The Tibial Tuberosity Advancement (TTA) procedure is one of the advanced procedures for the treatment of cranial cruciate ligament disease in dogs. TTA is now available at O’Gorman, Slater, Main & Partners and is performed by Shaun Ferneley, our Certificate-holding surgeon.

**Cranial Cruciate Ligament Disease**

Cranial cruciate ligament disease, which affects mainly large breeds of dog, is a common cause of hindlimb lameness in dogs. Complete rupture of this ligament causes a sudden, severe lameness with instability of the joint, but many dogs suffer intermittent mild lameness as the ligament weakens and partially tears prior to this.

Surgery is required in all but very small dogs to treat cruciate disease. For many years the only option was to attempt replacement of the cruciate ligament and a variety of techniques have been devised over the years to do this. We still perform this type of surgery in some cases, but no technique is perfect; implants sometimes break and healing can be prolonged and incomplete. The problems become more likely in larger dogs.

A different approach is to alter the mechanics of the stifle (equivalent to the human knee joint) so it no longer requires an intact cruciate ligament. The first technique to achieve this was the Tibial plateau Levelling Osteotomy (TPLO) and this is still performed by many specialists. The TTA procedure is a more recent development based on a better understanding of the mechanics of the stifle. These techniques do not rely on the survival of a graft and can even take the strain off a partially ruptured ligament. Long-term prospects may also be better.

Our experience with the TTA procedure has shown a definite improvement in the recovery of dogs with cruciate disease compared to the more conventional procedure.

The special titanium implants used in the TTA procedure. These come in a variety of sizes to fit all sizes of dog.
What does the TTA procedure involve?

Tibial Tuberosity Advancement neutralises the force on the cranial cruciate ligament by moving the insertion of the patella tendon (the tendon containing the kneecap) forwards. This alters the direction of the pull of the muscles of the thigh, one of the main forces acting on the stifle joint. The stages of the procedure are:

- The stifle joint is opened and the cruciate ligaments and the menisci (cartilage pads within the joint) are examined. The remains of the ruptured ligament and any damaged portions of meniscus are removed.
- A longitudinal cut is made in the bone and a titanium spacer placed in the cut to move the tibial tuberosity (the front part of the tibia where the patella tendon is attached) forward by a calculated amount (determined on a radiograph taken before surgery).
- A special titanium plate is placed to hold the cut portion of bone in place. Titanium screws are used to hold plate and spacer in place.
- A bone graft, taken from the cut bone surface, is placed in the gap to help the defect fill in.

The comb-like implant fits through the plate and into a series of holes drilled in the tibial tuberosity, anchored with two screws in the tibia. The cage-like spacer maintains the correct advancement of the tibial tuberosity and is also held in position by two screws.
Post-Operative Care

Your dog will stay in the hospital overnight to provide adequate pain relief after this procedure. Most dogs are surprisingly comfortable following such a major procedure, but the use of morphine or similar pain relief is usually required overnight.

Your dog will probably come home with a bandage on the leg. This is to reduce the occurrence of post-operative swelling and does not provide any significant support. It will be removed after 2-3 days, or sooner if it does not stay on well.

Exercise restriction is vital after this procedure. Excessive use of the leg can result in fractures of the bone, usually a small piece at the top of the cut portion, but rarely the leg bone can fracture.

Your dog should not be allowed outside without a lead, even for toilet purposes, and walks should be restricted to no more than 10-15 minutes twice a day. Running, jumping and climbing stairs should be avoided. This strict regime should be continued until the follow-up radiographs to confirm healing, taken at least 6 weeks after the surgery.

The image to the right shows a dog’s stifle 6 weeks following TTA surgery. The gap created is already filling with healthy bone.

Prognosis and Complications

The majority (approximately 85%) of dogs will return to being free of lameness following the TTA procedure. Full recovery can take 6-8 weeks, occasionally longer, but improvement usually starts long before the operating site has completely healed. There may be some progression of arthritis, but this should be less than with the older procedures.

Any operation has potential complications and TTA is no exception, but the risk of serious complication is low. Fractures of the site can occur, mainly in dogs that are not adequately rested. Infection is always a risk.

About 1 in 20 dogs suffer a recurrence of lameness associated with late injury to the cartilages in the joint, which could require a further procedure to correct. This complication is in common with all other procedures for cruciate ligament disease.
How does it work?

