

The stifle joint is a complex joint in the hind limbs of quadruped animals. It is the equivalent joint to the human knee. Although the primary movement is like a hinge, the menisci (cartilaginous spacers) allow a gliding action during movement so that the axis of rotation of the femur relative to the tibia varies according to the degree of flexion. Medial and lateral rotation of the tibia is also possible. The stifle consists of three interrelated joints; the femorotibial, the femoropatellar and the proximal tibiofibular. There are four sesamoid bones: the patella, medial and lateral fabellae and the popliteal sesamoid. These sesamoid bones assist with the smooth movement of a tendon/muscle over the joint. The most well-known sesamoid bone is the patella, more commonly known as the 'knee cap' and is associated with the patella ligament. It is located cranially to the joint and sits in the trochlear groove of the femur.

The joint is stabilised by paired collateral ligaments (which act to prevent abduction and adduction of the joint) and paired cruciate ligaments.

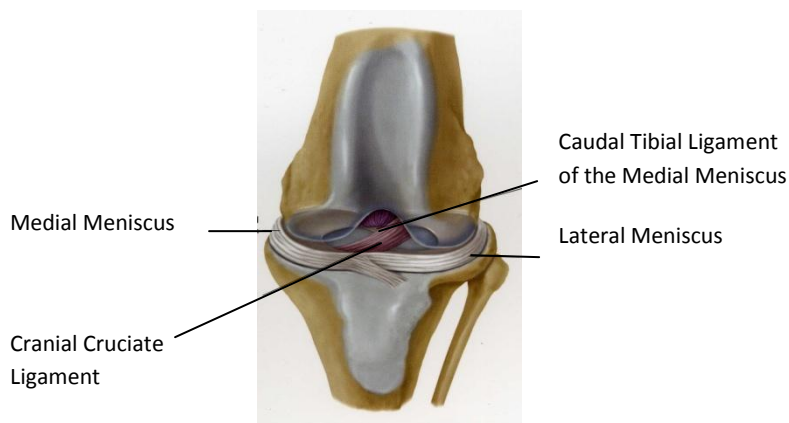
The cruciate and patella ligament are articular ligaments which join bone to bone at the stifle joint. These ligaments are not a single structure but are made up of a bundle of individual collagenous fibres and spindle-shaped cells known as fibrocytes, with little ground substance (an amorphous gel-like substance present in the composition of the various connective tissues). These fibres are tightly bound together to form the ligament. In a healthy ligament the fibres are all intact with no indication of inflammation or degeneration.

The ligament most commonly affected in dogs is the cranial cruciate ligament. The cranial cruciate ligament (CrCL) is a large, strong ligament located within the knee joint, It arises on the caudomedial aspect of the lateral femoral condyle and inserts on the cranial

intercondyloid area of the tibia. The ligament helps stabilise the stifle joint preventing damage to the other structures within the joint.

A healthy cruciate ligament prevents:

1. The cranial Drawer movement (cranial displacement of the tibia relative to the femur)
2. Overextension of the stifle
3. Excessive internal rotation of the tibia with respect to the femur



Craniocaudal view of normal left stifle



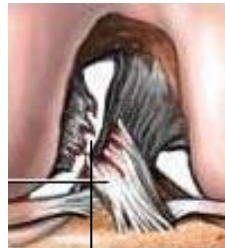
Craniocaudal x-ray of normal stifle

There have been many theories as to how cruciate injury occurs in dogs. One current line of thinking is that cruciate strain or rupture is not the result of a single acute trauma but is a disease process. Dogs in effect stand on their toes, with their heel bones (hock) up in the air. Their stifles are bent at an angle. This confirmation means that dogs develop vectors of force in their stifles when they are bearing weight. This is generally a shearing force that tries to push the tibia forward relative to the femur. This shearing force exceeds the ability

of their muscles to restrain them, as a result the force is transferred to the last link in the chain, the CrCL. The thought process is that every time a predisposed dog takes a step there is a microscopic jerk to the ligament causing minute damage. Overtime the body is unable to repair this damage as it is outpaced by new injury and the process of inflammation and ligament degeneration occurs, weakening the individual fibres. As this degeneration continues overtime, partial and complete ruptures occur; as the ligament weakens the disease process accelerates.

