Complications with and owner assessment of the outcome of tibial plateau leveling osteotomy for treatment of cranial cruciate ligament rupture in dogs: 193 cases (1997–2001)

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Objective—To identify complications associated with tibial plateau leveling osteotomy (TPLO) for treatment of cranial cruciate ligament rupture in dogs and assess owner perceptions of outcome.

Design—Retrospective study.

Animals—193 dogs that underwent unilateral or bilateral TPLO (253 TPLOs total) between November 1997 and March 2001.

Procedure—Complications associated with the surgical procedure were recorded. A questionnaire was sent to owners of all dogs to assess their perceptions of outcome.

Results—Complications were identified in 47 of the 193 (24.4%) dogs and in association with 52 of the 253 (20.6%) TPLOs. Dogs that underwent bilateral TPLOs during a single anesthetic episode had a higher complication rate than did dogs that underwent unilateral TPLO and dogs that underwent bilateral TPLOs during separate anesthetic episodes. Body weight, surgery time, whether a meniscal release or meniscectomy was performed, and extent of cruciate ligament damage were not associated with whether complications occurred. One hundred forty-one of 151 (93%) owners who responded to the questionnaire were satisfied with the outcome of the surgery. Assessments of outcome were not significantly different between owners of dogs that had complications and owners of dogs that did not.

Conclusions and Clinical Relevance—Results indicated that complications developed in approximately 25% of dogs undergoing TPLO for treatment of a cranial cruciate ligament injury but that most complications responded to appropriate treatment, and development of complications did not affect owner assessments of outcome. There was a higher incidence of complications when bilateral TPLOs were performed during a single anesthetic episode. (*J Am Vet Med Assoc* 2003; 222:1726–1732)

Rupture of the **cranial cruciate ligament (CCL)** is a common problem in dogs that results in lameness and progressive secondary osteoarthritis.[1,2] In 1983, Slocum and Devine[3] proposed that cranial tibial thrust generated by weight bearing and contraction of the extensor muscles of the stifle and hock joints resulted in cranial translation of the proximal end of the tibia relative to the femur in dogs with rupture of the CCL. Subsequently, they described use of a **tibial plateau leveling osteotomy (TPLO)** to neutralize cranial tibial thrust, suggesting that this would eliminate joint instability during weight bearing in affected dogs.[4,5]

The technique for TPLO, as originally described by Slocum and Devine,[4] involved a cranially directed closing wedge osteotomy of the proximal portion of the tibia. In 1993, Slocum and Slocum[5] described a modification that involved a radial osteotomy and cranial rotation of the proximal aspect of the tibia. This technique has since been patented, and only those trained and licensed by Slocum Enterprises Incorporated can legally perform the technique. Recently, Montavon[a] described a modified method for tibial plateau leveling that involved performing a closing wedge osteotomy just caudal to the insertion of the straight patellar ligament.

Slocum and Slocum[5] have stated that the most common complications of the TPLO were related to internal fixation and involved plate breakage, screw loosening, pin migration, and wire breakage. However, neither the incidence of those complications nor the clinical outcome of patients experiencing those complications was reported. In addition, to our knowledge, no peer-reviewed studies of complications associated with TPLO or of clinical outcomes of patients that had complications have been published. The purposes of the study reported here, therefore, were to determine the incidence and type of complications attributable to TPLO in dogs with a partial or complete tear of the CCL, what factors were associated with development of these complications, and whether clinical outcome in dogs with complications was similar to outcome of dogs without. We hypothesized that dogs with complications related to a TPLO would have clinical outcomes similar to those for dogs that did not experience complications and that the incidence of complications would be the same for dogs having a unilateral TPLO, bilateral TPLOs performed during separate anesthetic episodes, and bilateral TPLOs performed during a single anesthetic episode.

Criteria for Selection of Cases

Medical records of dogs examined at the University of Missouri Veterinary Medical Teaching Hospital between November 1997 and March 2001 were reviewed. Dogs that had undergone unilateral or bilateral TPLO for treatment of CCL rupture were identified.

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Dogs were included in the study if medial parapatellar arthrotomy had been performed to allow inspection of the CCL and menisci and TPLO had been performed by a licensed individual, as described.[5] Dogs were excluded from the study if surgery of any kind had previously been performed on the affected stifle joint, if there was any history of confirmed autoimmune joint disease, or if there was any evidence of concurrent systemic disease.

