Neil Embleton, B.Sc., DVM and Veronica Barkowski, DVM
Helivet Mobile Surgical Services, Sundre, AB, Canada

July 2016

SIMITRI STABLE IN STRIDE® SURGICAL PROCEDURE

The following components of the surgical procedure for successful implantation of the Simitri Stable in Stride® implant will be described:

- Patient preparation and surgical approach
- Femoral plate contouring and implantation
- Tibial plate contouring and implantation
- Common errors to avoid

A. Patient Preparation and Surgical Approach

Figure 3-1 The surgical limb is prepped from the greater trochanter of the femur to the distal tibia using standard aseptic technique. The patient is positioned in dorsal recumbency and the limb is draped in standard fashion.

Figure 3-2 A 12-15 cm curvilinear incision is made on the medial aspect of the surgical limb. The incision is centered over the stifle and extends equidistant both proximally and distally.

The joint is explored via arthroscopy (prior to skin incision) or via a minimal medial parapatellar arthrotomy. Damaged portions of menisci and cruciate ligaments are removed. Meniscal release is **NOT** required nor indicated under any circumstance. The arthrotomy is closed as per surgeon's preference.

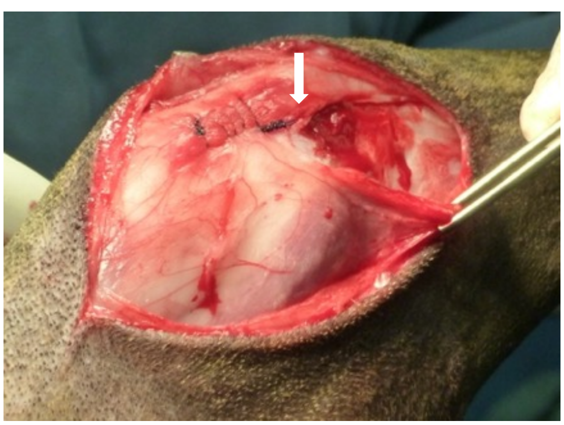

Figure 3-3 An incision is made through the conjoined tendons of the sartorius, gracilis and semitendinosus to expose the proximal tibia and medial collateral ligament. The incision originates at the level of the proximal tibia, cranial to the insertion of the sartorius (arrow) and extends distally approximately 6 cm. The incised tissues are reflected caudally, exposing the proximal tibia and medial collateral ligament.

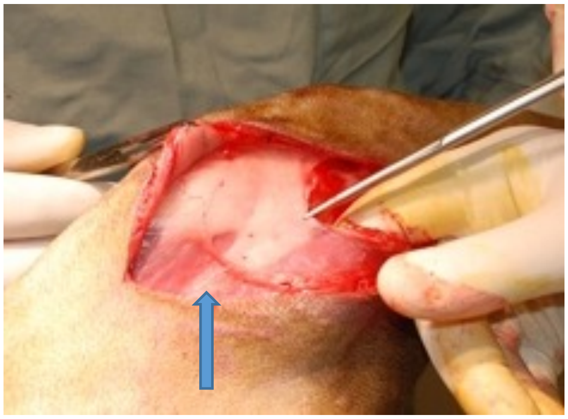

Figure 3-4 The fascial incision is extended 6 cm proximally (to arrow) between the cranial and caudal bellies of the sartorius muscle, exposing the vastus medialis musculature and underlying descending genicular artery and medial articular nerve.

Bluntly undermining the sartorius musculature with a finger prior to extending the incision proximally can aid in protecting the underlying artery and nerve.

Figure 3-5 Expose the distal femur starting from the proximal extent of the fascial incision and extending 40 mm distally by bluntly dissecting between the vastus medialis and pectineus tendon. The screw segment of the femoral plate will later be applied to this area.

Figure 3-6 The vastus musculature is reflected cranially with an Army retractor exposing the femur. The medial collateral ligament is also visible (blue arrow). The tip of the forceps is pointing to the genicular artery and medial articular nerve.

Figure 3-7 A 15 mm wide periarticular soft tissue tunnel extending from the exposed femur to the level of the distal patella is bluntly made using Mayo scissor. The tunnel is parallel to the long axis of the femur deep to the periarticular tissues, but superficial to the joint capsule.
By placing the femoral plate into this tunnel the femoral component can remain in close contact with the femoral diaphysis without compressing the genicular artery and medial articular nerve.

