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SIMITRI STABLE IN STRIDE® STIFLE RADIOGRAPHS

The following is intended for your technical staff and reviews proper patient positioning to obtain the diagnostic stifle radiographs required for preoperative planning of the Simitri Stable in Stride® procedure.

A. Preoperative Radiographs

Presurgical planning is critical for the success of this surgical procedure. Measurements obtained from preoperative radiographs will provide the information required to select the appropriate size of femoral and tibial plates and to position the femoral plate during surgery.

There are 5 key points for obtaining diagnostic stifle radiographs:

- Dogs must be sedated or anesthetized
- A calibration marker of known physical dimensions (in mm) must be on the plate for every image radiographed (see Figure 2-1)
- Radiograph one stifle at a time (mark as left or right)
- Center the stifle on radiograph with half of femur and half of tibia on the film
- Superimpose femoral condyles on the extended lateral radiograph (see http://beta.vin.com/Link.plx?ID=6618105 and explanation in next section)

Calibration Markers:

All radiographic images are magnified therefore to obtain accurate true to scale measurements this magnification factor must be determined.

Examples of calibration markers ⇒ L or R marker with straight edge **(do not use the old style clip-on combined L/R as it is difficult to tell which side is up)**, clipper blade, metal pins, metal ruler, commercial x-ray calibration markers are also available.

Measure the marker with a ruler to the nearest **millimeter** (mm).

Place marker near (but not on) the limb i.e. not on edge of plate, as it will be cut out of final image.

Marker should be positioned at the same height above plate as widest part of joint (ie not on the plate itself). Raise up with something radiolucent eg plastic or use commercially available holders)

The percentage a radiographic image is magnified can be determined by comparing the measurement of the marker on the radiographic image to the actual measurement of the marker. This can be done manually or in most cases radiograph viewing software will allow you to calibrate or "set the scale" prior to using measuring devices.

Note: The magnification of every radiographic image is different (even when taken on the same machine) because the distance that the stifle is above the plate will vary from patient to patient.

Figure 2-1: explanation of calibration markers

Two radiographic views **centered on** the injured stifle are required:

1. Extended lateral with condyles superimposed (Figure 1; It is critical that femoral condyles are superimposed)
2. Cranial caudal view with half of the femur and half of the tibia only included in view (Figure 2)

For the **extended lateral stifle radiograph** the dog is positioned in lateral recumbency with the limb to be radiographed closest to the plate and the contralateral limb flexed and rotated dorsally out of the field of view (Figure 2-4). The femoral condyles are superimposed in both the cranial caudal (most important) and proximal distal directions. A calibration marker is present on the image (R marker) and it has been raised off of the plate to the level of the joint.

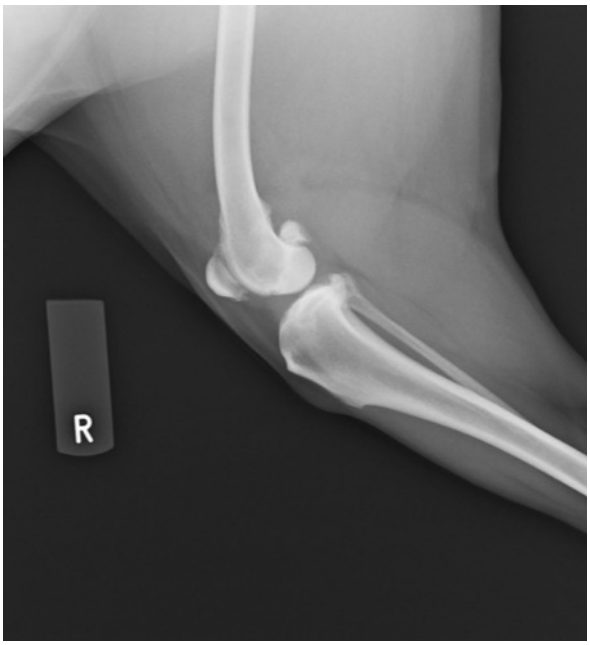

Figure 2-2 This is an example of a correctly positioned diagnostic extended lateral stifle radiograph. Condyles are superimposed, the radiograph is collimated to include half of the femur and tibia and a marker of known dimensions (R marker) is included in the image and has been raised to the level of the joint (in this case with a stack of gauze squares).

Superimposing the medial and lateral femoral condyles allows for better assessment of stifle joint pathology and is critical for obtaining accurate measurements of the medial condyle. In most cases if the affected limb is simply stretched into an extended position on the plate the condyles will not be superimposed; the medial condyle will be longer (more caudal; Figure 2-3) and the lateral condyle will be closer to the tibia (more distal; Figure 2-4). Some minor adjustments to the the limb on the plate will correct the positioning and is described below.

