Surgical treatment of a proximal diaphyseal tibial deformity associated with partial caudal and cranial cruciate ligament deficiency and patella baja

S. Vincenti[1], S. Knell[1], A. Pozzi[1]

[1] Clinic of small animal surgery, Vetsuisse-Faculty, University of Zurich, Zurich, Switzerland

Summary

Caudal cruciate ligament injury can be a complication following tibial plateau leveling osteotomy (TPLO) (Slocum und Slocum, 1993) especially if the post-operative Tibial Plateau Angle (TPA) is less than 5 degree. We describe a case of negative TPA associated with partial cranial and caudal ligament rupture treated with a center of rotation of angulation (CORA) based cranial tibial opening wedge osteotomy and tibial tuberosity transposition. A 13 kg, mixed breed dog was presented for right pelvic limb lameness. Radiographically a bilateral patella baja and a malformed tibia tuberosity along with a bilateral TPA of -8 degree were detected. Arthroscopically a partial rupture of the cranial and caudal cruciate ligaments were found. A cranial tibial opening wedge osteotomy of 23 degree and a fibular ostectomy were performed. The osteotomy was fixed with a 8 holes ALPS 9 (KYON, Switzerland) and a 3-holes 2.0mm UniLock plate (Synthes, Switzerland). Then a proximal tibial tuberosity transposition of 10mm was performed and fixed with a pin and tension band construct. The postoperative TPA was 15 degree. The radiographic controls at 6, 10 weeks, 6 months and 1 year after surgery revealed an unchanged position of the implants and progressive healing of the osteotomies. At the 6 and 12 months recheck evaluation the dog had no evidence of lameness or stifle pain and radiographs revealed complete healing of the osteotomy site and no implant failure.
The diaphyseal CORA based osteotomy allowed accurate correction of a proximal tibial deformity associated with negative TPA.

Keywords: knee, caudal cruciate rupture, patella baja, tibial deformity

Chirurgische Behandlung einer proximalen diaphysären Fehlstellung der Tibia assoziiert mit einem partiellen kaudalen und kranialen Kreuzbandriss und einer Patella baja

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Eine Verletzung des kaudalen Kreuzbandes stellt eine moegliche Komplikation nach einer Tibial Plateau Levelling Osteotomy (TPLO) dar (Slocum und Slocum, 1993); vor allem, wenn der Tibia Plateau Winkel (Tibial Plateau Angle, TPA) kleiner als 5 Grad ist. Wir beschreiben einen Fall mit negativem TPA in Zusammenhang mit einem partiellen kranialen und kaudalen Kreuzbandriss, der mit einer center of rotation of angulation (CORA) basierten Tibia Keilosteotomie und Tuberositas Tibia Transposition behandelt wurde. Ein 13 kg Mischlingshund wurde aufgrund einer Lahmheit an der rechten Hintergliedmasse vorgestellt. Auf den Röntgenbildern beider Kniegelenke wurden eine bilaterale Patella Baja und eine malformierte Tuberositas Tibia zusammen mit einem bilateralen TPA von –8 Grad nachgewiesen. Arthroskopisch wurde eine partielle Ruptur des vorderen und hinteren Kreuzbandes diagnostiziert. Eine Tibia Keilosteotomie von 23 Grad und eine Fibula Ostektomie von dem rechten Knie wurden durchgeführt. Die Osteotomie wurde mit einer 8-Loch Advanced Locking Plate System (ALPS) 9 Platte (KYON, Schweiz) und einer 3-Loch 2.0 mm UniLock-Platte (Synthes, Schweiz) fixiert. Anschliessend wurde eine proximale Tuberositas Tibiae Transposition von 10 mm durchgeführt und diese mit einer Drahtzuggurtung stabilisiert . Der postoperative TPA betrug 15 Grad. Die Röntgenkontrollen 6 und 10 Wochen, 6 und 12 Monaten nach der Operation zeigten eine unveränderte Position der Implantate und progressive Heilung der Osteotomien. Bei der Nachkontrolle nach 6 und 12 Monaten hatte der Hund keine Anzeichen von Lahmheit oder

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Schmerzen und die Röntgenaufnahmen wiesen eine vollständige Heilung der Osteotomie und keine Anzeichen von Implantatversagen auf. Die diaphysäre CORA basierte Osteotomie ermöglichte die Korrektur einer proximalen Tibia Deformation verbunden mit einem negativen TPA.