B. Femoral plate positioning

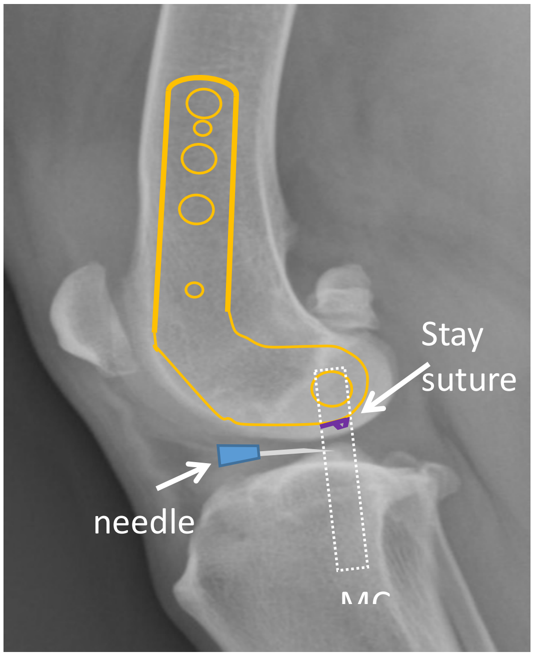

Figure 3-8 As previously described in the *Preoperative Planning Module* a stay suture will be used to aid in positioning of the femoral plate in the proximal distal direction over the MCL. The measurement used for placement of the suture is ***B* – *6* mm.** ***B*** was measured on the preoperative extended lateral radiograph.

Figure 3-9 With the stifle in full extension, a 22 gauge needle is walked off the proximal tibia at the level of the cranial edge of the medial collateral ligament. This marks the starting point for measuring stay suture placement.

Figure 3-10 Calipers, or a ruler are used to measure ***B* – *6* mm** cranial to this point (see *Preoperative Planning Module*). An absorbable stay suture is then placed centered over the medial collateral ligament (MCL). ***Note:*** *by using the cranial edge of the MCL there is less chance of iatrogenic damage to the medial meniscus.*

.

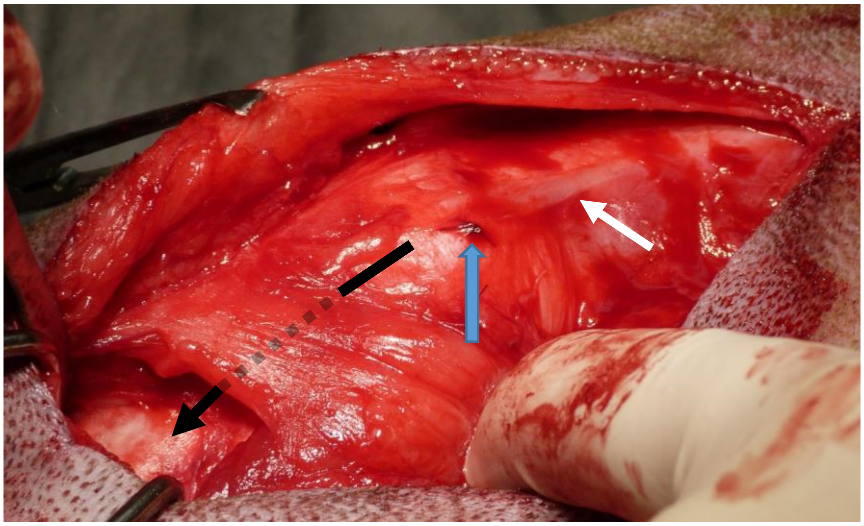

Figure 3-11 This picture shows the stay suture (blue arrow) centered over the MCL (white arrow). The femoral component will be inserted through the soft tissue tunnel (dashed line) in the direction of the black arrow.

