Caudal Femoral Thrust – A potentially significant factor in canine cruciate ligament disease?

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Published 14.8.2018

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Keywords: canine, cruciate disease, stifle, tibial ostetomy, biomechanics

Abstract

There are indications in recently published literature that the TTA and the TPLO are not completely restoring the cranio-caudal stability after a rupture of the canine CrCL. A force is generated by the quadriceps muscle pressing the patella onto the femur, thereby pushing the femur in a caudal direction. In analogy to the cranial tibial thrust CTT, this force is called here by the author 'caudal femoral thrust' CFT. This CFT could be of significant strength because the pull of the quadriceps muscle is using the patella as hinge. In patients without intact CrCL the femur can be moved caudally on the tibial plateau by the CFT. The existence of a significant CFT could explain some of the described instability after TTA and TPLO including the caudal subluxation of the femur in the fluoroscopic videos. The CFT could be investigated using computer and cadaveric models. In case the CFT has a significant role in canine CrCL disease, surgical techniques eliminating the effect of the CFT should be explored.

Cranial cruciate ligament (CrCL) rupture is very common in dogs and causes stifle joint instability leading to progressive osteoarthritis and meniscal damage.[1] Fluoroscopic video analysis of walking dogs with CrCL deficiency show a cranial translation and internal rotation of the tibia mainly during the stance phase.[2] Traditionally the instability has been surgically treated using passive restraint of the cranial motion of the tibia.[1]

Newer surgical procedures target the force behind the cranial tibial thrust (CTT).[1] This force is generated by the quadriceps muscle stabilizing the canine stifle joint during weight bearing. The tibial plateau angle (TPA) of carnivores is around 20-23 degrees. Because of this TPA the patella tendon is not always inserting perpendicularly to the proximal tibial joint surface, and the weight is not transmitted with a 90° angle through the tibial plateau.[1] This creates a cranially directed shear force (CTT), subluxating the tibia in the absence of a functional CrCL (Figure 1).[1]

The most commonly used corrective tibial osteotomy procedures (tibia plateau leveling osteotomy TPLO and tuberositas tibiae advancement TTA) eliminate this cranial shear force by reducing the maximal patellar tendon angle (PTA) to 90°.[1] The cranial shear force is turned into a caudal shear force by the rotation of the tibial plateau. An overcorrection of the TPA leads to increased forces (caudal tibial thrust) acting on the caudal cruciate ligament.[3]

There are indications in recently published literature that the TTA and the TPLO are not completely restoring the cranio-caudal stability after a rupture of the canine CrCL. Results published by Don Hulse et al. and Skytte and Schmökel show that the clinical results of the TTA and the TPLO are better in partial CrCL rupture with some stability remaining in the affected stifle.[4,5] Published studies with radiographic and fluoroscopic video sequences after TTA and TPLO show that there are patients with residual stifle subluxation during weight bearing.[6-9] As an explanation, under-correction or rotational instability have been proposed to

explain this finding.[10] Many surgeons have now adapted their target TPA after TPLO to 0-2°, or an additional lateral suture for the TPLO is advocated in selected cases.[10]

In 1993 an article was published by Schmökel and Montavon introducing a modification of the tuberositas tibia transposition with the goal to reduce the pressure on the retropatellar joint surface.[11] A similar surgery has been performed for a long time in human patients under the name Maquet-Bandi procedure.[12] The aim of these procedures was to reduce the force which is generated by the quadriceps muscle pressing the patella onto the femur, thereby pushing the femur in a caudal direction. In analogy to the cranial tibial thrust CTT, this force is called here by the author 'caudal femoral thrust' CFT (Figure 2).

This CFT could be of significant strength because the pull of the quadriceps muscle is using the patella as a hinge. In patients without intact CrCL the femur can be moved caudally on the tibial plateau by the CFT. The CFT is depending on the stifle angle and is active during the weight bearing.[13,14] The pull of the gastrocnemius muscle and the CTT act together leading to the well-known subluxation of the stifle joint after rupture of the CrCL.[2] The CFT could additionally increase this subluxating force.

