapezoid Imaging can help fit larger structures into one view.
- Phased Array: These probes are used for cardiac imaging and are design to have a narrow triangle shaped image, that is well suited for scanning between ribs. Larger patients are best imaged with a 2-4 MHz probe, medium 3-8 MHz and even 4-12 MHz probes are available for very small patients.
- Linear Rectal Repro/Endocavitary: The linear rectal transducer is the standard for large animal reproductive ultrasound. Frequencies range 3.5-10Mhz. There are also repro rectal probes that have a slightly curved array that produce a slightly wider field of view.

WIRELESS POCKET SIZED TRANSDUCERS

Wireless transducers: Conventional transducers connect to the ultrasound via a cord, whereas wireless probes create their own wireless signal and transmit to a device that has an app installed to produce the ultrasound image. These units come in different forms like the conventional transducers above. Some have two or more types incorporated into one unit. Although not quite as powerful as conventional systems, wireless transducers have improved significantly and also have a size advantage, some can even be comfortably carried in your shirt pocket. They are great for quick looks and can often give you the diagnostic information you need. For more challenging cases and most cardiac imaging, it is still best to have a higher end system available. We recommend having both a wireless and a conventional ultrasound, using the wireless for accessing for fluid collections, cystocentisis procedures or basic diagnostic imaging. The Ultrasound Store is now offering a free wireless with the purchase of the Ultros Q10 Tablet, while supplies last!

SYSTEM ADJUSTMENT

Quick Guide

1st	Gain	Adjust so fluids are black. Bone is white. Liver or spleen medium gray
2nd	Frequency	Use highest frequency that still allows proper penetration to area of interest AOI
3rd	Depth	Set so that none of your AOI is cut off and is easy to view
4th	Focal zone(s)	Adjust so the marker is in line horizontally with your AOI
5th	Other settings	See below if your image is still not as good as you would like

GAIN

- Gain controls the overall brightness of the image. When adjusting this, if you image the bladder (image 1) or other fluid, this should be displayed as black. If the gain is too high, you may see gray instead. If you look at bone (image 2), it should be white. If you image muscle or liver (image 3), we should be displaying a medium gray. It is useful to look at the grayscale bar along the right side of the image. You should see white at the top and black at the bottom, with a smooth transition from white to black.