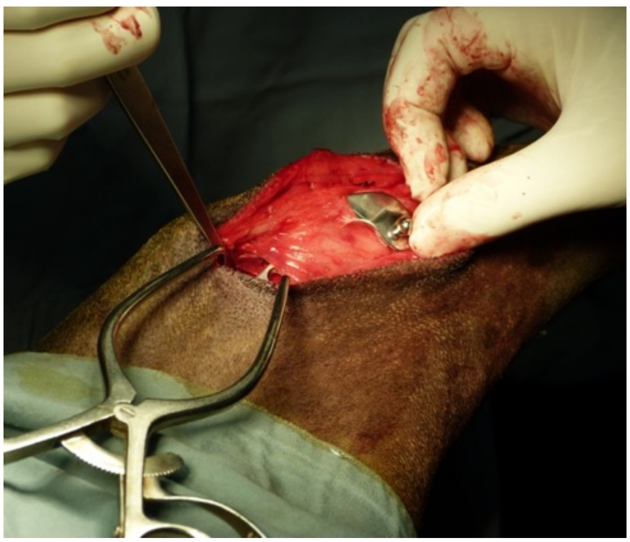

Figure 3-12 With the limb in full extension, the screw segment of the femoral plate is inserted into position through the soft tissue tunnel.

The distal edge of the femoral plate is positioned at the level of the stay suture with the femoral ball is centered over the medial collateral ligament. The screw segment of the femoral component is positioned as parallel as possible to the Y axis of the femur. At this point you can assess the plate to determine if any additional contouring of the plate is needed.

Femoral Plate Contouring

The femoral component comes precontoured however, adjustments may be required to account for variations in medial femoral diaphyseal curvature as the position of the screw segment changes relative the the Y axis of the femur.

The goal of contouring is to ensure the stem of the femoral ball is perpendicular to the sagittal plane of the femur/stifle (Figure 3-14 and 3-15) and parallel to the transverse plane. In other words, the stem should project medially in relation to the stifle joint without deviating cranially, caudally, distally or proximally. There are two adjustments that may be required to correct any deviation to the stem; a bend and/or a twist. Before any contouring, always engage locking screw plugs to prevent damage to the screw holes.

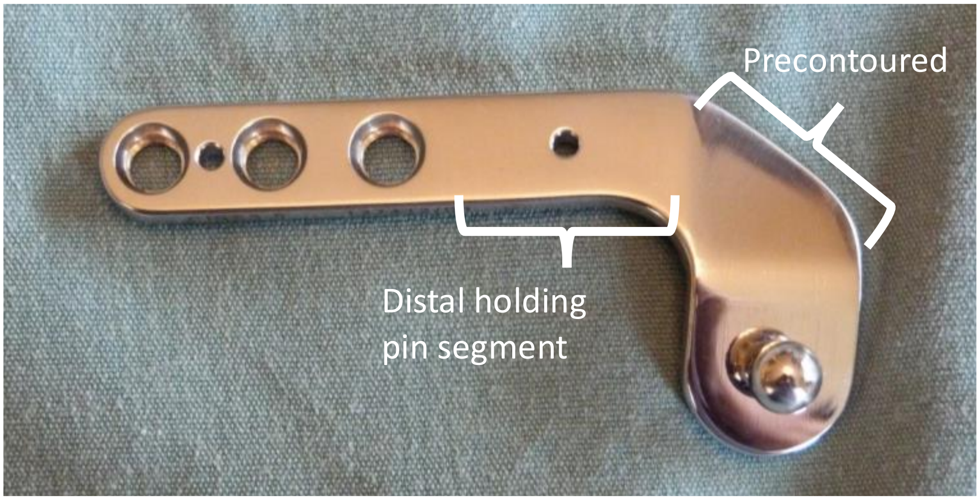

Figure 3-13 The precontoured area of the femoral plate is indicated above as well as the distal holding pin segment. Manual adjustments are made to the distal holding pin segment.

A. **Bend:**

With the femoral plate held in position as shown in Figure 3-14, observe the orientation of the stem of the femoral ball to the sagittal plane of the femur/stifle. Ideally the femoral stem should be projecting medially without proximal or distal deflection, if the ball deflects, it can be corrected with a 1-2 mm bend in the distal holding pin segment (Figures 3-15). The bend is concave for distal deflection (most common) and convex for proximal deflection (rare). Use locking screw plugs to prevent damage to screw holes. Avoid over contouring of the plate as this will cause the ball and stem segment to elevate away from the femur; this will increase the offset required for the tibial component to engage correctly.