Schlüsselwörter: Knie, kaudaler Kreuzbandriss, Patella Baja, Tibia Deformation, Hund

Introduction

The normal tibial plateau angle (TPA) in dogs ranges between 18 and 26 degrees (Morris et al., 2001; Wilke et al., 2002; Reif et al., 2003;). When outside the reported range, the TPA may be considered pathologic, although the normal range may vary depending on breed (Su et al., 2015). Dogs with a TPA greater than 35 degrees are frequently associated with cranial cruciate ligament rupture (Selmi and Padiha Fiho, 2001; Osmond et al., 2006). Several proximal tibial osteotomies have been reported to treat cranial cruciate ligament rupture including tibial plateau leveling osteotomy (TPLO), cranial closing wedge osteotomy, TPLO combined with cranial closing wedge osteotomy, triple tibial osteotomy (Kim et al. 2008) and the Center of Rotation of Angulation (CORA)-based corrective osteotomies (Raske et al., 2013). Reports of dogs with a TPA lower than the normal range are rare. These dogs may be at higher risk of caudal cruciate ligament rupture because of increased strain on the ligament (Slocum et al., 1993; Warzee et al., 2001).

Figure 1: Preoperative (A, B) radiographic views of the right tibia. Note the patella baja (white arrow) and the distally displaced tibial tuberosity (white arrow head) in the mediolateral view (A) of the right stifle.

This report describes a dog presented with a proximal tibial deformity consisting of a negative TPA in addition to a distally displaced tibial tuberosity associated with a partial caudal and cranial cruciate ligament rupture and patella baja, which was treated with a diaphyseal corrective osteotomy and a proximal tibial tuberosity transposition.

History and clinical examination

A 16 months old, male castrated, mix breed dog weighting 13 kg was presented to the Small Animal Hospital of the University of Zurich after an acute worsening of a chronic right pelvic limb lameness. The owner reported that the dog had shown a grade 1/4 lameness of 8 months duration, which had suddenly worsened to a grade 4/4 a few hours prior to the presentation. No obvious trauma had been observed by the owner. When the lameness first appeared, the dog was treated by the referring veterinarian with anti-inflammatory medications for a 2 weeks duration and afterwards with a long course of corticosteroids for about 6 months. Both therapies did not produce significant improvement of the clinical signs.

The general physical examination upon presentation to University of Zurich revealed normal general parameters. During the orthopedic examination the dog showed a grade 3/4 right pelvic limb lameness and reluctance to climb stairs. On palpation moderate muscle atrophy of the right pelvic limb and bilateral mild stifle swelling were detected. The swelling appeared to be caused by thickened patellar tendon and mild joint effusion. Palpation of the right stifle revealed pain during flexion and extension. Tibial compression test and cranial draw-

er test were negative. No medial or lateral patellar luxations were detected. The orthopedic examination and a subsequent neurological examination did not reveal any further abnormality. Preoperative haematology and serum biochemistry were unremarkable.

Radiography

Orthogonal radiographic views of both stifles revealed a mild increase of intra-articular soft tissue radio-opacity and cranial displacement of the infrapatellar fat pad, with the signs being worse in the right stifle (Fig. 1). A deformity of the proximal tibia in the sagittal plane was detected bilaterally, with pathologic recurvatum and a distally displaced tibial tuberosity in association with a patella baja, (patella displaced more distally than normal). The TPA, measured using previously described methods, was –8 degrees (Slocum and Devine, 1983; Slocum and Slocum, 1993). The mechanical caudal proximal tibial angle (mCaPTA) was 98 degrees (Dismukes et al., 2008) (range in non- Labrador breeds: 61.9–64.2). The diagnosis of patella baja was based on the measurement of the ratio in mm between the patellar tendon length and the patellar length as described in Mostava et al., (2008). This ratio was 1.75 and 1.8 for the right and left stifle, respectively. Increased soft tissue radio- opacity in the joint was suggestive of joint effusion bilaterally (Fig. 1).