After a proximal tibial osteotomy, the PTA is maximally 90° in extension, in more flexed stifle positions the quadriceps is pulling the tibia caudally together with the hamstring muscles.[1] Affected dogs hold the unstable stifle in a more flexed position throughout the gait to reduce the cranial shear force.[2] The CFT and the gastrocnemius muscle move the femur in a caudal direction. The stifle stability without a functional CrCL is depended on the balance of these force vectors. In a substantial percentage of patients treated with a tibial osteotomy after CrCL rupture the forces subluxating the stifle joint are not completely neutralized. [6-9] A TTA procedure reduces the CFT 20-30% in dogs and humans.[13,14] Changing the TPA with a TPLO should reduce the CFT parallel to the tibial plateau slightly, but no information could be

found in the literature about that. The existence of a remaining significant CFT could explain some of the described instability after TTA and TPLO.

The CFT could be investigated using computer and cadaveric models. In case the CFT has a significant role in canine CrCL disease, surgical techniques eliminating the effect of the CFT should be explored.

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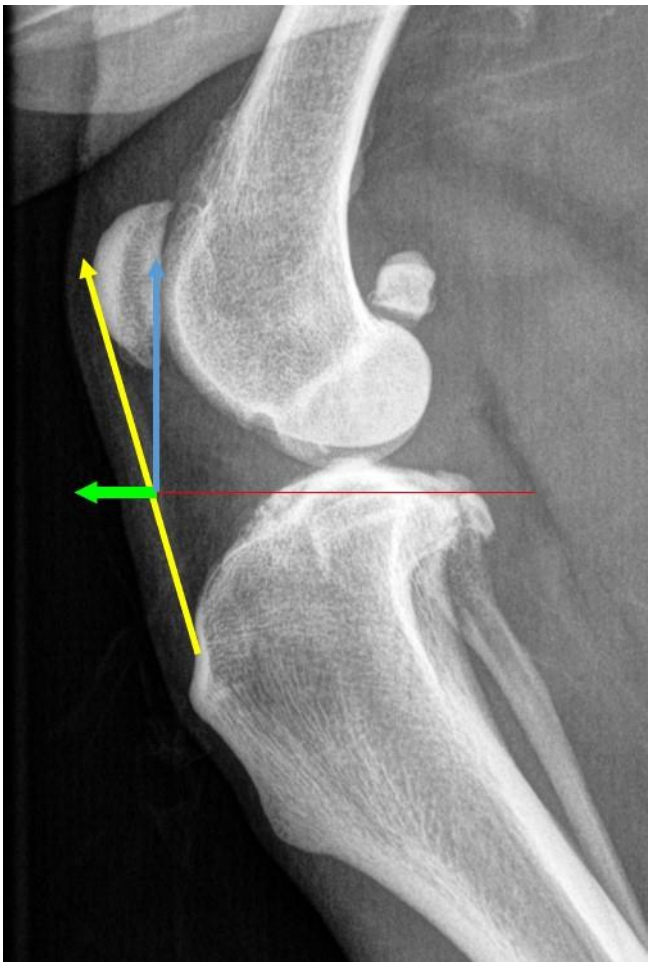

Figure 1: Illustration of the cranial tibial thrust (CTT, green arrow) resulting from the pull of the patellar tendon on the tibial crest. Insertion of the patellar tendon (yellow arrow) with an angle larger than 90° to the tibial plateau (red line) results in a cranially directed shear force CTT neutralised by an intact CrCL

