SWINE SCANNING LESSON NUMBER 2

BioSoft Toolbox® for Swine

Inside This Lesson

Equipment settings must be checked before the start of each scanning session.

Gain Controls

Figure 1. Aloka

Figure 2. Aquila Vet

Scanning for Backfat and Loin Muscle Area

The purpose of this lesson is to describe proper procedures for ultrasound scanning of live swine to determine carcass composition. Numerous reports have indicated that percentage lean is strongly and positively correlated with loin muscle area and negatively with backfat depth. Thus, accurate live animal measurement of the traits has led to genetic improvement of them. Ultrasonic backfat depth and loin muscle area are determined from a cross sectional or transverse image of the loin muscle. The measurements are taken at the 10th and 11th rib interface due to repeatability advantages and the technician's ability to visualize this particular anatomical location on the ultrasound console monitor screen.

The linear and area measurements associated with a loin cross section can be made with an ultrasound console or personal computer, if the images are saved for later processing using BioSoft Toolbox® II for Swine. For accurate measurements, proper procedures and scanning protocol must be adhered to. The accuracy of measurements will only be as good as the quality of the images that are collected for each animal. The collection of quality images requires an understanding of ultrasound equipment, porcine anatomy, and a significant amount of scanning practice by the ultrasound technician.

Scanning Equipment

BioSoft Toolbox® II for Swine is compatible with the Aquila Vet scanner fitted with an 18 cm, 3.5 MHz linear array transducer. The program also works for images collected with the Aloka SSD 500V scanner and UST 5011 3.5 MHz linear array transducer.

To avoid damage to equipment, the ultrasound scanner console should never be connected to an electrical power source or turned on until the ultrasound transducer has been properly attached. Likewise, the unit should be turned off before detaching the ultrasound transducer. It is absolutely necessary that several equipment settings be made on the ultrasound scanner prior to collecting images. The ultrasound technician must make sure that the settings are correct before each scanning session. It is also important to make sure that during the scanning session, settings are not accidentally changed.

On the Aloka SSD 500V, magnification of the image size must be set to X1.5. This setting is controlled by a button on the front face of the console. The ultrasound scanner can be checked to make sure the magnification is correct by looking at the display lower left hand corner (see Figure 3). Focus zones 1 and 2 must be enabled, with zones 3 and 4 in the 'off' position. Frame correlation is to be set to 'auto'; contrast to '4'; and AGC to '1'. Refer to the Aloka SDD 500V User's Manual for more information on properly setting the equipment.

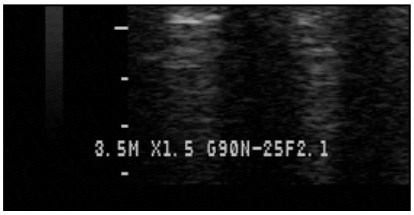

Figure 3. Aloka 500 gain and magnification settings.

Aloka 500 overall gain (G), controlled by the large circular knob on is to be set to G90 or its maximum value. The slider controls located just above the overall gain knob control NEAR gain (N) and FAR gain (F). The NEAR gain is to be set to N-25, and the FAR gain is to be set to F2.1. These values appear on the console display in the lower left corner as shown in Figure 3.

Aquila Vet images are to be captured at a 26 frames per second magnification with total gain set at 255, near gain at 80 and far gain at 0. Focal zone 2 is the default zone for the Aquila Vet set to 26 frames per second. The Aquila Vet gain settings are seen in Figure 4.

Figure 4. Aquila Vet gain settings.

Weight and Age at Scanning

Although some lean growth modeling studies have collected cross sectional images from all ages of pigs, the measurements have the most predictive power at or near the end of the growing phase. In the USA, pigs are typically scanned at off-test time or just prior to harvest at a market weight range of 230-280 pounds (104 - 127 Kg). Pigs consistently achieve this weight by the time they are approximately six months old. Also, at this weight and age, pigs will have expressed their individual genetic potential for carcass traits. Off test scanning of potential breeding boars and gilts to determine estimated breeding values is a common application of ultrasound. Some herds in the USA collect ultrasound images from all siblings, relatives, and progeny, enhancing the rate of genetic improvement.