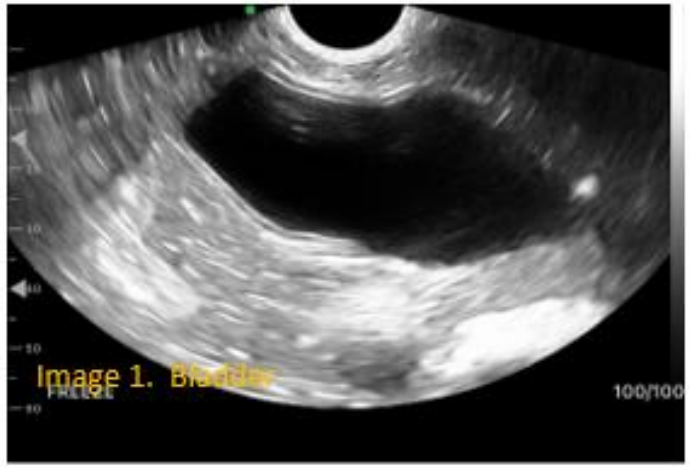
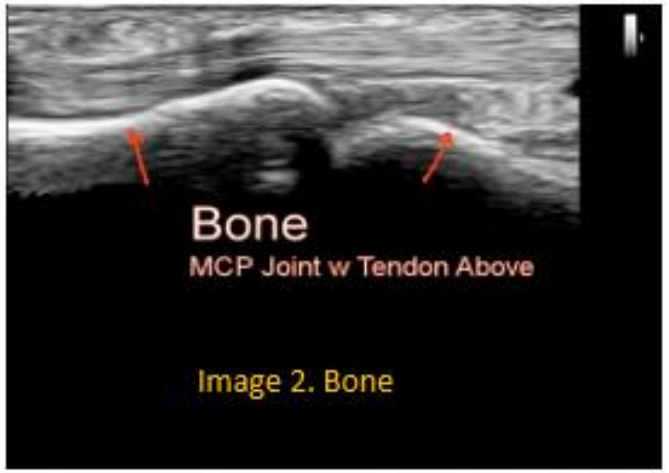
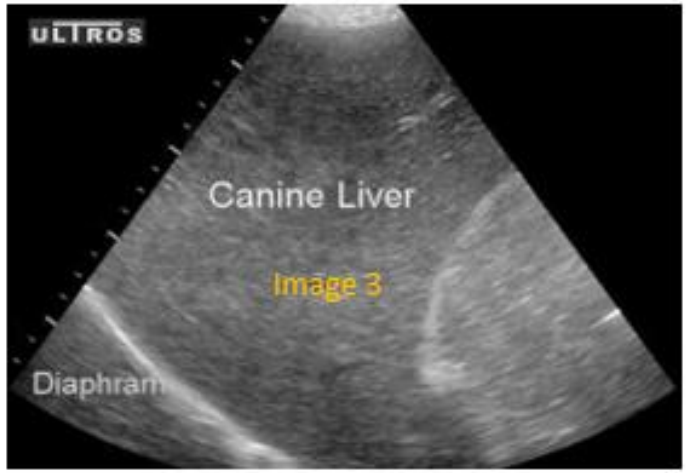
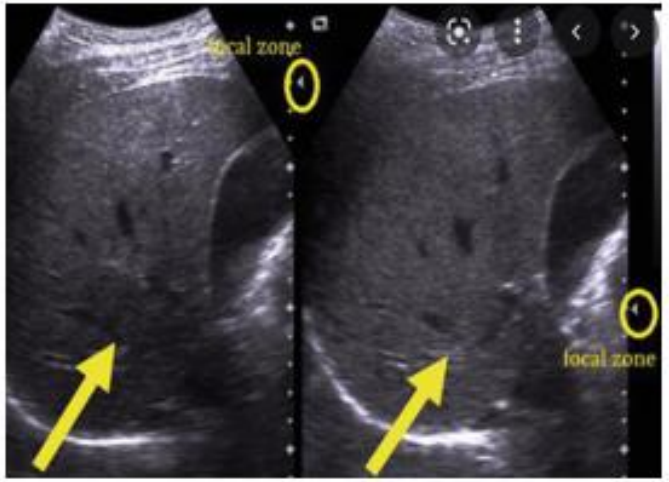
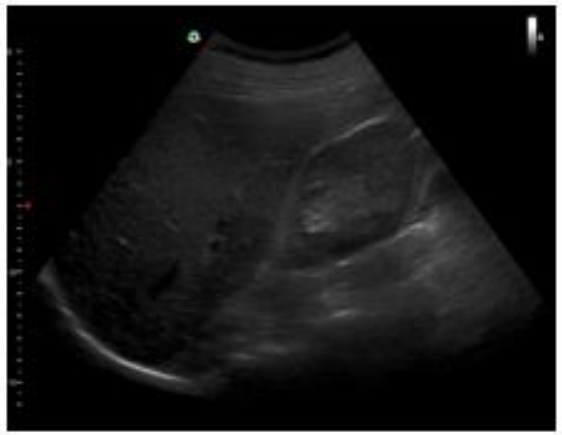