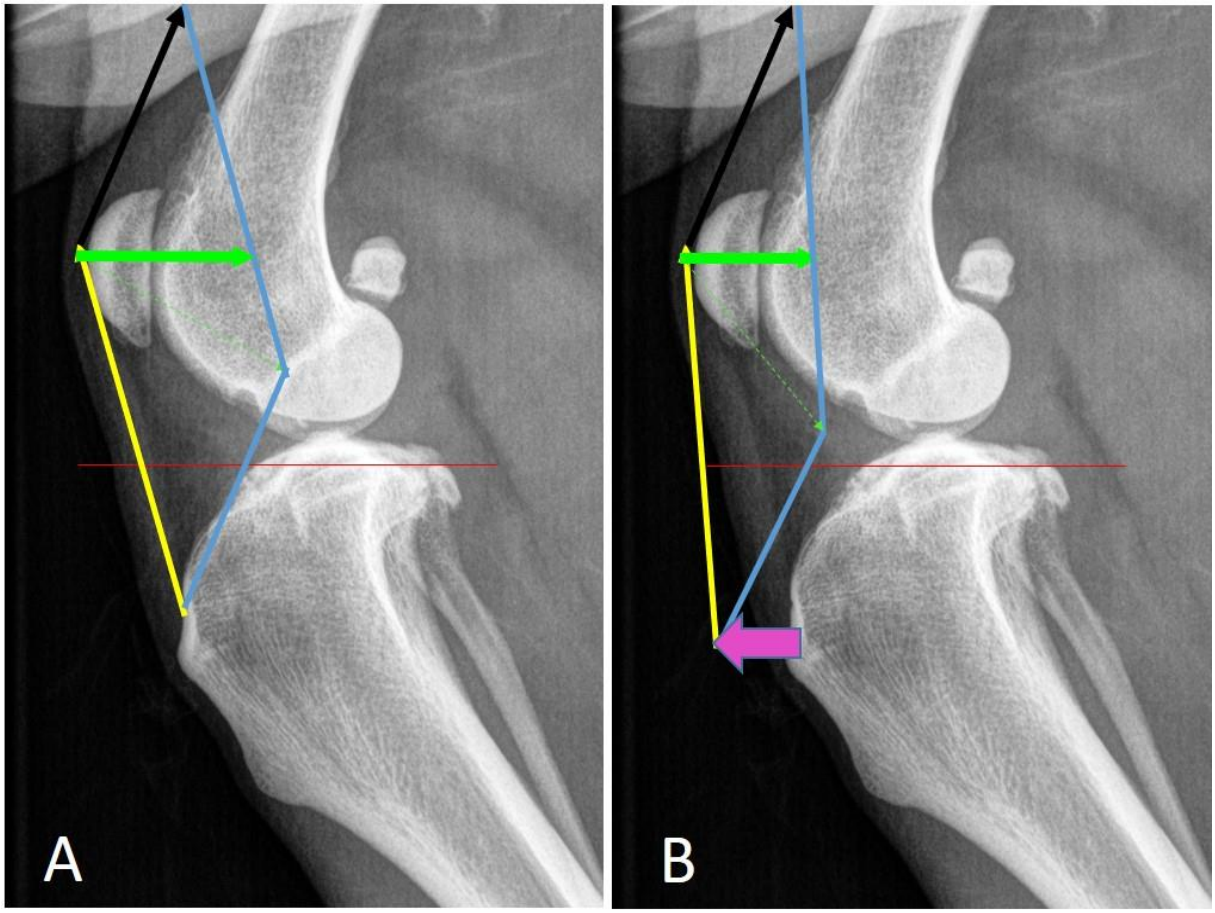

Figure 2 A+B: Fig A is showing the caudally directed force caudal femoral trust CFT (green arrow) in a stifle resulting from the pull of the quadriceps muscle on the patella (black arrow) connected to the tibia by the patellar tendon (yellow line). The CFT is pushing the femur caudally on the tibial plateau (red line).

Fig B illustrates the effect of a tuberositas tibia advancement (pink arrow) on the CFT (green arrow). The magnitude of the pressure between the patella and femur is reduced by ca 20% in dogs.