Tibial Plateau Leveling Osteotomy (TPLO) for Treatment of Cranial Cruciate Ligament (CCL) Disease

What is the Cranial Cruciate Ligament and Why is it Important?

The CCL is a ligament in the canine knee joint and performs the same function as the ACL in the human knee joint. The CCL connects the femur (thigh bone) and the tibia (shin bone) and limits certain movements of the knee joint thus providing stability. Dogs have a knee joint in both hindlimbs just like people do.

What is Cranial Cruciate Ligament Disease and how is it different from ACL Tears in People?

Cranial cruciate ligament disease is a chronic degeneration and eventual tearing of the cranial cruciate ligament (CCL). Human ACL tears are more commonly caused by excessive force/trauma during sporting activities (skiing, soccer, basketball).

How does canine knee anatomy differ from human knee anatomy?

Dogs typically have a 20-30 degree backward slope of the tibial (shinbone) joint surface whereas people average 5 degrees. The rounded ends of the femur rest on this surface so the higher angle in dogs causes the femur to slide down the slope whereas the human tibial surface is a more stable platform for the femur. This difference in slope has caused differences in how ACL tears are treated surgically in dogs vs. people.

What causes CCL Disease?

We don't completely understand why CCL disease happens in dogs but genetics play a large role as certain breeds (Labradors, Rottweilers, Pitbulls, Newfoundlands) are more predisposed to the condition than others. CCL disease is one of the most common canine orthopedic conditions we see especially amongst medium, large, and giant breeds.

What is a typical history for a dog with a torn CCL?

A typical history we hear for a dog with a torn CCL is that a sudden lameness occurred during mild/moderate activity (running in the backyard, going up the stairs, jumping on the couch). This event represents a ligament that has been degenerating for some time, finally developing a significant tear that causes pain and inflammation in the joint. Many times, this event is accompanied by a yelp or other indication of pain, and the dog starts holding up the affected rear leg. Over the next few days to weeks, the joint inflammation decreases and the dog will begin toe-touching or bearing limited weight on the affected limb.

How is a CCL tear diagnosed?

Similar to people, there are physical manipulation tests performed by a veterinarian that are used to diagnose a CCL tear. These tests are called the cranial drawer test and the cranial tibial thrust test. In most dogs these tests can performed in the exam room. Animals that are more painful or with nervous temperaments may need to be sedated to safely perform and accurately interpret these tests.

A positive sits test can also raise the suspicion of a torn CCL. Normally a dog will sit with its hindlimbs tucked squarely under the hips with the knee and ankle joints fully flexed. A dog that sits with the leg extended to the side would have a positive sits test.

All dogs with CCL tears experience swelling in the knee joint due to increased amounts of joint fluid. This swelling can be palpated during a physical exam and visualized with x-rays.

X-rays also show us the relative positions of the femur and tibia. In a dog with a CCL tear, the tibia will be inappropriately positioned in front of the femur.

So my dog has a CCL tear, why should I care?

CCL tears cause pain. Dogs with CCL tears experience pain due to the swelling, inflammation, and instability of the knee joint. The lameness, whether complete or partial, is evidence the dog is painful.

CCL tears cause instability of the knee joint. Unstable joints experience inappropriate wear of the cartilage surfaces which causes damage and/or loss of cartilage (arthritis). Loss of cartilage is an irreversible process.

Dogs with CCL tears have a high risk of concurrent meniscal tears. Every knee has two C-shaped cartilage structures that sit between the femur (thigh bone) and the tibia (shin bone) called the medial and lateral menisci. CCL tears very frequently cause tears in the medial meniscus. These torn portions get caught and crushed in between the femur and tibia during gait which is painful.

Pain and instability causes decreased joint range of motion and limits activity. This can significantly affect the quality of life for any dog but especially young and/or active dogs.

What are the treatment options?

There are two main categories of treatment: medical or surgical. Medical treatment involves managing pain with medications and joint supplements to decrease inflammation and pain. This strategy relies on the body's efforts to stabilize the knee joint. Over time, the body will lay down scar tissue and develop bony spurs around the knee attempting to stabilize the joint. Often this only provides minimal stability. This process also takes many months to years, during which the joint is unstable and severe arthritis develops. Since arthritis is irreversible cartilage loss, options are limited when severe arthritis is present.

