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CLINICAL RESEARCH

WILEY

Radiographic assessment of popliteal sesamoid position and cranial tibial subluxation in canine stifle joints undergoing TPLO: A retrospective study of 163 dogs

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Abstract

Objective: To determine the prevalence of popliteal sesamoid displacement (PSD) in dogs with cranial cruciate ligament disease (CCLD) on radiographs, assess its reduction following tibial plateau leveling osteotomy (TPLO), and evaluate cranial tibial subluxation (CTS) pre- and postoperatively.

Study design: Retrospective radiographic observational study.

Sample population: A total of 163 client-owned dogs diagnosed with CCLD and treated with TPLO.

Methods: Pre- and postoperative 90° flexion radiographs were reviewed to assess CTS, tibial plateau angle (TPA), stifle opening angle, PSD, and osteotomy localization. Statistical analyses evaluated associations between PSD, CTS, TPA, and osteotomy location.

Results: A PSD was observed in 14.4% of cases preoperatively and was associated with significantly higher CTS. Popliteal sesamoid reduction was achieved in 100% of cases post-TPLO. The CTS persisted postoperatively in all dogs with preoperative subluxation ($N = 82$; 50.3%), though at significantly reduced levels. Osteotomy positioning did not significantly affect postoperative CTS. Postoperative TPA showed a weak negative correlation with residual CTS.

Conclusion: A PSD is an infrequent finding, typically associated with more pronounced preoperative CTS. This displacement reliably resolves after TPLO when CTS was minimal. Although postoperative CTS was frequently observed, it was generally mild and not significantly affected by the osteotomy location.

Clinical significance: The PSD occurs infrequently after CCLD but is associated with increased CTS. Popliteal sesamoid reduction was associated postoperatively with minimal CTS and appropriate TPA. Radiographic assessment of

popliteal sesamoid reduction may provide an additional, objective parameter for detecting any residual cranio-caudal instability following TPLO.

1 | INTRODUCTION

Cranial cruciate ligament disease is one of the most frequent causes for hindlimb lameness in dogs.[1] Several surgical techniques have been described and TPLO is one of the most common surgical procedures.[2]

Radiographic assessment of the stifle joint may provide complementary information when evaluating a suspected diagnosis of CCLD.[3] One of the earliest and most consistent radiographic indicators is the effacement of the infrapatellar fat pad shadow, commonly referred to as the infrapatellar fat pad sign.[4] Caudal displacement of fat density behind the joint capsule is also indicative of synovial distention.[5] Additional consistent findings include the presence of osteophytes, enthesophytes, and subchondral sclerosis.[4] In some cases, cranial displacement of the proximal tibia may be apparent on a standard lateral radiograph without the need for stress positioning.[6] This subjective cranial displacement of the proximal tibia relative to the femur is commonly referred to as a "Cazieux-positive" sign.[3] Tibial compression radiography has also been described as a reliable diagnostic method, particularly useful for detecting partial cranial cruciate ligament tears.[7,8] Objective measurement of cranial tibial displacement is especially valuable in cases where the displacement is difficult to appreciate subjectively.[9]

The popliteal sesamoid is located at the junction of the popliteus tendon and the popliteus muscle itself. It articulates with the lateral tibial condyle, but its position depends on the contraction of the popliteus muscle.[10] When the stifle is fully extended, the popliteal sesamoid bone is adjacent to the caudodistal part of the articular part of the lateral tibial condyle. When the stifle is flexed, the popliteal sesamoid bone moves cranially and proximally to lie between the lateral condyles of femur and tibia.[10] PSD has been described as a useful parameter in the interpretation of tibial compression radiographs in cases of canine CCLD with an accuracy of 99% and a specificity of 100%.[11] The PSD can sometimes be detected on a 90° flexion radiograph,[11] but its incidence has never been reported.

The objectives of this study were: (1) to determine the prevalence of dogs with CCLD showing PSD on 90° flexion radiographs; (2) to identify popliteal sesamoid reduction after TPLO and (3) to determine the prevalence of persistent CTS after TPLO and predisposing factors of CTS.

We hypothesized that when the popliteal sesamoid is distally displaced preoperatively, it would return to its anatomical position following an adequate TPLO procedure.

