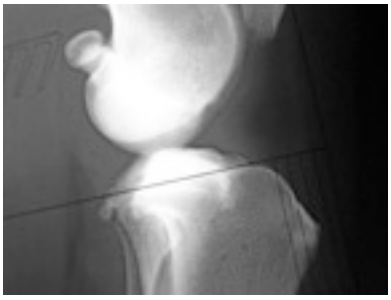
Tibial Tuberosity Advancement

August 2009 Edition 3

Welcome

Cranial Cruciate Ligament Rupture is the most common cause of hindlimb lameness in dogs.. In this issue, we will look at our preferred technique for the management of this condition and the rationale behind that preference and the technique itself.

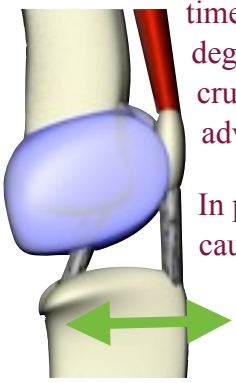


Cranial Cruciate Ligament (CCL) failure is generally a non traumatic condition in the majority of our patients. Most often it follows a degenerative pattern. There are many theories to explain the premature degeneration of the Cranial Cruciate Ligament including autoimmunity, conformation of the tibial plateau and most recently abnormal development of the tibial tuberosity. Whatever the actual cause of the ligament degeneration, it results in progressive weakening of the ligament and ultimate failure.

The Consequences of Cranial Cruciate Ligament Degeneration

As mentioned, ultimate CCL failure results from the progressive pathology of the collagen of that ligament. The process of progressive degeneration results in exposure of the collagen of the ligament to the joint space. This results in synovitis and this in turn results in fibrillation of the articular cartilage and an appearance consistent with that seen in Degenerative Joint Disease (DJD). This process will often be well under way before the mechanical consequences of CCLR are noted clinically. Radiographic effusion will be seen in this phase. Clinically, this early phase may be associated with only stiffness after rest but no overt lameness.

The functions of the CCL are to restrict cranial tibial translation relative to the femur and to restrain excessive internal tibial rotation. As the ligament failure progresses these effects will become known to the patient even if they cannot be demonstrated by Anterior Drawer Test or Tibial Postural Thrust Test. At this point lameness will be a consistent feature. This may be missed by owners if the pathology is bilaterally symmetric as the resulting poverty of action may not be sufficiently overt to alert them to their pet's problem. As a result, by the time of actual presentation, the degree of DJD and the extent of cruciate pathology may be quite advanced.



In patients with CCL deficiency the caudal aspect of the medial meniscus experiences a significant increase in load. It has been estimated that the increase is up to 20,000 times the load experienced in a normal stifle. This increased load along with concurrent Cranial Tibial translation can result in a wide range of medial meniscal injuries. Lameness scores are often 1 or 2 points higher in patients with CCL deficiency and concurrent medial meniscal pathology. Meniscal injury may prompt initial presentation.

Surgical Management Options

In general it is recognised that CCL deficiency is a surgical condition in all but the smallest breeds. The surgical procedures have been categorised in a number of ways. The most common method is by relative position of the device used to resolve the instability: intra-articular, extra articular and peri-articular techniques. A better way to describe them however is based on how they address the absence of the Primary Stabiliser of the stifle, the CCL.

The stifle is inherently unstable due to the mismatch of the two key forces acting around it. There is a compressive force acting through the stifle and a ground reactive force. These two forces are not parallel and the resulting vector creates a cranial thrust across the tibia →(Fig 1). Resistance to cranial Tibial Thrust is provided by the primary stabilising structure of the Cranial Cruciate Ligament. When the primary stabiliser is weakened or absent, the stresses build on the secondary stabilisers: Caudal Horn of Medial Meniscus, Collaterals, Joint Capsule and the periarticular muscles. Surgical procedures such as the Lateral Suture Technique and the Over The Top Technique, aim to restore stifle stability by replacing the primary stabilising mechanism.

