Luxation of the long digital extensor tendon
as a complication to Tibial Plateau Levelling
Osteotomy
A presentation of four cases

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Summary
Craniocruciate ligament disease in dogs is frequently treated with Tibial Plateau Levelling Osteotomy (TPLO). Herein we describe four cases of dogs presenting with sudden lameness in the operated leg one to 12 months post TPLO surgery. On examination, all of the dogs had luxation of the long digital extensor tendon (LDE) resulting from the TPLO surgery. All of the dogs underwent revision surgeries. The LDE tendon was either secured in its normal position or transected, and an tenodesis was performed. The dogs recovered well after surgery and lameness was resolved in all four cases.

Keywords
Long digital extensor tendon, luxation, TPLO complication

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Introduction
Tibial Plateau Levelling Osteotomy (TPLO) has become widely accepted in the treatment of cranial cruciate ligament disease in the dog (1, 2). Unlike intra-articular reconstruction and extra-articular imbrication techniques, TPLO is not used in order to attempt to repair, or replace, the entire function of the cranial cruciate ligament, rather the aim is to reduce the cranial tibial thrust, thereby eliminating the shearing forces that occur in the stifle joint (3). Several surgical and post-operative complications of the technique have been reported. Complications can be either intra-operative or post-operative. Intra-operative complications include: under and over rotation of the tibial plateau, intra-articular screw placement and malalignment caused by incorrect osteotomies or inadequate reduction of the osteotomy line. Post-operative complications reported include: infections, implant failure, fractures of the tibial crest, patellar tendinitis and mal or non unions (1, 3–5).

The long digital extensor tendon (LDE) has its origin in fossa extensoria, cranial laterally on the femoral condyle. The tendon passes intra articularly and enters a groove, the sulcus muscularis, at the cranial-lateral aspect of the tibia. The tendon is held in place by a restraining ligament across the groove. A tendon sheath surrounds the tendon in the groove and communicates with the stifle joint. The long digital extensor muscle has two functions, flexion of the hock and extension of the digits. The most frequently occurring injury to the LDE tendon seems to be avulsion fractures of the tendon origin (6, 7). Rupture of the tendon may occur in concurrence with lateral patellar luxation (8). Habitual and permanent luxation of the LDE tendon has been described, mainly in young dogs (6, 9), but to the authors’ knowledge luxation has not previously been described as a complication of TPLO. In order for a luxation of the LDE tendon to occur, the integrity of the restraining ligament has to be broken. Movement of the stifle joint during extension/flexion and contraction of the muscle will then cause the tendon to luxate.

As part of the previously mentioned TPLO procedure (3), the musculature of the cranio-lateral and caudo-lateral proximal tibia is elevated, and gauze is packed between the bone and the elevated soft tissues. Potentially, the LDE tendon may be inadvertently elevated from its groove during this stage of the operation. When the osteotomy is made, the cranio-lateral tibia, which cannot be visualized during surgery, is transected by the osteotomy line. There is a risk that the restraining ligament itself, or its attachments, may be injured during this stage of the operation.

The aim of this paper is to describe four cases of luxation of the long digital extensor tendon as a complication of TPLO surgery.

Materials and methods
The medical records of four dogs that had previously undergone TPLO were reviewed. The dogs were admitted with lameness of the operated leg. After a normal post-operative improvement, lameness had occurred one to 12 months after surgery. In three of the four dogs, the TPLO had been perform-
ed according to the method described by Slocum et al. (3), but with a few differences: the procedure included arthroscopy for inspection of the joint and removal of damaged parts of the cranial cruciate ligament and the medial or lateral meniscus. Also, meniscal release was not performed. The fourth dog had undergone a failed TPLO procedure at a referring practice, which resulted in a malalignment of the tibia.

The dog also had a rupture of the cranial cruciate ligament on the contralateral leg.