2 | MATERIALS AND METHODS

2.1 | Data collection

Medical records of dogs that underwent unilateral TPLO between January 2023 and December 2023 were reviewed retrospectively. Standard craniocaudal and mediolateral projections of the stifle were obtained pre- and postoperatively. Orthogonal radiographs included the distal femur (proximal to the femoropatellar joint), the entire tibia and tarsocrural joint, using standard TPLO views.[12] Radiographic measurements were thus performed on a 90° flexion mediolateral radiographic projection. All images included a radiographic magnification marker for calibration purposes. Radiographs were reviewed by two board-certified surgeons using digital software (PACS: Picture Archiving and Communication System, Carestream Health, Philipps, Rochester, New York; VPOP: Virtual Preoperative Orthopedic Planning, VetSOS Education Limited, Shrewsbury, UK).

Data collected included pre- and postoperative stifle joint angle, TPA, CTS, and popliteal sesamoid position and location of the osteotomy. Cases were excluded if radiographic technique hindered the ability to obtain accurate measurements, or additional stifle procedures (patellar luxation correction, other type of tibial osteotomy, or lateral fabellar suture) were performed.

2.1.1 | Stifle joint angle

Pre- and postoperative stifle joint angles were measured according to the method of Murakami et al.[13] The stifle angle was recorded by calculating the caudal angle of the intersection of the anatomical axis of the distal femur and the proximal tibia.

2.1.2 | Tibial plateau angle

The TPA was measured according to Palmer pre- and postoperatively.[14]

2.1.3 | Cranial tibial subluxation

Preoperative CTS was evaluated on radiographs subjectively ("Cazieux-positive" sign) and objectively according to Bielecki et al.[9] Quantitative measurements were performed on 90° flexion pre- and postoperative mediolateral radiographs (Figure 1).

2.1.4 | Popliteal sesamoid displacement

The popliteal sesamoid is normally superimposed to the caudal tibial plateau on 90° flexion radiographs.[11] A PSD was detected when the popliteal sesamoid was identified distally to this landmark as described by de Rooster and van Bree (Figure 1).[11]

2.1.5 | Evaluation of popliteal sesamoid reduction after TPLO

In cases where the popliteal sesamoid was identified as distally displaced preoperatively, the location of the popliteal sesamoid bone was assessed on postoperative radiographs. A popliteal sesamoid was considered reduced if it was superimposed or above the caudal tibial plateau.

2.1.6 | Localization of the osteotomy

Localization of the osteotomy was assessed on postoperative radiographs. The ideally centered osteotomy (ICO) had the center of the osteotomy located on the intercondylar eminence, whereas the distally centered osteotomy (DCO) had the center of the osteotomy at least 5 mm distal to the ICO. To measure the ICO, the distance from the insertion of the patellar tendon to a single point on the planned osteotomy line and the distance from the caudal margin of the tibial plateau to the point where the osteotomy transects the caudal tibial cortex were measured on pre-operative radiographs. These were used as landmarks to place a circle with the diameter of the saw blade used in surgery over the proximal tibia in the postoperative radiographs. Then, a circle with the diameter of the saw blade used in surgery was superimposed over the actual osteotomy line (Figure 2).

2.2 | Statistical analysis

All variables are described using standard descriptive statistics. Frequency tables are presented for qualitative variables, while quantitative variables are summarized using the mean, SD, minimum (min), quartiles (Q1, Q3), median, and maximum (max). Group comparisons were