In the canine stifle (see image left), the main forces acting on the joint are the weight of the dog (the red down arrow) and the pull of the muscles through the patella (the red up arrow). In the normal standing position, the force of the muscles pulls forward relative to the weight, creating a forward force called Tibial Thrust (the small red arrow) which the cranial cruciate ligament normally resists.

The direction of the main forces change as the position of the leg changes. The diagram on the right shows a point where these forces are parallel. At this point there is no Tibial Thrust and the cranial cruciate ligament is under no tension. This occurs when the patella ligament is at right angles to the line through the joint.

The TTA procedure moves the insertion of the patella tendon forwards so that it makes a right angle with the line through the joint in the normal standing position. This makes the
main forces act parallel to each other and eliminates the Tibial Thrust, thus rendering the cruciate ligament irrelevant.

The TPLO procedure does the same job by tilting the joint surface, thereby moving the line through the joint to be at right angles to the patella tendon.

**Which is best? TTA or TPLO (or something else)?**

**Advantages of TTA:**

- The surgery is less invasive and less technically demanding than TPLO, leaving less potential for complications.
- The weight-bearing axis of the bone is not cut, so the full weight of the dog does not come onto the healing bone cut. Consequently, the implants required are not as heavy and if complications of healing occur, the weight bearing axis of the bone is not affected.
- Light titanium implants are used, which have greater compatibility with the dog’s own tissues and are less likely to cause implant related problems.
- The TTA procedure achieves the change in mechanics without increasing any other forces within the joint. This means there is less potential for unexpected joint wear following this procedure.
- It is possible to correct a luxating patella at the same time. This condition can sometimes occur at the same time as cranial cruciate ligament disease.
- The procedure does not suffer from Pivot Shift as a complication (an abnormal joint action sometimes seen following TPLO associated with alterations in limb alignment).

**Advantages of TPLO:**

- It has been around for longer and those surgeons using it for a long time have become familiar with avoiding its pitfalls.
- It has the potential to alter the rotational limb alignment. This means that dogs with abnormal limb conformations can be corrected at the same time. Unfortunately this means that, with only small errors, rotational limb deformities can inadvertently be created also.
- The implants are easier to remove should implant related problems occur.
Is there anything else?

There are still the graft placement techniques, the best of which seems to be a heavy suture placed outside the joint. There have been some recent refinements in the technique which improve it, but it still has limitations. It works pretty well for small to medium sized dogs, but the larger the dog, the greater chance there seems to be of implant failure or prolonged recovery.

There is also a procedure called Triple Tibial Osteotomy (TTO). This procedure makes three cuts in the bone to produce an effect that is part-way between TTA and TPLO, changing both the joint slope and moving the insertion of the patella tendon. The overall effect of this procedure is the same and so the results should be similar.

The complexity is slightly greater than TTA, with three cuts to be made accurately, but not as technically demanding as TPLO. It does cut the weight-bearing axis and so requires similar implants to TPLO.

Perhaps its greatest advantage is for dogs where the alterations of angle required are extreme, pushing both TTA and TPLO to their limits. By altering the angles in two ways, it has greater potential for alteration of angles.

Conclusion:

The jury is still out as to which procedure is best. TTA is a newer procedure so the same amount of long-term follow-up has not yet been seen. The early evidence is that TTA is at least as good as TPLO in the short term correction of the lameness caused by cranial cruciate ligament disease.

There were initial predictions that TPLO would halt the progression of arthritis seen following conventional surgeries. However, comparisons of the long-term results have struggled to prove a significant difference. More recent studies have shown some unexpected side effects including patella tendon injuries, abnormal wear in the joint and remodelling of the joint slope to return towards the normal state. These seem to be the result of increased forces within the joint related to the way that TPLO alters the joint mechanics.

This evidence does not mean anyone should stop doing the TPLO, but more factors are being highlighted which must be considered when performing this operation, making it a technique demanding the greatest skill and accuracy.
The design of the TTA procedure is based on a better understanding of stifle joint mechanics than was available when TPLO was designed. It is also simpler to perform correctly. Consequently, in theory at least, TTA should have fewer unexpected side effects and may be better at reducing the progression of arthritis. However, we will have to wait for the evidence.