Current Advances in Cruciate Ligament Tear Repair

Peter Sebestyen, DVM, Dipl. ACVS

Veterinary Surgical Specialists of Orange County

Tustin CA, USA

Cranial cruciate ligament tear is a common cause of chronic pelvic limb lameness in dogs. The economic impact of this condition was estimated to be over 1.3 billion dollars in 2005 (Wilke 2005). The cranial cruciate ligament prevents cranial translation of the tibia during weight bearing. Failure of the ligament results in subsequent instability, lameness and progressive degenerative joint disease. Although acute traumatic tear may occasionally be seen, more commonly it occurs gradually as a fatigue failure of the ligament, often under conditions of normal loading. Genetic basis of the cruciate ligament tear has always been assumed due to breed predisposition and it was recently confirmed in the Newfoundland breed (Wilke 2006 and 2009).

Many surgical procedures have been reported to treat patients with cranial cruciate ligament tear. The surgical techniques aim to stabilize the cranial cruciate deficient stifle with either extra-capsular or intra-articular implants. In the early eighties a dynamic stabilization method was introduced. Dynamic stabilization was achieved with leveling the tibial plateau by performing osteotomy. The tibial plateau leveling osteotomy neutralizes the cranial tibial translation during weight bearing (Slocum 1987). By the millennium the TPLO became the gold standard of cruciate repair especially in large breed dogs. In 2005 a prospective clinical trial was published describing the effect of TPLO, lateral suture and intra-articular fascia late graft techniques on limb function upon recovery (Conzemius 2005). Force plate analysis showed no significant differences at six months postoperatively and the authors concluded that the surgical technique had no influence on the outcome. The publication came as a shocking surprise to the world of veterinary surgery since the TPLO was considered a superior technique by most surgeons at that time. There could be a number potential explanation for controversy between clinical experiences and scientific evidence. Patients with cranial cruciate ligament tear may be at different stages of the disease at the time of diagnosis. This spectrum includes dogs with an

acute tear, significant instability and minimal secondary changes at the beginning of the spectrum and also patients with severe degenerative changes, meniscal pathology and minimal or no instability at the end of the range. Patients at different level of this disease spectrum may respond differently to the same uniform treatment. Dogs with acute tear, severe cranial drawer and lack of DJD would gain the most form stabilizing procedures. However, patients with chronic disease, more advanced DJD and meniscal pathology may benefit little from stabilization. Intra-articular treatments, meniscal management and physical therapy may be more important treatment modality for this subset of patients. Having recognized these differences further research is aiming to develop an algorithm for treating patients with cruciate disease at different stages stressing either stabilization or intra-articular treatments.

Joint stability emphasis: Relatively small percentage of dogs present with acute cruciate ligament tear without secondary changes. They are the best candidates for extra-articular stabilizing methods as the primary dysfunction is caused by instability alone. Many modifications have been recently made to the original lateral suture method. The recently introduced Tightrope CCL repair uses stronger suture material in more isometric fixation points to preserve range of motion and prevent failure from cyclic loading. The technique advocates more stable fixation utilizing bone tunnels as opposed to the conventional fabella-to-tibial tuberosity suture. The tightrope suture may be applied non-invasively via small stab incisions minimizing postoperative morbidity. Despite of these improvements, the tightrope suture is expected to loosen with time and if periarticular fibrosis fails to develop in the meantime, instability will recur. The tightrope and other lateral suture stabilizing methods are best suited to treat joints with severe instability and minimal or no secondary changes. They make less therapeutic sense for treating partial tears with minimal or no instability. Patients on the middle of the disease spectrum with minimal or no joint instability, and moderate to severe secondary changes are better candidates for geometry altering treatment methods.

Slocum developed dynamic stabilization technique from the basis of the tibial compression test. The basis of his hypothesis was that the magnitude of cranial tibial thrust (CrTT) is proportionate to the tibial plateau angle (TPA). If the TPA is leveled to 0-5 degree with the functional axis of the tibia (or the direction of the main compressive forces), the CrTT becomes zero. (Slocum 1983). The tibial plateau leveling osteotomy (TPLO) was developed and its positive biomechanical effect was confirmed by in vitro studies.

Tepic proposed the theory of tibial tuberosity advancement (TTA) based a biomechanical model of the human knee (Tepic 2002). In this model the total joint force is parallel to the patella tendon and not to the functional axis of the tibia. At a patella tendon-tibial plateau angle (PTA) of 90 degrees or less, the total joint force will not generate cranially directed vector force and the joint is stable even without cranial cruciate ligament. Based on

this, advancement of the tibial tuberosity was proposed to create a PTA equal or less than 90 at normal standing angle of the stifle eliminating the cranially directed forces (Tepic 2002).