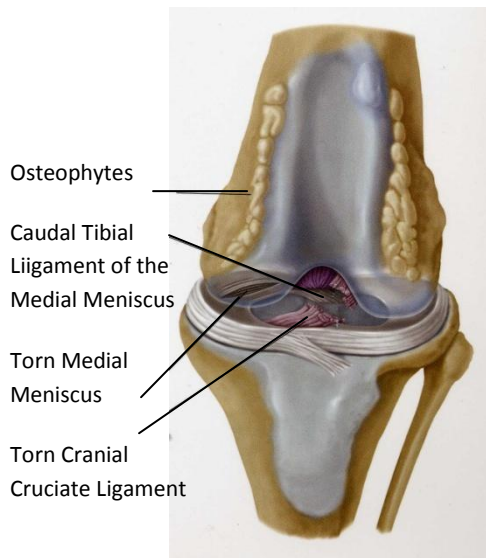


Partial tear of the ligament fibres

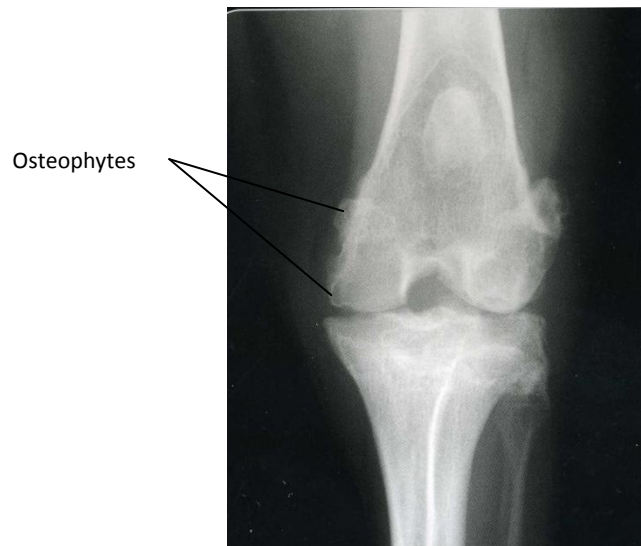


Complete rupture of the ligament

When a partial or complete rupture of the CrCL occurs the stifle becomes unstable and secondary osteoarthritic changes occur within the joint. In large breed dogs this also involves the development of periarticular osteophytes.



Craniocaudal view diseased cruciate ligament



Craniocaudal x-ray of disease stifle

The patella is the largest of the sesamoid bones; the primary function of the patella is stifle extension. The patella increases the leverage that the tendon can exert on the femur by increasing the angle at which it acts. The patella articulates with the femur and covers and protects the articular surface of the knee joint.

The patella ligament forms part of the quadriceps complex (quadriceps muscle / patella / patella ligament/tendon). The dog possesses one patellar ligament that is formed from the distal insertion of the quadriceps and connects the patella to the tibial tuberosity. It is separated from the joint capsule by the infrapatellar fat pad. There is often a synovial bursa between the distal part of the ligament and the tibial tuberosity. The medial and lateral femeropatellar ligaments extend from the patellas to the femoral epicondyles and also have attachments to the fabella (two small sesamoid bones that are embedded in the head of the

gastrocnemius muscle). The function of a healthy patella ligament and the femoropatellar ligaments is to keep the patella positioned in the trochlear groove.