Procedures

Data obtained from the medical records included signalment, duration of lameness prior to TPLO, body weight, affected limb, and whether unilateral or bilateral surgery was performed. To assess the effect of unilateral versus bilateral surgery on the incidence of complications, dogs were divided into 3 groups: unilateral TPLO, bilateral TPLOs performed during separate anesthetic episodes, and bilateral TPLOs performed during a single anesthetic episode.

All complications identified in the medical records were recorded. Perioperative complications (ie, complications that occurred at the time of surgery or prior to discharge from the hospital) were distinguished from complications that were first recognized after the dog was discharged from the hospital. Surgery time, extent of cruciate ligament damage (complete vs partial rupture), whether there was evidence of meniscal damage, and whether meniscal surgery (release or resection) was performed were also recorded. For each dog, radiographs were reviewed, and pre- and postoperative **tibial plateau angles (TPAs)** were determined in addition to the size of the saw blade used. The primary surgeon determined TPAs for each dog. In addition, measurements for all dogs were repeated by 1 of the authors (NHP). For each dog, the mean of the 2 measurements was computed and used for calculations.

A questionnaire was sent to owners of all dogs included in the study. The questionnaire asked owners about the activity level of the dog prior to lameness recognition and at the time the questionnaire was received and the severity of lameness prior to surgery and at the time the questionnaire was received. In addition, owners were asked whether they had administered any medications before or after surgery and their overall assessment of the outcome of the procedure. For each question, the respondents were given a list of responses from which to choose. The responses were subsequently tabulated and used for statistical analyses.

Statistical analyses—The χ^2 test was used to test for an association between complication rate and grouping (unilateral TPLO, bilateral TPLOs performed during separate anesthetic episodes, or bilateral TPLOs performed during a single anesthetic episode). If a significant difference was recognized among the 3 groups, pairwise post-hoc χ^2 analysis was done to determine which pairs were different. For matched data (ie, lameness before surgery vs after recovery, activity level before injury vs after recovery), a Wilcoxon signed rank test was performed. For data with a quantitative outcome (ie, body weight, surgical time, and postoperative TPA), a Wilcoxon rank sum test was performed. For all analyses, a value of $P < 0.05$ was considered significant.

Results

One hundred ninety-three dogs satisfied the criteria for inclusion in the study. Of these, 133 underwent unilateral TPLO, and 60 underwent bilateral TPLOs. Therefore, a total of 253 TPLOs were performed, including 130 TPLOs on the left hind limb and 123 TPLOs on the right hind limb. At the time of the study, 3 dogs were known to have died 8, 19, and 21 months after surgery; all 3 had died for reasons unrelated to their orthopedic conditions.

Mean ± SD age of the 193 dogs at the time of surgery was 4.7 ± 2.1 years (range, 1.1 to 11.4 years). For the 30 dogs that underwent bilateral TPLOs during separate anesthetic episodes, mean age at the time of the second surgery was 5.2 ± 2.0 years (range, 2.4 to 10.4 years).

Thirty-nine of the 193 (20.2%) dogs were of mixed breeding. The remaining 154 represented 30 breeds. The most common breeds included Labrador Retriever (n = 38; 19.7%), Rottweiler (30; 15.5%), German Shepherd Dog (12; 6.2%), and Boxer (11; 5.7%). Eighty-eight (45.6%) dogs were neutered females, 76 (39.4%) were neutered males, 21 (10.9%) were sexually intact males, and 8 (4.1%) were sexually intact females. Mean ± SD duration of lameness prior to surgery was 6.5 ± 7.2 months (range, 0 to 44 months).