Case #1
A two-year-old Labrador Retriever was initially admitted with a rupture of the cranial cruciate ligament. Arthroscopy and TPLO were performed. Postoperative complications did not seem to have occurred. Three months after surgery, the dog developed a moderate lameness of the operated limb, and the owner noticed a clicking sound in the leg at every step. The owner could not relate the onset of lameness to a traumatic episode. Examination showed signs of lameness, a clicking sound on flexion and extension of the stifle joint, local pain and a small swelling over the cranio-lateral proximal region of the tibia. The LDE tendon could be palpated in a luxated position caudal to the sulcus muscularis. The luxation was confirmed with ultrasonographic examination. Surgical intervention was performed one week later. A small incision was made over the sulcus muscularis. The LDE tendon had a severe periartitis with hypertrophic villi in the tendon sheath, and luxated caudally when the stifle was flexed. Remnants of the restraining ligament could be identified at the cranial aspect of the sulcus. The LDE tendon was repositioned and fixed in its natural position with a 1 mm Kirshner wire (Synthes®) bent into a U-shape. The wire was bent to size with a width matching the two eminences of origin of the restraining ligament. The K-wire was introduced into the bone with a mallet and the wound was closed routinely. On suture removal after two weeks, the clicking sound had disappeared and the dog had regained full use of its legs.

Case #2
An eight-year-old Border Collie was referred after a one-year history of lameness. The dog admitted with slight left hind limb lameness. Palpation revealed joint distension and thickening of the periarticular structures of the stifle joint. Arthroscopy revealed synovitis, a partial rupture of the cranial cruciate ligament, and intact menisci. TPLO was performed. At follow-up after three months the dog was doing well without any residual lameness. The patient returned five months postoperatively because of a sudden onset of lameness. The stifle was painful when manipulated and a swelling, mainly located along the LDE tendon sheath, could be palpated. Examination performed under sedation revealed that the LDE tendon was permanently luxated caudally. Corrective surgery was performed a week later. A small incision over the sulcus muscularis revealed a luxated LDE tendon with hypertrophic villi both on the tendon and within the tendon sheath. The osteotome line appeared to have gone through the cranial eminence from which the ligament was detached. The LDE tendon was fixed in its normal position with two 2.0 mm cortical screws (Synthes) and a 0.8 mm cerclage wire (Synthes) in a figure-of-eight configuration.

On follow-up one month after the second surgery the lameness had resolved, and the dog was pain-free when clinically examined.

Case #3
A seven-year-old Riesenschauzer was admitted with a lameness of the right hind limb. A ruptured cranial cruciate ligament was diagnosed. Arthroscopy and TPLO were performed as previously described. On follow-up after four weeks, it was reported that recovery had been uneventful and that the lameness had resolved. A sudden lameness in the operated leg occurred approximately twelve months after the TPLO surgery. At examination the LDE tendon could be luxated caudally. The sulcus muscularis was shallow and surrounded by osteophytes. The luxation was confirmed with ultrasonographic examination, which also showed a swelling of the tendon sheath as well as the tendon. The area of the LDE tendon was surgically exposed, and the sulcus was found to be very shallow due to extensive bony proliferations. Functional reconstruction was deemed to be impossible, and the LDE tendon was transected at its origin and sutured to the caudolateral aspect of the origin of the cranial tibial muscle as previously described (6).

According to the owner, two months after the operation the dog was functioning well.

Case #4
A six-year-old Rottweiler was referred due to a continuous lameness after TPLO of the left stifle. The procedure had left the dog with a pronounced genu varum and an internal rotation of the tibia, probably due to an incorrectly performed osteotomy. On the radiographs taken three months postoperatively, the osteotomy appeared to be placed distal to the tibia and not perpendicular to the functional axis of the tibia. The dog also had a rupture of the cranial cruciate ligament in the contralateral leg. It was bearing weight on the operated leg, but the joint was painful and a clear clicking sound could be heard during manipulation of the joint. On palpation, the tendon sheath of the LDE tendon was painful and was markedly distended. The LDE tendon luxated habitually during movement. Arthroscopy and TPLO was performed on the right leg. The left LDE tendon was visualized by a small incision and it was found to luxate freely on manipulation. The restraining ligament was severed from its cranial attachment, and remnants of the ligament, still attached to the caudal notch of the sulcus, had healed to the tendon itself (Fig. 1). There was a marked synovial effusion around the tendon and a proliferation of the synovial membrane in both the sheath and on the tendon. After loosening of the attachment of the restraining ligament to the tendon, the LDE tendon was replaced and fixed with a 1 mm Kirshner wire bent into a U-shape matching the width of the fossa. The wound was closed routinely.

