

Eight-week postoperative tibial plateau leveling osteotomy radiographs do not change the prescribed management plan for most dogs

Courtney L. Hancock, DVM¹; Steven W. Frederick, AS, LVT, VTS^{2*} ; Sarah K. Israel, DVM, DACVS¹

¹Small Animal Medicine and Surgery, BluePearl Pet Hospital, Stone Oak, TX

²Medical Affairs, Mars Veterinary Health, Vancouver, WA

*Corresponding author: Steven W. Frederick (steven.frederick@effem.com)

Objective

To determine how frequently routine 8-week tibial plateau leveling osteotomy (TPLO) radiographs resulted in a change to the prescribed postoperative management plan when evaluated by surgery residents versus senior clinicians, and how often the resident and senior clinician plans differed.

Methods

In this prospective interobserver agreement study, dogs that presented for a routine 8-week TPLO evaluation at a single veterinary referral hospital between October 2024 and July 2025 were eligible for enrollment. Three evaluators (2 senior clinicians, 1 surgical resident) independently performed physical examinations (PEs) and later reviewed each dog's radiographic evaluation (RE). After each PE and RE, each evaluator documented their findings and management decision on standard forms. A Cohen κ score was used to evaluate interrater reliability for PE and RE management choice.

Results

97 dogs (291 evaluations) were enrolled. Corresponding PE and RE recommendations were consistent in most cases (173 [59.5%]). The elected case management plans after each evaluation differed more often for senior clinicians (45.4%) than residents (30.5%). Interrater reliability for overall, PE, and RE prescribed management plans were fair ($\kappa = 0.2233$), fair ($\kappa = 0.2252$), and slight ($\kappa = 0.1965$), respectively. Patellar desmitis (99 [34.2%]) was the most common radiographic finding, but rarely resulted in a different management plan (18 [18.2%]).

Conclusions

Management plans based on PE and RE evaluations were inconsistent, with REs resulting in prolonged exercise restriction in up to 40.5% of dogs.

Clinical Relevance

Clinicians should weigh the costs and risks associated with routine radiographs against their anticipated protocol changes until practical guidance about the clinical impact of common radiographic findings is available.

Keywords: TPLO, routine radiographs, training level, ALARA, experience

Cranial cruciate ligament disease is a common cause of pelvic limb lameness in dogs, and it is commonly treated with the tibial plateau leveling osteotomy (TPLO) procedure.¹ Short-term postoperative care following TPLO minimally includes a combination of exercise restriction and periodic in-person evaluations with the operating surgeon to monitor recovery progress, with radiographic evaluation of the stifle and osteotomy site performed after 6 to 12 postoperative weeks.^{2–4} Yet, owing to the financial

costs and potential unnecessary exposure to ionizing radiation associated with routine radiographic evaluations in cases that are presented for routine (not “for-cause”) evaluations, the inclusion of periodic TPLO radiographs solely for monitoring have been questioned in recent years.^{5,6}

Olivencia et al⁵ and Alexander et al⁶ retrospectively found that postoperative TPLO radiographs performed solely as a matter of policy (not “for cause”) rarely resulted in the surgeon recommending a change to the dog's prescribed postoperative management plan. However, the cases evaluated for those studies were all operated and managed by senior surgeons with vast experience with the TPLO procedure. It is unclear to what extent the evaluator's experience with the TPLO procedure impacts

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evaluator confidence in assessing the dog's recovery solely with an orthopedic examination and whether less experienced evaluators rely more heavily on the more robust information provided by radiographic evaluation of the surgical site.

The objective of this prospective study was to determine how frequently the findings on routine (not "for cause") postoperative stifle radiographs performed 8 weeks after TPLO resulted in a change to the prescribed postoperative management plan when evaluated by a surgery resident versus a senior clinician. Our second objective was to determine how often the prescribed postoperative management recommendations made by evaluators from the surgical resident group and the senior clinician group differed. We hypothesized that the prescribed postoperative management plans based solely on the results of the orthopedic examination or radiographic evaluation would differ in < 5% of cases, consistent with the findings reported by Alexander et al.⁶ Our second hypothesis was that the prescribed postoperative management plan would not differ between senior clinicians and surgery residents.