Surgery

The dog was initially treated with a short course of NSAIDs (Carprofen 4 mg/kg SID) in preparation for right stifle arthroscopy and a tibial corrective osteotomy. The method for planning the corrective osteotomy was modified based on Raske et al., (2013) to achieve a postoperative TPA of 15 degrees. The CORA was determined by intersecting the proximal and distal anatomic axes. The proximal anatomic axis was marked based on the desired postoperative angle (TPA=15 degrees; mCaPTA=75 degrees) (Fig 2). This angle of correction was selected to decrease the cranial tibial thrust force while preventing caudal tibial thrust, which would occur with a TPA of 5 degrees or smaller (Slocum et al., 1993; Warzee et al., 2001). In addition, a proximal transposition of the tibial crest was planned for correction of the patella baja.

The patient was pre-medicated with acepromazine (0.01 mg/kg) and methadone (0.2 mg/kg), anaesthesia was induced with propofol and maintained with isoflurane (2%) on a mixture of oxygen and air. A femoral and sciatic nerve block was performed using ropivacaine (1 mg/kg) and dexmedetomidine (5 µg dexmedetomi-

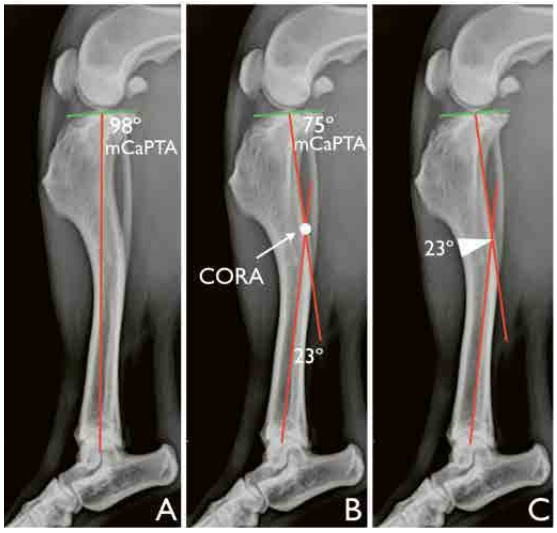

Figure 2: Preoperative planning for the tibial corrective osteotomy. The center of rotation of angulation (CORA) was determined by the intersection between the proximal and distal anatomic axes. The proximal anatomic axis was drawn at the desired postoperative angle (TPA = 15 degree; mCaPTA = 75 degree). The corrective opening wedge angle corresponds to the angle between the proximal and the distal anatomic axis.

Figure 3: Immediate postoperative (A, B) radiographic views of the right tibia. Note that the tibial tuberosity was displaced about 10mm proximally, reducing the severity of the patella baja (C). Good alignment was achieved on both sagittal and frontal planes postoperatively (C, D).

dine per ropivacain ml). Cefazolin (22 mg/kg IV) was administered after induction of anaesthesia and repeated every 90 minutes intraoperatively. Arthroscopy of the right stifle was performed using a short, 30° fore-oblique, 2.7 mm arthroscope, revealing a severe synovitis and a partial rupture of the cranial and the caudal cruciate ligament. No meniscal tears were detected. Subsequently, a cranio-medial approach to the proximal and mid- diaphyseal right tibia as well as the corrective osteotomies were performed. The tibial recurvatum was corrected with a cranial tibial opening wedge osteotomy performed distally to the tibial crest (Fig 3). The tibia was shortened by 5 mm to decrease soft tissue tension caused by the flexor muscles during correction. Then, a mid-diaphyseal fibular ostectomy was performed and a 5 mm long segment was removed. A 23 degree cranial opening wedge osteotomy was done in order to achieve a postoperative TPA of about 15 degree (Fig 3). No jig was used and the fragments were manually reduced and kept in alignment while applying the first medial plate. The tibial osteotomy was stabilized with a 8 holes ALPS 9 (KYON, Switzerland) plate applied to the medial side of the tibia and a 3-holes 2.0 mm UniLock plate (Synthes, Switzerland) applied to the cranial aspect of the tibia as a tension band plate (Fig 3). A tibial tuberosity transposition was performed to correct the patella baja. A 10 mm proximal transposition was selected to displace the patella proximally without significant increase in risk of tuberosity fracture. The tibial tuberosity was stabilized using a pin and tension band construct with two 1.8 mm Kirschner wires and 1 mm diameter cerclage-wire.