Forty-seven of the 193 (24.4%) dogs experienced complications. Complications were identified in association with 52 of the 253 (20.6%) TPLOs. Sixty-six separate complications were identified in the 47 dogs that had complications (**Table 1**). Thirty-five dogs had a single complication, 8 had 2 complications each, 2 had 3 complications each, 1 had 4 complica-

Table 1—Complications associated with tibial plateau leveling osteotomy for treatment of cranial cruciate ligament injuries in 193 dogs

Complication	No. of dogs	Percentage of complications	Complication rate*
Perioperative complications			
Broken drill bit	7	10.6	3.6
Fibular neck fracture	6	9.1	3.1
Tibial fracture[a]	3	4.5	1.6
Laceration of popliteal vasculature[a]	3	4.5	1.6
Placement of screw in joint[a]	2	3.0	1.0
Placement of jig pin in joint[a]	2	3.0	1.0
Placement of screw in osteotomy	1	1.5	0.5
Gauze sponge left in surgical site[a]	1	1.5	0.5
Broken holding pin	1	1.5	0.5
Complications identified after hospital discharge			
Osteomyelitis†[a]	14	21.2	7.3
Tibial tuberosity fracture	6	9.1	3.1
Incisional infection[a]	6	9.1	3.1
Broken screw	4	6.1	2.1
Fibular neck fracture	3	4.5	1.6
Septic arthritis[a]	3	4.5	1.6
Loose screw	2	3.0	1.0
Draining tracts[a]	1	1.5	0.5
Ring sequestrum	1	1.5	0.5

*Number of dogs with complications divided by number of dogs undergoing surgery (193). †Diagnosed radiographically.
[a]Complications that were treated.

tions, and 1 had 5 complications. The most common complications were osteomyelitis (diagnosed radiographically), fracture of the fibular neck, a broken drill bit, avulsion of the tibial tuberosity, and incisional infection.

Mean ± SD weight of dogs in the study was 41.2 ± 11.7 kg (90.6 ± 25.7 lb; range, 15.6 to 82 kg [34.3 to 180.4 lb]). Body weight of dogs with complications was not significantly different from body weight of dogs without complications.

One hundred thirty-three dogs underwent unilateral TPLO, and 26 (19.5%) developed complications. Thirty dogs underwent bilateral TPLOs during separate anesthetic episodes, and 10 complications developed in relation to the 60 anesthetic episodes (16.7%). Thirty dogs underwent bilateral TPLOs during a single anesthetic episode, and 12 (40%) developed complications. Complication rates for these 3 groups were significantly (P = 0.027) different. There was no difference in complication rate between dogs undergoing unilateral TPLO and dogs undergoing bilateral TPLOs during separate anesthetic episodes. Dogs undergoing bilateral TPLOs during a single anesthetic episode had a significantly higher complication rate than did dogs undergoing unilateral TPLO (P = 0.031) and dogs undergoing bilateral TPLOs during separate anesthetic episodes (P = 0.030).

Twenty-six of the 66 (39%) complications occurred during the perioperative period (ie, during surgery or before dogs were discharged from the hospital), and 40 (61%) occurred after dogs were discharged from the hospital (Table 1). Eleven of the 26 (42%) perioperative complications were treated, and 24 of the 40 (60%) complications recognized following hospital discharge were treated.

Surgery time was documented for all dogs. Mean ± SD surgery time was 106 ± 34 minutes (range, 48 to 230 minutes). Surgery times for dogs that developed complications were not significantly different from times for dogs that did not develop complications.

Condition of the cruciate ligaments was recorded for 200 of the 253 (79.1%) stifle joints. The CCL was completely ruptured in 152 (76%) and partially ruptured in 48 (24%). There was no difference in complication rate with respect to partial or complete tearing of the CCL.

Whether medial meniscal surgery was performed was recorded for 203 (80.2%) stifle joints. In joints in which the medial meniscus was torn, the damaged portion was removed. In joints in which the medial meniscus was grossly normal, meniscal release was performed by transecting the caudal meniscotibial ligament of the medial meniscus. Medial meniscectomy was performed in 82 of 203 (40.4%) joints, and meniscal release was performed in 121 (59.6%). Type of meniscal surgery (meniscectomy vs meniscal release) was not significantly associated with whether complications developed.

Mean ± SD preoperative TPA was 26.2 ± 4.0° (range, 17.0 to 46.0°), and mean postoperative TPA was 6.5 ± 3.9° (range –7.0 to 24.0°). Mean change in TPA was 19.8 ± 4.8°. Postoperative TPA was significantly (P = 0.046) higher in dogs with complications than in dogs without complications. However, results may have been biased by inclusion of 1 dog that fell and suffered a fracture of the proximal portion of the tibia within hours after undergoing TPLO. Prior to falling, but after TPLO, the TPA was 14°. Following reconstruction of the fracture, the TPA was 24°. When this dog was removed from the analysis, there was no significant difference in postoperative TPA between dogs with and without complications.