Methods

This study was reviewed by the BluePearl Science Veterinary Clinical Studies Committee prior to case enrollment, and the study was approved to begin enrollment on October 9, 2024. Written client consent was obtained for all dogs that were enrolled.

Client-owned, skeletally mature dogs that were presented to a single veterinary referral hospital for routine (not "for-cause") 8-week (56 ± 7 days) TPLO evaluation between October 9, 2024, and July 31, 2025, were eligible for enrollment. All TPLOs were performed by a senior clinician with at least 5 years of postresidency experience with TPLO, and all osteotomies were stabilized with locking TPLO implants from Arthrex Inc or Synthes (DePuy Synthes traditional TPLO plate; Johnson & Johnson MedTech). Dogs were ineligible for enrollment if they were presented "for cause" at any time between the TPLO procedure and the 8-week evaluation or if the dog had a grade 3/5 to 5/5 lameness or overt findings consistent with major complications during the 8-week orthopedic examination (**Table 1**).⁷

Table 1—A scale used by senior clinicians with orthopedic surgery experience or surgical residents to grade canine pelvic limb lameness following tibial plateau leveling osteotomy procedures in dogs.

Grade	Description
0	No lameness under any conditions
1	Subtle lameness or lameness seen only in specific conditions
2	Mild, consistent lameness under all conditions
3	Moderate consistent lameness
4	Severe, toe-touching lameness
5	Non-weight-bearing lameness

Standard prescribed management plan and evaluation protocol

All clinicians in the hospital's surgery department prescribed the same postoperative management plan immediately following the TPLO procedure. Clients were recommended to restrict the dog's activity in the house, with no access to furniture or stairs, and outdoor activity was limited to leash walks of a 5-minute duration per walk for the first 2 weeks, with walk duration increased by 5 minutes per walk for each additional week. In-person recheck evaluations were required after 2 and 8 postoperative weeks. The 2-week evaluation consisted of an orthopedic examination and incision evaluation with suture removal. The 8-week evaluation consisted of an orthopedic examination and orthogonal stifle radiographs performed under sedation (dexmedetomidine, 5 to 8 $\mu\text{g}/\text{kg}$, IV; butorphanol, 0.1 to 0.2 mg/kg , IV).

All dogs were evaluated by the surgeon who performed the TPLO at all time points, and the actual management of the case was unrelated to the simulated decision-making related to this study.

Study-specific protocol

Clinical evaluations were completed by the operating clinician prior to study evaluations being performed by different evaluators. Study evaluations were performed by 5 senior clinicians (4 board-certified surgeons and 1 resident trained in surgery) with at least 5 postresidency years of experience with TPLO and 3 surgery residents (1 first-year, 1 second-year, and 1 third-year resident) participated in this study as evaluators. Approximately 300 TPLOs were performed annually at the study hospital in the 5 years preceding and including the enrollment period.

At the scheduled 8-week postoperative evaluation, each dog received 3 independent orthopedic examinations performed by the 2 senior clinicians (including the operating clinician) and 1 resident from within the pool of evaluators. After each evaluator's orthopedic examination, the evaluator filled out a standardized orthopedic examination form with a lameness grade (out of 5), any client-verbalized concerns about the dog's recovery, and a binary choice between proceeding with the standard postoperative management plan and adjusting the prescribed management plan (**Table 1**; **Supplementary Material S1**). Once all 3 orthopedic examinations were performed, orthopedic stifle radiographs were performed as previously described, and the dog was discharged with the management plan prescribed by the primary surgeon on the case (unrelated to the study evaluations).