Image 1. Bladder

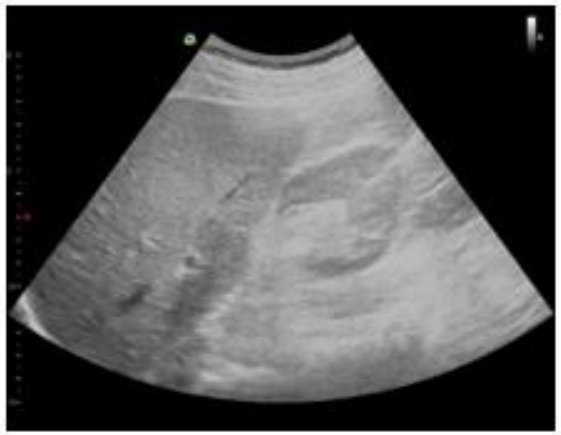

Bone
MCP Joint w Tendon Above
Image 2. Bone


ULTROS
Canine Liver
Image 3
Diaphram

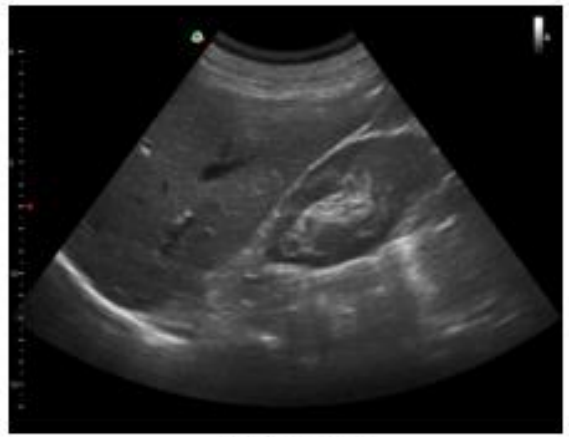

focal zone
focal zone



Too Dark



Too Bright



Just Right

Focal Zone(s)

- The focal zones can be adjusted on most systems to improve the resolution at a given depth. The focal zones are represented on the screen with arrows (these can be seen on the right side of image 4 above). You can select how many focal areas are active and at what depth. Adjust these to be horizontally aligned with the area of interest (AOI). Note the area by yellow arrows in image 4, see how the image is improved when the focal zone is in line with the AOI. Note: The more focal zones you have activated, the slower the frame rate. One focal zone provides the clearest definition, but in a narrower range.

Dynamic Range

- **Dynamic Range**- adjusts how many levels of gray are displayed in the image, like adjusting the contrast but just for the image, not the whole display screen. This is subjective and will typically be at a good starting point when you select your exam preset. Exam presets are set to a default by the manufacturer, but a good applications specialist can create custom presets for you and the type of patient you are imaging.

Depth

- If your depth is too shallow you may be cutting off anatomy that you may want to be imaging. Too deep and the anatomy you want to see will be smaller than optimal. Adjusting depth to display the largest view of the target anatomy, without cutting any off, is the general rule. Pro tip: Split/Dual screen, Panoramic View and Trapezoid Imaging can help fit larger structures into one view. Convex transducers have a wider field of view and usually have lower frequencies, hence they are generally better for deeper structures

Frequency

- Higher frequencies produce better resolution
- Lower frequencies give better penetration

Use the highest frequency that still allows you to penetrate to the area of interest

TGC – Time Gain Compensation

- On most ultrasound systems, adjustments are made via sliders. Sliders at the top adjust the brightness/gain of the image at the top of the ultrasound display. The lower sliders adjust the bottom of the image.
- These should be set to produce an even appearance from the top to the bottom of the image.
- Some higher end systems have Automatic Tuning buttons that can make these adjustments for you. Often, you will need to fine tune the overall Gain to set the image brightness to the optimum level after using Auto Tuning.

Spatial Compounding, Frequency Compounding & Speckle Reduction

- Most modern and higher end systems have most or all of these features. These technologies have greatly improved the look and quality of the ultrasound image.
- Spatial Compounding (SC) may just have an on/off selection or you may have different levels. SC greatly improves image quality by steering the ultrasound beams at different angles and provides a smoother image, better defined tissue borders and more information forming the US image.
- Frequency Compounding (FC) improves signal to noise ratio, spatial resolution, and image quality. It also reduces speckle and clutter artifacts.
- Speckle Reduction greatly improves the look of the image by reducing speckle. Most systems have multiple levels that can be adjusted to suit your preference. I prefer a mid to high level setting.

Tissue Harmonic Imaging (THI)

- THI technology can improve axial resolution and can be very useful in larger patients. Contrast resolution can be enhanced as well, such as clearing cysts and fluid collections of internal echoes, and better differentiation between various tissue types. Tip: try turning this on and off to create the clearest image, as various depths are affected differently

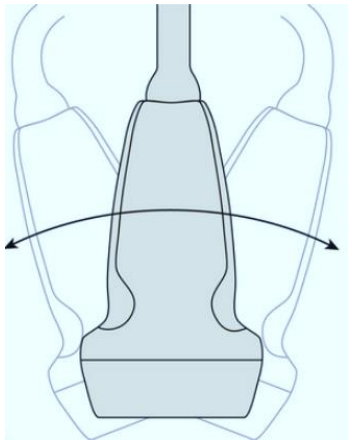
Screen Adjustments

- You can make adjustments to your display screen for brightness and contrast. This is for the overall display screen and can affect how your ultrasound image looks as well. This can be found in your system settings or menu screen, depending on the system. It is best to scan in a darkened room. This allows the best viewing of the screen. Your screen should be adjusted to the ambient light level of your scan area.