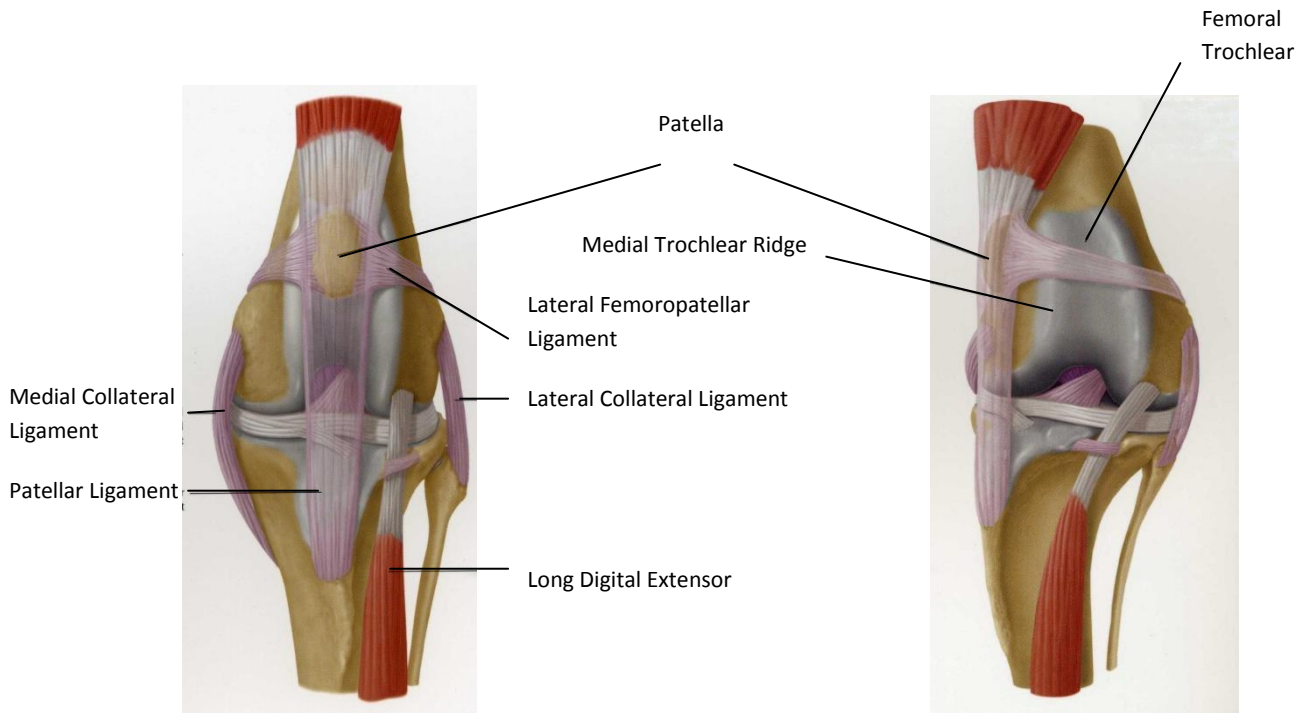
The disease process associated with the patella ligament results in luxation of the patella from the trochlear groove. Patella luxation can be congenital, developmental or trauma related. Congenital patella luxation is related to developmental abnormalities that create misalignment of the quadriceps complex. The patella can luxate because the point where the patella ligament attaches to the tibia can sometimes be attached too far inward. As the quadriceps contract, the force pulls the patella against the inner groove, over time the inner side of the groove wears down and the patella is free to move out of the groove and luxation occurs.

Underlying abnormalities of the hip and stifle joints are often seen in association with medial patella luxation. If the patella luxation occurs in immature animals, the tibia and femur bones become twisted.

Stifle abnormalities include

1. Lateral rotation and bowing of the distal femur
2. A shallow trochlear groove with a poorly developed medial ridge
3. Dysplasia of the distal femoral epiphysis
4. Rotation and lateral laxity of the femorotibial joint
5. Medial bowing and rotation of the proximal tibia
6. Medial deviation of the tibial tuberosity and attachment of the patella ligament.

Any one initial abnormality can lead overtime to others which exacerbate the disease process and lead an intermittent luxation to become permanent.