Two hundred thirty-two of the 253 (92%) TPLOs were performed with a 24-mm saw blade, 20 (8%) were performed with a 30-mm blade, and 1 was performed with an 18-mm blade. There were not enough surgeries performed with 18- and 30-mm blades to determine whether blade size was associated with development of complications or outcome.

Owners of 151 of the 193 (78.2%) dogs completed and returned assessment questionnaires, including owners of 41 of the 47 (87%) dogs that had developed a complication associated with the TPLO. Follow-up time ranged from 6 months to 4 years. Respondents were contacted by telephone and asked whether their dogs were receiving any antiarthritis medications at the time the survey was completed. We were able to contact 111 of the 151 (73.5%) respondents by telephone.

Owners' perceptions of their dogs' activity levels before lameness recognition and at the time the questionnaire was completed were not significantly different. Eighty-seven of 151 (57.6%) owners indicated they thought their dogs had a continuous lameness prior to surgery, and 64 (42.4%) indicated they thought their dogs had an intermittent lameness. At the time the questionnaire was completed, 8 (5.3%) owners thought their dogs were continuously lame, 24 (15.9%) thought their dogs were intermittently lame, and 119 (78.8%) thought their dogs were not lame. Owner perceptions of the severity of lameness prior to surgery were significantly (P < 0.001) different from perceptions of the severity of lameness at the time questionnaires were completed.

Owner satisfaction with the outcome of the procedure was high. One hundred forty-one of 151 (93%) owners indicated they were satisfied or very satisfied with the final outcome of the procedure. Assessments of final outcomes were not significantly different between owners of dogs that had complications and owners of dogs that did not.

Thirty-three of 111 (30%) owners who responded to the telephone survey reported that their dogs were regularly taking antiarthritis medications at that time. Antiarthritis medications administered after surgery included carprofen, etodolac, aspirin, ibuprofen, acetaminophen, glucosamine-chondroitin sulfate,[b] green-lipped mussel extract,[c] and polysulfated glycosaminoglycans.[d] Owner assessments of final outcome were not significantly different between dogs receiving antiarthritis medications at the time of the study and dogs that were not.

Discussion

Results of the present study indicated that complications developed in approximately 25% of dogs undergoing TPLO for surgical treatment of a CCL

injury. However, most of these complications responded to appropriate treatment, and development of complications did not appear to affect owners' assessment of the outcome of the procedure. The complication rate was higher when bilateral TPLOs were performed during a single anesthetic episode.

Few reports of complications associated with other methods for surgical management of CCL injuries in dogs have been published, making it difficult to compare complication rate for dogs in the present study that underwent TPLO with complication rates for dogs undergoing other procedures. In a study[6] of 80 dogs undergoing fibular head transposition, complications included iatrogenic fracture of the fibular head (12.5%), tearing of the lateral collateral ligament (2.5%), persistent cranial drawer motion (6%), and seroma formation (10.7%). In a separate study, Dupuis et al[7] reported a 16.7% complication rate in an experimental evaluation of fibular head transposition. Complications included fibular head fracture, fibular neck fracture, and poor placement of the holding pin. According to Vasseur,[8] infections occur in 1 to 2% of dogs following extracapsular stabilization. In 2 consecutive studies, Dulisch[9,10] reported 18 and 21% incidences of suture reactions associated with extra-articular stabilization when gas-sterilized, multifilament, polyamide suture with a smooth coating was used. In 1 of these studies, Dulisch[10] reported that *Staphylococcus aureus* was isolated from 67% of dogs with suture-related complications. Complications identified in the present study were all recognized at the time of or within 8 weeks after surgery and should, therefore, be considered short-term complications.

For dogs included in the present study, TPLOs were performed by multiple individuals with a wide range of surgical experience, even though all surgeons who performed the procedure had been licensed. The surgeons with the least amount of surgical experience were second-year surgery residents; the surgeon with the most experience had been board-certified for more than 15 years. Because the University of Missouri is a teaching institution, a senior faculty member participated in most cases in this study. As such, it was not possible to determine complication rates related to individual surgeons.

