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

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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 osteotomy 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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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, 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).

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 weighing 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-opac-ity 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 (Dis-mukes 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-opac-ity in the joint was suggestive of joint effu-sion 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 post- operative TPA of 15 degrees. The CORA was deter-mined by the intersection between the proximal and distal anatomic axes. The proximal anatomic axis was marked based on the desired postoperative angle (TPA=15 degree; 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 transposi tion 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 isoflu-rane (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-
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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 (0.02mg/kg IV or IM q6 hours for 30 hours), tramadol (2mg/kg PO q12 hours as required) and carprofen (4mg/kg PO q24 hours for 7 days). Antibiotic therapy with cefalexin (22mg/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
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; Demianiuik 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 contralateral 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 (Demianiuik 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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References


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