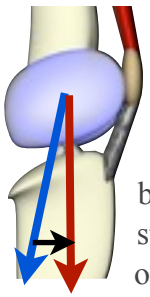


Fig 1

Techniques such as Tibial Tuberosity Advancement (TTA), Tibial Plateau Levelling Osteotomy (TPLO) and Triple Wedge Osteotomy address the unstable cranial cruciate deficient stifle by abolishing the shear force across the stifle, thus negating the need for a cranial cruciate ligament. The suggested cause of the Cranial Tibial Shear Force differs between the two main techniques of TTA and TPLO. Figure 1 represents the mechanical basis for the TTA as devised by Slobodan Tepic (Kyon). In this model, the compressive force (-) is parallel to the Straight Patellar Tendon. In the TTA the Tibial Tuberosity is Advanced to the point where the angle between the Straight Patellar Tendon and the Tibial Plateau is 90 degrees. At this point in the load phase of the stride, the Cranial Tibial Thrust is abolished as a result of making the two forces across the joint parallel to one another (Fig 2).

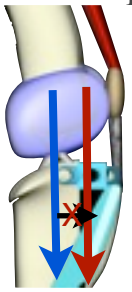


Fig 2

In the Slocum Model (Fig 3), The force is perpendicular to the Tibial Plateau Angle (TPA). The mismatch between these is postulated to create the Cranial Tibial Thrust across the stifle. In the Slocum model the force is abolished by rotating the tibial plateau until the TPA is 6 degrees (Fig 4).

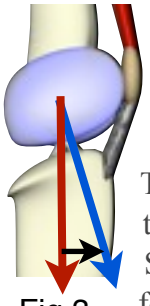


Fig 3

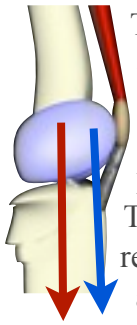


Fig 4

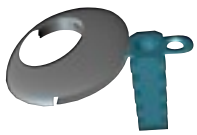
Both of these procedures (TTA and TPLO) immediately restore stifle stability and this results in patients loading the surgical limb within one to three days of surgery in most cases. This is clearly an advantage over the cruciate "replacement" techniques as it reduces muscle loss and allows earlier intervention in the contra-lateral stifle in cases with bilateral symmetric CCLR. The breeds that most commonly present with Cruciate Ligament Rupture (Labradors, Rottweilers, Retrievers etc.) will often have concurrent orthopaedic pathology in other joints such as the elbows and/or hips. Again the advantage of early loading post operatively is clear to see and one that the patient values.

Recently the mechanical principles underpinning the two techniques have been evaluated in cadaveric specimens. In these studies, it was shown that the TTA restores normal joint forces whilst following TPLO, there is increased stress through the medial femoral compartment. This explains the arthroscopic findings of focal full thickness cartilage lesions on the medial femoral condyle in patients following TPLO. These findings, in our view, validate the long term superiority of the TTA over TPLO for addressing the unstable, cruciate deficient stifle.

TTA Implants

All of the Kyon TTA instruments are made from Titanium. This makes them lightweight but also strong and highly biocompatible. The five components are: Plate, Cage, Fork, 2.7 or 3.5 mm screws for the plate and 2.4 mm screws are used to secure the cage in position. A dedicated set of instruments is required to perform the TTA including a jig for drilling the angled fork holes and small bending instruments to permit perfect contouring of the plate and the lugs on the cage to accommodate the different tibial anatomies encountered.