Tibial plateau leveling osteotomy for the treatment of CCL injuries is a technically demanding procedure. Because of the nature of the procedure, the potential for complications is high. Complications reported previously were related to the surgical implants[5] and included plate breakage, screw loosening, pin migration, and wire breakage. In the present study, plate breakage, pin migration, and wire breakage were not recognized. Other complications reported in a study[e] of 75 dogs included infection around the bone plate, fracture of the tibial tuberosity, patellar fractures, screw-related seroma formation, and incisional seroma formation. Findings in the present study suggest that complication rate associated with TPLO is higher than rates reported for other techniques used for surgical management of CCL injuries in dogs. However, direct comparisons of complication rates for the various surgical techniques are not possible because of differences in study designs and reporting of data.

In the present study, the duration of lameness prior to surgery ranged from 0 to 44 months (mean, 6.5 months). This wide variation was likely attributable to many factors. Dogs with acute traumatic rupture of the CCL were likely to be examined shortly after the injury, whereas dogs with chronic deterioration of the CCL and slowly developing osteoarthritis were likely to be examined months or years after the onset of a low-grade lameness. Frequently, the onset of lameness and owner recognition of the lameness were not the same, as evidenced by severe muscle atrophy and a palpable medial buttress in dogs whose owners reported an acute onset of lameness. In addition, the duration of lameness prior to surgery was probably falsely increased, because there was a 3-month waiting period for elective appointments with the Orthopedic Surgery Service at the University of Missouri at the time dogs included in this study underwent surgery.

Clinically, the most important complications encountered in the present study were fracture of the proximal tibial fragment shortly after surgery (3 dogs) and septic arthritis (3 dogs). The fractures occurred when these patients inadvertently fell during the perioperative period. In all 3 dogs, tibial fracture repair was performed, and fractures went on to heal. However, reconstruction in 1 dog resulted in a TPA that was greater than ideal (24°). Regardless, owners of all 3 dogs were pleased with the final outcomes. In the 3 dogs with septic arthritis, treatment consisted of joint lavage and administration of antimicrobial drugs chosen on the basis of results of bacterial culture and susceptibility testing. Treatment was successful in all 3 dogs, and owners were satisfied with the final outcome.

Six dogs had minimally displaced avulsions or fractures of the tibial tuberosity in this study. In each case, the fracture was identified at the time of the first recheck examination 6 to 8 weeks after surgery. In all 6 dogs, the fracture healed without specific treatment. Tibial tuberosity avulsion fractures were seen with greater frequency when the surgery service at the University of Missouri was just beginning to perform this procedure. At that time, a temporary stabilization pin was being placed just distal to the attachment of the straight patellar ligament. The technique has since been altered, and the temporary stabilization pin is currently placed just proximal to the insertion of the straight patellar ligament. In addition, care is taken to avoid making the tibial osteotomy too far cranially. This adjustment maximizes the bone supporting the tibial tuberosity and presumably decreases the probability of a tibial tuberosity avulsion.

Fracture of the fibular neck was seen in 9 dogs in this study. In 6 of those dogs, the fracture was noticed on postoperative radiographs. In the remaining 3, it was an incidental finding on follow-up radiographs obtained 6 to 8 weeks after surgery. Rotation of the tibial plateau places stress on the proximal portion of the fibula, increasing the risk of fracture. This complication was not problematic in any of the dogs in which it was recognized, and no attempt was made to treat it.

The single most common complication recognized in this study was osteomyelitis. In all instances, the

diagnosis was made on the basis of radiographs interpreted by a board-certified veterinary radiologist. Because the radiographic diagnosis of osteomyelitis was not confirmed with results of bacterial culture, whether the osteomyelitis was of bacterial origin was not definitively established. In all of these dogs, the attending clinician elected to treat the patient with cephalexin or amoxicillin-clavulanic acid at recommended dosages, and all dogs responded to this treatment. The effect of radiographic diagnosis of osteomyelitis on the overall incidence of complications was minimal, in that most dogs with radiographic evidence of osteomyelitis had an additional complication. If dogs with radiographic evidence of osteomyelitis as a sole complication (n = 6) were deleted, the overall complication rate would have been 21.2% (41/193). Interestingly, 6 of the 14 dogs with radiographic evidence of osteomyelitis had undergone bilateral TPLOs during a single anesthetic episode, and 4 of these dogs had multiple complications.