Normal left stifle

Left stifle with medially luxated patella

Patella luxation can be graded I-IV

Grade I - the patella can be manually luxated but is reduced (returns to the normal position) when released;

Grade II - the patella can be manually luxated or it can spontaneously luxate with flexion of the stifle joint. The patella remains luxated until it is manually reduced or when the animal extends the joint and de-rotates the tibia in the opposite direction of luxation;

Grade III - the patella remains luxated most of the time but can be manually reduced with the stifle joint in extension. Flexion and extension of the stifle results in re-luxation of the patella;

Grade IV - the patella is permanently luxated and cannot be manually repositioned.

There is always some controversy regarding the best approach to treatment for cranial cruciate ligament repair. Non surgical treatment is only suitable for small dogs (<10kg) if lameness is not pronounced. If improvement is not seen within 6 weeks then surgical intervention should be considered.

There are many surgical procedures used for the repair of a ruptured or partially ruptured CrCL, the results are variable. Surgical techniques are divided into two categories.

1. Techniques that replace the function of the ligament.
 - a. Intra-articular repairs
 1. Over the top
 2. Tightrope
 - b. Extra-articular repairs
 1. Lateral suture

These techniques give good stability post surgery but are vulnerable to breaking or weakening (most vulnerable 6-8 weeks post surgery)

2. Techniques that alter the anatomy of the joint, to reduce cranial tibial thrust, improve stability and allow weight bearing.
 - a. Tibial plateau levelling osteotomy (TPLO)
 - b. Tibial tubercle advancement (TTA)
 - c. Tibial wedge osteotomy (TWO)
 - d. Triple tibial osteotomy (TTO)

These techniques give good stability and are predominantly used in large breed dogs; they are more technically demanding and invasive and are performed by specialist orthopaedic surgeons.

Tibial Plateau Levelling Osteotomy

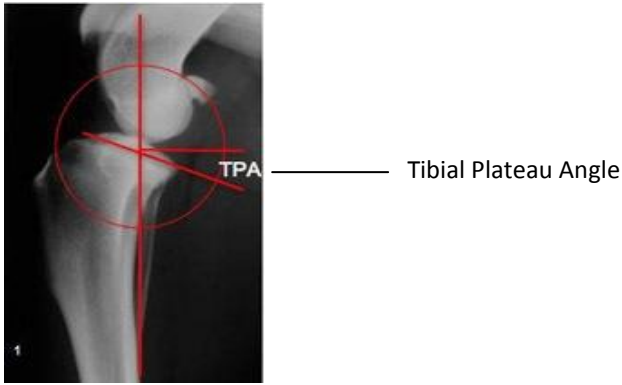
In normal canine anatomy there is a backwards, downwards sloping angle to the upper part of the tibia (the tibial plateau) and the long axis of the bone. When the cruciate ligament is torn the tibial slope allows the femoral condyles to move backwards and downwards along the tibial plateau as the tibia moves forward from cranial tibial thrust. TPLO surgery attempts to correct this downwards sloping angle and reduce cranial tibial thrust. More than 90% of the dogs that have TPLO surgery regain normal or near normal function of the limb (full weight-bearing)

Potential complications include

Infection, poor bone healing, patellar ligament strain/ patellar tendonitis, tibial crest fracture, implant failure, osteoarthritis, meniscal tear.

Surgical procedure

Surgery is done under general anaesthesia and with an epidural. Analgesic medication is also injected directly into the joint. Strict asepsis is followed to reduce the risk of infection. Radiographs will have been taken previously and measurements made to accurately achieve the required tibial plateau angle. A tibial slope of between 3-7 degrees is desired.