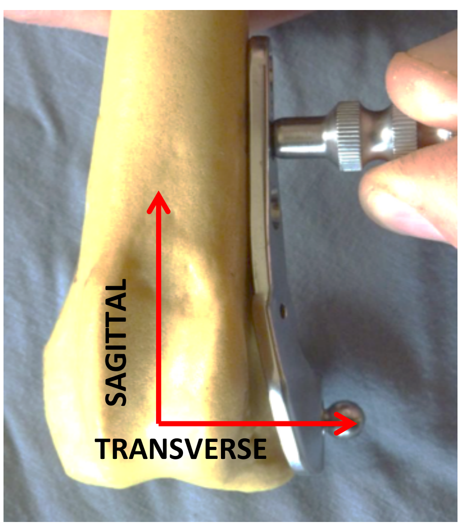

Figure 3-14 The femoral stem should be perpendicular to the sagittal plane of the femur as is seen here.

Do not over contour the plate.

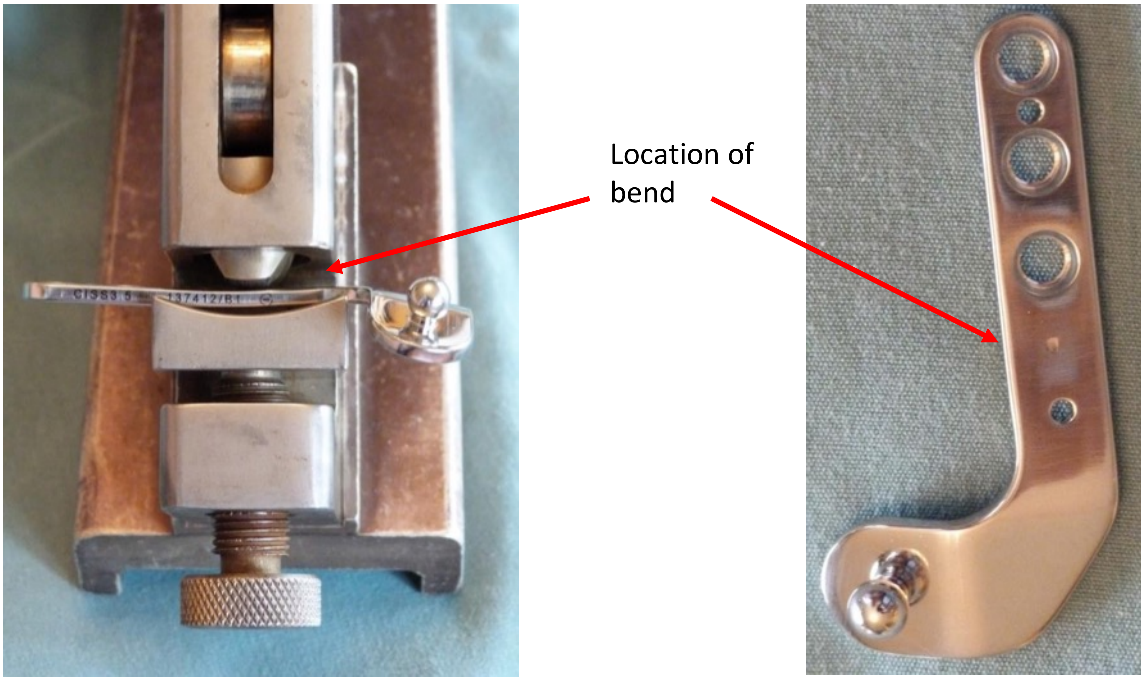

Figure 3-15 location of bend through distal holding pin segment of femoral plate

B. Twist:

As described in the *Preoperative Planning Module,* the screw segment of the femoral plate may need to be positioned cranial or caudal to the Y axis of the femur in order to position the femoral ball in the ideal location. The femoral plate is precontoured (twisted through distal holding pin segment) to cause the femoral stem to project medially from the stifle joint when the screw segment is centered on the Y axis (Figure 3-16). Due to the curvature of the femoral diaphysis, moving the femoral plate cranially or caudally will cause the orientation of the stem of the femoral ball to also change (Figure 3-16). The goal of the twist is to allow the screw segment to match the curvature of the diaphysis, while allowing the femoral stem to project medially (i.e. not cranially or caudally). Therefore; if the screw segment is positioned cranial to the Y axis, the screw segment must be twisted away from the ball and stem segment (decrease precontoured twist); if the position is caudal to the Y axis, then the twist is toward the ball and stem segment (increase precontoured twist)(Figure 3-17 and 3-18). Locking screw plugs must be used in the screw holes to prevent damage during twisting. The use of a locking drill guide in the last hole may aid in visualizing the degree of twist needed (Figure 3-17).