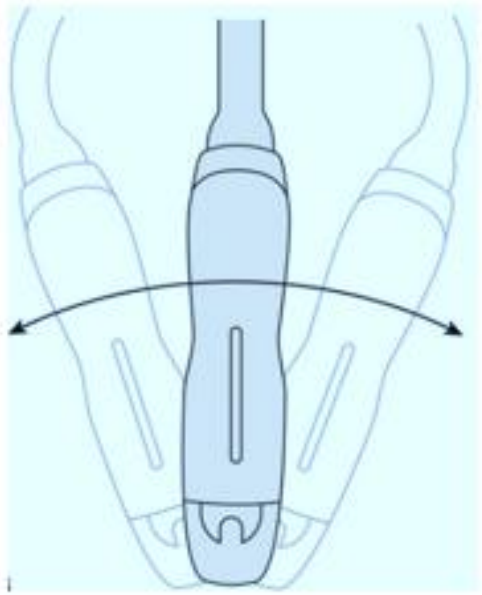
OPERATOR ADJUSTMENTS

How the operator/ sonographer moves and angles the probe as well as the amount of pressure applied can greatly affect the image. The goal is to have the ultrasound beams reflect off the structure being imaged at a perpendicular angle. This provides the strongest reflection of the sound beams to be picked up by the transducer. Remember the transducer sends out a sound pulse, and then listens for the returning echo.

- **Heal-Toe maneuver:** This maneuver is accomplished by rocking the transducer back and forth along the long axis. Use sufficient gel so that the transducer face doesn't have any air gaps or you will lose the image in that area. The transducer is not moved from its location, but rather the transducer is only angled.



Rocking maneuver: move the transducer from side to side in the short axis. The transducer is not moved from its location, but rather the transducer is only angled.

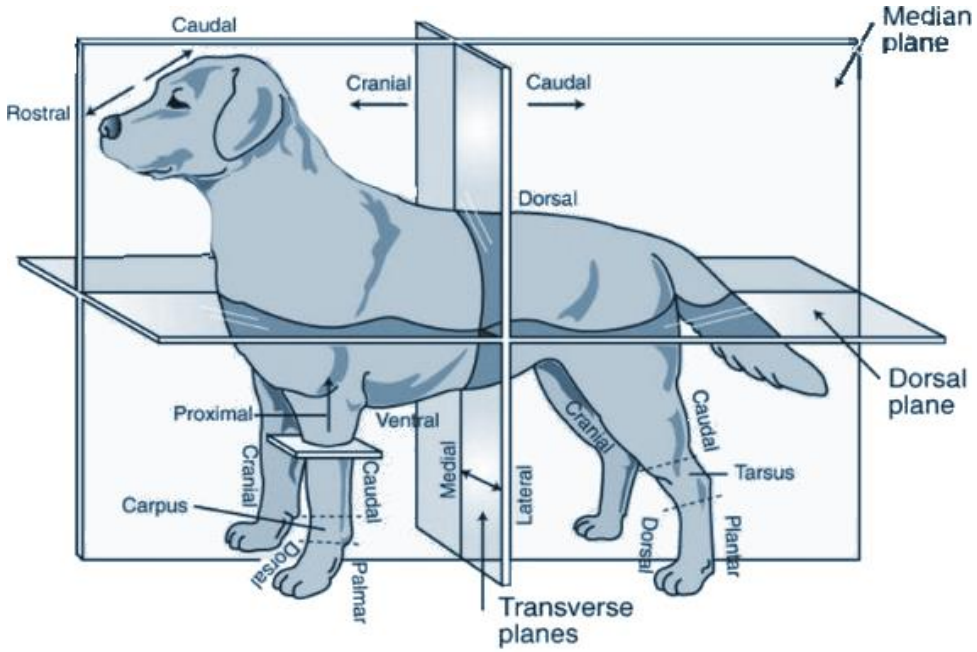


- **Pressure applied to the transducer:** applying downward force can improve image quality by reducing the distance from the skin to the AOI, as well as assuring good contact with the skin (no air gaps). Not too much pressure though.
- **Longitudinal and Transverse scan planes:** to get the most information from the scan you will need to image the structure in two planes, long and short axis. Also make sure to sweep through the entire structure, saving pictures for documentation.