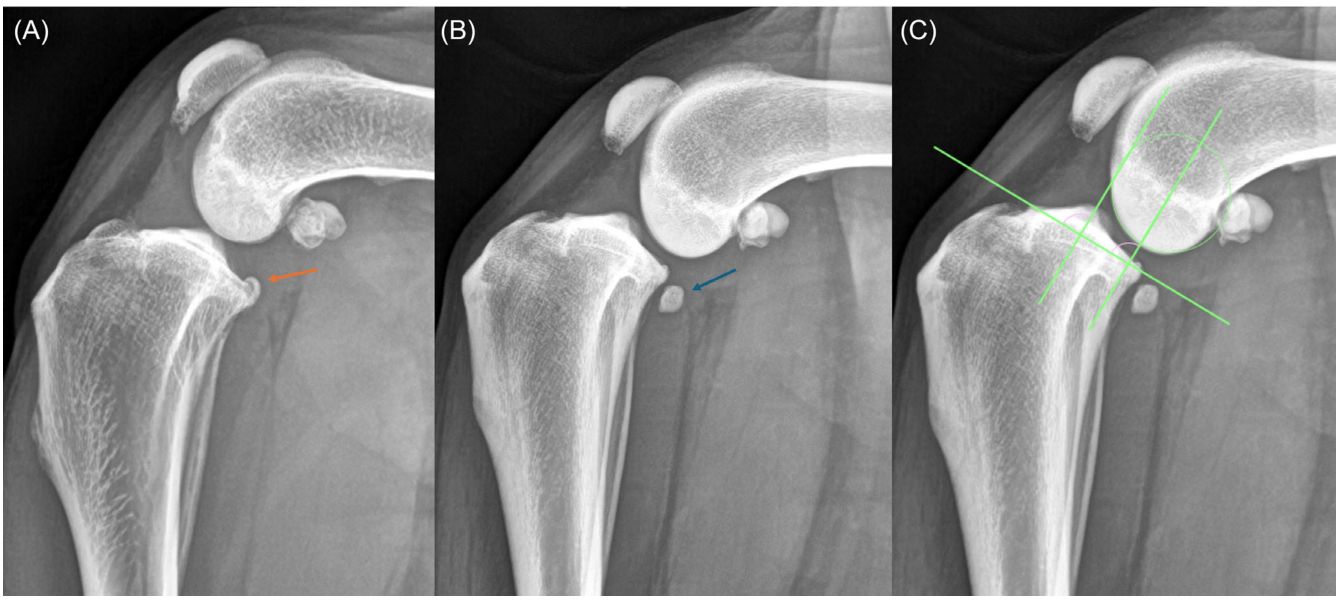

FIGURE 1 Preoperative mediolateral radiographs illustrating subjective evaluation (A, B) and objective (C) of cranial tibial subluxation (CTS). No subjective CTS visible in (A). Obvious subjective CTS is visible in (B). Objective quantification of the CTS illustrated in (C) according to Bielecki et al. The line through the center of the femoral condyle perpendicular to the tibial plateau is caudal to the line through the intercondylar eminence perpendicular to the tibial plateau. PSD is illustrated in (B) (blue arrow) showing the localization of the popliteus sesamoid in comparison to its normal localization in (A) (orange arrow).

performed using Mann–Whitney tests. The normality of the variables was assessed both numerically and graphically.

To analyze the evolution of subluxation quantification postoperatively relative to preoperative measurements, a linear mixed-effects model was used. This model included the time of measurement (pre- and postoperative), popliteal displacement (yes/no), and their interaction. Estimated mean values for each group at each time point were obtained using contrasts within the model.