Once the study enrollment window had finished, the same 3 evaluators who performed the orthopedic examinations independently reviewed the stifle radiographs for each dog. While reviewing the projections, each evaluator filled out a standardized radiographic evaluation form with details about which implant type (Arthrex vs Synthes) was used, radiographic abnormalities (eg, patellar desmitis, suspected surgical site infection), and the evaluator's prescribed management plan based solely on the

radiographic findings, without consideration for the recommendation made after the orthopedic examination (**Supplementary Material S2**). The evaluators were asked to choose 1 of 4 management plans: (1) return to normal activity over the next 2 weeks; (2) 2 more weeks of controlled walks prior to proceeding to option 1; (3) 2 weeks of full activity restriction prior to proceeding to option 2; and (4) full exercise restriction until the dog returned for an additional in-person evaluation in the future.

Statistical analysis

Statistical analyses were performed with Stata SE, version 19.0 (StataCorp LLC). Numerical data were assessed for a normal distribution with the Shapiro-Wilk test. Parametrically distributed numerical data were summarized as mean $\pm$ SD, frequencies of categorical data were counted and presented as proportions (%), and 95% CIs for proportions were calculated on the basis of binomial frequency distributions. Observed frequency distributions were compared between variables with the χ^2 test of independence. Interrater reliability for physical examination and radiograph recovery plan recommendations was evaluated with the Cohen κ test, with cutoffs or groupings for κ scores defined as below 0 (poor), 0.0 to 0.2 (slight), 0.21 to 0.40 (fair), 0.42 to 0.60 (moderate), 0.61 to 0.80 (substantial), and 0.81 to 1.00 (almost perfect). A P value of $< .05$ was considered statistically significant.

Results

Ninety-seven dogs were enrolled. There were 35 mixed-breed dogs, 14 Labrador Retrievers, 4 Boxers, 4 German Shepherd Dogs, 3 American Pitbull Terriers, 3 Australian Shepherds, 3 Cane Corsi, 4 breeds each with 2 dogs, and 23 other breeds with 1 dog each. The mean $\pm$ SD age was 6.9 ± 2.8 years, and mean weight was 30.4 ± 12.3 kg. Spayed female dogs were most common (57 of 97 [58.8%]), followed by neutered male dogs (31 of 97 [32.0%]). There were 6 intact female and 4 intact male dogs.

Five senior clinicians performed the TPLO procedures, impacting 15.5% to 23.7% of the dogs each. Fifty-seven dogs (58.8%) were treated with Synthes implants, and 40 dogs (41.2%) were treated with Arthrex implants. All dogs were given lameness grades of 0/5 to 2/5 by the operating clinician; however, 14 dogs (4.8%) were graded 3/5 by evaluators on their orthopedic examination form (**Table 2**).

Table 2—Conglomerate canine pelvic limb lameness grading by 3 evaluators 8 weeks after tibial plateau leveling osteotomy using the scale in Table 1.

Lameness grade	No. (%) of dogs
0	34 (11.7)
1	144 (49.5)
2	99 (34.0)
3	14 (4.8)
4	0 (0)
5	0 (0)

Based on orthopedic examination findings, evaluators recommended a gradual return to exercise over a 2- to 4-week period in 243 cases (83.5%) or activity restriction for 2 additional weeks before gradual return to exercise over a 2- to 4-week period in the remaining 48 cases (16.5%). On the basis of radiographic evaluation findings, evaluators recommended a gradual return to exercise over a 2- to 4-week period in 212 cases (72.8%), activity restriction for 2 additional weeks before gradual return to exercise over a 2- to 4-week period in 61 cases (21%), and exercise restriction until another in-person evaluation could be performed in 18 cases (6.2%). When the corresponding orthopedic and radiographic evaluation forms for each evaluator were reviewed, the prescribed management plan was consistent in most cases (59.5% [173 of 291]); however, evaluators elected a more restrictive postoperative management plan based on the radiographic evaluation in the remaining 118 cases (40.5%).

