The use of ultrasound technology for reproductive work is growing in popularity among bovine practitioners; but why stop there?

Many other body systems can be readily examined with the equipment you already have for rectal ultrasound. Most bovine rectal probes are linear, with frequency ranges from 4.5 to 8.5MHz or up to 10MHz for some newer probes. This equipment provides approximately 10 to 15 cm maximum depth of penetration; low frequency curvilinear rectal probes have greater penetration.

Using ultrasound isn’t just super fun, it’s also a useful diagnostic tool for a variety of conditions in different body systems and is not only useful for research or referral practice, but also for the general bovine practitioner. What structures can be imaged with an ultrasound? The better question is, “what structures can’t be imaged?” The major limits are depth of the structure of interest relative to the maximum penetration of your probe, attenuation of ultrasound waves by gas or bone between your probe and the structure of interest, and adequate restraint to protect yourself and your machine.

Recent publications provide reference material for ultrasound examination of a variety of bovine body systems that can be scanned with a rectal probe. Several studies have used rectal probes, or probes with similar specifications, for a variety of non-reproductive imaging studies. For example, thoracic ultrasound can be used to investigate respiratory disease (Buczinski et al 2013), or teat ultrasound to investigate difficult milkers (Franz et al 2009) or reticulum ultrasound to investigate suspected hardware disease or motility disturbances (Streeter et al 2007, Braun et al 2015), or topline ultrasound for a more objective measure of body condition score (Pothmann et al 2015), to name a few. Ultrasound can also be useful for picking up subclinical diseases. Ultrasound examination at the base of the ear, using a 7.5MHz linear probe, can detect subclinical otitis in calves and is quite specific for diagnosing clinical cases of otitis (Gosselin et al 2014). Also, a rectal probe can be used to diagnose lung disease before the onset of clinical signs in neonatal calves with 94% sensitivity and 100% specificity (Ollivett et al 2015).

The musculoskeletal system can also be examined with a rectal probe. For example, a rectal probe can be used to image gross evidence of extension of deep digital sepsis up a flexor tendon sheath, or for differentiation between causes of swellings associated with lameness (Kofler et al 2014).

Some portable bovine ultrasound machines are compatible with additional probes; common additions are abdominal probes (curvilinear low frequency probes between 2.5 to 5MHz) and tendon probes (high frequency linear probes usually 6 to 10MHz). An abdominal probe adds considerable size and depth to the field of examination. Such a probe allows you to carry out
more sophisticated examinations of the abdomen during a bovine colic work-up (Braun et al 2011), diagnose liver abscesses (Doré et al 2007), make an ante-mortem diagnosis of portal vein thrombosis (Braun et al 2002) or abomasal lymphoma (Buczinski et al 2011), assess fetal well-being trans-abdominally during late gestation (Buczinski et al 2011), or get a larger field of view during a thoracic ultrasound to name a few possibilities. The high resolution of a tendon probe is useful to obtain more detailed images of bovine musculoskeletal structures, and can image conditions such as septic arthritis or ligament ruptures (reviewed by Kofler et al 2014). Also of note, the narrow footprint of a tendon probe is also handy for thoracic ultrasound of smaller ruminants, where intercostal space is limited (personal experience).

If you still aren’t ready to take the rectal probe out of the rectum, there are many structures that can be examined via rectal ultrasound, in addition to the ever-popular reproductive tract. The urinary tract (Lesser et al 2014, Floeck et al 2009), boney pelvis (Grubelnik et al 2002) portions of the small and large intestines, or even abdominal fat necrosis (Tharwat et al 2012), among other structures, can all be examined during a rectal ultrasound.

The most common sites that I have personally found useful to use the rectal probe (outside of reproductive examinations) in ambulatory practice include: thorax (lung), umbilicus and reticulum. Below is more detail on the ultrasound exam of these sites

Preparation of the bovine (or small ruminant) patient for external ultrasound imaging is simple. A clean, shaved site is ideal. Ultrasound gel is the standard coupling agent, but for patients that cannot be shaved, or when you don’t have ultrasound gel handy, 70% isopropyl alcohol can be used to soak the site and the probe can be applied directly to the soaked hair or clipped skin. Obstetrical lube can be used in a pinch, but image quality appears to suffer (personal experience).

