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CRUCIATE DISEASE – WHAT ARE MY CHOICES?

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INTRODUCTION
The first report of a cranial cruciate ligament rupture in the dog was in 1926 but it was not until the 1950's that the first report of surgical correction was described. Since then, numerous surgical techniques for repair of the cranial cruciate-deficient knee have been reported in the literature.28 Selection of a technique for repair of the cranial cruciate-deficient knee should be based upon numerous criteria including size, age, and function of the dog, chronicity of the injury and surgeon preference. Repair techniques are classified as extra-articular and intra-articular. Extra-articular repairs are those that stabilize the joint from outside of the joint capsule and include fascia lata imbrication, lateral retinacular imbrication (DeAngelis technique), and fibular head transposition. Intra-articular techniques use some sort of graft material to anatomically replace the cranial cruciate ligament.

All surgical procedures for CCL instability begin with a thorough exploration of the stifle joint through a lateral parapatellar approach. All intra-articular structures are examined. The most common injury coexisting with a CCL rupture is a tear in the caudal horn of the medial meniscus (discussed later). The caudal cruciate ligament (CaCL) and collateral ligaments are also examined, as well as the tendons of the long digital extensor and popliteus. The remaining stumps of the ruptured CCL and any remaining intact CCL are removed. It is assumed that the remaining intact CCL is either damaged or will become completely ruptured if left. If the caudal horn of the medial meniscus is damaged, only the damaged portion is removed.

EXTRA-ARTICULAR REPAIR TECHNIQUES

Fascia Lata Imbrication
Imbrication refers to the overlapping of two layers like tiles or shingles. The affect of imbrication of the fascia lata is to take any slack out of the fascia lata thus tightening the tissue. The tightening of the fascia lata thus stabilizes the joint by minimizing the cranial translation and internal rotation of the tibia. This technique, as the sole means of stabilization, was first reported in 1966 and later modified in 1969 by adding a second layer of Lembert sutures.29,30 Fascia lata imbrication is most appropriately used as an adjunct to other methods of stifle stabilization and should not be used as the sole method of stabilization.

The Lembert and Mayo-Mattress suture patterns are the main type of suture patterns used to imbricate the fascia lata. An absorbable suture such as Vicryl or PDS, are the preferred suture material type. Suture placement starts distal and proceeds in a proximal direction. Tension is judged, before placing the first suture, by how much the edges of the fascia lata will overlap. Care must be taken to not place so much tension on the tissue that a lateral patellar luxation is produced.

Lateral Retinacular Imbrication
Lateral retinacular imbrication for stabilization of the cranial cruciate deficient stifle was first reported in 1970 by DeAngelis and Lau. This technique is commonly referred to as the DeAngelis technique or a lateral suture.31 This technique originally consisted of placing a heavy nonabsorbable suture material around the lateral fabella to the distal one-third of the patella ligament. The suture material corresponds to the orientation of the normal cranial cruciate ligament as it travels through the joint except that the suture is outside of the joint capsule. Numerous modifications of this technique have been made including placing the suture through a hole drilled in the tibial tuberosity and adding a similar directed suture from the medial side of the joint.32 Placement of two sutures from the lateral collateral ligament to the patella and one suture from the fabella to the patella ligament has also been described for stifle stabilization.33

Lateral retinacular imbrication has been used for stabilization of the stifle of all sizes of dogs. Typically, lateral retinacular imbrication works best for dogs 40-45 pounds and less in weight. Variable results are encountered as the size of the dog increases. Fascia lata imbrication generally is performed in addition to this technique to further stabilize the joint. Heavy nonabsorbable suture material (nylon, braided polyester) is used for lateral retinacular imbrication. Stainless steel wire has also been used.34 Typically, the suture is tightened with the stifle extended and the tibia externally rotated. Multiple knots are needed to secure the suture. Passing the suture through a hole in the tibial tuberosity probably allows better anchoring for the suture. Over time, all of these sutures break or loosen. Hopefully the sutures maintain joint stability until periarthritis fibrosis stabilizes the joint. The most common postoperative complications with this technique are swelling and drainage from the suture. These two complications are reported to occur in 18% and 21% of cases.35,36

Fibular Head Transposition
Fibular head transposition is an extra-articular repair technique that uses the lateral collateral ligament to stabilize the stifle joint.37 The lateral collateral ligament runs from the lateral epicondyle of the femur to the fibular head. After cranial transposition of the fibular head, the orientation of the lateral collateral ligament is redirected to approximate that of the cranial cruciate ligament. Cranial drawer motion and excessive internal rotation of the joint are prevented by this orientation of the lateral collateral ligament. This procedure can be used for any size of dog with either acute or chronic ruptures of the cranial cruciate ligament. Fibular head transposition is particularly suited for dogs with osteoarthritis of the stifle where an intra-articular technique is not desirable. Chronicity of cranial cruciate rupture prior to repair has been reported not to affect clinical results after repair with this technique.37 Another benefit of fibular head transposition is the shorter recovery time compared to intra-articular techniques.37