Interrater reliability for the overall prescribed postoperative management plan election for each dog was fair ($\kappa = 0.2233$; $P < .001$). Interrater reliability for the prescribed postoperative management plan recommendation based on each evaluator's physical examination findings was fair ($\kappa = 0.2252$; $P < .001$). Interrater reliability for the prescribed postoperative management plan based on each evaluator's radiographic evaluation interpretation was slight ($\kappa = 0.1965$; $P < .001$).

Senior clinicians were more likely to prescribe different management plans based on their orthopedic and radiographic evaluations than surgery residents (45.4%; 95% CI, 38.3% to 52.7%; vs 30.5%; 95% CI, 21.5% to 40.8%, respectively; $P = .015$). The likelihood of prescribing a different management plan differed between the 5 individuals within the senior clinician group (27.5% to 65.4%; $P = .003$) and between the 3 individuals within the resident group (18.2% to 70.0%; $P = .016$), as well. There was no difference between the 2 implant types in either an overall management plan prescription (40.4% vs 40.8%; $P = .934$) or by the number of evaluators (0, 1, 2, or 3) prescribing a different plan ($P = .736$).

Radiographic diagnoses and their influence on the prescribed management plan were inconsistent across evaluators. Patellar desmitis was documented in 34.2% (99 of 291) of cases, but the prescribed management plan based on the radiographic evaluation was only different from the plan based on the orthopedic examination in 18.2% (18 of 99) of the cases in which desmitis was documented. Subjective delayed radiographic osteotomy healing was documented in 13.1% (38 of 291) of cases, and prolonged exercise restriction was prescribed in 31 of the cases (81.6%). In 6 of the cases with subjective delayed radiographic osteotomy healing, there was no change in the exercise plan, and a single case was prescribed strict cage rest with an additional in-person evaluation prior to return to activity. Fractures of the fibula (1.2% [4 of 291]) and the distal pole of the patella (1.2% [4 of 291]) were rarely and inconsistently documented, but when they were documented on

the radiographic evaluation form, prolonged exercise restriction was prescribed in all cases. Lucency around the screw tracks was documented on 3 radiographic evaluation forms (1.0%), and on all 3 forms, prolonged exercise restriction with an additional in-person physical evaluation after 4 weeks was recommended, though empiric antibiotics were not recommended by the evaluators in any of these cases.

Discussion

Routine monitoring of canine high tibial osteotomy recovery includes physical examination and radiographs after 6 to 8 postoperative weeks.²⁻⁴ However, retrospective data suggest that the radiographic findings for dogs without concerning history or orthopedic examination findings were impactful in only 2% to 4.15% of cases.^{5,6} In this study, prospective comparison of the clinical decision-making process when utilizing either physical examination or radiographic evaluation findings in a population of TPLO dogs presented for routine monitoring evaluations resulted in different recovery plan recommendations in 10.7% to 40.5% of the total cases depending on the evaluator, which was greater than the predicted 5% threshold. We failed to accept our first hypothesis. Additionally, while the recovery plan recommendations based on radiographic evaluation were inconsistent across our population, the evaluator with the least recommended changes recommended change in 2 and 5 times more cases than reported by Alexander et al⁶ and Olivencia et al,⁵ respectively.

In human medicine, the phenomenon of “over-testing,” which describes the practice of performing tests because they exist rather than because they’re needed, has been reported.⁸ Over-testing can result in waste of finite health resources, and avoidance of radiographic over-testing is supported by researchers who have demonstrated the low effect of follow-up radiographic evaluation on treatment plans after certain fracture repairs.⁹ While Alexander et al⁶ and Olivencia et al⁵ provide evidence supportive of that stance, our study aimed to validate it through a prospective assessment that controlled aspects lacking in their study designs. Despite our failure to reject our first hypothesis, evaluation of the radiographic studies inconsistently resulted in a different prescribed postoperative management plan than the one prescribed following the orthopedic examination. This inconsistency suggests that interpretation of routine TPLO monitoring radiographs is subjective and that the utility of routine radiographic evaluations following TPLO should be performed on a case-by-case basis at the clinician’s discretion to limit costs and medical risks associated with over-testing.