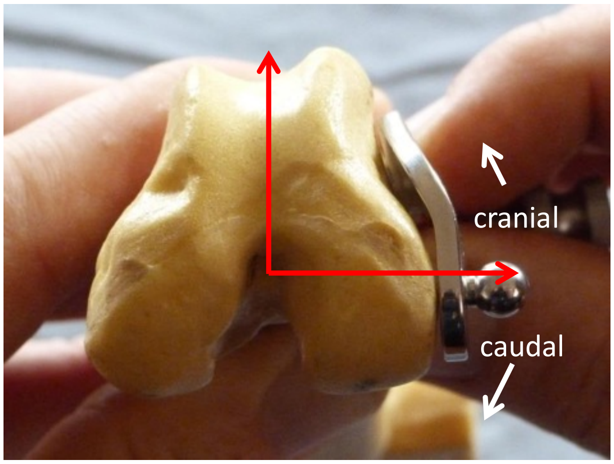

Figure 3-16 If the femoral plate is moved off the center of the Y axis, the femoral ball will be deflected cranially or caudally in the direction of the arrow as show.

Figure 3-17 The location of the twist is indicated by the red bracket. Locking screw plugs will be engaged into holes 1 and 2 prior to twisting. The direction of the twist depends on location of screw segment on femur. Twisting the drill guide away from ball decreases the precontoured twist (cranial screw segment position); twisting toward the ball decreases the twist (caudal position).

Figure 3-18 Stainless steel crescent wrenches (or bending irons) are used to accurately twist the femoral component without introducing any additional bend.

Figure 3-19 After twisting and bending the femoral plate (if required), it is reinserted into the tunnel and aligned with the stay suture with the limb in full extension. Reassess the femoral ball and stem and if you are satisfied with the orientation (projecting medially), the proximal 5/64" holding pin is implanted while maintaining the plate position and compressing the femoral plate to the femur.

Fine Tuning Femoral Plate Position

During flexion and extension, the stay suture will remain fixed in position relative to the tibia and therefore the femoral plate will move in relation to the suture. If the stay suture travels along edge of femoral plate, the ball is in an isometric position. If the stay suture moves **away** from the femoral plate during flexion the femoral component is cranial to its ideal position. If the stay suture moves **under** the femoral component during flexion the femoral component is caudal to its ideal position. Adjustment should be made to the cranial caudal position of the femoral plate and the ball position reassessed. When the ball is as isometric as possible, the distal femoral holding pin is engaged. Perfect isometric placement is not critical as the travel channel within the articular insert allows for up to 8 mm of ball movement.

Note: The femoral ball should remain within the cranial caudal limits of the MCL. If you cannot achieve a relatively isometric position over the MCL then you must reassess and adjust the proximal distal position of the femoral plate.

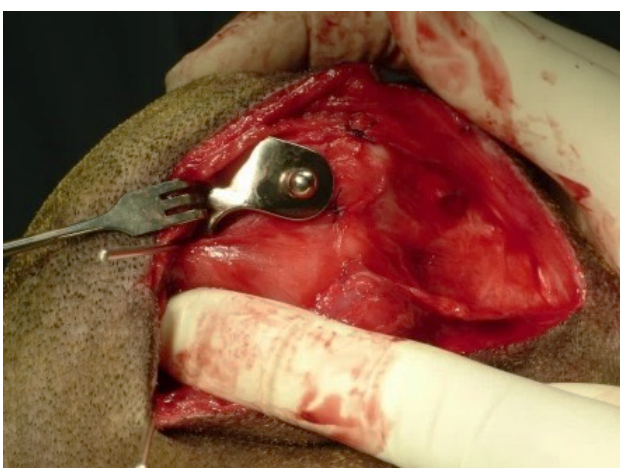

Figure 3-20 The stay suture is on the edge of the femoral plate in flexion (and extension), therefore the femoral plate is in an isometric position.

