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Advanced Practitioner Cranial Cruciate Ligament Masterclass Mini Series

Session Three: Tibial Plateau Levelling Surgery (TPLO)

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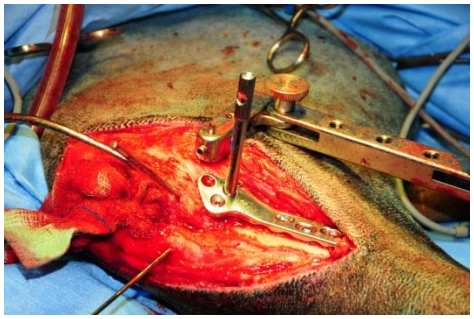

Webinar 3 - TPLO surgery

Introduction & History – what is TPLO? & brief evolution

1. In 1978, Henderson & Miller identified that canine stifle anatomy was such that there is cranial tibial thrust at a standing angle. This is because of the directions weight bearing forces (femoral condyle and tibial plateau) equate in a cranially directed thrust force called cranial tibial thrust, called according to vector mechanics. In the normal stifle joint, this force is constrained by the cranial cruciate ligament and the stifle is stable. When the cranial cruciate ligament ruptures associated with cranial cruciate ligament disease, the cranial thrust force is no longer neutralized and cranial tibial thrust instability occurs.
2. In 1984 Slocum and Devine realized that if they changed (flattened / neutralized) the angle of the Tibial Plateau relative to the tibial diaphysis, cranial tibial thrust (and therefore instability in the stifle with ruptured cranial cruciate ligament) would also be neutralized. This was called the Tibial Plateau Levelling Osteotomy (TPLO) procedure
    a. The original TPLO was performed using a cranial closing wedge (CWO)
    b. The technique was matured and refined into the curved osteotomy TPLO. Slocum patented the procedure and it was introduced about 1995. A specific oscillating saw coupled to a curved blade with set radii. A specific plate (the Slocum TPLO plate) was used to stabilise the osteotomy. Courses were held and there was no option but to attend the course. The patent ran out about 10 years later. Other manufacturers produced different plates of different sizes and blades so that it could be adapted to different sizes of dogs.
    c. Before the patent expired, the Cranial Wedge Ostectomy (CWO) TPLO was re-visited by people unwilling / unable to attend a TPLO course. This created 2 bodies of surgeons, those who were performing TPLOs and those who were doing CWO-TPLOs.
    d. Around 2006, Synthes produced a locking compression (LCP) TPLO plate. This was a big step forward as it made the osteotomy much more stable and reduced associated complications
    e. Over the last few years, evidence is emerging that of the procedures available, TPLO produces the best longer term outcomes for dogs with cranial cruciate ligament disease, and with lowest complication rates. There is no proven difference in outcome between TPLO and CWO-TPLO.

       In order of outcome: TPLO appears to be better than TTA which is better than extra-capsular suture (lateral fabella suture) which is better than Intra-Capsular sutures (fascia lata graft)
    f. The TPLO technique was initially taught with the use of
        i. a jig to stabilise the osteotomy, and dissection around the tibia and
        ii. packing with swabs to minimse the chance of arterial bleeding.

       Experience of multiple surgeons and studies have shown that neither of these is necessary, and many surgeons have now abandoned these steps, which makes the procedure quicker, less traumatic, more biologic, and avoids potential complications associated with these steps.

Which dogs benefit from TPLO? And why?

There is an argument that can easily be made that all dogs benefit from TLPO surgery. Reasons in favour of TPLO surgery include:

- Outcome is generally very good
- Dogs weight bear much quicker than with lateral fabella suture
- Longer-term outcome is better than all the other techniques including TTA
- In experienced hands, complication rates are very low
- Locking plates (the Synthes LCP TPLO plate) have made the technique much simpler, much less soft tissue dissection is required, the chance of screws stripping in the tibial diaphysis is eliminated, infection rate is probably less
- More stifles seem to be stable with TPLO compared to TTA surgery
- Small dogs in theory do better with TPLO surgery as the potentially very high TPA is neutralized. Lateral fabella sutures would reasonably struggle to control cranial tibial thrust in such stifles.
- Dogs with partial cranial cruciate ligament rupture in theory arguably do better with TPLO as the procedure reduces strain on the cranial cruciate ligament hence possibly protecting it. This is in contrast to lateral fabella sutures that produces temporary partial stability at best; this is likely to have little effect on a stifle that already only has a few millimeters of instability due to cranial cruciate ligament rupture.