Olivencia et al⁵ and Alexander et al⁶ speculated that board-certified surgeons with extensive experience managing postoperative TPLO cases might be more confident assessing recovery solely with physical examination than less experienced practitioners, skewing their retrospective results. In this prospective study, both highly experienced clinicians and surgical residents were included as masked evaluators. It was presumed that the resident group’s recommendations

would closely reflect the senior clinicians, as the senior clinicians are instrumental in the teaching and development of the residents’ clinical and decision-making skills. However, senior clinicians were unexpectedly more likely to recommend prescription of a more conservative postoperative management plan based on radiographic review than the residents; thus, we were unable to accept our second hypothesis. These differences could be attributed to inconsistencies in surgical training, clinical experience, hubris, or differing opinions.

The prescribed management plan decisions made by the evaluators at each stage of this study were largely inconsistent, suggesting that, regardless of experience level, subjective interpretation of both the orthopedic and radiographic evaluation findings by the individual evaluator plays an important part in the prescribed postoperative management of TPLO dogs. This finding was corroborated by Olivencia et al⁵ when multiple dogs diagnosed with radiographic patellar desmitis by the same board-certified surgeon evaluator were treated differently. This inconsistency and evidence of subjective influence in decision-making suggests that additional evidence-driven guidance about optimal postoperative recovery staging is needed. Unfortunately, owing to the study’s design and temporal limitations of a residency program, the clinical outcomes of the dogs beyond the final study evaluation point were not tracked and the “correct” decision for each case is unknown, so further prospective studies are needed to establish best practices.

Radiographic patellar desmitis is identified on 6- to 8-week postoperative imaging in 31% to 80% of TPLO dogs.^{5,10} That finding was supported by the dogs in our study, as patellar desmitis was the most reported radiographic abnormality from both the senior clinician and resident groups. However, the clinical relevance of the presence of radiographic patellar desmitis remains unclear, since neither palpable swelling of the patellar ligament nor increased lameness were noted by any evaluators on the corresponding orthopedic examination forms. Despite that inconsistency, members of the senior clinician group were more likely than evaluators from the resident group to document that they would prescribe a more restricted postoperative management plan when radiographic desmitis was identified. Additionally, while the prescribed postoperative management plan changed because of radiographic patellar desmitis in some cases, the changes associated with the diagnosis were limited to lengthening the duration of exercise restriction. Since the dogs did not have clinical signs associated with the desmitis and no treatment such as extracorporeal shock wave therapy was recommended, it is unclear whether the presence of radiographic patellar desmitis warranted a change to the prescribed recovery plan in those dogs.¹⁰

Postoperative radiographs have been attributed to major financial costs in human studies.⁹ In veterinary medicine, this practice, driven by tradition, impacts animals, humans, and the hospital. The As Low As Reasonably Achievable (ie, ALARA) principle is

the cornerstone of radiation safety, proposed by the US Nuclear Regulatory Commission.¹¹ An increased awareness of radiation exposure to veterinary personnel has continued to push the “hands-free” radiography movement across US veterinary hospitals. While the care and welfare of animals remain the utmost priorities, the fiscal and physical impacts to veterinary businesses associated with this practice are apparent. To avoid unnecessary strain on veterinary hospitals, the continuance of practicing optimized care backed by evidence-based medicine is essential. Clinicians should consider these risk factors to make an appropriate risk-benefit analysis to justify performing routine radiographic evaluations for TPLO dogs that are otherwise clinically recovering as expected.

This study aimed to address potential blind spots in the existing evidence regarding the utility of routine radiographic evaluations in postoperative TPLO dogs by prospectively controlling for potential confounders like training and experience levels among the evaluators and collection of data related to the reasoning behind recovery decision-making. While the study's goals were accomplished, the study was isolated to a single hospital with a small number of evaluators within each group, representing a limitation. It is possible that inclusion of multiple enrollment sites across a variety of hospital types (eg, academic vs private practice) might have changed the results and conclusions of this study.