Thoracic ultrasound in calves has been the topic of several recent publications (Teixeira et al 2017, Ollivett et a 2016, Ollivett et al 2015, Adams et al 2016). The technique is technically simple to perform and has a variety of uses outside of a research setting including both group screening and investigating individual cases. Additionally, thoracic ultrasound can be used to screen at risk calves for pneumonia before field anesthesia for other procedures. The calf can be restrained by an assistant or head lock for smaller calves, and in a chute for larger calves. Clipping may improve image acquisition particularly if the patient has a thick or very dirty coat, however a diagnostic image can often still be obtained through alcohol soaked hair provided the coat is not too thick or dirty. The ultrasound can be set to a relatively shallow depth, depending on the thickness of the thoracic wall (thin for young calves, thicker for adult cattle) and adjusted to visualize the depth of any lesions identified. The calf lung field can be imaged from the 10th to the 1st intercostal space on the right, and from the 10th to the second on the left. The probe is pressed between and parallel to the ribs, starting at the caudo-dorsal margin of the lung field. The footprint of the probe can be angled slightly cranially or caudally to keep the image between the ribs. The aerated lung surface will create a hyperechoic line, and reverberation artifact will be present beyond this line. This line should slide back and forth with respiration and may be referred to as the, “glide sign”. Ribs will also create an echogenic white line; it is important to differentiate ribs from lung surface. Slight repositioning or fanning of the probe can be used to
determine rib vs lung surface. Once the lung surface has been identified, the probe is moved ventrally (and slightly caudally) to stay between the ribs, and move along with the hair. Each rib space is scanned from the dorsal lung margin, just below the epaxial musculature to the ventral margin of the lung, as shown in the power point. To examine the cranial aspect of the lung, the probe is positioned between the elbow and the thorax, under the triceps muscle, to image the portion of the thorax deep to the thoracic limb. The thymus is important to differentiate from consolidated lung when examining the cranial most portion of the lungs. This structure may be differentiated because it is not continuous with the lung surface, rather the aerated lung makes a ‘curtain’ artifact at the edge of the lung surface, and the thymus does not move with the lung. Throughout the exam, the lung surface is assessed for any deviations from the smooth echogenic gliding hyperechoic line. Anechoic space between the thoracic wall and the lung surface indicates fluid within the thorax. Roughening of the pleura creates an irregular echogenic line with irregular reverberations; these abnormalities are referred to as comet tails. Anything that disrupts the gas interface at the lung surface such as an abscess or consolidation will appear as a less echogenic defect in the lung surface. Severe or large areas of consolidation will appear similar to liver, and these areas may be referred to as hepatized lung. Ultrasound evaluation of these abnormalities of the lung surface have been used to create grading systems (Adams et al 2016, Ollivett et al 2016). Such grading systems may be useful for herd screening or evaluation of staff detection rates or treatment success.

Another technically simple site to examine is a calf’s umbilicus. This is a simple technique that aids in the decision between medical management, lancing an external abscess and going in for abdominal surgery. This technique is likewise helpful for imaging the contents of an umbilical or inguinal hernia. Loops of bowel, adipose, and abomasal tissue, for example, can often be differentiated using ultrasound and thus the technique can aid in surgical and anesthetic planning. This can be done while the calf remains in standing restraint. Images are most rewarding when the site is clipped, and soaked with alcohol or gel. The probe is pressed perpendicular to the long axis of the body, against the extra abdominal portion of the umbilical defect first, then the defect is followed by slowly sliding the probe cranially and caudally. The defect in the extra abdominal portion can be examined, then traced in both directions. Defects that cross the body wall, such as umbilical remnant infections, appear as a tube or cord that can be followed from the extra-abdominal portion and remain in view while crossing through the body wall, and may be traced cranially or caudally. Infected umbilical vein remnants travel cranially toward the liver. Urachal remnants travel caudally toward the apex of the urinary bladder. Infected umbilical artery remnants are less common but can also be traced caudally, and may continue around the urinary bladder toward the aorta. A 2009 VCNA article by Steiner et al provides a useful reference for bovine umbilical ultrasound.

The reticulum is another reasonably simple site to image using the rectal probe. I have found this technique useful for ruling in traumatic reticuloperitonitis/ perireticular abscesses in cases where the physical exam reveals only vague or non-specific signs of systemic illness. This technique may also be a useful adjunctive diagnostic tool for vagal indigestion or forestomach outflow obstructions (Braun et al 2009). The cow should be in standing restraint and the examiner’s body and machine positioned cranially to avoid kicks. The cord of the probe
shouldn’t hang too low where the cow could step on it. Images are more rewarding when the site is clipped and soaked in alcohol or gel. The probe is pressed against the cranio-ventral abdomen, just to the left of midline, parallel to the long axis of the body. The reticulum can typically be imaged at the cranial most portion of the abdomen. The normal caudal border of the reticulum will create a cleft as it lies against the rumen. Luminal contents cannot typically be imaged due to gas production by bacteria along the wall.

Constant improvement in ultrasound technology across medical fields has translated into ever-improving equipment available for use in production animals. Many potentially practical applications have been investigated, but have not yet been widely adopted by general food animal practitioners. As we become more familiar with different uses of our ultrasound machines, we can contribute to the development of more practical applications. So don’t limit your probe or your mind; get the most out of your ultrasound machine!

References:


