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TPLO principles, patient selection and preoperative planning

Derek B. Fox
DVM, PhD, Dipl ACVS, Assistant Professor, Missouri, USA

TPLO Principles

In the veterinary surgical vocabulary, the TPLO procedure, or tibial plateau leveling osteotomy, refers to the alteration of the proximal tibial joint reference angle by the performance of a dome or radial osteotomy in the sagittal plane for the purpose of stabilizing the cranial cruciate deficient joint. Other types of osteotomies such as opening, neutral, chevron, intracutural or closing wedges can accomplish the same task, however over the past 8 years, the most frequent technique has employed the use of the dome osteotomy.

When examined in the sagittal plane, the proximal canine tibia possesses a joint orientation line that intersects with the mechanical axis at approximately 26 degrees from perpendicular. This angle has been much studied and is referred to in the literature as the tibial slope, tibial plateau angle (TPA) or the complement of the mechanical proximal caudal tibial angle (mPTCdA). Recent research has demonstrated that this angle may be breed-dependent.

The TPLO procedure is geared toward alleviating cranial tibial thrust, which is the dynamic instability of the canine cruciate-deficient stifle during weight-bearing. Cranial tibial thrust is the cranially-oriented tibial translation that results from femoral tibial compression from both weight bearing forces and contraction of the gastrocnemius, hamstring and quadriceps muscle groups in the cruciate deficient stifle. In the normal stifle, the cranial cruciate ligament would resist cranial tibial thrust. The purpose of the TPLO procedure is then to provide functional stifle stability during the stance phase of the gait cycle by eliminating cranial tibial thrust. The completion of a TPLO induces converts cranial tibial thrust into caudal tibial thrust, thus increasing strain on the caudal cruciate ligament and stabilizing the joint during weight bearing.

Patient Selection

Historically, the TPLO procedure was limited to large-breed dogs only due to limitations in sizing of the appropriate saws and implants. With the popularity of the procedure, came the advent of differently-sized saw blades and size-specific plates for post-correctional stabilization. The TPLO procedure has thus been now described for all sizes of dogs and even cats. Despite recent reports failing to show advantages in clinical outcome of dogs undergoing TPLO versus extracapsular suture techniques, the procedure has become the current standard of care for most veterinary canine patients. However, other very successful techniques exist, including the aforementioned extracapsular suturing techniques, and the tibial tuberosity advancement procedure. Whereas most dogs with cranial cruciate ligament rupture would be a candidate for any of the surgeries mentioned here, some patient-specific criteria may dictate why the TPLO would be advantageous. Although a direct relationship has not been shown, speculation still surrounds the possible causal effect of tibial slope on cranial cruciate ligament rupture. Regardless, a percentage of cases is seen clinically that have tibial slopes that can be considered excessive (>30°). For those cases, completing another stifle stabilizing procedure may not fully eliminate the cranial tibial thrust. Although a recent study argues against this supposition, it should be noted that dogs with slopes greater than 30° were not evaluated. Therefore, it is still commonly held that dogs with excessive slope may show the most improvement from a leveling osteotomy. An advantage of the TPLO procedure is that rotational corrections of tibial torsional deformities can be made at the time of the leveling procedure. Torsional deformities of the tibia have been suspected as being contributory to cranial cruciate ligament disease and patellar luxation. Thus presenting dogs with cranial cruciate ligament rupture and concomitant torsional deformity may be optimally treated with TPLO. Patients that are not candidates for the TPLO procedure would be any dog that is of a size that is not compatible with the surgeons osteotomy equipment. Another major criteria for exclusion would include those dogs with traumatically-induced cranial cruciate ligament rupture that has concurrent compromise of the caudal cruciate ligament since the strain on the caudal cruciate ligament increases following the TPLO procedure.

Preoperative Planning

Orthogonal radiographs are required to plan for the corrective dome osteotomy employed in the TPLO procedure. Frontal plane radiographs are used to assess if torsional deformities of the tibia are present. If the tibia is normal and void of torsional deformity, the stifle should appear straight on the frontal plane radiographs, with the fabella bisected by the femoral cortices, and the center of the patella bisecting the mid-femur. The tibiotalar joint should also be straight such that the medial cortex of the calcaneous should bisect the intermediate ridge of the distal tibia. Radiographic evi-
dence of torsional rotation may be addressed at the time of surgery at the discretion of the surgeon. Sagittal plane radiographs of the tibia are used to plan the actual osteotomy. First the mechanical axis of the tibia in the sagittal plane is determined and is defined as the straight line running between the intercondylar eminences proximally to the center of a best-fit circle superimposed over the talus distally. The joint orientation line of the stifle is determined either by finding the tangential line to the medial tibial condyle, or by defining points at the cranial and caudal most aspects of the tibial slope, and drawing a straight line through them. The intersection of the proximal tibial joint orientation line and tibial sagittal plane mechanical establishes the TPA which is measured from a line perpendicular to the mechanical axis.

Next the size of the saw blade to be used is determined. Standard sizes of saw blades that are commonly available are named for the radius that defines the arced blade: 30mm, 24mm, 18mm and 12mm. Transparent templates are useful for preoperatively sizing the blade on the films. Remember that the saw blades will cut an arc in the bone, and an arc is simply a fraction of a circle. The circle that constitutes the arced cut should be centered over the intercondylar eminences of the proximal tibia. Optimally, the size blade that is chosen will be able to be centered as described and cut an arc with the following criteria:

1) The cranioproximal portion of the osteotomy should exit the bone cranial to intermeniscal ligament
2) The caudodistal portion of the osteotomy should exit the bone roughly perpendicular to the caudal cortex of the tibia, or angled slightly proximally to it.
3) Be positioned in a proximal-distal relationship to allow just enough room proximally to apply the designated number of screws through the proximal portion of the chosen TPLO plate.
4) Not be so big as to compromise the tibial crest: the optimal cut should actually allow the remaining tibial crest to widen toward its base following the cut, not taper to become more narrow.

This arc can be drawn on the pre-operative radiographs, or a copy of the radiographs. Many surgeons are now measuring the distance from the most prominent aspect of the tibial crest caudally in perpendicular fashion until the osteotomy is reached. This number is used intra-operatively to establish a reference mark for the cranial position of the saw.

Once the saw blade size is chosen, then those two numbers (radius of the arced blade and the tibial slope) are used to determine how much rotation of the tibial slope is required to reduce the slope to ~5° in millimeters (X). This is determined by the trigonometric formula:

\[ X(\text{mm}) = \left(2\pi(\text{saw blade diameter})\right)\left(\text{TPA-5°/360°}\right) \]

Therefore, if you measured the TPA to be 26°, and wanted to use the 24mm saw blade, and wanted the post-correctional TPA to be 5°, the calculation would be:

\[ X(\text{mm}) = \left(2\pi24\text{mm}\right)\left(21°/360°\right) \]
\[ X(\text{mm}) = 8.8\text{mm} \]

This means that after completing the dome osteotomy intra-operatively, you would rotate the tibial plateau along the arced cut a total of 8.8mm to correct the TPA from the measured 26° to 5°.

**Additional Reading**


Kowaleski MP, McCarthy RJ. Geometric analysis evaluating the effect of tibial plateau leveling osteotomy position on postoperative tibial plateau slope. Vet Comp Orthop Trauma 17:30-34: 2004.