Describing the ultrasound image:

- Hyperechoic: Appearance of brighter gray than surrounding tissues on an ultrasound. Structures that return stronger echoes of sound
- Hypoechoic: Appearance of darker gray than surrounding tissues on an ultrasound. Tissues that return weaker echoes of sound
- Anechoic: Areas without echoes, such as cysts or fluid fill cavities. Black appearance
- Isoechoic: Equal echogenicity to the adjacent soft tissues
- Homogenous: Of uniform structure or composition; such as a normal liver or spleen
- Heterogenous: Non-uniform appearance

Positioning:



We are here to help!

Our Telemedicine system connects you with our sonographers in real-time. With a remote-controlled camera, we can see the probe's position on the patient, guide you to the right spot and help you optimize the image. We can also see your keyboard to tell you what button to press or adjust. We can see the image on your screen through a live feed to assist you in acquiring the correct diagnostic image. It is very reassuring to have an expert "looking over your shoulder" as you learn! We even have radiologists and cardiologists available to interpret the really tough cases. You've got this! We have your back.

Ultros Q10 Ultrasound with Robotic Camera and Telemed Tablet

4. Patient variations

Patient size greatly affects the image and determines what transducer you must use and what frequency to select. The further an ultrasound beam travels through the body, the more it is scattered and attenuated. Fat and air are factors affecting quality by causing disruptions to ultrasound beams. Deterioration in resolution with increasing thickness of fat is common. Using pressure to decrease the distance between the skin and the AOI may be helpful in improving the image. Edge artifacts are caused by the ultrasound beams being deflected by striking the edge of a curved structure. Shadowing occurs when the ultrasound beam strikes a strong reflector such as bone or calcifications for example. The effect is a display of black below the strong reflector. Age of the patient can change the appearance of the image, accumulation of extra water in soft tissue, as occurs with edema; loss of muscle mass, as happens with hypotrophy; and accumulation of fat in the muscle, thereby producing an US image not as sharp and with less contrast. Pathology will alter the normal appearance of the tissue being imaged.

It is important to gain experience in imaging normal sonoanatomy before an operator can reliably visualize any pathology. Our telemedicine sonographer support will greatly aid you in gaining this knowledge.

The sonographer can often change the" acoustic window" to avoid structures that might cause artifacts. If you are imaging the heart, you need to scan between the ribs for example. You may find it helpful to picture the ultrasound transducer as a FLASHLIGHT and that you are pointing that flashlight at the AOI.

4. Equipment Condition and Quality

Having your system maintained and calibrated is important to keep your system imaging at its best. There are a number of adjustments that could be affecting your image. Having your system tuned with excellent presets is a huge help. The Ultrasound Store never uses the default settings that the factory thinks are best. We are constantly looking to improve upon the system's performance and create the best exam presets possible. This allows most patient exam settings to be selected with one touch of a button!

Just like TV's and computers, ultrasound technology is constantly improving. Even a system 5 years old ultrasound system will produce image quality inferior to a new system that may even cost much less than the "old" system. Think back only a few years ago and your TV had "only" 480 pixels. Then 720p, 1080p and now 4k UHD TV screens are available and ultrasound resolution has many more variables than a TV screen. Technologies mentioned in the system adjustment section, such as spatial compounding, frequency compounding, speckle reduction and tissue harmonics are relatively new features, and have greatly improved image quality. The number of processing channels the ultrasound machine uses to interpret the echo information, makes a big difference in image quality. 32 processing channels are still used in low end systems, but the new Ultros Q10 Tablet Ultrasound uses 51,200, allowing it to produce excellent image quality, but it is still affordable. The number of piezo electric crystals in the transducer that send and receive the ultrasound pulses affect image quality. The more densely packed the crystals are, the more information is available to create the image.

We are happy to answer your questions and assist you in getting the best image quality. Feel free to email s.cone@ultrasoundstore.com, call 877-465-7088 or message us on WhatsApp +1 (410) 991-6511

Looking to upgrade or get training? Visit us today at www.UltrasoundStore.com or call us at 877-465-7088 or WhatsApp chat with at +1 410-991-6511