In conclusion, despite the unexpectedly high number of dogs that had their theoretical postoperative management plans changed after evaluators reviewed the 8-week radiographs, nearly all the prescribed changes were limited to extended activity restriction. Since radiographs inherently create added cost and risks associated with sedation and exposure to ionizing radiation, clinicians should weigh those costs and risks against what they plan to do in response to potential radiographic findings until objective evidence about the clinical significance of common radiographic abnormalities (eg, patellar desmitis) is better understood.

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ORCID

Steven W. Frederick  <https://orcid.org/0000-0003-4606-3632>

References

1. von Pfeil DJF, Kowaleski MP, Glassman M, Dejardin LM. Results of a survey of Veterinary Orthopedic Society members on the preferred method for treating cranial cruciate ligament rupture in dogs weighing more than 15 kilograms (33 pounds). *J Am Vet Med Assoc*. 2018;253(5):586–597. doi:10.2460/javma.253.5.586
2. Bergh MS, Peirone B. Complications of tibial plateau levelling osteotomy in dogs. *Vet Comp Orthop Traumatol*. 2012;25(5):349–358. doi:10.3415/VCOT-11-09-0122
3. Gatineau M, Dupuis J, Planté J, Moreau M. Retrospective study of 476 tibial plateau levelling osteotomy procedures: rate of subsequent ‘pivot shift’, meniscal tear and other complications. *Vet Comp Orthop Traumatol*. 2011;24(5):333–341. doi:10.3415/VCOT-10-07-0109
4. Pacchiana PD, Morris E, Gillings SL, Jessen CR, Lipowitz AJ. Surgical and postoperative complications associated with tibial plateau leveling osteotomy in dogs with cranial cruciate ligament rupture: 397 cases (1998–2001). *J Am Vet Med Assoc*. 2003;222(2):184–193. doi:10.2460/javma.2003.222.184
5. Olivencia-Morell PJ, Frederick SW, Forbes JN, Cross AR. Evaluation of the clinical value of routine radiographic examination during convalescence for tibial plateau-leveling osteotomy. *Vet Surg*. 2021;50(8):1644–1649. doi:10.1111/vsu.13726
6. Alexander A, Compagnone K, Grierson J, et al. Influence of radiographic examination findings on recommendations made during routine clinical re-evaluation of dogs with uncomplicated tibial plateau leveling osteotomy. *Vet Surg*. 2021;50(1):44–52. doi:10.1111/vsu.13533
7. Cook JL, Evans R, Conzemius MG, et al. Proposed definitions and criteria for reporting time frame, outcome, and complications for clinical orthopedic studies in veterinary medicine. *Vet Surg*. 2010;39(8):905–908. doi:10.1111/j.1532-950X.2010.00763.x
8. Müskens JLJM, Kool RB, van Dulmen SA, Westert GP. Overuse of diagnostic testing in healthcare: a systematic review. *BMJ Qual Saf*. 2022;31(1):54–63. doi:10.1136/bmjqs-2020-012576
9. Moore EV, Weeren R, Paek M. Extended long-term radiographic and functional comparison of tibial plateau leveling osteotomy vs tibial tuberosity advancement for cranial cruciate ligament rupture in the dog. *Vet Surg*. 2020;49(1):146–154. doi:10.1111/vsu.13277
10. Gallagher A, Cross AR, Sepulveda G. The effect of shock wave therapy on patellar ligament desmitis after tibial plateau leveling osteotomy. *Vet Surg*. 2012;41(4):482–485. doi:10.1111/j.1532-950X.2012.00958.x
11. ALARA. United States Nuclear Regulatory Commission. Updated March 9, 2021. Accessed July 20, 2026. <https://www.nrc.gov/reading-rm/basic-ref/glossary/alara.html>

Supplementary Materials

Supplementary materials are posted online at the journal website: avmajournals.avma.org.