Management of the Cranial Cruciate Ligament-Deficient Large Dog Utilizing Tibial Plateau Leveling Osteotomy (TPLO)

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Diagnosis of cranial cruciate ligament ruptures has historically been accomplished by eliciting a cranial drawer sign. Surgical management of the deficiency in the stifle joint has historically been to eliminate the cranial drawer, either by intracapsular replacement of the torn cranial cruciate ligament or by surgically preventing the tibial plateau from "drawing" cranially with extracapsular sutures, muscle and/or bone advancements, or other implants. The veterinary literature is loaded with descriptions of these techniques (and modifications of these techniques). These techniques have not consistently returned patients to full pre-injury function and athletic capability for all types of dogs, nor have they been able to prevent progressive degenerative joint disease.

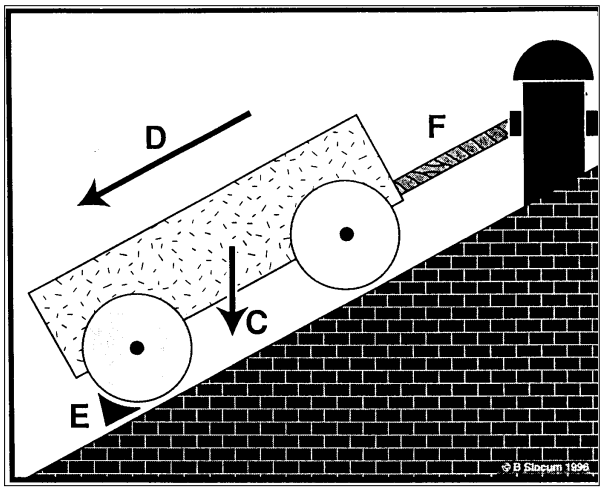
Slocum, in 1982, described cranial tibial thrust, a natural active force created by weight bearing plus muscular compression of a sloped tibial plateau against the femoral condyles in the dog's stifle. Cranial tibial thrust is responsible for rupture of the cranial cruciate ligament, both in strenuous and normal activities. Understanding the forces generated in the stifle led Slocum to approach the management of the cranial cruciate ligament deficiency in the dog's stifle from a different angle. He ultimately developed the Tibial Plateau Leveling Osteotomy, a technique that eliminates the cranial tibial thrust (but not the cranial drawer…a force created by the diagnostician!).

In the **traditional model** of stifle joint stability, the cranial and caudal cruciate ligaments are considered the sole resistance to cranial and caudal sliding movements of the tibial plateau in relation to the femoral condyles (cranial and caudal "drawer" motions). The traditional model represents a passive force model whereby the tibia and femur sit quietly awaiting application of an external force. Utilizing this model, intra- or extra-capsular repair techniques should only fail

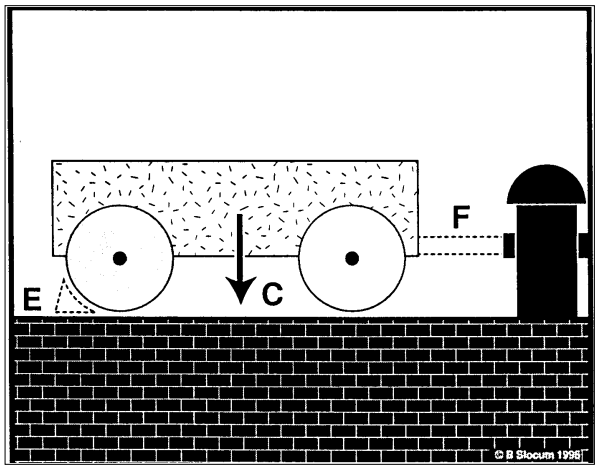
due to tissue or implant failure for some reason, or because of some major external traumatic force. It should also become impossible for the caudal horn of the medial meniscus to become impinged unless the repair fails because the traditional model suggests that all internally generated forces of the stifle only act to flex and extend the joint, the ligaments acting only as passive restraints.

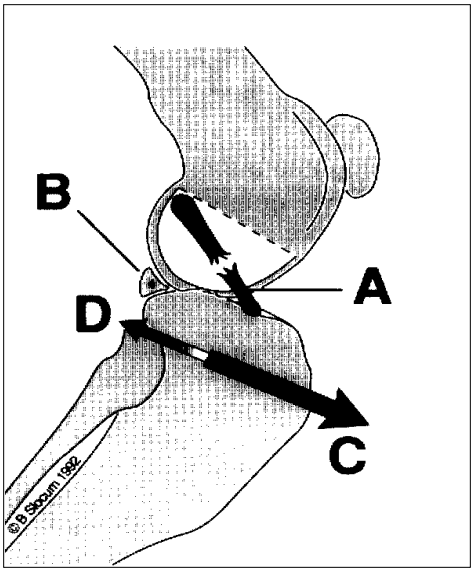
An **active model** of the stifle joint includes forces created by muscles and weight bearing. As the dog walks, it produces a force creating tibial compression and cranial translation of the proximal tibia. When the cranial cruciate ligament has been ruptured, a meniscal click can often be heard as the caudal horn of the medial meniscus is impinged between the femoral condyle and tibial plateau. Muscles in the active model produce stifle stability through a balance of the moments around the instant center of motion. Zero movement of the tibial plateau results when the moments of stifle flexion (pulls of the biceps femoris muscle, pes anserinus group, and tibial head of the semimembranosus,) and stifle extension (pulls of the quadriceps and long digital extensor muscles) are in balance. Cranial tibial thrust, created by weight bearing, and extensor muscular compression of the tibial plateau against the femoral condyles is counteracted by pull of the stifle flexor muscles, the cranial cruciate ligament, and the caudal horn of the medial meniscus. The tarsal tendon within the Achilles tendon and extensors of the hock (gastrocnemius and superficial digital flexor muscles) help prevent the limb from collapsing during weight bearing.

