Introduction

Canine cranial cruciate ligament (CCL) repair has been performed for many years using extracapsular and/or lateral suture stabilization techniques, including the TightRope (TR) CCL (Figure 1). It is similar in concept to the Internal Brace technique used for stabilization and repair of ligaments in the ankle and the knee (Figures 2 and 3, respectively) using sutures and implants. This paper will review different techniques using suture to stabilize the knee, including the TR CCL technique, which can be used as a model for human ligament repair.

Mechanical Studies

The paper that introduced the TR CCL technique\(^9\) presents a comparison (using FiberTape and #5 FiberWire separately) in cadavers to other extracapsular stabilization techniques such as the Arthrex CCL Suture Repair technique using #5 FiberWire, the Securos 80# monofilament leader line crimp clamp fixation system, the Securos XGEN CCR System, and the Jorgensen LigaFiba Iso Toggle System. After cycling the constructs up to 100 N for 100 cycles, the TR CCL with FiberTape and the LigaFiba Iso Toggle System both demonstrated the highest yield and ultimate loads. However, the TR CCL with FiberTape and FiberWire had much lower cyclic displacement compared to the Iso Toggle.

Another study tested the various suture materials used in extracapsular repair\(^{10}\) with many of the same materials tested in the above mentioned study. Ultimate tensile load was highest for the LigaFiba suture, followed by the Securos XGEN OrthoFiber suture, #5 FiberWire, FiberTape, and generic monofilament leader line. However, FiberTape and FiberWire had the lowest elongation at failure by far compared to the other sutures. Another paper had similar findings\(^{11}\). It is important to emphasize that this study tested the actual suture material, not the construct itself. Both studies show a small amount of displacement of FiberTape and FiberWire, which demonstrates the power of these sutures and constructs for CCL repair.

Clinical Studies

The study mentioned above\(^9\) also included a clinical study that compared the TR CCL technique to tibial plateau leveling osteotomy (TPLO), another commonly used technique to repair the CCL deficiency by leveling the top surface of the tibial joint and stabilizing the cut area with plates and screws. It is a much more invasive technique, so the theory is that there will be better retention of the natural anatomy with TR CCL vs. TPLO. The study showed that at 8 weeks and 6 months post-surgery, there were no major differences in tibial cranial thrust between techniques at any timepoint. There were also no differences in radiographic scoring and VAS clinical scores at 6 months post-surgery between techniques. Lastly, even though TPLO had a higher rate of complications compared to TR CCL, the difference was not significant. However, TR CCL had lower cranial drawer measurements compared to TPLO at 8 weeks and 6 months post-surgery. In addition, the anesthesia time and surgical time were statistically lower for TR CCL compared to TPLO. This demonstrates that TR CCL, an arthroscopic technique, is a viable option for canine knee repair compared to a more invasive technique.

One of the most complete studies using the TR CCL technique\(^{12}\) involved 1,004 cases from 29 surgical centers. Patients were monitored between 3 months and 3 years, and...
the dogs weighed between 2.93 kg. From these cases, 54.1% were restored to full function levels from preinjury levels, while 39.8% were restored to limited acceptable function levels from preinjury levels. This equals a 93.9% success rate. There were no catastrophic complications, but there were 9.9% major complications requiring further surgical or medical treatment (such as meniscal tears, implant/technique failures, or infections), and 10.1% minor complications not requiring additional treatment.

A retrospective clinical study compared TR CCL to TPLO and tibial tuberosity advancement (TTA), another surgical procedure for CCL repair\(^1\). At one year follow-up, there was a significant difference in Visual Analog Scores (VAS), as rated by the patients’ owners, for return to function for the TR CCL and TPLO groups compared to TTA (p = 0.016), while there was no difference in VAS for pain for any group (p = 0.44). However, the TTA patients were found to have many more major complications compared to the TR CCL or TPLO patients; TTA and TPLO combined had many more major complications than TR CCL. Lastly, TPLO and TTA were two and seven times more likely to have complications compared to TR CCL.

Studies that use other extracapsular stabilization techniques do not perform as well. For instance, a recent paper\(^14\) demonstrates that a lateral fabellar suture technique does not perform as well as TPLO, according to owner reports, while most other data was similar between groups. Another recent paper\(^15\) demonstrated that TPLO performed better than the Securos lateral fabellar suture technique. Lastly, a study from 2010\(^5\) demonstrated that there were no radiographic differences between TPLO and generic lateral fabellar suture stabilization with a Securos crimping device. Some possible reasons for this could include the type of suture used and the lack of anatomic markers for the other extracapsular stabilization techniques. All of this work demonstrates that the TR CCL technique is a viable option for stabilization of ligaments and tendons. Therefore, this technique can be translated to human suture-based techniques such as the InternalBrace for ligament and tendon repair.

Conclusion

This paper demonstrates that the concept of suture stabilization for ligament and tendon repair, specifically TR CCL, has been successfully used in the canine population. Therefore, this concept, in the form of the InternalBrace for ligament and tendon repair, can be successful for ankle and knee ligament repair.

References

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6. Canine Cranial Cruciate Ligament Repair Anchor System Surgical Technique, Arthrex #VLT0003C