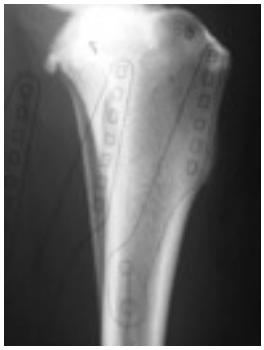
Contour Plate

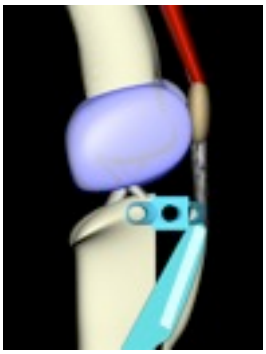


Bend Cage Lug

Fork Guide

Instrumentation





Assessment and Pre Operative Planning

Following admission of a patient with suspected Cranial Cruciate Pathology we take orthogonal radiographic views of the affected stifle. These permit us to rule out any other potential causes of stifle based lameness such as neoplastic processes and the late consequences of femoral condylar osteochondrosis. Palpation of the stifle is performed to establish whether there is a positive Anterior Drawer and Tibial Postural Thrust. Anterior drawer is checked with the stifle in a neutral and flexed position as this will often permit diagnosis of partial Cranial Cruciate Ligament Rupture. A stifle that is stable in extension, but unstable in flexion will indicate Craniomedial band rupture with intact Caudolateral band. Following this, the joint is prepared for aseptic synovial aspiration. Synovial fluid is examined for its gross characteristics (colour, viscosity, volume and turbidity) and also microscopically to rule out any underlying inflammatory joint disease (Septic Arthritis or Immune Mediated Polyarthritis). If following these assessments, there is insufficient evidence to confirm Cranial Cruciate Ligament Pathology, the patient is prepared for arthroscopic evaluation of the stifle joint. This will permit direct visualisation of the soft tissue structures and articular surfaces of the stifle and should provide a definitive diagnosis of the cause of lameness.

The radiographs obtained previously also allow us to establish the implant size required for that patient, in terms of the number of fork prong holes that can be safely drilled and the amount of advancement needed to establish a 90 degree angle between the Straight Patellar Tendon and the Tibial Plateau (see next page). The advancement will be achieved by interposing a cage between the osteotomised Tibial Tuberosity and the body of the tibia. These cages come in 3, 6, 9 and 12 mm sizes. Minor incremental increases in advancement can be made by increasing the depth of cage position. A cancellous bone graft is harvested from the tibia and used to pack both the cage and the osteotomy gap and thus accelerate union across the osteotomy. A faster union reduces cyclic implant loading and reduces the likelihood of implant associated complications such as plate failure and screw loosening.

Our Experience of TTA

We began using the TTA technique in May 2006. All three surgeons have attended the Kyon TTA course, which is a requirement before Kyon will provide instrumentation and implants. We only use Kyon implants and not those produced by other suppliers on the basis of quality control. Since May 2006 we have performed 360 TTAs. We moved to TTA from the Closing Wedge Osteotomy and have found the TTA technique to be one that is consistent in providing a good outcome with minimal post operative complications (see below). As with most orthopaedic procedures strict attention to detail is important in securing a good outcome and this depends on accurate pre-operative planning and intra-operative accuracy in terms of the plane and line of the osteotomy and implant contouring and positioning. We have found that TTA allows much earlier intervention by our Rehabilitation team as the patient is more comfortable and confident in limb use earlier in the post operative phase. This makes Physiotherapy and Hydrotherapy more effective as it is complementary to the patient's voluntary limb use early in the post operative phase.

Post Surgical Risks

There are five chief post operative risks:

Late Meniscal Injury: This is a risk seen with all techniques used to manage Cranial Cruciate Ligament Rupture and has been estimated at 16% in the Lateral Suture Technique. This also occurs following TTA and is the commonest complication seen.

Fracture of the Tibial Tuberosity: We have seen this in less than 1% (n=3) of our TTA patients and only two of these have required surgical revision. One was noted as a healed fracture during routine radiography before surgery on the second stifle.

Patellar Luxation: Again this is uncommon and has been seen in less than 1% of our TTA cases. All cases have been in Retrievers, a breed that is noted for significant internal tibial rotation following CCL rupture.

Infection: Kyon TTA implants are made from Titanium which is more biocompatible than surgical stainless steel and as such has a greater resistance to bacterial colonisation. Our incidence of post operative infection is just over 1%.

Implant Failure: This is a complication associated with all implant based orthopaedics. It is generally due to prolongation of cyclic stress on the implant as a result of delayed union. We have not had any instances of implant associated complications.

Upcoming Events at Torrington Orthopaedics

Continued Professional Development

If you are interested to delve deeper into this subject, there is an evening seminar on the 30th of September. The seminar will start at 8 p.m. with food and refreshments being served at 7:30. The seminar is limited to 50 places and there is already keen interest. Please contact us if you wish to attend and are not already booked on the course.

Other News

We have a new Resident starting in September. His name is Andrea Geraci, an Italian Veterinary Surgeon who has been working in the UK for over ten years and has a keen interest in advancing his orthopaedic knowledge. He attended last year's Kyon TTA course at Torrington Orthopaedics.

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