Ruptured Cranial Cruciate Ligament (RCCL) and TTA Information for the Veterinarian

Stifle Anatomy and Pathophysiology of a RCCL

The most common orthopedic disorder and cause of lameness affecting the canine stifle is a partial or complete rupture of the cranial cruciate ligament (CrCL). The CrCL functions to limit the internal rotation of the tibia relative to the femur prevent hyperextension of the stifle joint and prevent cranial translocation of the tibia relative to the femur. During flexion of the stifle joint, the tibia rotates internally relative to the femur, and the two cruciate ligaments twist on each other, thus limiting the degree of internal rotation. This process is called the “screw-home mechanism”. If the CrCL ruptures then there is additional internal rotation of the tibia. This may be as much as 23 degrees of additional rotation. When the stifle is extended, the cruciate ligaments untwist from each other and have no effect. Stability of the knee is then relied on by the collateral ligaments.

Injuries usually occur when there is excessive internal rotation of the stifle while at 20–50 degrees of flexion or forceful hyperextension. The breaking strength of the CrCL is around four times the body weight of the dog. There are two bands of the CrCL (the craniomedial band and the caudolateral band, which is larger). The craniomedial band is tight in flexion and extension, while the caudolateral band is taut in extension. If the craniolateral band is only torn, most likely from hyperextension, there usually is no drawer motion because the craniomedial band is still intact. Injuries caused by excessive rotation are more likely to injure the craniomedial band and a small amount of drawer motion will be present in flexion but not in extension.

The most likely expressed pathogenesis of CCL rupture has been degenerative changes on the ligament that occur with disuse and age. As the animal ages, the degenerative changes progress. The changes tend to be less severe in animals less than 15 kilograms in body weight. A sedentary lifestyle of the middle-aged dog and concurrent obesity, leading to diminished mechanical strength, may contribute to the rupture.

However, during the last few years, additional contributing information has included the tibial slope. This has been theorized as an explanation for the increased occurrence of RCCL in the larger and younger dogs. The top of the tibia is called the tibial plateau. The tibial plateau may have a slope. When the dog walks, the femur slides backward against the tibial plateau and thus pushes the tibia forward (tibial thrust). The CrCL function is to prevent this sliding motion. The steeper the slope the, the more stress is placed on the CrCL. This added biomechanical stress inflicts additional shear forces upon the CrCL and leads to tearing and rupture.

Recently, the affect of early spaying and neutering has been questioned as also a contributing factor. Studies have shown that females and males, spayed or neutered at seven weeks or even less than a year of age, grew significantly taller than animals spayed or neutered at an older age. It appears that the sex hormones and growth-related hormones both promote the closure of the growth plates at puberty. Due to lack of the sex hormones in early spayed or neutered dogs, the bones continue to grow which may lead to abnormal bone growth thus resulting in alterations in body proportions and lengths of the bones. A disparity in growth between the femur and tibia, which grows longer, could lead to the abnormal angle in the stifle. In addition the longer and heavier tibia may cause increased stresses on the CrCL.
Biomechanics of TTA. Why does it work?

The forces within the knee are very complicated and change as the knee is rotated through its range of motion. In the normal standing position, there is a tendency for the lower end of the femur to slide backwards on the tilted tibial plateau. This is called tibial thrust. This force can be corrected by 1) either cutting the tibial plateau (TPLO); rotating it into a more flat position or 2) by counteracting this force by changing the angle of the very strong patella tendon through advancing the tibial tuberosity (TTA).

Basically, the research has shown that if the angle between the tibial plateau and patella tendon is moved to 90 degrees, then the weight bearing forces will be redistributed so that the CrCL is not required to stabilize the stifle joint. Following a TTA procedure the tibial thrust is neutralized and the CrCL is no longer needed to stabilize the joint.

The TTA procedure involves an osteotomy of the tibial Tuberosity, which is a non-weight bearing portion of the tibia. The Tibial Tuberosity is advanced cranially to align the patella tendon perpendicular to the tibial plateau. No tibial thrust will be produced thus eliminating the need for the CrCL.

The normal joint, viewed from the side, shows the upper bone, the femur and the lower bone, the tibia. The Tibial Plateau is the actual point of contact between the femur and the tibia. In this diagram the Patellar Tendon is clearly visible. It is this structure that must offset the abnormal forces that are created with a rupture of the cranial cruciate ligament.

In the typical joint, the angle formed between the Tibial Plateau and the Patellar Tendon is about 115 degrees when the
leg is in a normal standing position.

The abnormal motion that occurs in a knee with a torn cruciate ligament is called Tibial Thrust. After the TTA Surgery, the corrected angle is now 90 degrees, which will offset the forces in the knee that tend to make it unstable.

Surgical Appearance

This diagram shows the knee once it has been stabilized with the appropriate Titanium implants. These implants are very lightweight and are designed to stay in permanently.

What are some of the advantages for a TTA versus TPLO?

