Key Points:
- Manual image calibration provides the most accurate measurements and should be performed prior to any digital planning. The calibration sphere should be placed at the same vertical height as the object to be measured. If this cannot be achieved, the magnification error can be expected to be approximately 1% per centimeter of distance between the sphere and object of interest.
- Digital TPLO planning can help improve the accuracy of the osteotomy, avoid fibular penetration and hence improved surgical outcome can be expected.
- Image stitching can be useful for measurement of TPA in large breed dogs or any dog where a stifle centered image provides easier identification of landmarks used for TPA-measurement (such as animals with ALD etc.)

Digital radiography (DR) has gained popularity in veterinary surgery for planning of various orthopedic procedures. Digital on-screen measurement tools are one of the numerous advantages afforded by this new technology. Magnification is an inherent artifact to radiography, and this basic concept remains when utilizing DR. When digital radiographs are viewed on a computer monitor, the displayed size of an object depends on the monitor size and the magnification (zooming) used. In other words, there is no way of visually detecting any magnification errors and hence digital calibration has to be performed. In fact, DR has been shown to reduce the accuracy of templating when planning for total hip replacements in people, when inappropriate calibration methods are used. Calibration is generally performed utilizing a marker of known size. This marker can be a metal ruler or any other object of known size. The author prefers to use a metal sphere (see Figure 1) attached to a flexible arm (OrthoMark, RolleSolutions Inc, Castro Valley, California) to minimize the effects of radiographic image distortion (i.e. the size of a sphere does not change with beam orientation). In a recent study evaluating digital calibration techniques, manual calibration (i.e. manually outlining the calibration sphere with the circle tool) was the most accurate method of calibration. Magnification errors were only observed with vertical (not horizontal) discrepancy between the object of interest and the calibration sphere. The authors found an approximate magnification error of 1% per centimeter of distance between the calibration sphere and object of interest. Automatic detection of the marker sphere should be used with caution and manual adjustment of the outline of the sphere is recommended if there is any discrepancy (see Figure 2).

Accurate pre-operative tibial plateau angle (TPA) measurement and planning is crucial for proper tibial plateau leveling osteotomy (TPLO) execution. TPA measurement is usually performed using landmarks on both the stifle and tarsocrural joints from a medio-lateral radiograph, therefore, both joints must be included in the traditional TPLO radiograph. Centering the x-ray beam over the stifle joint is vital to accomplish accurate TPA measurements but this poses a problem in large and giant breed dogs because the length of the tibia prevents collimation to include both the stifle and tarsus in a stifle-centered radiograph. With recent advances in digital radiography and imaging software, it is feasible to ‘stitch’, or combine two
images into a single image. To reproduce a TPLO radiograph, a stifle-centered and tarsus-centered radiograph can be stitched into a single image. This approach provides easier identification of TPA landmarks (see Figure 3) and may be used for animals with severe degenerative joint disease (DJD), angular limb deformity (ALD), or for obtaining a TPLO radiograph without necessitating sedation. To perform image stitching two images are merged using commercially available software such as Orthoplan Elite (Sound-Eklin, CA). For TPLO-image stitching the distal tibial crest is an easy landmark for use as a common point of reference to create the overlay. Proximal-distal, cranial-caudal, and rotational adjustments are then made to ensure accurate superimposition of the individual images prior to final image ‘stitching’ (see Figure 3). A detailed video of the technique can be found at http://www.soundeklin.com/stitching-movie. This technique can be utilized for other procedures such as angular limb deformity, creation of whole limb radiographs etc.

TPLO-planning can easily performed utilizing the same commercially available software. Key features of TPLO-planning that simplify and likely improve surgical outcomes of this procedure include:

- Measurement of the distance from the tibial tuberosity to the planned osteotomy
- Choosing the appropriate blade size (using the circle tool) to accomplish a centered osteotomy
- Measurement of possible ‘buttress’ loss for animals with larger TPAs or proximal insertion of the patellar tendon by ‘cutting’ the proximal fragment and rotating it digitally (see Figure 4)
- Measurement of proposed screw length on the craniocaudal view to avoid fibular penetration (see Figure 5)

Figure 1: Calibration sphere on flexible arm
Figure 2: On-screen image calibration using the marker sphere - manual calibration is recommended if the outline does not match the sphere.

Figure 3: Image stitching for TPLO-images; (A) conventional TPLO-image (B) close-up of image A - note difficult identification of landmarks for TPA measurement (C) stiflescoped image (D) close-up of image C - note the simplified identification of landmarks for TPA measurement (E) tarsus-centered image (F) stitched image prepared by merging images C and E (G) close-up of image F
Figure 4: Digital planning and execution of TPLO

Figure 5: Measurement of screw length for TPLO-planning to avoid fibular penetration
Disclosure: The author does not receive any financial compensation from Sound-Eklin (the software used to illustrate digital planning for these proceedings and the presentation).

References: