

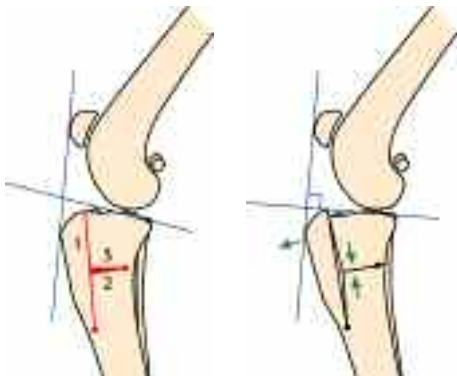
VETERINARY INSTRUMENTATION

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Triple Tibial Osteotomy (TTO)

Objective:

This operation is based on the biomechanical analysis performed by Dr Slobodan Tepic, which revealed that in order to remove the shear strain from the cranial cruciate ligament the tibial plateaux should be perpendicular to the patellar ligament. There are two basic ways to achieve this; i) advance the tibial crest (the basis of the Tibial Advancement technique described by Professor Montavon and ii) alter the alignment of the tibial plateaux to the patellar ligament to 90° (a modification of the Slocum technique). Dr Warrick Bruce reasoned that rather than doing one technique or the other, there is merit in doing a little of both to achieve the same outcome, but with less radical angular changes. In the operation of triple tibial osteotomy (TTO) a small closing wedge osteotomy is performed and this simultaneously advances the tibial crest (see figures below).



Pre-operative patient assessment

Every patient is assessed for the degree of lameness, overall alignment of the limb, stifle range of movement, as well as the degree of stability within the joint.

Pre-operative radiographic assessment

Standard lateral and craniocaudal views of stifles are required.

The stifle is positioned in extension for the lateral view (fully extending the joint without forcing it). Ensure that there is no cranial subluxation of the tibia (with this degree of extension the collaterals should be tight and therefore the tibia should not be subluxated however, when in doubt compare it with the contralateral side). The hip is packed up and the femur and tibia positioned parallel to the plate.



The femoral and tibial condyles should be superimposed on top of each other. Sometimes this is very difficult to do!

The X-ray beam should be centered at the tibial plateau.

A summary of the pre-operative radiographic calculations is as follows:



Define the tibial plateau (TP) slope angle.

Draw a line from the cranial aspect of the medial tibial condyle to the apex of the popliteal notch. (i.e. approximately the cranial and caudal cruciate ligament insertions) (line 1)



The Tibial Plateau angle may be determined by drawing a line along the long axis of the tibia through the overlapping intercondylar eminences as shown.

Please note that the Tibial Plateau angle, although of interest, is not involved in calculation of the Correction Angle (CA). The important relationship is that between the tibial plateau and the straight patella ligament.



Draw a line marking the cranial edge of the straight patellar ligament (PL) from patella to tibial tuberosity (line 2).

Draw a line perpendicular to the TP (Line 3). Start line 3 at the cranial aspect of the patellar ligament insertion (proximal end of line 2).



Calculate the correction angle (CA) degrees. This is the angle between lines 2 and 3.

Calculate the wedge angle (WA) (= $(0.6 \times \text{correction angle}) + 7.3$ degrees)



Measure length of line 2 . (the patellar ligament length in mm (PL))

Mark a point (at the caudal aspect of the cranial cortex of the tibia) exactly the length of the patellar ligament distal to the tibial tuberosity (ie from the distal end of line 2). This point is the distal end of the tibial crest osteotomy.

Draw the tibial crest osteotomy line (TCO). It is made parallel to the axis of the tibial shaft and is usually parallel to the cranial aspect of the tibial crest. Its proximal end should be cranial to the cranial aspect of the menisci. Measure the TCO in mm.

Define the wedge position (WP = half of the TCOmm) along the TCO and draw a line (extending caudally from the TCO line) perpendicular to the TCO at this location. This line marks the centre line of the wedge. Its caudal end is the apex of the

wedge, the base of the wedge is located along the TCO an equal each side of this centre line.

Surgery

The patient is positioned in dorsal recumbency for the initial part of the surgery which is to explore the medial aspect of the stifle joint.

Make a medial parapatellar approach to the stifle. Incise medial fascia and joint capsule together (electrocautery is great for this). Inspect intra-articular structures. Remove torn ends of cruciate. Inspect menisci, if meniscal injury is present then resect injured portion. Perform a partial meniscectomy in preference to a complete meniscectomy where possible. The protocol for dealing with case where there is no obvious meniscal pathology is:

- a) Fresh complete rupture with no meniscal pathology. Perform meniscal release by incising the caudal menisco-tibial ligament of the medial meniscus.
- b) Partial rupture no meniscal pathology. Leave menisci alone; just resect the ruptured portion of the CrCL. However, check the remaining intact CrCL bands by placing a curved haemostat behind them and applying some pressure to make sure they are not stretched or incompetent but have reasonable strength.

Lavage joint and partially close capsule and fascia together in one layer (cruciate pattern PDS suture).

For dogs weighing less than 35 kgs, use a medium VI TPLO plate (TPLO353557).

For dogs 35Kg or heavier, use a large VI TPLO plate (TPLO353579). Use the angle finder and overlay to select a plate offering best fit for the caudal 2/3 of the proximal tibia. Smaller plates are available for dogs less than 20kgs. It is recommended that the appropriate size of plate is pre-contoured by twisting the proximal portion of the plate 10- 15° towards the midline.

With the patient now in lateral recumbency with the affected leg down and parallel to the operating table, the sartorius muscle and the crural fascia are reflected from the medial aspect of the tibia, taking care to preserve the saphenous blood vessels distally.

An appropriately sized pre-contoured TPLO plate is placed against the medial surface of the tibial to check that the plate is adequately contoured. Adjust the plate molding accordingly. Using the osteometer or a surgical ruler, measure the predetermined TCO from the distal end of the joint capsular incision, parallel with the tibial crest, and mark the location of the distal extremity of the TCO with the bone scribe. This point is placed caudal to the cranial cortex of the tibia. Check that there is enough room to apply the selected plate.

A 2mm hole is drilled at right angles to the tibia at this point. It is helpful to make this a generous 2mm by gently moving the



drill bit in and out of the hole. This will ease introduction and removal of the saw guide.

The pin on the saw guide is then inserted into this hole and the saw guide is aligned parallel to the tibial crest.

The TCO is completed from the distal hole in the tibia through to the tibial plateau. The patellar ligament is protected at all times.



The TCO is checked to ensure that the osteotomy is complete. The length of the TCO is remeasured. A point halfway along the TCO is marked. Invariably this point is located at the base

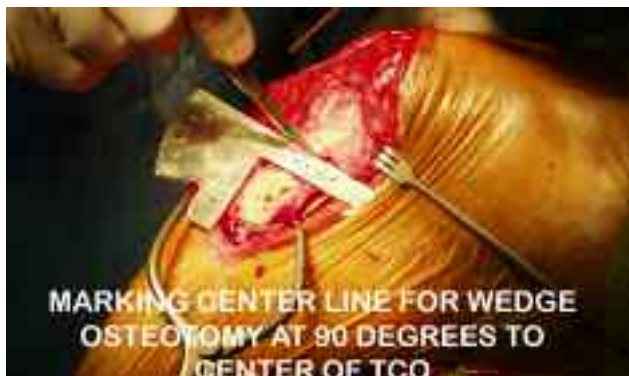


of the medial collateral ligament.

The osteometer is now used as a set square to mark a line from the TCO halfway point perpendicular to the TCO.

Please note that the osteometer is now a double sided measuring device and no longer has a peg to be pushed into the TCO. The leading edge of the osteometer is instead laid along the TCO.

The origin of popliteal muscle is elevated from the caudal aspect of the tibia in the area adjacent to this mark. A spoon Hohman



retractor and a dry surgical swab are used to retract the soft-tissues at this point to prevent iatrogenic damage to the popliteal artery. In addition the soft tissues attached to the medial aspect of the tibia either side of marked line are cleared away with a periosteal elevator.

The proximal part of the TCO is then forced apart using a periosteal elevator. This will hinge the tibial crest forward and allow the insertion of the small blade of the Wedgie more distally (the handle of the Wedgie is at right angles to the TCO). The Wedgie is then carefully rotated to give the maximal amount of tibial crest advancement (the handle of the Wedgie is now parallel to the TCO). In some smaller dogs, it may be easier to insert the larger blade of the Wedgie more proximally in place of the periosteal elevator during the wedge osteotomy procedure. However, the Wedgie must be positioned distal to the wedge osteotomy during the closure of the tibial wedge osteotomy.

A 2mm drill hole is placed at the caudal end of the marked line, but placed 2-3mm inside the caudal cortex of the tibia.

As the bone in this region slopes away, it is necessary to start drilling perpendicular to the bone surface until the drill bit engages the bone. Once this occurs the drill is then aligned per-



pendicular to the long axis of the tibia. Additionally the guide hole should run at right angles to the medial surface of the tibia so that the saw guide in position lies flat against bone. The guide hole (and saw cut) may exit the lateral cortex or even the caudal aspect of the tibia. The proximal tibia will hinge around the guide hole medially. It is worth spending some time working out where everything is prior to completing this location hole. Again it is helpful to slightly enlarge this 2mm guide hole. When this is completed the pin on the saw guide is inserted into this drill hole

and aligned along the marked centre line.

The hooked end of the osteometer is then placed between the saw guide and the tibia and hooked behind the guide pin.



This arrangement serves to accurately guide the wedge osteotomy of the tibia. For example if the calculated wedge angle (WA) is 12 then the osteometer is rotated till half of this angle (6) is adjacent to the perpendicular mark (wedge centre line) and the gauge is fixed to the tibia with a 1.4/1.6mm K-wire through one of the guide holes in the osteometer. The saw guide is then aligned alternatively with the 0 and 12 to create the appropriate sized wedge. The fine saw blade is used to cut a full thickness wedge from the proximal tibia. The slot in the saw guide is 1.0mm so it important that the blade cut (the width at the teeth) is less than 1.0mm.

The saw cuts should enter the caudal locating hole so once the wedge cuts are complete and the sawguide is removed the saw blade should be used to extend the cuts down into the locating hole. The wedge is removed and the tibial osteotomy checked



to ensure that there are no bone ledges or edges left behind.

The gauze swab and the retractor placed caudal to the tibia are removed.

A pair of Kern forceps is placed onto the distal end of the tibial crest.

Then one point of a pair of large speed-lock fragment forceps



is inserted into the stifle joint and the other point is hooked around the jaws of the Kern forceps. The fragment forceps are then gradually closed using a combination of the speed-lock threads and upward pressure on the foot (tibial thrust action). This action serves to gradually close the tibial wedge osteotomy at the same time keeping the caudal tibial cortex intact. This provides a very stable situation as the bone is in effect being molded into its new shape. Reducing the tibial wedge also causes the tibial plateau to rotate forwards which serves to hold the tibial crest in its new advanced location. If it is difficult to completely close



the wedge it may be necessary to re-cut the apex of the wedge near the locating hole.

Once the osteotomy has been closed the plate is rechecked and any necessary molding adjustments are made. The plate is then fixed to the bone using cortical screws except in the top two holes when long cancellous screws are used without prior tapping. The load guide is also used to apply axial compression. The resected wedge is used as a bone graft and placed into the triangular space left behind the tibial crest.

Following wound lavage, the sartorius muscle, the fascia and the rest of the joint are closed with monofilament absorbable sutures. If TCO fractures at its distal end then stabilize the TC using a single K-wire and a tension band wire (passed in a fig-8 between 1.5mm diameter holes). Avoid placing the pin too high as this



may lead to tibial crest fractures

Close rest of soft tissues routinely. Apply an RJB for 3-5 days post-op. Take post-op films.

TTO Post-operative Care Instructions

Medications

The following medications are suggested:

A NSAID (e.g. carprofen, meloxicam, firocoxib) is used for a minimum of 7 days.

Oral antibiotics (e.g. cephalosporins, clavulonate-amoxicillin) are used for 5 days.

Cartrophen-Vet injections starting at around 19 days post-opera-



tively and subsequent injections are given weekly for 4 weeks.

Exercise

Enforced rest is required for the first 6 weeks following TTO surgery. This means the dog should be confined to a small room or run for the duration of this period. The only exercise allowed is short-duration (10 minutes maximum), slow walks on a leash for toileting purposes. Walking up and down flights of stairs, jumping up, or any uncontrolled activity must be avoided. Take care to avoid slipping when walking on wet or smooth surfaces. An old towel can be used as a hind-quarter sling if it is placed underneath the abdomen.

Physiotherapy:

Postoperatively, physiotherapy in the form of passive range-of-motion exercises can be performed after RJB removal. Ideally, all joints of the affected limb should receive physiotherapy 2 to 3 times a day but instruct clients to concentrate mainly on the stifle joint if time is short. During each session, a minimum of 10 flexions and extensions should be performed on each joint. After flexion and extension of the individual joints, the entire limb should be cycled through its full, pain-free range-of-motion 10 times. It is very important never to force the joints or cause pain, but gently manoeuvre the limb through a range-of-motion that is well tolerated.

Longer-term follow-up and care:

At around 6 weeks post-operatively a radiograph of the stifle to assess the progress of healing are recommended. All going well, controlled exercise on a leash may begin at this time. Leash walks should be minimal at first (15 to 20 minutes twice daily), and then gradually increased after 8 weeks post-operatively.

Sit/stand exercises should also begin around 6 weeks post-operatively. This can be achieved during leash walking by commanding the dog to "sit" and just before the dog assumes the sitting position, the command to "walk-on" is given. This routine is repeated 10 or more times every walk and has the effect of building the quadriceps muscle mass, which is very important in rehabilitation following cruciate repair. There should be no unsupervised exercise, and running and jumping should be avoided during the 6 to 12 week post-operative period. Between 8 and 12 weeks, exercise can be increased slowly to 30 to 40 minutes twice daily. Deep-water swimming for 10 to 15 minutes several times a week, if possible, is excellent therapy at this stage. By 12 to 16 weeks the patient should have returned to near normal activity. However, there is a large variation in how quickly individuals return to full function following TTO surgery. If there is not near normal activity by 12 to 16 weeks post-operatively, then make an appointment for reassessment.