Figure 3-21 Screws are inserted into holes 1, 2 and 3. Screw hole #1 is closest to the joint. Locking screw drill guides ensure centered placement of the screws. Screw hole # 1 is implanted first. Initially a 3.5 mm bicortically placed non locking screw is used to compress the plate to the femur. Screw holes #2 and 3 are then engaged using 3.5 or 4.0 locking screws. Finally, the cortical screw in hole #1 is exchanged for a 4.0 cortical locking screw.

Note: Ensure all screws are bicortical. For 3.5 mm plates, a 4.0 cortical locking screw must be used in screw hole # 1 for all patients and if bone size will allow, in all screw holes in cases larger than 30 kg. (2.7 mm plates take 2.7 mm locking screws.)

C. Tibial plate contouring and implantation

Figure 3-22 With the stifle in full extension and in a neutral position (i.e. not rotated) engage the tibial insert over the femoral ball and position the plate such that the ball is located in the middle of the travel channel. The screw segment should be in close contact with the medial cortex of the tibia and aligned with the long axis of the tibia. Approximately 3-4 mm cranial to the caudal edge of the tibia. Do not engage holding pin until you confirm proximal distal position and tibial offset of tibial plate as is described below:

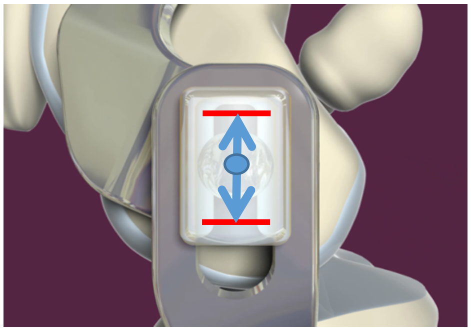

Figure 3-23 While holding the screw segment in the position described in Figure 3-22, place stifle through a full range of motion and observe the movement of the ball within the travel channel. Adjust the proximal distal position as required to ensure that the ball travel does not exceed the limits of the travel, i.e. it should not touch the end of the channel nor should the ball enter the "key hole".

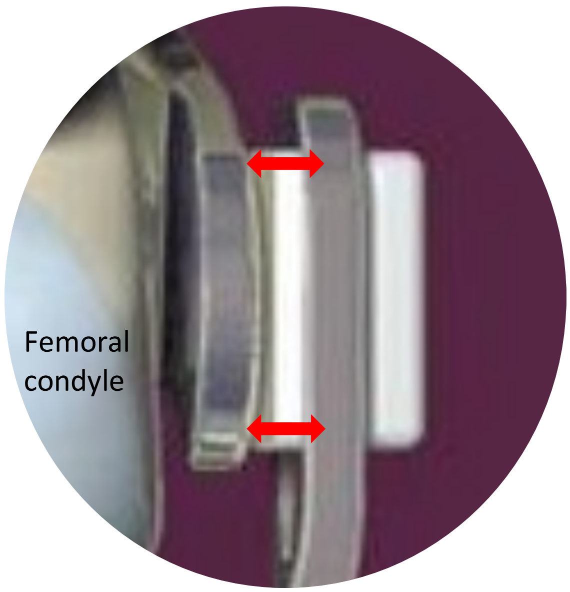

Figure 3-24 Although the screw segment should have good contact with the medial tibial cortex, it is more important that the tibial insert should engage the femoral ball without compressing towards the femoral plate or pulling away from the femoral plate. In addition, the flanges on all sides of the tibial insert should remain in contact with (parallel to) the corresponding surface of the ball and stem segment of the femoral plate throughout flexion and extension. There should not be significant changes in this contact (distance between red arrows is the same and constant) except to allow for a normal degree of tibial rotation as is allowed by the flanges of the insert (10 degrees) and minimal varus and valgus movement. Tibial torsion may increase internal rotation beyond the limits of the implant therefore it is vital to ensure that this rotation is not exceeded.