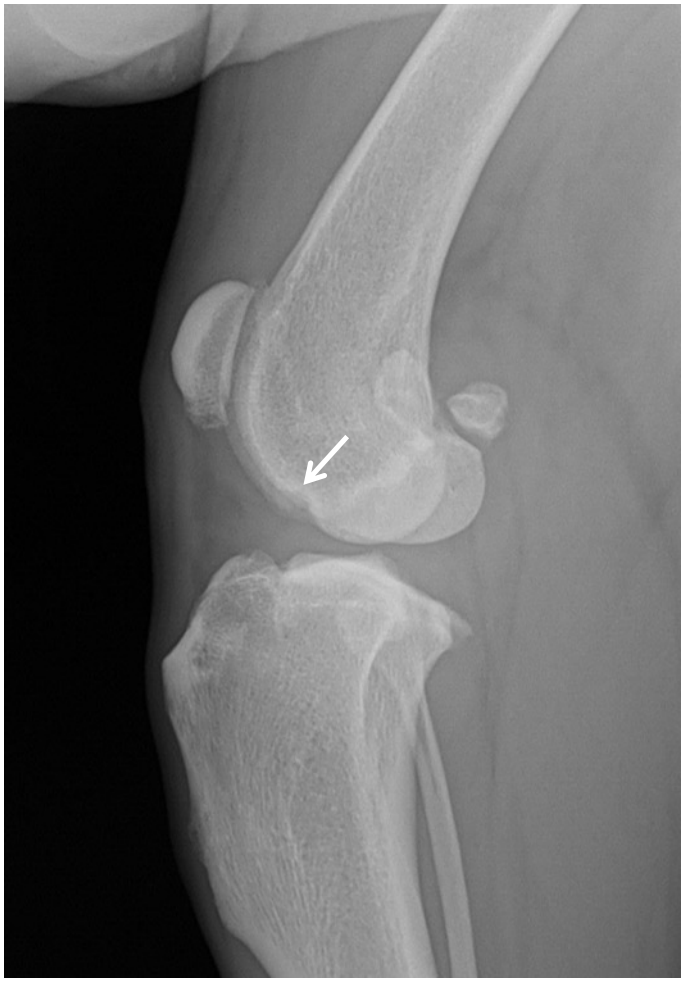

Figure 2-3 This radiograph is incorrectly aligned in the cranial caudal direction. The medial condyle appears longer than the lateral in this radiograph. Note the notch on the lateral condyle at the attachment of the long digital extensor tendon (arrow).

To correct the **cranial caudal** orientation of a radiograph first determine which femoral condyle appears to be the "longest". In most cases this will be the medial condyle. If in doubt the presence of a notch corresponding to the attachment of the long digital extensor tendon aids in identification of the lateral femoral condyle. To correct the alignment of the condyles the patella must be rotated towards the "shorter" condyle. Therefore, if the medial condyle is longer, as is seen in Figure 2-3, the patella must be rotated toward the plate. This is most easily achieved by slightly rotating the hock away from the plate either by placing a small pad under the calcaneus or by manually rotating the hock away from the plate (Figure 2-4). Take care not to lift the lower limb off the plate when rotating the hock.

Figure 2-4 Demonstration of patient being positioned for extended lateral radiograph. Arrow indicates direction of rotation of lower limb to cause patella to rotate toward plate thereby aligning the femoral condyles. Note that the lower limb is being held without lifting it. Also note that the image will be collimated to include only half of the tibia and femur, the marker will be raised to the level of the joint and hands will be covered with lead shields (or alternatively, a pad placed under the caudal hock to maintain rotation) prior to taking the radiograph.

Figure 2-5 In this radiograph the lateral femoral condyle appears to be more distal (closer to the tibia) than the medial condyle. Note notch of the long digital extensor tendon identifies the lateral condyle.

To correct an extended lateral radiograph that is not aligned in the **proximal distal** orientation (Figure 2-5) place a pad under the coxofemoral joint of the limb being radiographed. This will change the angle of the femur so that it is more parallel to the plate and will re-align the femoral condyles in the the proximal distal direction. Note that dogs that have natural padding over the hip (i.e. overweight) will likely not require any adjustment.

For the **cranial caudal stifle radiograph** the dog is positioned in dorsal recumbency. To obtain a true cranial caudal view of the affected stifle it is important only one stifle is radiographed at a time. Allow the dog to rotate towards the contralateral side with the contralateral limb in a relaxed position. This will cause the affected stifle to easily be held in extension with the patella centered over the distal femur without internal rotation of the lower limb. For most dogs the stifle will be raised above the plate by several inches therefore it is important to raise the calibration marker to the level of the stifle joint to adjust for the increased magnification of the stifle joint on the radiographic image.

Figure 2-6 This is an example of a correctly positioned cranial caudal radiograph. The patella is centered over the femur, half of the femur and tibia are in view, the radiograph is centered over the stifle joint and the tail has been moved out of the way of the stifle joint. The calibration marker (R marker) has been raised to the level of the stifle joint with a stack of gauze squares.

Figure 2-7 To demonstrate the correct positioning of the dog for the cranial caudal radiograph this radiograph has not been correctly collimated. The affected limb is straight and the patella centered. The contralateral limb is in a relaxed position and the pelvis is tilted toward the contralateral side. By doing this it is much easier to center the patella of the limb to be radiographed. As a final position check, the patella can be palpated to ensure that it is centered directly on top of the femur prior to taking the radiograph. Note that there is no marker present on the radiograph to indicate which limb this is nor for calibration.