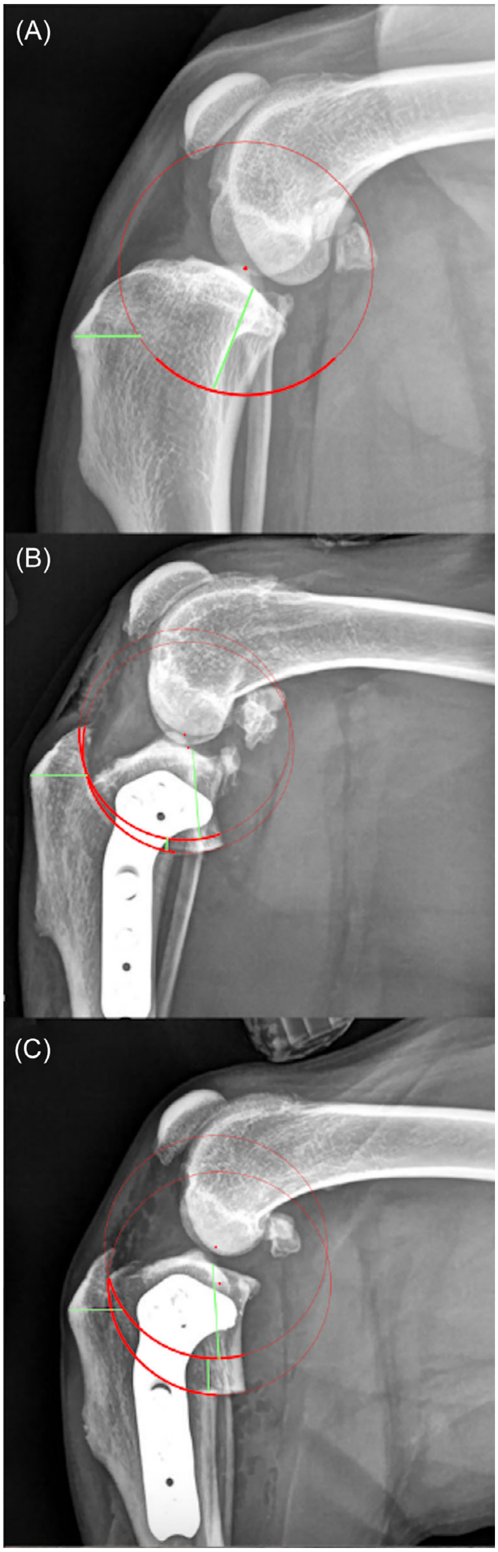

FIGURE 2 Preoperative (A) and postoperative (B, C) mediolateral radiographs illustrating assessment of osteotomy localization. On preoperative radiograph (A), the distance from the insertion of the patellar tendon to a single point on the planned osteotomy line and the distance from the caudal margin of the tibial plateau to the point where the osteotomy transects the caudal tibial cortex were measured on preoperative radiographs. These were used as landmarks to place a circle with the diameter of the saw blade used in surgery over the proximal tibia in the postoperative radiographs (B, C). Then, a circle with the diameter of the saw blade used in surgery was superimposed over the actual osteotomy line. (B) Illustrates a representative example of an ideally centered osteotomy (ICO), with the center of the osteotomy located at the intercondylar eminence, whereas (C) demonstrates a typical distally centered osteotomy (DCO), with the center positioned at least 5 mm distal to the ICO.

Absolute change in subluxation quantification was calculated as the difference between postoperative and preoperative values. Relative change was calculated by dividing the absolute change by the preoperative value and multiplying by 100. This relative change was modeled using a linear model, incorporating popliteal displacement, preoperative values, and their interaction.

Measurements of the tibial plateau angle were compared according to popliteal displacement using Mann–Whitney tests, and associations with subluxation measurements were assessed using Spearman correlation tests. The same methodology was applied to compare values of the stifle opening angle based on popliteal displacement and to evaluate associations with subluxation quantification.

All statistical analyses were conducted at a 95% CI ($p < .05$) using SAS software version 9.4. Graphs were generated using R version 4.5.0.

3 | RESULTS

3.1 | Descriptive analysis

The study included a total of 163 dogs. Mean pre- and postoperative stifle opening angles were 85.08° (±8.58) and 83.17° (±8.16), respectively. Mean pre-and postoperative TPA were 28.36° (±3.81) and 6.74° (±4.53) respectively.

Popliteal sesamoid was not visible in three dogs (3/163 [1.8%]). Those cases were systematically excluded from all analyses involving popliteal sesamoid. A total of 23 dogs (23/160 [14.4%]) exhibited PSD on 90° flexion radiographs. Among the dogs with popliteal displacement ($N = 23$), a reduction of the popliteal sesamoid was observed in all cases after TPLO (23/23 [100.0%]) (Figure 3).

A "Cazieux-positive" sign was present in 23 dogs (23/163 [14.1%]) and a PSD was systematically present in those cases. Preoperative CTS measured objectively was present in 82 dogs (82/163 [50.3%]). In these dogs, mean pre- and postoperative CTS quantification was 3.99 mm (±2.23) and 2.60 mm (±1.31), respectively. Postoperative CTS was not observed in any dog that did not have CTS preoperatively.

The osteotomies were assessed as DCO in 55 dogs (55/163 [33.7%]) and ICO in 108 dogs (108/163 [66.3%]).

Descriptive statistics for pre-and postoperative measurements and observations are summarized in Table 1.

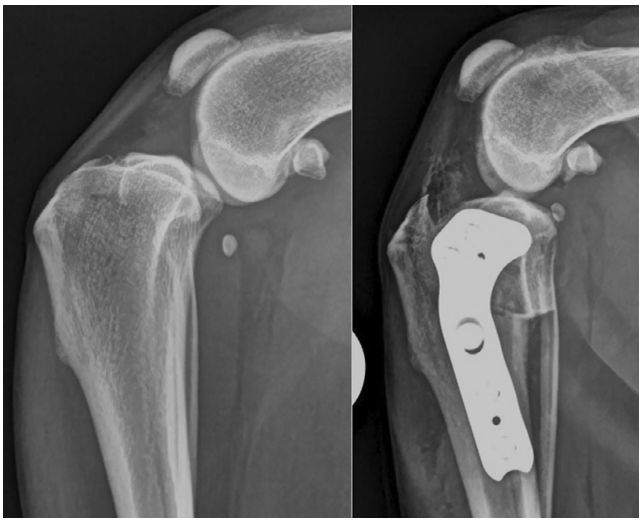

FIGURE 3 Pre- and postoperative mediolateral radiographs illustrating a "Cazieux-positive" sign with popliteal sesamoid displacement (PSD) and its reduction following tibial plateau leveling osteotomy (TPLO) with a tibial plateau angle of 7°.

3.2 | Evaluation of subluxation quantification

3.2.1 | Influence of osteotomy site

This section focused on dogs with preoperative subluxation ($N = 82$). Descriptive statistics for postoperative subluxation quantification, as well as its absolute and relative changes compared to preoperative measurements, are presented overall and by osteotomy location in Table 2. Postoperative measurements and changes in subluxation quantification were comparable across osteotomy locations (ICO vs. DCO) ($p = .83$ and .15, respectively).