Implant-related complications (20/66) were broken drill bits, broken screws, intra-articular placement of screws and jig pins, screw loosening, development of a draining tract associated with the metallic implants, placement of a screw across the osteotomy, and a broken holding pin. Of these, inadvertent intra-articular placement of screws and jig pins were potentially the most serious. In the 2 dogs in which intra-articular placement of screws was recognized on postoperative radiographs, the dogs were immediately returned to surgery, and the screws were removed and replaced with appropriately directed screws. Owners of 3 of the 4 dogs with intra-articular placement of screws or jig pins responded to the survey, and all 3 indicated that they were very satisfied with the final outcome of the surgery. In the 2 dogs in which loose screws were evident on recheck radiographs, the dogs did not have any clinical signs, and the owners elected not to have the screws removed. The dog with the draining tract was treated successfully with implant removal following union of the osteotomy. The broken drill bits were not retrieved, nor was the broken holding pin. Anecdotally, some surgeons performing this procedure elect to leave the temporary holding pin in place in an effort to maintain 1 more point of fixation between the proximal and distal tibial fragments. This practice has not been evaluated to determine whether it affects final outcome.

The popliteal vasculature was inadvertently lacerated during surgery in 3 dogs in the present study. This occurred when the soft tissues were being elevated from the caudal aspect of the proximal portion of the tibia. It was not possible to determine whether the popliteal artery, popliteal vein, or branches of those vessels were damaged. In our experience, this complication was less likely if care was taken not to stray into the soft tissues while elevating them from the proximal portion of the tibia. The preferred technique for occlusion of the bleeding vessel was application of hemostatic clips.[f] In all 3 dogs, the bleeding was controlled, although multiple attempts at hemostatic clip placement were invariably necessary.

In 1 dog in this study, a gauze sponge used to protect the soft tissues while the osteotomy was being performed was inadvertently left in the surgery site. The sponge was seen on postoperative radiographs, and the dog was immediately returned to surgery where the sponge was removed without incident. This case underscores the importance of accurate sponge counts or use of radiopaque sponges during this procedure.

A ring sequestrum developed where the distal jig pin was placed in 1 dog. This most likely occurred because of drilling at high speed while applying great force on the drill. The combination of high speed and pressure generates excessive heat that will damage bone, leading to necrosis.[11]

The recommended recovery time following a TPLO is at least 4 months[5] and is determined by the rate of bone healing. Performing bilateral TPLOs during a single anesthetic episode minimizes total recovery time in patients with bilateral rupture of the CCL. However, in the present study, the complication rate was higher in dogs that had bilateral TPLOs performed during a single anesthetic episode. The greater surgery time associated with performing bilateral TPLOs during a single anesthetic episode may help explain this higher complication rate. However, surgery times for dogs that developed complications were not significantly different from times for dogs that did not develop complications. Ideally, it would be preferable to protect the operated leg in the short term by transferring weight off of it. Depending on the size and temperament of the patient, it can be difficult for some owners to support their pets with slings. Dogs are also likely to be unstable on their hind limbs following bilateral TPLOs because of pain. Further, bilateral TPLOs will inherently force earlier weight bearing on the operated limbs after surgery. It is logical, therefore, that more complications would be seen when bilateral TPLOs are performed during a single anesthetic episode. Because of the higher complication rate, we do not recommend performing bilateral TPLOs during a single anesthetic episode.

Those complications that occurred in the perioperative period were in general more technical in nature, whereas those that occurred following discharge from the hospital appeared to be related to infection or excessive activity on the part of the patient. Attention to detail and surgical technique will minimize the perioperative complication rate. Strict adherence to proper sterile technique during surgery and appropriate incision care after surgery will minimize the rate of infection-related complications. Owner education will reduce complications associated with excessive activity on the part of the dogs.

In the present study, surgery times for dogs that developed complications were not significantly different from times for dogs that did not develop complications. However, previous studies[12,13] have shown that shorter anesthesia and surgery times are associated with a lower infection rate.

In the present study, the extent of CCL damage (complete vs partial rupture) was not significantly associated with whether complications developed. In our hospital, the typical practice is to resect the entire CCL, even in dogs with only partial rupture. However,

exceptions are made, and the decision is left to the discretion of the primary surgeon.