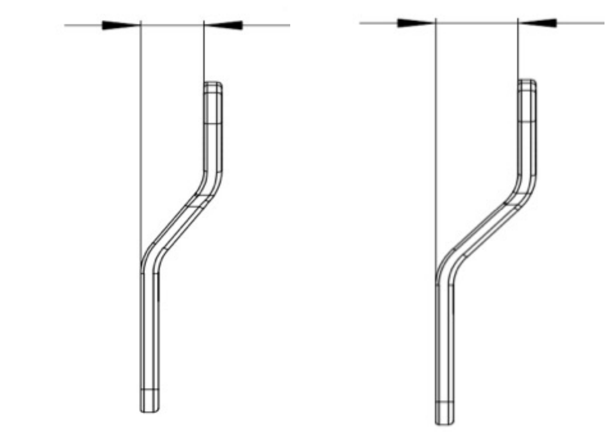

Figure 3-25 Tibial plates are available in several offsets to accommodate the difference between the width of the femoral condyles and the tibial diaphysis. Measurements obtained on the preoperative cranial caudal radiograph will aid in choosing the tibial plate offset that will best fit your patient (see *Preoperative Planning Module*). Fine tuning of the tibial offset may be necessary during surgery to account for individual variation in patients.

Fine Tuning Tibial Offset

As described in Figure 3-24, the contact between the tibial insert and femoral plate is used to assess whether the tibial offset is correct for your patient. Incorrect contact between the plates at the articulation can lead to insert failure and/or disarticulation.

- If the tibial plate compresses towards the femoral plate or the top of the tibial plate angles away from the femoral plate the offset needs to be increased.
- If the tibial plate pulls away from the femoral plate or the top of the tibial plate angles towards the femoral plate the offset needs to be decreased.

It is always best to use the precontoured tibial plate offset that best fits your patient. If your patient falls in between plate sizes, choose the smaller plate and either implant the screw segment so it does not compress the tibial cortex (locking screws permit the plate to be elevated from the bone) or bend the plate to increase the offset. It is generally easier to increase the offset than to decrease it and small changes to tibial offset can be made with plate benders however caution must be used to not damage the UHMWPE insert or the screw holes. Use screw plugs and a small bending tool. Excessive bending of the tibial plate may weaken the plate and should be avoided.

Figure 3-26 Once the proximal distal position and tibial offset are corrected as described above, align the screw segment as described in Figure 3-22 and insert the distal holding pin. Reconfirm position and **reduce the subluxation** of the tibia prior to engaging the proximal holding pin. Avoid internal or external rotation of the tibia. **Reconfirm ball travel and parallel contact between tibial insert and femoral plate before implanting screws.**

Figure 3-27 Locking screw drill guides are employed to ensure centered placement of all screws. Screws are inserted as per the femoral component starting with screw hole #1 (closest to joint). Initially a 3.5 mm cortical screw (or 2.7 mm screws for 2.7 mm plates) is used to **very gently** compress the screw segment to the tibia without causing excess compression at the articulation. Screw holes #2 and 3 are then engaged. Finally, the cortical screw in hole #1 is exchanged for a 4.0 cortical locking screw.

Note: Use caution when compressing the tibial plate to not over compress. Excessive compression could lead to misalignment of the tibia and/or insert failure.

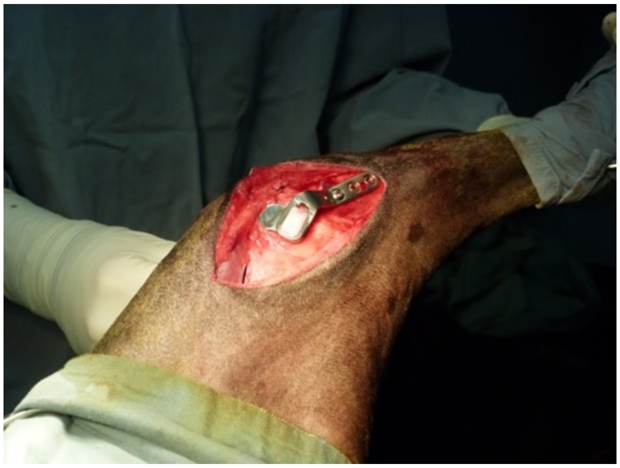

Figure 3-28 Ensure the articulation is as parallel as possible and moves as freely as possible after each screw is placed. Do not allow the engagement of the screws to alter the orientation of the articulation. Prior to closure reconfirm correct position by placing stifle through full extension and flexion. There should be no interference with full range of motion.