A medial approach to the stifle joint is used with the dog placed in lateral recumbency with the affected leg downwards and its lateral side on the operating table. The opposite leg is drawn back and secured out of the way to expose the medial aspect of the affected leg. A medial arthrotomy (incision of the joint) is performed to clean the damaged CrCL and release the medial meniscus (meniscal release is intended to make the meniscus less vulnerable to post-operative injury. If the meniscus (typically the medial one) is torn the surgeon will remove the torn portion. Elevation of the tibial muscles is performed to expose the tibia.

A curvilinear osteotomy is made (using a patented curved blade and oscillating saw) of the tibial plateau, which allows its rotation to a lower angle relative to the long axis of the bone (the amount of rotation applied is based on pre-operative x-ray measurements and other factors determined by the surgeon). The osteotomy is then stabilised in the new position with a specialised bone plate and multiple screws. The plate must be moulded by the surgeon to the exact shape of the dog's tibia during the operation.



TPLO osteotomy plate

Once the osteotomy is stabilised the incisions are closed with multiple layers of sutures, the final layer being sutures or surgical staples in the skin. Post-operative x-rays are taken to assess the new tibial slope and the position of the bone plate and screws.



Post TPLO X-rays

A compression bandage may then be applied for the first 24-36 hours. The use of systemic narcotics, transdermal patches (fentanyl) and NSAID's may be used in conjunction for post surgical analgesia along with antibiotic therapy.

Medial luxating patella correction surgery using trochleoplasty and tibial tuberosity translocation

The process that causes patella luxation can be complex; as a result, often more than one surgical procedure is needed in combination to correct the problem. Translocation of the tibial tuberosity (and ligament attachment to it) along with trochleoplasty (deepening of the trochlear groove) are performed together in many cases and this aims to realign the extensor mechanism and stabilise the patella in the trochlear groove.

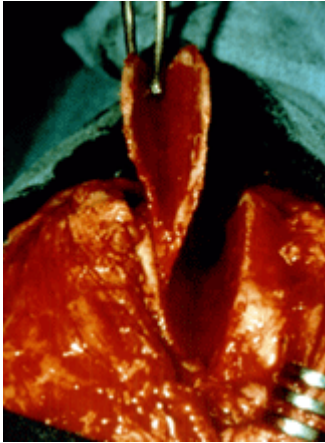
Possible complications

Inadequate surgical intervention resulting in further surgery, secondary cartilage ulceration, secondary osteoarthritis

Surgical procedure

Surgery is done under general anaesthesia and with an epidural. Analgesic medication is also injected directly into the joint. Strict asepsis is followed to reduce the risk of infection. The animal is usually positioned in dorsal recumbency (supported by sand bags or a plastic trough) with free movement of the limb to allow manipulation during surgery to evaluate alignment. A lateral incision is made extending from the distal end of the tibial tuberosity to the proximal end of the trochlear groove. The incision continues through the fascia lata and joint capsule to expose the trochlear groove. Parallel incisions are made in the articular cartilage of the trochlear groove and a V shaped incision is made using a hack/hobby saw and the wedge removed. The V shaped incision is deepened before the wedge is trimmed

and replaced, recessed into the deepened groove, the patella will hold this in place and over time fibrocartilage will form to heal the incision site.