Surgical management is the best way to manage a torn CCL for most dogs as it is for most people with torn ACLs. Surgery provides immediate stability for the affected knee thus minimizing arthritis in the affected knee.

Are orthopedic braces effective?

No commercially available brace has been proven to provide any significant stability for CCL tears. Custom molded braces (about $1000) can be manufactured, and these may be able to provide some stability. Braces are typically not tolerated well by dogs and are frequently chewed or otherwise damaged. Since a brace must be worn constantly to provide stability, they often cause rubbing sores or other skin trauma as well. In short, there are very few dogs we feel are good candidates for braces.

What are the surgical treatment options and why do we prefer TPLO?

TPLO (tibial plateau leveling osteotomy):

This is the most commonly performed and recommended surgery for CCL disease. It was developed by Dr. Slocum in the late 1990's and involves making a curved cut in the top of the tibia (shin bone) then rotating the top piece of bone backwards to level the tibial joint surface. The bone is then secured in its new location with a bone plate and screws. This procedure stabilizes the knee by transferring the functions of the normal CCL to other ligaments and soft tissues so the CCL is no longer needed.

TTA (tibial tuberosity advancement):

The TTA is another relatively common procedure performed for CCL disease. It involves making a linear cut behind the tibial tuberosity and then levering this section of bone forward and securing it with a metal wedge +/- other implants. "Advancing" the tibial tuberosity forward has a similar effect to TPLO wherein the mechanics of the joint are changed where other structures take on the function of the CCL so it is no longer needed.

What we don't like about TTA is the difficulty in removing implants should it be required and the higher degree of difficulty in achieving reliable results. It is a more difficult procedure to plan correctly and advancement of the tibial tuberosity is limited by a range of implant sizes whereas TPLO correction is dictated by how far the bone is rotated (more customizable).

Lateral Fabellotibial Suture (AKA Lateral Suture):
This was one of the original procedures devised for CCL disease in dogs. A suture is applied on the outside of the knee joint in the same orientation as the CCL to mimic its function. There have been many iterations of this procedure with different sutures, anchor points, and anchor methods.

Lateral suture has several disadvantages compared to TPLO. Despite being a less invasive procedure, recovery is often slower (4-6 weeks) before consistent leg use compared to TPLO (2 weeks). Recent studies have shown that it frequently provides much less stability than originally thought (Beale paper citation). Tensioning the suture in surgery is subjectively determined which makes stabilization less predictable compared to TPLO where rotation is calculated precisely. Long term stability of lateral suture relies on scar tissue developing around the suture since the commonly used nylon sutures will eventually fail. If failure occurs prior to this scar tissue forming then instability occurs and surgical revision is necessary. Infection rates also tend to be higher for lateral suture than TPLO (source?).

TPLO is our preferred procedure for multiple reasons. It is a permanent alteration to the tibial shape so even if implants require removal, the knee is still stable. Implants are also relatively easily and non-

invasively removed if necessary. TPLO is very predictable and reproducible whereas other techniques can struggle in these regards. Its predictability and reproducibility stems from the ability to plan and virtually perform the procedure prior surgery. This planning allows accurate execution of the operation to achieve a stable joint and minimize possible complications.

What are the potential complications of TPLO?

Infection is a potential complication of TPLO, or any CCL tear surgery, and occurs in 2-5% of TPLO cases according to the literature. There is a relatively small amount of soft tissue (muscle and fat) covering the area where the TPLO plate is placed. This proximity to the skin elevates infection risk. Both the surgeon and owners are responsible for minimizing this risk. As the surgical team, there are many different ways we reduce contamination. IV antibiotics are given during surgery, the leg is meticulously shaved and aseptically prepped, and a sticky iodine drape is applied to the skin so the leg skin is minimally exposed to the wound during surgery. The bone plates we use are also coated in an antimicrobial polymer that acts for 3 months to kill any bacteria around the plate. After the pet goes home, owners reduce infection risk by making sure the cone collar stays on at all times for the first 2 weeks so the pet cannot lick and chew at their incision. In the rare case of deep infection around the plate, it is managed with antibiotics until the bone heals, then the plate and screws are removed to resolve the infection. The prognosis is usually excellent.