Note: Ensure all screws are bicortical. A 4.0 cortical locking screw must be used in screw hole # 1 for all patients and if bone size will allow, in all screw holes in cases larger than 30 kg.

Figure 3-29 Routine closure of the soft tissues is performed in two layers using a simple continuous pattern of an appropriate absorbable monofilament suture. The first layer is the conjoined tendons of the sartorius, gracilis and semitendinosus. The second is the subcutaneous layer. The skin is closed with surgical staples or as per surgeon's preference.

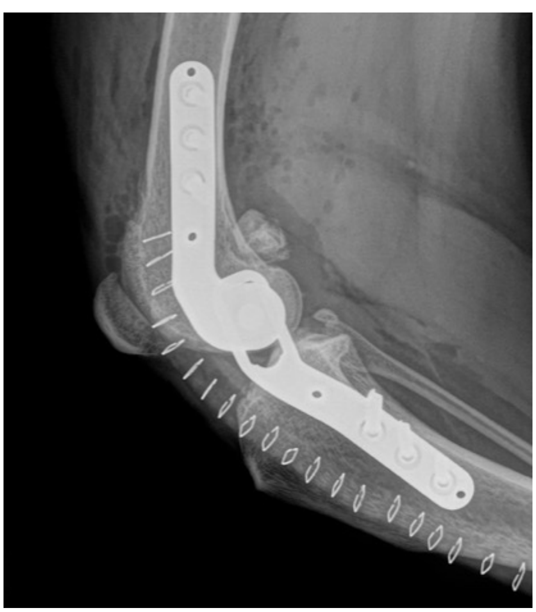

Figure 3-30 Post-operative lateral and cranial caudal radiographs are taken to confirm correct implant position and bicortical screw engagement.

D. Common errors to avoid

Correct positioning of the Simitri Stable in Stride® implants is dependent on following the recommendations in the *Preoperative Planning Module* and *Surgical Technique Module.* Common errors that can lead to implant positioning errors include:

1. Pre-operative planning errors:
    - Inappropriate patient selection (i.e. body weight exceeds maximum for implant selected)
    - Incorrect (or lack of) measurement of presurgical radiographs
        - Condyles not superimposed
        - Measuring lateral instead of medial femoral condyle
        - Failure to account for radiographic magnification
    - Failure to identify tibial torsion
    - Failure to identify concurrent collateral ligament insufficiency or concurrent luxating patella

2. Surgical errors:
    - Incision over distal femur does not extend far enough proximally to allow access to proximal screw hole (hole #3) of the femoral plate
    - Improper placement of stay suture.
        - Failure to place limb in full extension while measuring and placing stay suture
        - Failure to measure accurately (use calipers or ruler)
        - Incorrect measurements obtained preoperatively
    - Femoral component implantation is too proximal or distal (measuring error)
    - Femoral component too caudal or cranial (femoral ball should not be cranial or caudal of the MCL)
    - Inappropriate (over/under) contouring of the femoral and tibial plates.
    - Inappropriate positioning of the tibial component.
    - Failure to reduce subluxated tibia.
    - Failure to repair concurrent collateral ligament injuries prior to implantation
    - Failure to repair concurrent luxating patella prior to implantation
    - Articulation not parallel during implantation (insert should be in contact with femoral plate)
    - Femoral ball travel exceeds limits of travel channel
    - Implanting screws before ensuring plates are in the correct position.
    - Failure to use 4.0 mm screw in first screw hole of all patients (3.5 mm plates)
    - Failure to use 4.0 mm screws in all screw holes of patients >30 kg (assuming bone is wide enough to accept a 4.0 mm screw)
    - Failure to recognize and react to tibial torsion - be extremely cautious of cases with significant tibial torsion. Excessive tibial torsion can lead to significant internal tibial

rotation of the proximal tibia. Excessive tibial torsion can overwhelm the implant and this may not be evident until the implantation.