Meniscal release has been recommended for dogs with a grossly normal medial meniscus[14] to prevent the caudal horn of the medial meniscus from being crushed between the medial femoral condyle and the medial aspect of the tibial plateau following TPLO. However, no studies of the benefits of this procedure have been published, and meniscal release could possibly result in some joint instability.[15] Thus, studies are warranted on the effect of meniscal release in dogs undergoing a TPLO.

Mean preoperative TPA in this study was 26.2°. In a previous study,[16] dogs with CCL rupture had a mean TPA of 23.8°, and dogs without CCL rupture had a mean TPA of 18.1°. In a separate study,[17] mean TPA in 156 stifle joints with CCL rupture was 23.3°, and the intraobserver variability in TPA measurement was ± 3.4°. In a study[g] of 15 dogs with CCL injuries, mean TPA was 30° but ranged from 23 to 36°. Together, these results would seem to support the theory that a higher TPA may be a factor in CCL rupture.

The range of postoperative TPAs in the present study was wide. It has been reported that cranial tibial thrust is converted to caudal tibial thrust as the TPA is decreased,[18,19] and the minimum TPA needed to eliminate cranial tibial thrust has been reported to be 6.5 ± 0.9° less than the angle needed to level the tibial plateau.[18] Slocum and Devine[14] recommended rotating the tibial plateau to the point at which it would be level, suggesting that if the proximal aspect of the tibia is over-rotated, increased stress would be placed on the caudal cruciate ligament, possibly leading to rupture and lameness. None of the dogs in the present study were reported to develop a caudal cruciate ligament rupture, including the dog with a postoperative TPA of –7°. This would suggest that dogs may be able to compensate for TPAs that are not ideal. However, further controlled studies are needed.

Findings in this study pertain to larger dogs in which the TPLO is performed with a 24-mm osteotomy blade. Further studies are warranted to evaluate complications associated with and outcomes of TPLO performed with the other osteotomy blade sizes.

It is difficult to make strong conclusions regarding surgical outcome on the basis of data provided by owners, because few are able to distinguish the various grades of lameness. In a previous study,[20] a significant difference was found between owner perceptions of degree of lameness and results of force plate analyses performed on dogs that underwent an intracapsular technique for treatment of CCL rupture. However, owner assessments do have some value. In 1 study,[21] for instance, it was concluded that owner assessments could be useful for estimating functional outcome following treatment of CCL injury but should not be used to replace assessments made by veterinary surgeons. In the present study, owners reported that activity levels of their dogs at the time of questionnaire completion were not significantly different from activity levels before lameness recognition. However, many factors may influence owners' satisfaction with a surgical procedure, including the owner's relationship with the attending clinician or student, the expense of the procedure and a lack of willingness to admit that a large sum of money was spent on something that did not work, loyalty to the university, degree of stoicism of the dog, and level of activity of the dog. In the present study, we were unable to obtain objective assessments of limb use, such as force-plate analyses and kinematic gait evaluations.[22-24] Therefore, our findings must be interpreted in light of this lack of objective data.

In this study, only those dogs that had undergone TPLO at least 6 months previously were included. The longest follow-up time was 4 years, and the shortest was 9 months. In a study[5] of 394 dogs that underwent TPLOs using 1 of 2 surgical techniques, 50% of which were available for follow-up evaluations 6 months to 8 years after surgery, outcome was reported to be excellent for 73%, good for 21%, and fair for 3%. The procedure was reported to have failed in 2%. Long-term assessments are warranted on larger numbers of dogs to determine the overall success of the procedure and whether long-term sequelae are related to any complications. However, results of this and a previous study[5] suggest that TPLO is a useful treatment for dogs with CCL rupture.

The complication rate in this study was higher than rates reported for other surgical techniques used for treatment of CCL rupture.[6-8] Results of the present study suggest that most complications that do occur with TPLO will respond to appropriate treatment. Even so, veterinarians should be mindful of those complications before performing this procedure and should be prepared to manage them appropriately. Owner satisfaction and perception of outcome are high with this procedure.

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[c]Glyco-Flex, Vetri-Science Laboratories, Essex Junction, Vt.
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