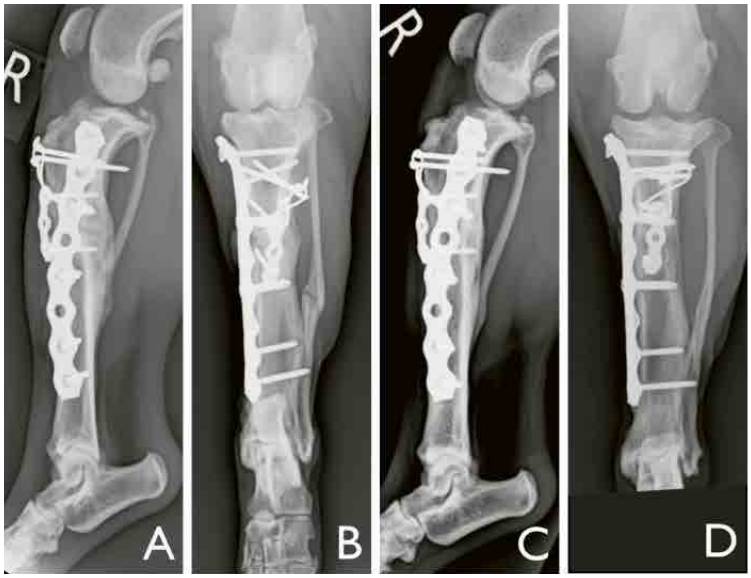

Figure 4: Recheck radiographs obtained 10 weeks (A, B) and 6 months (C, D) postoperatively. Note radiographic evidence of healing 10 weeks postoperatively (A, B) and bone remodeling at the 6 months recheck radiographs (C, D).

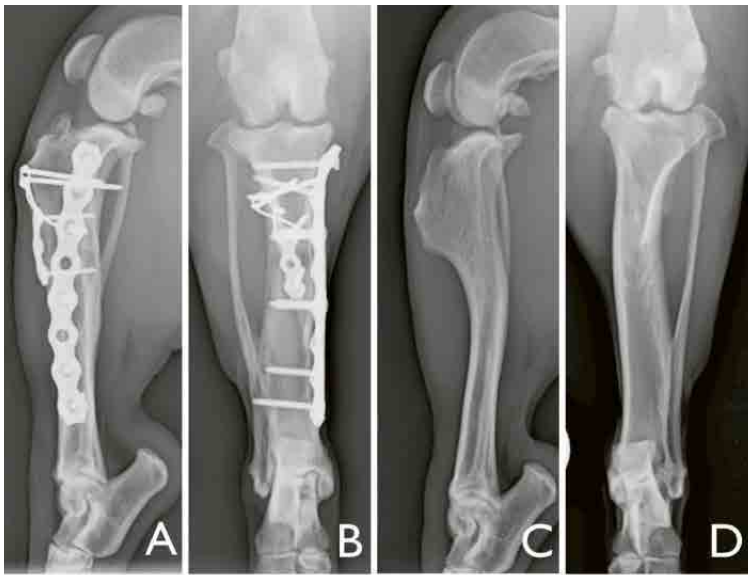

Figure 5: Recheck radiographs obtained 12 months of the operated limb (A, B) and the controlateral limb (C, D). Note radiographic evidence of complete healing of the osteotomies and no progression of the disease at the level of the controlateral limb.

Demineralized Bone Matrix (DBM) (Osteoallograft, Orthomix, Veterinary Transplant Services, USA) and autogenous cancellous bone graft collected from the tibial ostectomy wedge were placed in the osteotomy site. The surgical site was closed in standard fashion. Postoperative orthogonal radiographic views were obtained and the postoperative TPA was 15 degrees. Postoperative analgesia consisted of methadon (0.2mg/kg IV or IM q4 hours for 12 hours) followed by buprenorphine (0.02 mg/kg IV or IM q6 hours for 30 hours), tramadol (2 mg/kg PO q12 hours as required) and carprofen (4 mg/kg PO q24 hours for 7 days). Antibiotic therapy with cefalexin (22 mg/kg PO q 12 hours for 10 days) was administered.