Hemorrhage (bleeding) is another potential complication of TPLO. There is a relatively large artery called the cranial tibial artery that runs across the back surface of the tibia that can potentially be cut with the saw during the procedure. This occurs in 1-2% of cases according to the literature. There are multiple strategies used during surgery to avoid the artery but occasionally this vessel can be cut. We have many tools to ligate the vessel should this happen and dogs have a very redundant blood supply so the outcome is not affected and healing progresses normally in these dogs

The risk of other complications should be exceedingly low if the procedure is planned appropriately and executed accurately.

What tests need to be completed prior to surgery?

A complete blood count, and blood chemistry along with a urinalysis are required to ensure your pet is a good anesthesia candidate and there are no other health concerns that would preclude surgery. Sedated, well positioned x-rays of the knees are also needed for surgical planning purposes. Approximate cost for these tests is $510.

What is the cost for the procedure?

For most dogs (<90 lbs) who need a regular sized plate with six screws, the procedure is about $3700.

For large dogs (90-120 lbs) who need a large plate with eight screws, the procedure is about $3900.

For extra large dogs (>120 lbs) who need an extra large plate with ten screws, the procedure is about $4200.

The two week incision recheck is at no cost. The eight week x-ray recheck visit is about $170.

What does the recovery period entail?

For the first 2 weeks, your dog needs to wear a cone collar to ensure he/she cannot lick or chew at the incision. After the incision has been evaluated at the 2 week recheck, and confirmed to be healed, the plastic cone menace can be shelved and your family can celebrate!

Dogs typically start a small amount of weight-bearing either as they are leaving the hospital or within the first 2-3 days after surgery. Some dogs may take as long as 5-7 days to start some weight-bearing, but this is uncommon.

The first 8 weeks after the procedure require strict exercise restriction meaning no running, jumping, playing with other dogs, or other activities where the dog would aggressively push off with the affected limb. This is important because during this period we are relying on the bone plate and screws to hold the two bone pieces together. Excessive force could cause fracture of the implants or the bone which could necessitate revision surgery. We do want your pet to use the limb frequently after surgery in a controlled manner such as walks on a short leash and home rehab exercises. We typically recommend your pet be confined to a small area where they can walk but not jump on things such as a play pen or laundry room or spare bedroom.

At your consult appointment, you will be given a detailed discharge instruction packet that includes a week by week rehabilitation exercise protocol.

TPLO sounds painful, how will my dog's pain be managed?

Pain management is critical to TPLO cases. During closure, a long-acting local anesthetic called Nocita is infused into the tissues. Nocita releases bupivacaine (local anesthetic) slowly over the course of 3 days to keep the surgical area numb. This dramatically reduces the need for oral or IV pain medications. While in the hospital, your pet will receive IV opioid pain medications as needed until discharge. Anti-inflammatories such as carprofen and other pain medication such as gabapentin are sent home. Typically, this is all that is needed to manage your pet's pain adequately.

What are the differences between partial vs. complete tears? How does treatment differ?

Most large breed dogs with CCL tears (~80%) will start with a partial tear that progresses to a complete tear. Symptoms of a partial tear are typically less dramatic with a mild to moderate lameness that may wax and wane for some period. This lameness may be weight-bearing or non-weight-bearing. All partial tears will progress to a complete tear in dogs with CCL disease.

Initially, there was debate about how to treat dogs with partial tears and if surgery should be delayed. Research in the last decade has discovered that treating partial tears with TPLO surgery may allow the body to repair the partial tear and thus regain/retain the stabilizing function of the natural CCL thus maximizing stability and improving long-term outcome. In summary, we would prefer to diagnose a partial tear and perform TPLO at that time to improve the dog's prognosis.

Is TPLO recommended for small dogs?

Yes! Thanks to smaller implant systems developed in the last 5-10 years, TPLO is now available for almost all dogs, even toy breeds <10 pounds. Previously, lateral suture was routinely recommended for these small dogs. We like TPLO especially for small breeds because they typically have steeper tibial slopes and a greater degree of instability compared to large breeds which makes stabilization with lateral suture more challenging and less predictable.

Is there any way to prevent CCL Disease?

At this time, there is no known way to prevent CCL disease. Approximately 50% of dogs will tear the CCL in the other knee within 12 months of the first.

We hope this article has been helpful in