Restraining the Pig

Figure 5. Restraining crate for scanning pigs.

Quality ultrasound images can only be collected from pigs that are properly restrained. The pig must be confined to a crate that will restrict its forward, rearward, and lateral movement. The pig must also be restrained so that it is not able to raise its head above the top of the crate or to climb out of the crate. Quality images can only be captured when the pig is near motionless.

Some technicians have developed a mechanical bar that goes between the legs of the animal (from front to back) and can be raised to elevate the pig off of its feet. An example crate with a raising bar that was developed by swine researchers in Canada is shown in Figure 5. This is an extremely useful innovation that contributes not only to capturing excellent quality images, but to the safety of both the pig and the technician. This innovation also cuts down considerably on the amount of time required to scan the pig, and minimizes the stress level of the pig.

Figure 6. Scanning crate and equipment setup.

Equipment Set Up

Generally, the equipment should be positioned securely and in a way that allows the technician to comfortably view the ultrasound console monitor screen. Technicians may find it convenient to position the crate and a table for the ultrasound equipment as shown in Figure 6. This configuration allows the technician to both observe the real time image and the positioning of the transducer on the back of the pig at the same time. For cross sectional scanning, a sound emitting standoff guide that conforms to the pig's back should be securely attached to the ultrasound transducer prior to scanning. A couplant should be applied at the interface of the standoff guide and ultrasound transducer.

Animal Preparation

Many problem images can be avoided if the anatomy of the pig is understood.

The external scanning region needs to be cleaned thoroughly and free from any dirt or other debris. If the pig has a very thick hair coat, it may be necessary to clip the hair so that the ultrasound signal can be transmitted without excessive reflection or absorption. These simple preparations will allow the ultrasound waves to freely penetrate the skin and lead to clear images.

After cleaning the scanning site, a vegetable oil couplant must be liberally applied to the skin surface. Soybean oil makes a very good type of couplant; however, other oils such as corn oil can be used effectively. Acoustic gel is generally too expensive to be used as a scanning couplant for animals. The couplant allows the ultrasound signals to easily penetrate the skin and enter the tissues below the skin surface. A couplant will eliminate air pockets between the transducer and skin surface that can reflect the ultrasound energy before it reaches the skin.

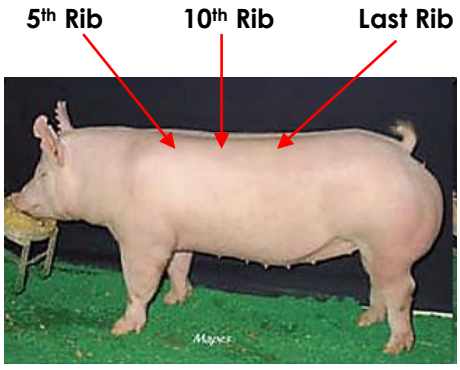

Figure 7. Porcine Anatomy

Anatomical Location

From the outside of the animal, a starting point for locating the 10th and 11th rib interface is found approximately a hand's width posterior of the posterior end of the forearm (see Figure 7). In other words, a hand's width behind the shoulder. Pigs can be scanned on either the left or right side; however, it is important that all pigs within a contemporary group be scanned on the same side. It is logical for a right handed person to scan the right side and vice versa. Another consideration is angle of the ribs. Notice in Figure 8 that the ribs are not perpendicular to the spine and consequently, the transducer will need a similar angle.

Figure 8 is the skeleton of a mature porcine that has 14 ribs with the 10th rib identified. The red arrow in Figure 7 is showing the similar position.