3.2.2 | Influence of popliteal displacement

The evolution of subluxation quantification from pre- to postoperative measurements is illustrated in Figure 4 according to the presence or absence of popliteal displacement, for dogs with subluxation in which the popliteal sesamoid was visible ($N = 81$).

To model this evolution, a mixed-effects model was used. The model accounted for the time of measurement (preoperative vs. postoperative), the presence or absence of popliteal displacement, and the interaction between these two factors, and was applied to dogs with visible popliteal sesamoid and preoperative subluxation ($N = 81$). Based on this model, the interaction between time of measurement and PSD was found to be statistically significant. The estimated pre- and postoperative mean values derived from this model using contrasts are presented in Table 3, stratified by PSD status. Based on the contrasts derived from the model, preoperative CTS quantification was significantly higher in dogs with PSD compared to those without displacement (coefficient: 2.9 ± 0.45). In contrast, postoperative measurements were similar regardless of PSD status (coefficient: 0.061 ± 0.32, $p = .85$).

TABLE 1 Descriptive statistics of pre- and postoperative measurements ($N = 163$).

	N	Mean	SD	Min	Q1	Median	Q3	Max
Stifle opening angle (°)								
Preoperative	163	85.08	8.58	63.00	79.80	85	90.50	109.40
Postoperative	163	83.17	8.16	66.70	79.00	82.40	86.70	134.20
Tibial plateau angle (°)								
Preoperative	163	28.63	3.81	20.00	26.00	28.00	31.00	41.00
Postoperative	163	6.74	4.53	−3.00	4.00	6.00	9.00	23.00
Cranial tibial subluxation (mm)								
Preoperative	82	3.99	2.23	1.00	2.20	3.40	5.30	11.30
Postoperative	82	2.60	1.31	0.20	1.60	2.35	3.40	7.00

TABLE 2 Descriptive statistics of postoperative quantification of subluxation and its absolute and relative change compared to preoperative measurements, overall and by osteotomy location ($N = 82$).

	N	Mean	SD	Min	Q1	Median	Q3	Max	*p*-value[a]
CTS postoperative (mm)	82	2.60	1.31	0.20	1.60	2.35	3.40	7.00	.83
DCO	28	2.59	1.34	0.20	1.60	2.40	3.50	5.20	
ICO	54	2.61	1.30	0.90	1.60	2.20	3.40	7.00	
Absolute changes (mm)	82	−1.39	1.96	−7.40	−2.10	−1.00	−0.30	1.70	.15
DCO	28	−1.99	2.54	−7.40	−3.60	−1.55	−0.35	1.70	
ICO	54	−1.08	1.52	−4.60	−1.80	−0.80	−0.30	1.70	
Relative changes (%)	82	−23.12	45.00	−87.30	−48.15	−31.30	−11.11	170.00	.11
DCO	28	−33.34	41.99	−87.30	−70.93	−37.25	−10.26	50.00	
ICO	54	−17.83	45.97	−72.88	−44.74	−28.29	−11.11	170.00	

Abbreviations: CTS, cranial tibial subluxation; DCO, distally centered osteotomy; ICO, ideally centered osteotomy.
[a]*p*-value of the non-parametric Mann–Whitney test.

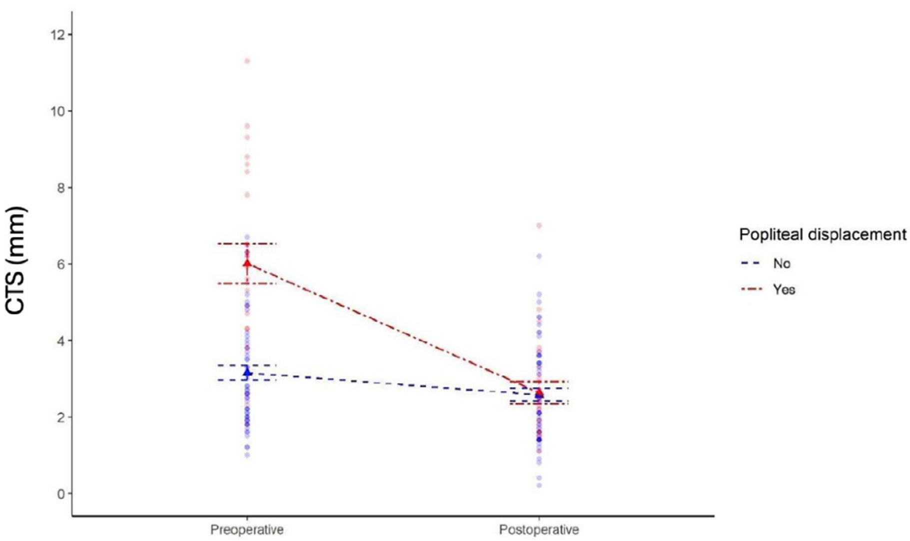

FIGURE 4 Mean values and standard error of pre- and postoperative quantification of cranial tibial subluxation (CTS) according to the displacement or not of the popliteal sesamoid in dogs with CTS and in which the sesamoid is visible ($N = 81$); the transparent dots represent individual measurements.