The surgical procedure involves cutting the ligamentous attachments of the fibular head to the tibia so that the fibular head can be transposed cranially. The fibular head is moved forward to a point that the drawer sign has been eliminated. The fibular head is then secured to the tibia with K-wires and a tension band wire.37 Postoperatively, the leg is placed in a soft-padded bandage for 10-14 days. The dog's activity is limited for the first month and then slowly increased over the second month. Long-term clinical evaluation of this procedure indicated that 90% of the dogs had an excellent or good result.38 Progression of OA continues over time with this technique, however. Research evaluation of fibular head transposition showed that the technique did not control cranial drawer motion or rotational...
instability, was not successful in restoring limb function, and did not prevent joint degeneration. Significant elongation of the lateral collateral ligament occurred over the first 3 weeks after surgery. Stiffness of the collateral ligament increased over time, however. Clearly there is a difference in the clinical and research evaluation as to how effective fibular head transposition is. The most common complications associated with fibular head transposition were iatrogenic fracture of the fibular head intraoperatively (12.5%) and seroma formation (10.7%) over the fibular head postoperatively. Other complications that have been reported include wire breakage and tearing of the lateral collateral ligament. Pin loosening and migration, damage to the peroneal nerve, and laceration of the caudal geniculate artery are other possible complications.

INTRA-ARTICULAR REPAIR TECHNIQUES
There are numerous procedures in which a fascial, patellar ligament, or non-biologic graft is pulled through the stifle joint in such a way that the natural function of the CCL is closely mimicked. The majority of these procedures are performed through a lateral parapatellar approach and the joint is explored and debrided as in the extraarticular procedures. The "under-and-over" procedure is generally the represen-tative of these procedures and is the most commonly used. This procedure utilizes an autogenous graft including the lateral 1/3 of the patellar ligament as well as the fascia lata from the lateral thigh. This graft is prepared by incising its lateral, medial, and proximal attachments, leaving it attached distally. The graft is then pulled under the intermeniscal ligament and through the joint "over the top" of the lateral femoral condyle where it is anchored by sutures or a bone screw and spiked washer. The joint is closed routinely. This graft will weaken during the first 2 weeks after surgery and will gain strength after that. It reaches preoperative strength 6 weeks after surgery. A support bandage is necessary for 6 weeks after surgery. Other extraarticular procedures utilize carbon fibers, allografts from patellar ligament, or other autogenous grafts; however, the basic procedure is the same. Progression of OA continues over time with this technique indicating that the graft is not effective in stabilizing the joint. A recent report has evaluated the use of a hamstring graft made up of the tendons of the semitendinosus and gracilis in research dogs for replacement of the cranial cruciate ligament. At 52 weeks post-implantation of the graft, the grafts were intact and had become ligament like structures. Minimal OA was present in the joint and lameness had resolved by 52 weeks postoperatively. Clinical trials are needed to evaluate this technique in dogs with naturally occurring cranial cruciate ruptures.

TIBIAL PLATEAU LEVELING OSTEOTOMY
Tibial plateau leveling osteotomy (TPLO) for the treatment of cranial cruciate injury in dogs was developed by Dr. Barclay Slocum. The procedure is licensed and patented. To perform the procedure, one must take the course offered by Slocum Enterprises. The procedure was originally developed for treatment of cranial cruciate injuries in large and giants breeds of dogs and for performance dogs. Today, we use the procedure for dogs as small as 15-20 pounds. The original procedure that he developed was a closing wedge of the proximal tibia. This evolved into the current procedure that is being used: tibial plateau osteotomy. The goal of these procedures is to decrease or eliminate the forces acting on the stifle referred to as cranial tibial thrust. Cranial tibial thrust is created by muscle contraction forces (gastrocnemius) and by weight bearing stress applied to the tibial plateau. A typical dog will have a tibial plateau slope of approximately 22-25 degrees. Because of force being applied to an angled tibial plateau during weight bearing, part of this force is applied in a manner that drives the tibia in a cranial direction in comparison to the femur resulting in cranial tibial thrust. The goal is to change the tibial plateau angle down to approximately 5 degrees. Rotation of the tibial plateau will counteract the forces that drive the tibia cranially. Studies have shown that rotation of the tibia creates greater stress on the caudal cruciate ligament. It is believed that the caudal cruciate ligament helps to stabilize the stifle by acting like, to a degree, the cranial cruciate ligament. Experience has shown that the progression of OA is minimal over time further indicating that the stifle is functionally stable following TPLO. This is not the experience using other repair techniques. A number of studies have been published that have provided further information about TPLO. Dogs with surgical transaction of the cranial cruciate ligament had normal force plate values for peak vertical force and vertical impulse by 18 weeks after following TPLO. Complications following TPLO have been reported to range from 20.6% to 28% but most of the complications do not influence the final outcome for the dog. Most of the complications do not require further surgical intervention. Types of problems associated with TPLO include osteomyelitis, septic arthritis, fibular neck fracture, implant loosening or breakage, tibial tuberosity fracture, tibial fracture, and others. With experience performing the procedure, the number of complications is lower.

REFERENCES
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