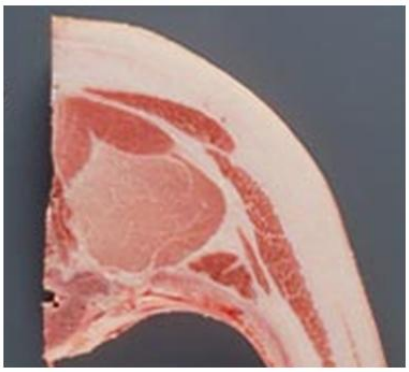

Figure 9. 5th rib cross section

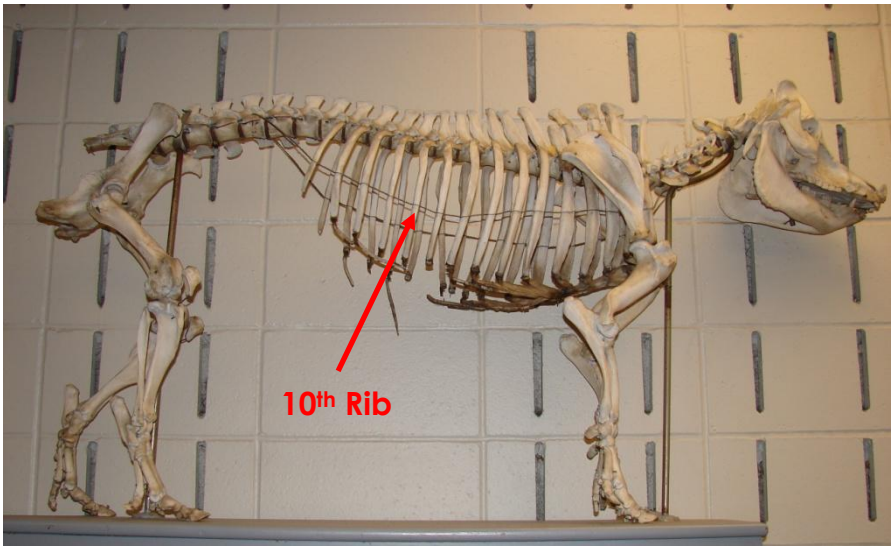

Figure 8. Skeleton of Mature Porcine

Figure 10. 10th rib cross section

Figure 11. Last rib cross section

Positioning the Transducer

The single most important cross sectional image quality factor is anatomical location. Thus, a discussion about correct positioning of the transducer on the outside of the animal warrants a detailed description of internal porcine anatomy. The ability of technicians to visualize the internal anatomy of the pig allowed real time ultrasound to replace early A-Mode devices that emitted only a single sound wave and had no two-dimensional display. With real time ultrasound and knowledge of porcine anatomy, technicians were able to establish a repeatable measurement location on the pig. This location is the cross sectional view of the 10th and 11th rib loin interface.

The 10th and 11th rib interface is a standard location for measurement of backfat and loin muscle area for several reasons. First of all, the number of ribs present in a pig can vary from 14 to 17 pair. However, all pigs have at least 11 pair. Entire carcass dissection studies have shown that measurements of fat and muscle taken at the 10th and 11th rib interface are powerful indicators of total carcass composition, also known as the proportion of lean muscle, fat, connective tissue and bone. Other anatomical characteristics about the 10th and 11th rib interface allow this location to be easily defined and visualized by ultrasound technicians.

From a squared area perspective, the loin muscle starts out as a small muscle at the first rib and reaches maximum size at the last rib. Loin muscle shape also changes from anterior to posterior. As shown in figures 9, 10, and 11, loin muscle shape is circular at the 5th rib, symmetrical oval at the 10th rib, and non-symmetrical at the last rib.

Another anatomical factor to consider is the fat deposition pattern in pigs. As pigs reach skeletal maturity, their growth curve levels out, and they begin to deposit a greater amount of fat in relation to muscle onto their skeletons. Pigs have an anterior to posterior fattening pattern. This means that backfat depth will typically decrease linearly from front to back.