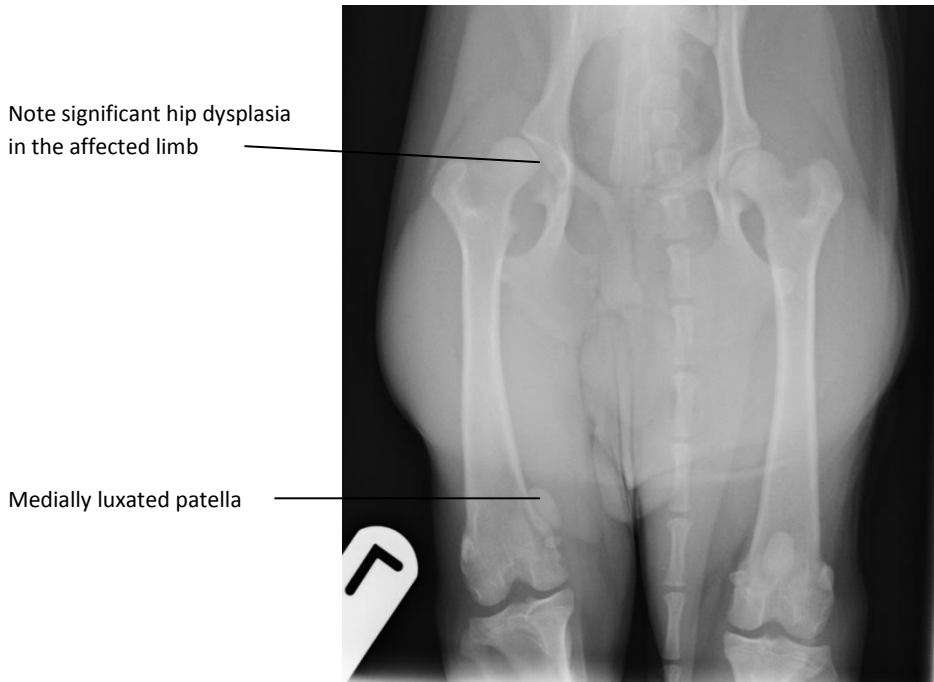
Removal of wedge



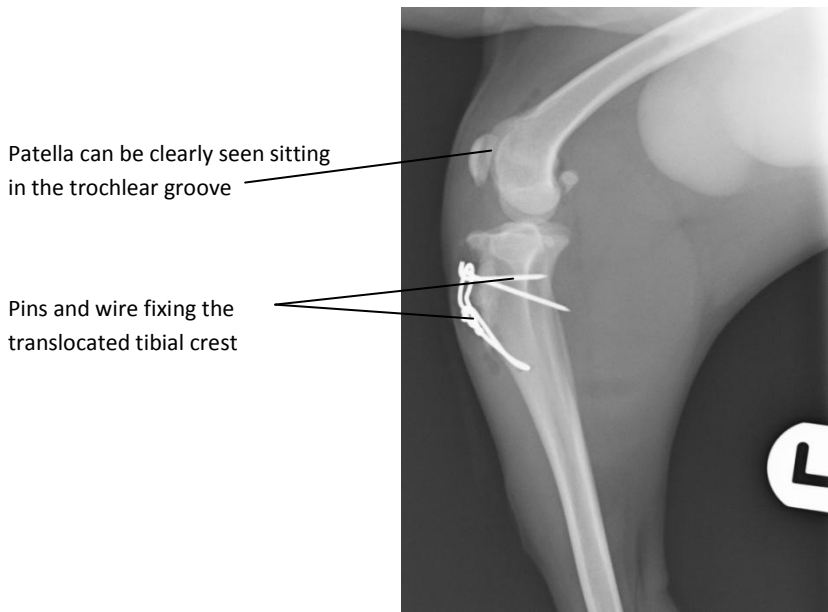
The wedge replaced after groove deepening

Release of the medial joint capsule alongside the patella ligament is then performed, in severe cases this may need to extend proximally into the quadriceps muscle group. The cranial tibial muscle is retracted to expose the proximal tibia. The tibial tuberosity is detached with the distal periosteal attachment and the tibial tuberosity is moved laterally so that the patella does not luxate medially on flexion. The tibial tuberosity is held in place using Kirschner /arthrodesis wire, the wire is bent and cut and the end buried under the cranial tibial muscle. The joint capsule and fascia lata are sutured closed separately and finally the skin is sutured or stapled.

A light Robert Jones bandage may be applied for several days post surgery. The use of systemic narcotics, transdermal patches (fentanyl) and NSAID's may be used in conjunction for post surgical analgesia along with antibiotic therapy.



Pre op x-ray of 7m old Cavalier King Charles Spaniel with grade III medially luxating Patella of the left hind limb



Post op x-ray of the same 7m old Cavalier King Charles Spaniel