TABLE 3 Estimated values from the mixed model for preoperative and postoperative quantification of subluxation, based on the presence or absence of popliteal sesamoid displacement, in dogs with subluxation and a visible popliteal sesamoid ($N = 81$).

Cranial tibial subluxation (mm)	Popliteal sesamoid displacement Yes	No
Preoperative	3.1 ± 0.24	6.0 ± 0.98
Postoperative	2.6 ± 0.17	2.6 ± 0.27

Note: The results are presented using the model-estimated mean and its SE (±SE).

Regarding the change in measurements, CTS quantification was significantly lower postoperatively compared to preoperative values in dogs with PSD (coefficient: −3.4 ± 0.31). Similarly, in dogs without PSD, postoperative CTS quantification was also significantly lower compared to their preoperative values (coefficient: −0.58 ± 0.20).

A linear model was used to assess the relative change in subluxation quantification as a function of preoperative measurements, PSD status, and their interaction, in dogs with CTS and a visible popliteal sesamoid. The results of this linear model are summarized in Table 4.

3.2.3 | Influence of TPA

Table 5 presents the descriptive statistics of the pre- and postoperative TPA, both overall and according to whether popliteal sesamoid reduction was observed. Regardless of the time point (pre- or postoperative), the TPA was similar between groups with and without popliteal reduction ($p = .48$, preoperatively; $p = .46$, postoperatively).

Preoperatively, TPA values were not significantly correlated with CTS quantification ($r_s = -0.147$, $p = .19$). Postoperatively, a weak negative correlation was observed between TPA and CTS quantification; as CTS measurements increased, TPA values tended to decrease ($r_s = -0.243$). However, this association was relatively weak.

TABLE 4 Results of the linear model assessing the relative change in subluxation quantification based on preoperative measurements, the presence or absence of popliteal sesamoid displacement, and their interaction, in dogs with subluxation and in which the popliteal sesamoid is visible ($N = 81$).

	Category	Results	*p*-value
PSD	Yes	−51.6 ± 25	.042
CTS (mm)		−10.6 ± 3.55	.0037
PSD × CTS	Yes	6.80 ± 4.89	.17

Note: The results are presented using the regression coefficient and its SE (±SE).

Abbreviations: CTS, cranial tibial subluxation; PSD, popliteal sesamoid displacement.

3.2.4 | Influence of stifle opening angle

Descriptive statistics for the stifle opening angle are presented overall and by PSD in Table 6, for dogs with a visible popliteal sesamoid. No significant difference in stifle opening angle was observed between dogs with and without PSD ($p = .14$, preoperatively; $p = .97$, postoperatively). Preoperatively, a significant positive association was observed: higher CTS quantification was associated with higher stifle opening angle measurements. However, this association was relatively weak ($r_s = 0.222$). No significant association was found postoperatively ($p = .089$).

Overall, 50.3% of dogs were diagnosed with preoperative CTS, while 14.4% exhibited a "Cazieux-positive" sign. A PSD was consistently observed in these cases. No CTS developed postoperatively in dogs that were free of CTS preoperatively, and all dogs with a minimal postoperative CTS showed popliteal sesamoid reduction. The CTS tended to decrease after surgery.

4 | DISCUSSION

This study analyzed 163 dogs, with 50.3% (82/163) exhibiting CTS preoperatively and 14.4% (23/160; excluding

TABLE 5 Descriptive statistics of the tibial plateau angle and according to whether the popliteal sesamoid is reduced or not, for dogs in which the popliteal sesamoid is visible ($N = 160$).

	N	Mean	SD	Min	Q1	Median	Q3	Max	*p*-value[a]
Preoperative	160	28.65	3.84	20.00	26.00	28.00	31.00	41.00	.48
No	136	28.78	3.95	21.00	26.00	29.00	31.00	41.00	
Yes	24	27.92	3.15	20.00	26.00	28.00	31.00	32.00	
Postoperative	160	6.73	4.55	−3.00	4.00	6.00	9.00	23.00	.46
No	136	6.87	4.69	−3.00	4.00	6.00	9.00	23.00	
Yes	24	5.92	3.68	0.00	3.50	6.00	9.00	13.00	

[a]*p*-value of the non-parametric Mann–Whitney test.