The outcome of the surgery was difficult to evaluate because of the concurrent problems with limb alignment. The referring
A veterinarian reported two months after surgery that the LDE tendon was in its normal position and the dog was using its leg.

**Discussion**

Numerous complications with TPLO surgeries have been described (1, 3–5). Luxation of the LDE tendon in general is sparsely described, and has to our knowledge never been described as a complication to TPLO.

In the first three cases presented herein lameness occurred one to 12 months after TPLO surgery. Pain and lameness may have been related to the pronounced inflammatory reaction found in all of the cases rather than to the luxation itself, which might explain the delay in the appearance of clinical signs.

However, this theory is less likely because of the limited changes caused by the rotation.

The most likely hypothesis is that the luxation is caused by iatrogenic injury to the restraining ligament or its cranial or caudal attachment during surgery. The injury might occur during elevation of the soft tissues from the cranio-lateral tibia, when the cranio-lateral pouch is packed with gauze, or during the osteotomy, resulting in luxation of the tendon. The osteotomy line passes through, or in very close proximity to, the cranial insertion of the restraining ligament, therefore making injury to these structures likely. Dogs 1 and 2 did not have any new bone formation in the sulcus muscularis. Therefore it is unlikely that the osteotomy went directly through the groove, but it may have damaged the attachment of the restraining ligament. In the third dog, the presence of new bone in the sulcus muscularis indicates that the osteotomy may have passed through the groove. In the fourth dog, the sulcus was macroscopically normal in its central and caudal part, with what looked like an osteotomy line through the cranial aspect of the groove. The restraining ligament was detached from the cranial aspect and had healed to the tendon itself. When the restraining ligament is ruptured the LDE tendon will luxate caudally either intermittently or permanently.

In three of the four cases the lameness quickly resolved after surgical intervention, therefore it has been concluded that the injury and the luxation of the LDE tendon was the direct source of the lameness. The fourth dog had a valgus and rotational deformity of the leg and a concurrent cruciate ligament rupture to the contra lateral stifle, which made it difficult to establish the initial cause of the lameness and pain, and the result after intervention. However, before the second surgery the area was painful, and the LDE tendon luxated habitually.

Primary luxation of the LDE tendon is not a common problem (10), and previous injuries to the restraining ligament of the LDE tendon in these four dogs is unlikely. The case described by Bennet and Campbell (9) concerned a one-year-old Whippet with habitual caudal luxation of the LDE, much similar to the cases presented here. The Whippet had a malunited fracture of the femoral shaft with a resultant medial bowing of the leg. This malunion may have contributed to the luxation of the LDE, although the paper does not offer any conclusion in that respect. There were not any signs of injury detected during clinical examination of the cases presented in this paper prior to the TPLO surgeries. Initial recovery after TPLO was uneventful in the first three cases. It is therefore more likely that the injuries occurred during surgery or postoperatively as a result of altered anatomy.

Surgical correction of luxation of the LDE tendon is relatively easy, and the prognosis seems to be good after intervention. The diagnosis of luxation of the LDE tendon was easily made by palpation, but it will almost certainly be missed unless the surgeon is actively searching for it. Therefore, it is recommended that palpation of the area of the LDE tendon is included in the follow-up protocol after TPLO surgery, especially if the dog shows unexpected lameness.

**References**


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