Follow up examination

The dog was examined at 6, 10 weeks, 6 and 12 months after surgery. The postoperative radiographic recheck examination at 6 weeks after surgery revealed an unchanged position of the implants and progressive healing of the tibial and fibular osteotomies. The second postoperative radiographic recheck examination at 10 weeks after surgery revealed an unchanged position of the implants, bridging of the fibular ostectomy and tibial tuberosity transposition and callus remodelling at the level of the tibial osteotomy (Fig 4). At clinical evaluation the dog did not show evidence of lameness. At the 6 and 12 months postoperative recheck examination the dog had a normal gait and according to the owner it did not show any evidence of lameness during normal activity. The radiographs showed remodelling of the

osteotomy sites and a normal appearance of the implants. (Fig 4 and 5).

Discussion and Conclusion

In this case report we describe a tibial deformity characterized by negative TPA, tibial recurvatum and an anomaly of the tibial crest associated with patella baja and cruciate ligament injuries treated successfully with a corrective diaphyseal osteotomy. To our knowledge this is the first report of a dog with a negative TPA and proximal tibial recurvatum treated with a single diaphyseal osteotomy. We suspect that the deformity of this dog contributed to the caudal cruciate ligament injury, a rare finding in dogs without history of major trauma (Johnson and Olmstead, 1987).

Caudal cruciate ligament injury is cited as potential complication of the TPLO (Slocum et al., 1993) due to the increased strain on the caudal cruciate ligament. A cause-effect relationship between negative TPA and caudal cruciate ligament injury has been suggested by several authors based on the effect of changing TPA on stifle biomechanics (Slocum et al., 1993; Warzee et al., 2001; Demianiuk and Guiot, 2014). In this case the patella baja may have contributed to the damage to the caudal cruciate ligament during deep flexion, because of direct impingement of the patella on the origin of the caudal cruciate ligament as noted on the preoperative radiographs. The arthroscopic appearance of the cranial cruciate ligament was typical for an early partial tear, however a traumatic etiology could not be excluded. Despite the surgical correction, a mild degree of patella baja can be seen in the postoperative radiographs. We suspect that the soft tissue attachments of the patella to the femur initially prevented patella translation. The soft tissues stretched over time because the patella was in a normal position in the recheck radiographic examinations. Based on the follow up examination at 12 months the correction of the negative TPA was successful in returning the dog to normal function (Fig. 5). However, the controlateral limb, which had similar deformities, did not show lameness. One possible explanation is that the dog compensated by bearing more weight on the right side (sparing the contralateral limb). It is also possible that part of the etiology of the operated stifle may have been traumatic, rather than being related to a conformation abnormality.

Dogs with negative TPA have been previously treated with a reversed TPLO, by rotating the tibial plateau to increase the TPA rather than decrease it, as typically done with TPLO (Demianiuk and Guiot, 2014). The basis for increasing the TPA for treating a caudal cruciate ligament injury lay in the theoretical model of Slocum, which proposes that the magnitude of the cranial or caudal tibial thrust is dependent on the direction of the tibial slope (Slocum et al., 1983). In our case we selected a more distal corrective osteotomy because the center of the deformity was located in the mid-diaphysis and a reversed TPLO would have increased the TPA without correcting the recurvatum deformity. We used a similar preoperative planning method as described for the CORA-based tibial leveling osteotomy (Raske et al., 2013). After identifying the desired postoperative TPA, the CORA was defined as the intersection of the proximal and distal anatomical axis. Another possible approach would have been to use a normal chondrodystrophic tibia as a reference for the calculation of the proximal tibial axis. One of the advantages of these osteotomies is that they more accurately correct the proximal caudal tibial angulation described in several dogs with cranial cruciate ligament rupture (Osmond et al., 2006). Techniques such as the CORA-based leveling osteotomy may allow a better surgical correction than TPLO, because they take into account the proximal tibial deformity. In conclusion, we report on a novel approach to treat a tibial deformity in association with a negative TPA with a CORA-based, mid-diaphyseal opening wedge osteotomy.

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Corresponding author

Antonio Pozzi
Kleintierchirurgie
Vetsuisse-Fakultät
Universität Zürich
+41 79 585 16 95
E-Mail: apozzi@vetclinics.uzh.ch