TABLE 6 Descriptive statistics of the stifle opening angle overall and according to the presence or absence of popliteal sesamoid displacement, for dogs in which the popliteal sesamoid is visible ($N = 160$).

	N	Mean	SD	Min	Q1	Median	Q3	Max	*p*-value[a]
Preoperative	160	85.12	8.60	63.00	79.85	85.25	90.50	109.40	0.14
No	137	84.62	8.49	63.00	78.70	85.00	89.90	107.20	
Yes	23	88.08	8.84	69.50	82.00	86.50	92.80	109.40	
Postop	160	83.30	8.16	66.70	79.05	82.70	86.80	134.20	0.97
No	137	83.29	8.35	66.70	79.00	82.70	87.10	134.20	
Yes	23	83.34	7.07	68.20	79.90	83.10	85.70	103.40	

[a]*p*-value of the non-parametric Mann–Whitney test.

three dogs in which popliteal sesamoid was not visible) showing PSD on 90° flexion radiographs. Preoperatively, CTS quantification was significantly greater in dogs with PSD. A "Cazieux-positive" sign was systematically associated with PSD. In all cases with PSD, reduction of the popliteal sesamoid was observed postoperatively after TPLO (100%). Among dogs with preoperative CTS ($N = 82$), postoperative CTS persisted in all cases, at a lower degree. Postoperative measurements and changes in CTS quantification were comparable across osteotomy locations.

The initial aim of this study was to investigate a clinical observation made during routine postoperative evaluations: the apparent reduction of the popliteal sesamoid following TPLO procedures achieving an appropriate postoperative TPA. This observation raised the hypothesis that correcting the TPA through TPLO may contribute to the reduction of CTS, as indirectly evidenced by the repositioning of the popliteal sesamoid. The study was thus designed to systematically assess the relationship between TPLO outcomes, particularly TPA, and the quantification of CTS, with a specific focus on the presence and evolution of PSD. The authors held the hypothesis that radiographic stifle stability was associated with the position of the popliteal sesamoid.

In our study, the popliteal sesamoid was not visible in three cases (1.8%), which is lower than the 6% reported in the literature.[11] Failure of ossification of the popliteal sesamoid can occur, particularly in small breed dogs.[11] The position of the popliteal sesamoid varies with stifle range of motion.[11] To compare our pre- and postoperative results, we sought to compare stifle opening angles in order to minimize potential bias. Pre- and postoperative stifle opening angles were comparable and therefore did not influence the position of the popliteal sesamoid in our study. In our series, reduction of the popliteal sesamoid was achieved postoperatively in 100% of cases following TPLO, with postoperative TPAs ranging from 0° to 13°. However, it remains possible that TPAs exceeding this range may compromise popliteal sesamoid reduction. Robinson et al. identified a postoperative TPA of 14° as the threshold for a favorable clinical outcome.[15] The radiographic position of the popliteal sesamoid may therefore serve as a useful adjunct in the postoperative assessment of TPLO, though additional studies are required to validate this observation. Future cadaveric studies may help to identify the TPA value at which popliteal sesamoid reduction can be consistently observed.

Preoperative CTS was present in 50.3% of cases. In the present study, we observed that, in those cases, CTS persisted despite the performance of a TPLO. The clinical relevance of this residual subluxation remains undetermined. However, the postoperative CTS values observed in the present study remain relatively small (2.60° ± 1.31). It is important to clarify how non-weightbearing radiographs influence the magnitude of cranial tibial subluxation. Non-weightbearing radiographs represent a best-case scenario because they are obtained in the absence of functional loading forces. During actual weightbearing, cranial tibial thrust acts to accentuate cranial tibial subluxation, meaning the CTS would be expected to be equal or greater than what is measured on non-weightbearing views. Therefore, the residual CTS we document radiographically likely underestimates the functional instability experienced during gait. This is consistent with the results reported by Kim et al.[16] who demonstrated that TPLO does not consistently eliminate cranial tibial subluxation. However, our results were higher than the 33% reported. This discrepancy could be explained by the objective quantification of the CTS in our study. In their clinical experience, the authors have encountered cases with postoperative TPAs below 6°, yet with marked cranial tibial subluxation still present, accompanied by distal displacement of the popliteal sesamoid and a poor clinical outcome. The placement of a lateral suture resulted in a reduction of the CTS and a concomitant reduction of the popliteal sesamoid. This further suggests that reduction of the popliteal sesamoid is associated with stifle stability, provided that postoperative CTS is minimal. However, the threshold value remains unknown.