When cranial tibial thrust overcomes its opposing forces, tearing and eventual rupture of the cranial cruciate ligament occurs. Tibial Plateau Leveling Osteotomy is used to negate the effects of cranial tibial thrust by leveling the tibial plateau. This eliminates the need for a cranial cruciate ligament. This can be demonstrated with the following drawings, courtesy of Dr. Barclay Slocum:

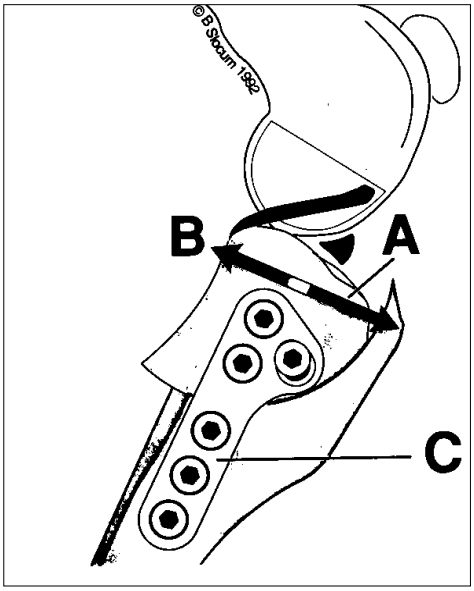


The wagon represents the femoral condyles, the inclined surface represents the tibial plateau, F = the cranial cruciate ligament, E = the medial meniscus, D = the forces of cranial tibial thrust, and C = the forces of weight.





ç The cranial cruciate ligament (A) is ruptured & the caudal horn of the medial meniscus (B) is impinged when the cranial tibial thrust (C) is not neutralized by the pull of the stifle flexor muscles of the thigh (D)



ç Cranial tibial thrust (A) is reduced by the Tibial Plateau Leveling Osteotomy until it is in balance with the pull of he stifle flexor muscles of the thigh (B) The tibia is functionally stabilized by the caudal pull, which is passively opposed by the caudal cruciate ligament. The Tibial Plateau Leveling Osteotomy plate (C) maintain the bone relationship during the healing process.

Experiences with both intracapsular and extracapsular techniques used to combat cranial tibial thrust in replacement of torn cranial cruciate ligaments in dogs over 50 lbs. have been mixed. In some cases the implanted material stretches or pulls loose, muscles weaken during the early stages of healing, or limitations of internal rotation occur, resulting in excess laxity, progression of degenerative joint disease, and possible limitations in athletic capabilities. If the caudal medial

meniscus is not removed at the time of surgery, it may become torn or impinged at a later date and require removal.

Our experiences with the TPLO procedure, which seem to distinguish this procedure from other techniques, are fourfold:

1. Patients return to more active, athletic activities. Most dogs return to their pre-injury function.
2. Patients usually regain full flexion of the knee unless degenerative changes are so chronic that large osteophytes limit range of motion.
3. Musculature of the thigh returns to pre-injury size.
4. Progression of degenerative joint disease is minimal, if not halted in its entirety.

We "release" the caudal medial meniscus at the time of TPLO surgery. That is, we bisect the caudal horn (or remove it completely if it is already torn) and pull the bisected portions caudally out of the joint so that it will not become impinged in the future. Specific radiographic positioning is critical and careful calculations are made to determine the degree of rotation required to level the tibial plateau to a point that cranial tibial thrust will be neutralized.

Question from a referring clinician: What if I find a cranial drawer sign after a TPLO surgery has been performed. Does this mean the surgery has failed?

Answer: NO! One aspect of the post-operative evaluation is that the cranial drawer sign remains. Therefore, the drawer sign is NOT a valid means, POST-OPERATIVELY, of judging the Tibial Plateau Leveling Osteotomy and is no longer a valid test for stifle "stability". Persistence of a cranial drawer sign AFTER a TPLO has been performed is NOT A SIGN OF FAILURE! Further, a small amount of drawer sign is purposely left in order to protect the integrity of the caudal cruciate ligament.

Question: How does TPLO compare in cost to other procedures?

Answer: It is slightly more expensive, but the results certainly justify the additional effort.

Question: Is there a difference in rehabilitation and recovery time from other procedures?

Answer: There is a slightly longer rehabilitation time because of the fact that an osteotomy has been performed, and therefore, the plate implant and stability must be protected more than with other "soft tissue" procedures. Again, the end justifies the means.

Question: Can this procedure be used on dogs less than 50 lbs.?

Answer: We have used it on dogs 42-45 lbs., but instrumentation is not yet available for smaller dogs. We are told it is coming, however.