First of all, even though it is relatively a newer procedure, thousands of TTA procedures have been performed. From the veterinary literature and reports by surgeons performing TTAs, the following observations have been made:

1. Quicker recovery – The procedure is less invasive and requires less surgical time.
2. Less implant failure – The strain put on he plate is less than what is seen with TPLO.
3. Good results with chronically arthritic knees
4. Fewer complications
5. Early research suggests that arthritis does not progress with a TTA as seen in the other procedures used, especially the extracapsular lateral suture techniques. It has also been shown that the TPLO procedure can still allow rotational instability (pivot shift) and this may lead to the progression of arthritis as the dog ages. This pivot shift does not seem to be a problem with the TTA procedure because it results in more control of rotation by the large quadriceps muscle, which pulls on the patella tendon.
6. Does not compromise the weight-bearing portion of the tibia.
7. Less invasive procedure
8. Better range of motion is maintained.
9. The titanium implants used for TTA are more bio-mechanically compatible.
10. The TTA decreases the joint forces
11. Has been done bilaterally (not recommended for TPLO)
12. Has been performed on dogs from 10-198 pounds
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When to refer for TPLO and NOT perform TTA

1. Excessive tibial plateau slope (greater than 30 degrees)
2. Angular limb deformity
3. Medial patella luxation present
4. Show dog (Due to the anterior placement of the tibial Tuberosity, a TTA may show some deformity when compared to the opposite normal leg)
5. Dog is less than 1 year of age

Radiographs needed for TTA

Properly positioned radiographs are needed prior to a TTA procedure. The proper sized cage used to advance the tibial Tuberosity needs to be determined. Also, the radiographs are needed to rule out any other possible causes for the lameness.

The following radiographic views should be performed:

1. Lateral of the right and left stifles – the animal needs to anesthetized and placed in lateral recumbency. **The leg to be radiographed needs to be placed in full extension (135 degrees) and there is no cranial subluxation of the tibia.** Most dogs with complete CrCL tears tend to have a cranial drawer when under sedation. The leg should be perpendicular to the edge of the table and foot pointed toward the person holding the leg. The opposite leg should be pulled forward, NOT backwards. Both the stifle and hock should be included in the film. A **true lateral**, as evidenced by superimposition of the femoral condyles is required. The beam should be focused over the stifle joint but the hock should be included.
2. Ventrodorsal view of the pelvis
3. Lateral view of the lumbar spine

The three sets of films should rule out the majority of other orthopedic causes for lameness in a rear leg.

Fees for TTA

There is a wide range of fees charged for any cranial cruciate repair procedure and local where he surgery is performed is also a factor. It is my goal to provide a service that allows the practicing veterinarian to participant in this newer technology and provide additional income that has been lost through referrals.

To keep it simple and so you can perform an estimate easily, the fee for a TTA procedure will be $975.00. That includes all the implants and materials needed for performing the surgery. The implants and the bone grafting material, used in the procedure, runs about $200 - $250.00 per case. The veterinary hospital is free to charge its own surgical fee. Also, all pre-operative radiographs, laboratory work-up, anesthesia, post-operative medications, post-operative films, bandaging charge, intravenous catheterizations and fluids, intra-operative monitoring and follow-up films charges for the veterinary hospital.
I have looked on the Internet and a low range at one hospital for a TTA procedure to be $2,000.00 to $2,500.00. This fee included surgery, pre-post-operative radiographs, pain medications, antibiotics, anesthesia, hospitalization, and three follow up examinations. Fees in this area can be $2500.00 inclusive or range from $1800.00 – 2800.00 for the surgery only.

If a TTA procedure is not an option for your client, an alternative procedure may be more feasible. Most extracapsular lateral procedures or over-the-top fascial strips are $400.00 – 500.00. A tightrope procedure, which includes the $235.00 tightrope implant, would be in the $750.00 – 800.00 range.

Veterinary Hospital Responsibilities and Recommendations

1. As previously outlined above, any and all pre-operative workup, except for the radiographs, is up to the hospital.
2. The hospital will be responsible for the anesthesia protocol used, monitoring and pain management. I prefer that each hospital do things the way they are use to doing it.
3. General surgical pack - I will have a general pack available but usually use what is available in the hospital.
4. I do recommend that the patient have an intravenous catheter and be given fluids with 1 gram of cephalizin added.
5. The skin should be surgically prepared with a surgical scrub.
6. A cap, mask and gown will be needed.
7. Also, large drapes that cover the dog and table should be available.
8. Suture material available should either be PDS, Maxon or Monocryl. Sizes available should be 3/0, 2/0 and 0. Because of their better strength and duration PDS or Maxon are preferable. If needed, I do carry some suture material with me.
9. Good surgical lighting would be helpful and there should be Mayo stands, OR table or an area available to open and organize the packs needed.
10. A technician should be available in the OR to monitor the patient and help provide supplies when needed. Also, the technician should be able to glove up and assist if needed.
11. Bandaging material needed (1 inch tape, 4 inch cast padding, 4 inch Kling and 4 inch Elasticon)

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