Potential complications associated with TPLO

- Infection: up to 4-8%
- Fracture – tibial tuberosity or diaphysis - very low 0% if performed correctly
- Late meniscal tear 5-10%
- Popliteal artery bleed / other severe vascular bleed. <10%. Reduce rate with good technique, and can be controlled.
- Intra-articular penetration of stifle joint with jig pin or proximal plate screw. <5%. Can be eliminated with careful technique, not using the jig, and locking plates.

The evidence

Measuring Tibial Plateau Angle (TPA)

- VCOT 2005: radiographic measurement of TPA closely follows anatomic TPA. Median angle is 23.5 and measurement error increases with more deviant TPAs.
- JAVMA 2009: comparison of TPA on conventional & digital radiographs: high correlation. Inter-viewer & inter-technique differences resulted in rotation differences of <1mm
- VCOT 2011: Stifle angle has no effect on TPA in dogs. Similarly cruciate status (rupture) has no effect.

Evidence for TPLO?

- Vet Surg 2006: If post-op TPA between 0 and 14 degrees, no relationship between TPA and GRFs i.e. post-op function i.e. outcome not affected by TPA in this post-op range
- Vet Surg 2010: TPLO causes mild varus & increase in medial compartment loading, compared to TTA that does not alter contact mechanics & stifle alignment.

- Tier Prax 2014: 3 of 5 TPLOs showed same motion pattern as unoperated stifles i.e. caudal femur slippage relative to femur
- Vet Surg 2013: Long term outcomes of TPLO & TR superior to TTA, also lower major complications & meniscal tear rates
- VCOT 2014: TPLO alters PTA to 90 degrees in dogs, similar to TTA, may provide a similar biomechanical function.
- Vet Surg 2016: TPLO results in walk & trot limb function similar to control at 6-12 months post-op: TTA and ECR do not

TPLO vs Cranial Closing Wedge Osteotomy (CWO)

- JSAP 2002: 8 dogs had CWO (7 small terriers); all did well.
- VCOT 2007: complication rates between CWO and TPLO similar, but CWO more likely to require revision surgery
- Vet Surg 2013: TPLO and CWO have similar complication rates & clinical outcomes
- VCOT 2011: Modified CWO removes less bone, preserves greater proximal bone stock and shortens the tibia less; less recurvatum, fibular fracture & patellar desmitis?

TPLO plate evolution:

- Slocum plate to Delta style plate to Locking Synthes LCP TPLO style
- Vet Surg 2013: use of the Synthes LCP TPLO plate associated with accurate tibial levelling, excellent & reliably bone union, minimal TPA shift, lower complication rate
- Vet Surg 2015: in dogs >50kg, locking plate TPLO associated with a lower incidence of infection

TPLO – jig or no jig?

- Vet Surg 2007: jig does not improve precision of TPLO surgery. Not using jig should reduce surgery time, eliminate complications associated with jig placement (distal pin) & allow unhindered osteotomy position.
- Vet Surg 2007: Jig not essential for osteotomy rotation, tibial plateau rotation, fragment reduction. Comparable results with / without jig.
- Vet Surg 2014: All locking plates: higher incidence of screw penetration when jig not used

TPLO – soft tissue elevation or not?

- VCOT 2009: anatomic description of the cranial tibial artery & medial approach to popliteal artery if bleeding occurs
- VCOT 2013: not elevating the soft tissues results in faster surgery, minimal soft tissue surgery and no severe haemorrhage. No diff in bone healing or complications (all minor)
- Vet Surg 2009: when gauzes used in soft tissue retraction, results in cotton debris.