Although these techniques have been developed based on different theories, both procedures accomplish similar benefit. TTA has several biomechanical advantages; however, the clinical significance of this is unknown. TTA is a simpler procedure with less steep learning curve and less room for technical errors. TPLO is more versatile and can be applied to a wider spectrum of cases than TTA.

Intra-articular treatment emphasis: There have been significant changes in the way we perform intra-articular treatment today for a cranial cruciate deficient stifle. Intra-articular treatment includes debridement of the remains of the failed ligament and management of meniscal pathology. We can carry out these via conventional arthrotomy or arthroscopy. Arthroscopy has become the standard of care treating shoulder and elbow joint disease in canines. Arthroscopy offers quicker recovery, better visualization due to illumination and magnification. Stifle arthroscopy provided less short-term postoperative morbidity in comparison to conventional parapatellar arthrotomy (Hoelzler 2004). The routine parapatellar stifle arthrotomy was associated with more progressive DJD when it was compared to minimally invasive arthrotomy (Lineberger 2005). In addition to being minimally invasive, arthroscopy offers increased sensitivity at recognizing meniscal pathology. In vitro study concluded that arthroscopy with probing had 8 times higher sensitivity to detect meniscal pathology than conventional parapatellar arthrotomy (Pozzi 2008).

Traditionally the remains of the completely or partially torn cruciate ligament were to be removed. Debridement of the broken ligament fibers is thought to lessen the inflammation; however, there is no scientific proof for this. In case of a complete tear, debridement of the remaining cruciate ligament makes therapeutic sense and it is unlikely to cause any harm even if it does not necessarily produce any obvious benefit. In case of a partial tear where the joint stability is still maintained, excising the remaining ligament will result in severe instability so actually makes matters worse. The incomplete tear with maintained joint stability is referred to as functional partial tear and it should not be debrided. As opposed to a non-functional partial tear where the physically intact parts of the ligament are not capable of maintaining joint stability. Non-functional cruciate ligament tear should be debrided similar to the complete tear. The most compelling testimony regarding the effectiveness of TPLO has come from “second look” arthroscopy in patients with functional partial tears. In these patients the cruciate ligament was not debrided, the meniscus was left intact and at second look, the cruciate ligament and the menisci appeared normal and functional (Beale 2006).

Meniscal tear has been described as a late complication following TPLO and TTA in 6-14 % of the cases necessitating re-operation. These late meniscal injuries are either missed at

the initial surgery (latent tear) or may subsequently develop following the stabilization (postliminary tear). Slocum recommended releasing the intact meniscus during TPLO procedure to reduce rate of postliminary meniscal injury. The basis of this recommendation was the clinical observation of the relatively frequent late meniscal injuries after TPLO. Although the cause of the postliminary meniscal tear is not understood, it has been suggested that the residual stifle joint instability is responsible for the damage. Recent study evaluated the effect of the meniscal release on the rate of subsequent meniscal injury following TPLO (Thieman 2006). The study concluded that in joints undergoing open arthrotomy without meniscal release there is a 3.8 times higher chance for subsequent meniscal tear. Interestingly, the group of patients treated with stifle arthroscopy without meniscal release performed as well as the open arthrotomy with meniscal release. The authors concluded that the so called subsequent or postliminary tears are likely latent meniscal tears that were missed at the time of the initial procedure. These minor meniscal tears later progress to a clinically significant, more severe meniscal injury manifesting as “postliminary” tears. As we have a higher chance to detect these minor meniscal injuries with arthroscopy, the incident of late meniscal injury will be less. The authors also concluded that meniscal release should be performed whenever complete and thorough exploration of the medial meniscus cannot be, or is not, performed.

While meniscal repair is possible in selected cases, the majority of meniscal damage will be treated by removal of the damaged part or partial meniscectomy. The medial meniscus is an important stabilizer of the stifle and contributes to normal load transmission of the joint. Disruption of this meniscal function will lead to joint instability and increased loading stress on the cartilage and subsequently results in osteoarthritis. Therefore preservation of much healthy meniscal tissue as possible should be the primary goal of any meniscal surgery.

Summary: Our patients with cruciate ligament disease may present with a wide range of severity in joint laxity and secondary changes. As chronicity increases, joint instability decreases and the benefits of stabilizing techniques diminish. Patients with stable partial tears represent a special subpopulation and are likely to respond better to a geometry altering method rather than to a static extra-articular stabilization. Non-invasive intra-articular management via stifle arthroscopy is proven to lessen postoperative morbidity, increase sensitivity to detect meniscal pathology and induces less osteoarthritic changes than conventional arthrotomy.