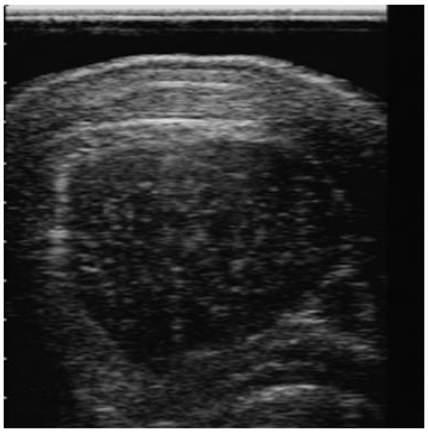

Figure 12. Anterior of 10th rib

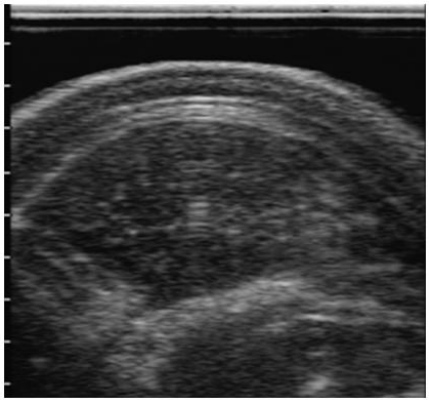

Figure 13. Posterior of 10th rib

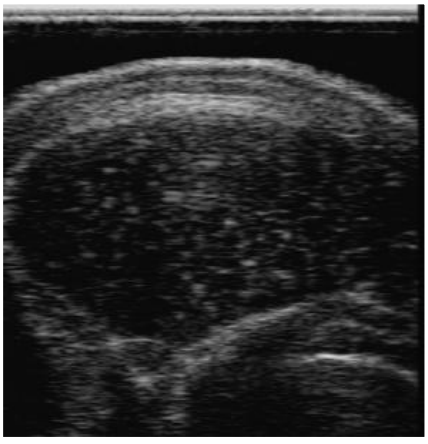

Figure 14. Crossing a rib

Collecting the Right Image

Anatomical landmarks provide the technician with the information needed to judge the quality of a loin cross sectional image. As mentioned above, the general shape of the loin muscle tells the technician a lot about anatomical location. A symmetrical oval shape indicates that the technician is very close to the 10th and 11th rib interface. The shape of the medial and lateral ends of the muscle should mirror each other and display gentle curvature.

In order to fine tune image location and quality, adjacent muscle groups and other factors come into play. Another unique attribute of the 10th and 11th rib location is that adjacent muscle groups are absent here. The spinalis dorsi and trapezious muscles are present at anterior locations while the multifidus dorsi becomes visible posterior of the 10th and 11th rib interface. Figures at the left illustrate muscle groups adjacent to the loin muscle and further explain the importance of locating a symmetrically shaped oval loin cross sectional image. A common mistake of technicians is collecting images anterior to the 10th rib. An image anterior of the 10th rib will sometimes display the desired ovular shape but spinalis dorsi or trapezious muscle groups will be present as shown in Figure 12.. At anterior locations, the technician will likely overestimate backfat depth and underestimate loin muscle area. On the other hand, at posterior locations, the image will have a flat ventral shape with the multifidus dorsi evident on the medial end (Figure 13). This will lead to an underestimation of backfat depth and an overestimation of loin muscle area.

The final consideration for cross sectional images is collecting the images between ribs. If the image is collected directly on top of a rib, the ovular shape will not be possible, and loin muscle area will be underestimated. A common problem with cross sectional images is that they partially cross a rib on the lateral end as shown in Figure 14. This is indicated by a flat lateral bottom to the loin and darkness in the lower right corner of the image. Partial crossing of a rib will also lead to underestimation of loin muscle area. A technician knows they are collecting images between ribs when the intercostales muscles (muscles between ribs) are visible and the lateral shape of the loin is a gentle curve that closely matches the medial shape. The intercostales muscles can be identified by two parallel lines which represent the top and bottom of the intercostales muscles.

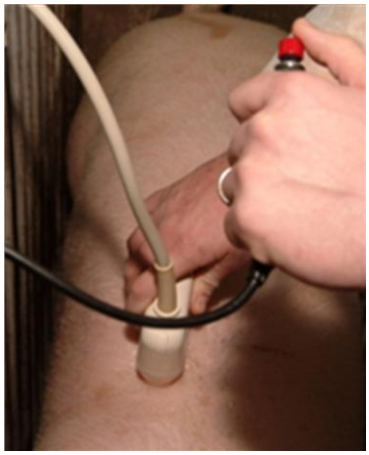

Figure 14. Transducer and freeze switch.

Freezing the Image

A remote 'freeze' switch can be provided with the Aquila Vet or Aloka SSD 500V. This switch is held by one hand of the scanning technician, and the transducer is held in the other hand as shown in Figure 14. The technician will be watching the image on the console monitor to determine when the transducer is in the correct location, and when a quality image can be frozen by pressing the freeze switch. If the image is not of good quality, then the image is released by pressing the freeze switch a second time.