TPLO – complications:

- JAVMA 2003: 28% complications most resolved without revision surgery. Similar complication rate to other techniques but major complication rate low.
- Vet Surg 2010: 2.8% meniscal injury, 6.6% infection including bilateral TPLO: complication rates lower than previously reported, bilateral TPLO reasonable
- VCOT 2011: better and faster recovery after TPLO if meniscus intact, 4.2% major complication including 2.1% meniscal injury. 3.1% pivot shift

- VCOT 2012: risk factors for complications not fully assessed but likely reduced complications with careful planning & execution and surgeon experience
- Vet Surg 2013: use of locking plate results in excellent tibial plateau levelling, bone union, minimal shift in tibial long axis and lower complication rates (no major)
- Can Vet J 2014: 3.1% major complications, 8.3% minor, higher risk for GSDs, higher TPA and higher body weight
- Vet Surg 2015: use of locking plates & post-op antibiotics independently reduced incidence of infection
- Vet Rec 2016: 4.7% infection rate, 37% required removal, particularly late SSI. Did not affect outcome.
- Vet Surg 2006: combination of CWO and TPLO for TPA>30 resulted in 78% complications and 33% second surgery rate; healing longer and complications higher than TPLO alone
- JSAP 2016: TPLO alone in dogs with TPA>30 resulted in very low complications, only 3.4% patellar tendinopathy

TPLO – the procedure

- Vet Surg 2004: centring the TPLO on the proximal tibial long axis point is the correct position to minimise anatomic deformities
- Vet Surg 2005 : distal centring of the TPLO results in abnormalities including inadequate tibial plateau levelling
- Vet Surg 2008: post TPLO TT fracture: increased risk with thinner TT width, and increased TPA at follow-up (rock-back), simultaneous bilateral TPLO
- VCOT 2015: pre-operative osteotomy measurement / planning is recommended with the recommended technique
- VCOT 2014: TPLO osteotomy can be planned and executed using K-wires but care not to cut the K-wires during osteotomy

TPLO: *tricks & tips to avoid complications*

- Plan the osteotomy; correct size of blade and position on the tibia
    - *Use the tip of the intercondylar eminences as the centre of rotation*
    - *Use the cranial prominence of the tibial tuberosity to calculate surgical landmarks*
    - *Do not allow the tibial tuberosity to become narrow below this point*
    - *Tibial tuberosity thickness should be minimum 10mm in medium dogs*
- Carefully transpose the pre-operative measurements onto the tibia. For landmarks:
    - *use 23G needle in the center of the joint directly through medial collateral ligament*
    - *use the cranial prominence of the tibial tuberosity*
    - Review the size and position of the osteotomy, including intended plate position.
- Place Gelpi retractors at the base of the arthrotomy to protect the patellar ligament from the TPLO saw blade
- Make half the osteotomy
- Mark on the bone the required rotation using osteotome and mallet, diathermy, bone scribe or K-wires.
- Complete the osteotomy
    - *Carefully feel, listen and observe for the completion of the osteotomy.*
    - *Cutting too deep increases the chance of significant bleeding and cutting the fibula*
    - *If significant bleeding occurs proceed with the next 2 steps rapidly and bleeding will stop in most cases. If not, pack the caudal proximal tibia with Lysostypt & swabs.*
- Insert a rotation pin into the cranial medial tibial plateau and rotate the tibial plateau.
    - *Take care not to cause anatomic deformity / movement in anything other than the sagittal plane. Hold the pes to counteract the force on the pin.*
- Stabilise the newly positioned tibial plateau using a K-wire through the proximal tibial tuberosity.
    - *Make sure the K-wire is just above the cranial prominence of the tibial tuberosity. Correct position will place it through the centre of the distal part of the patellar ligament. Point caudal and distal. Stop immediately the caudal cortex of the tibial plateau is penetrated.*
    - *Place pointed reduction forceps between the tibial tuberosity and the caudal tibial plateau. This will compress the osteotomy cranial-caudal*
- Carefully position the LCP TPLO plate on the bone, ensuring all screw holes overly bone.
    - *If necessary use a 23G needle to identify the margins of the bone*
    - *If the plate needs contouring, be careful that the most proximal screw does not point towards the joint; if so, drill and depth gauge carefully and only use a monocortical screw if high risk of intra-articular penetration likely.*
- Use principles of locking and non-locking screws to place locking screws in the proximal segment and non-locking screws in the distal segment, including compression screws.
    - If so, bend distally using pin bender, and trim to fit.