To assess for tibial torsion a second cranial caudal view is taken with the dog in the same position as the first view but centered over the tibia shaft and including the distal

femur (patella) and hock joint. The position of the calcaneus relative to the distal tibia serves as an indication of the degree of tibial torsion. Marked tibial torsion may cause significant internal rotation of the proximal tibia during flexion of the stifle. This can be extremely difficult to manage surgically and may interfere with the correct positioning and function of the Simitri Stable in Stride® implant.

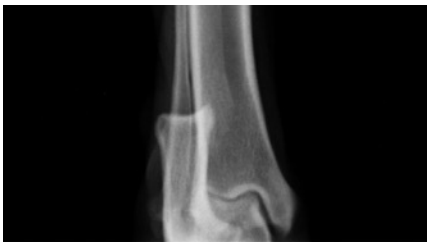

Figure 2-8 Cropped image of distal tibia with tibial torsion. Note that the calcaneus is not centered in this image but appears to be in a lateral position, this is due to torsion of the tibial shaft.

B. Radiographic Measurements

Measurements obtained from the preoperative radiographs are used to select the appropriate size of implant for your patient and to aid in positioning the implant during surgery. To obtain accurate measurements the calibration marker is used to adjust for the magnification of the radiographic image. As discussed above, a marker of known dimension (in mm) must be on every radiographic image (at the level of the stifle joint) and will be used to calibrate the software used to measure the radiograph or used to adjust the measurements obtained on the radiograph.

Most commercially available DICOM viewer software have measuring tools that allow you to make measurements on digital radiographs. Ideally your measuring tool should be set to measure in millimeters to one decimal place. Depending on the software used it may be possible to set the scale of the measuring tool prior to making measurements of your patient's radiograph. This will be done by measuring the image of your calibration marker on the radiograph and then entering the actual measurement of the marker in mm into the program which will then correct for the magnification on all measurement subsequently made on that radiograph. It is important to recalibrate for every new image taken. If the software cannot be calibrated the measurements obtain can be adjusted to true to scale manually by multiplying the measurements by the magnification factor (actual measurement of marker/software measurement of marker).

ImageJ is a program developed by the National Institute of Health, USA available at http://imagej.nih.gov/ij that allows true to scale measurements to be made on a variety of digital images including JPEG. This is also convenient for measurement of digital radiographic images from referring practices.

For radiographic films, measurements can either be made with a ruler on the processed films and then manually adjusted for the magnification as described above or, a digital photo of the film can be taken and software such as *ImageJ* can be used to measure the digital image of the film.

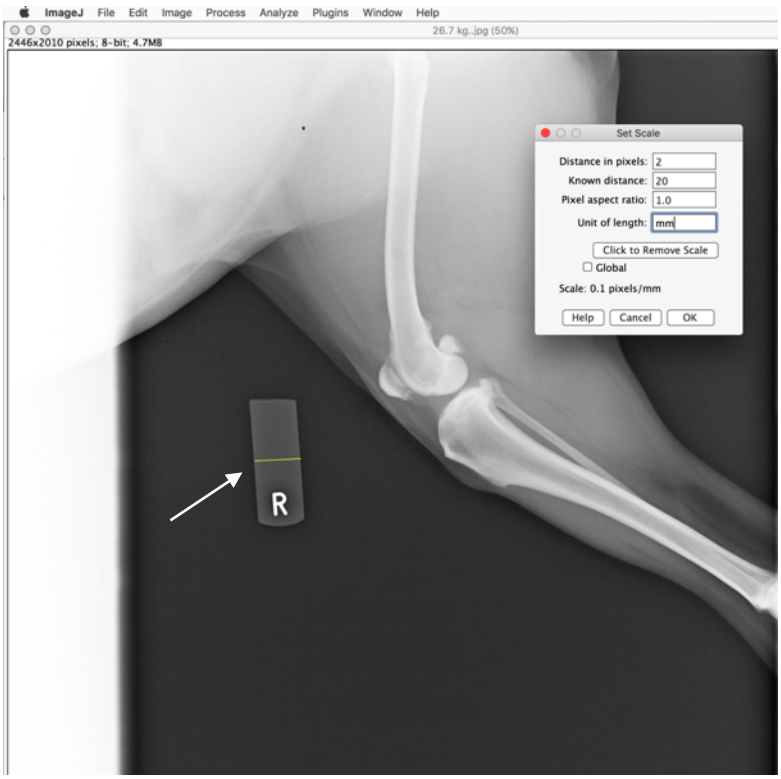

Figure 2-9 This is an example of how the magnification is corrected using ***ImageJ*** software. A line has been drawn across the R marker (arrow) using the *ImageJ* measuring tool. The marker was previously measured with a ruler and found to be 20 mm in width. By entering the "Known distance" (found in the "Set Scale" feature under "Analyze), the program will automatically provide actual true to scale measurements of any line subsequently drawn on this radiograph. Note: The scale must be reset for every radiograph measured.

Once a method for obtaining true to scale measurements has been established the extended lateral radiograph can be used to obtain the necessary preoperative measurements as is described in *Module 2 – Preoperative Planning*.