With BioSoft Toolbox® II for Swine, multiple images can be saved for the same animal. Then later during processing, the highest quality image can be chosen for measurements of backfat and loin muscle area. Perhaps a small increase in accuracy could be realized from averaging measurements from the two highest quality images.

Making the Measurements

When combined in a prediction equation with live animal body weight, ultrasonic backfat depth and loin muscle area measured on high quality images can accurately predict weight or percentage of lean in the pig.

Measurements of backfat and loin muscle area can be made directly on the ultrasound console using the length and area functions. The values can then be transferred to a piece of paper or entered into a spreadsheet. If images are saved with BioSoft Toolbox® II for Swine, the measurements are made with a personal computer and mouse and the values are stored in a database along with animal ID and any other animal information collected.

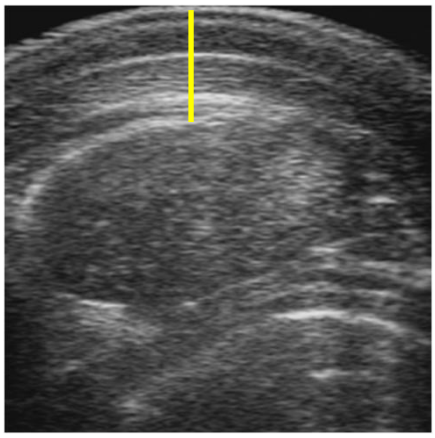

Figure 15. Measuring Backfat Thickness

Measuring Backfat Thickness

Backfat depth is to be measured at a point ½ the distance along the longest axis of the loin muscle and perpendicular to the skin surface (Figure 15). Technicians should note that traditional carcass measures of 10th rib backfat are taken at the ¾ distance away from the medial edge of the loin. The ½ distance is used because it is more easily and consistently measured on ultrasound images. In other words, the boundary between muscle and fat is more easily identified in the center of the loin.

Pigs have three individual layers of fat which are cumulatively referred to as backfat. Since a portion of the ultrasound waves will reflect back to the transducer upon contact with each new individual fat layer, the boundaries between the layers will be visible. For pigs with a very small amount of backfat, it is often difficult to distinguish the 3rd fat layer from the edge of the loin muscle. It is important to remember that all pigs have three individual fat layers. The measurement line should begin at the interface of the loin muscle and 3rd fat layer and extend to the skin surface.

Measuring Loin Muscle Area

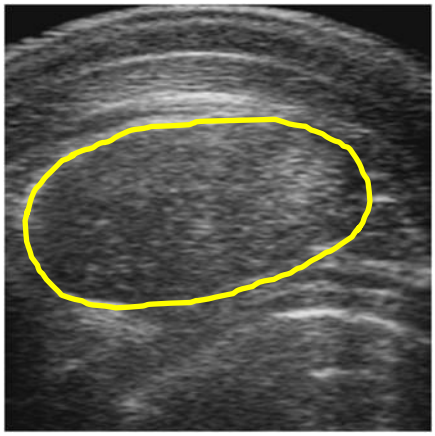

Figure 16. Measuring Loin Muscle Area

Accurate and repeatable measurement of loin muscle area requires a sufficient amount of practice. Whether using the trackball on the ultrasound scanner console or a computer mouse for tracing, the task is not easy. Boundaries between tissues are most readily defined in the center of the ultrasound image. This is due to the fact that ultrasound waves in the center have the least total distance to travel. Consequently, the medial and lateral boundaries of the loin will oftentimes be unclear. This means that some extrapolation in tracing the loin will be required. However, the amount of extrapolation can be minimized if adequate transducer contact is maintained during image collection.

One common cause for underestimation of loin muscle area is cutting off or "shorting" the lateral end. Boundaries on the lateral end are often the most unclear, so it is difficult to visualize the curve. The illiocostalis muscle (Figure) is a useful reference point for tracing the lateral end of the loin muscle. The far lateral end of the loin muscle is found at the illiocostalis halfway point. That is, if an imaginary vertical line is drawn from the illiocostalis halfway point upward, it will intersect the most lateral point of the loin. When tracing, technicians should generally try to visualize a symmetrically shaped loin cross section, and place the line accordingly.

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