The osteotomy location did not influence the postoperative CTS in this study. This does not align with the findings of Kowaleski et al. highlighting that distal centering of TPLO leads to CTS.[17] However, our definition of DCO was different from the one used in that study. Indeed, they defined a distally centered TPLO as a radial osteotomy centered as distal on the tibial long axis as possible without altering the integrity of the tibial plateau whereas we defined a TPLO as DCO if the center of the osteotomy was at least 5 mm distal to the ICO. Considering this, all DCO osteotomies in our study were less extreme than those reported in the study by Kowaleski et al. which may be considered as a worst-case scenario.[17] An ICO remains geometrically more accurate and biomechanically more effective than a DCO and should therefore still be pursued whenever possible.

A total of 82 dogs (50.3%) were diagnosed with a preoperative CTS. This diagnosis was based on an objective measurement described by Bielecki et al.[9] However, 14.1% of the cases exhibited spontaneous cranial tibial subluxation, corresponding to a "Cazieux-positive" sign. This radiographic sign has been scarcely reported in the veterinary literature. Its reported prevalence was 24.77% and it has shown a strong association with cranial cruciate ligament rupture. Specifically, it demonstrates a high predictive value (97.5%) and specificity (95.4%) for this condition, suggesting its potential utility as a reliable diagnostic indicator in clinical practice.[3] A distal displacement of the popliteal sesamoid was observed in all cases presenting a "Cazieux-positive" sign in our study. This association is consistent with the findings of Meinen and Verbeek.[18] While the position of the popliteal sesamoid has been previously reported in the context of CCLD diagnosis, it has only been described on compression radiographs.[7] This observation is biomechanically coherent with the in vivo fluoroscopic findings of Rey et al.,[19] who described the displacement pattern not as a cranial shift of the tibia but rather as a caudal slippage of the femur, the site of origin of the popliteus tendon. This alternative perspective helps explain why the sesamoid of the popliteus consistently follows this displacement in affected stifles.

This study had several limitations inherent to its retrospective radiographic observational design. Despite efforts to standardize radiographic positioning, variations in limb positioning, particularly stifle joint opening angle, could have influenced the apparent position of the popliteal sesamoid and the measurement of CTS. Although stifle opening angles were recorded and found comparable between pre- and postoperative radiographs, minor inconsistencies may still have introduced measurement variability. The assessment of PSD and CTS was partially reliant on subjective interpretation, especially in the identification of the "Cazieux-positive" sign. While objective measurements were performed to quantify CTS, interobserver variability may have influenced findings. Although two board-certified surgeons reviewed the images, formal assessment of inter- or intraobserver agreement was not performed. The study focused exclusively on radiographic parameters. Demographic factors and clinical outcomes, such as postoperative lameness, pain scores, or return to function, were not evaluated. This limits the ability to correlate radiographic findings (e.g., CTS or PSD) with patient-centered outcomes.

Displacement of the popliteal sesamoid is an infrequent radiographic finding on 90° flexion views and appears to be associated with more pronounced preoperative cranial tibial subluxation. Mild postoperative cranial tibial subluxation was frequently noted. Following TPLO, consistent reduction of the popliteal sesamoid was observed. This may serve as an objective radiographic indicator of cranio-caudal instability neutralization, as corroborated by the minimal postoperative CTS values. Postoperative TPA values are generally considered to reflect cranio-caudal instability neutralization. However, in our series, postoperative TPA in cases with PSD ranged only from 0° to 13°, which prevents definitive confirmation of this association. In this context, reduction of the popliteal sesamoid may therefore represent a more global postoperative indicator of cranio-caudal instability neutralization.

AUTHOR CONTRIBUTIONS

Picavet PP, DVM, MS, DECVS and Hamon M, DVM, DECVS: Manuscript authorship, study design, data gathering, data assessment, drafting of the manuscript, revision of the manuscript, and approval of the final version of the submitted manuscript. Corbarieu T, DVM: Data gathering, drafting of the manuscript, revision of the manuscript, and approval of the final version of the submitted manuscript. Toth D, DVM, MS, Monseur J, MS, Renberg W, DVM, MS, DACVS and Roush JK, DVM, MS, DACVS: Data gathering, revision of the manuscript, and approval of the final version of the submitted manuscript. Thibault A, DVM, DECVS: Study design, revision of the manuscript, and approval of the final version of the submitted manuscript.

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The authors declare no conflicts of interest related to this report.

DATA AVAILABILITY STATEMENT

Data available on request from the authors.

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