Osteosarcoma commonly arises in metaphyseal bone of large- or giant-breed dogs and is the most common primary bone tumor in dogs.1–5 In previous reports,1,6 spontaneously occurring osteosarcoma of the tibia accounted for 19 of 128 (14.8%) to 31 of 153 (20.3%) of appendicular osteosarcoma cases in dogs, with the proximal aspect of the tibia affected in 11 of 153 (approx 7%) appendicular osteosarcoma cases and up to 10 of 19 (approx 53%) tibial osteosarcoma cases.

The TPLO procedure was developed in the early 1990s to alter the biomechanics of the stifle joint in dogs with cranial cruciate ligament disease.7 Biradial osteotomy of the proximal tibial metaphysis and rotation of the tibial plateau are performed to decrease the tibial plateau angle with the purpose of eliminating cranial tibial thrust. The osteotomy site is then stabilized with a specialized TPLO plate.

Objective—To determine the signalment, tibial plateau leveling osteotomy (TPLO) plate type, clinical staging information, treatment, and oncological outcome in dogs that developed osteosarcoma at the proximal aspect of the tibia following TPLO and to calculate the interval between TPLO and osteosarcoma diagnosis.

Design—Multi-institutional retrospective case series.

Animals—29 dogs.

Procedures—Medical records from 8 participating institutions were searched for dogs that developed osteosarcoma (confirmed through cytologic or histologic evaluation) at previous TPLO sites. Signs, staging tests, treatment data, and outcome information were recorded. Descriptive statistics were calculated, and disease-free intervals and survival times were evaluated by means of Kaplan-Meier analysis.

Results—29 dogs met the inclusion criteria. The mean age was 9.2 years and mean weight was 45.1 kg (99.2 lb) at the time of osteosarcoma diagnosis. Most dogs had swelling over the proximal aspect of the tibia (17/21) and lameness of the affected limb (28/29). The mean interval between TPLO and osteosarcoma diagnosis was 5.3 years. One type of cast stainless steel TPLO plate was used in most (18) dogs; the remaining dogs had received plates of wrought stainless steel (n = 4) or unrecorded type (7). Twenty-three of 29 dogs underwent treatment for osteosarcoma. Median survival time for 10 dogs that underwent amputation of the affected limb and received ≥1 chemotherapeutic treatment was 313 days.

Conclusions and Clinical Relevance—Results supported that osteosarcoma should be a differential diagnosis for dogs with a history of TPLO that later develop lameness and swelling at the previous surgical site. Oncological outcome following amputation and chemotherapy appeared to be similar to outcomes previously reported for dogs with appendicular osteosarcoma. (J Am Vet Med Assoc 2014;244:1053–1059)
There have been multiple descriptions of fracture- or implant-associated osteosarcoma in companion animals. The diaphysis is reported as the most commonly affected location for both fracture- and implant-associated sarcoma. Because they are typically diaphyseal, it is thought that fracture-associated tumors do not represent spontaneously occurring osteosarcoma. There are many hypotheses about why fracture- or implant-associated sarcomas develop, including tumor development as the result of biological effects of metals released from implants, corrosion of metallic implants, altered cellular activity or excessive tissue damage caused by the fracture or presence of the implant, or infection resulting in osteomyelitis. The mean interval between fracture occurrence and osteosarcoma diagnosis has been reported as 5.8 years (range, 1 to 12 years).

A few clinical reports have described osteosarcoma development at the site of triple pelvic osteotomy and total hip arthroplasty in dogs. Reports of sarcoma development at the proximal aspect of the tibia following TPLO in dogs are also rare; 7 cases found in the literature included histopathologic diagnoses of osteosarcoma (5 dogs), histiocytic sarcoma (1), and poorly differentiated sarcoma (1). A low incidence (23 of 30,636 cases) of neoplasia at TPLO sites has been reported in a abstract based on results of a surgeon questionnaire.

Only a few cases of osteosarcoma at the site of a TPLO have been reported; thus, information on these types of cases remains scant. The purpose of the retrospective study reported here was to determine the signalment, TPLO plate type, clinical staging information, treatment, and oncological outcome in a cohort of dogs that developed osteosarcoma at the proximal aspect of the tibia following TPLO and to calculate the interval between TPLO and osteosarcoma diagnosis. The wider aims were to summarize clinical data in a larger number of cases than previously reported, to increase clinical awareness of osteosarcoma at TPLO sites, and to inform the design of future studies to investigate the potential relationship between TPLO and osteosarcoma in dogs.

Materials and Methods

Case selection—Hard copy and electronic medical records at each of 8 participating institutions (Colorado State University, Ontario Veterinary College, Alta Vista Animal Hospital, University of California-Davis, SAGE Centers for Veterinary Specialty and Emergency Care, Southpaws Specialty Surgery for Animals, Melbourne Veterinary Specialist Centre, and Orchard Road Veterinary Surgery Inc.) were searched to identify dogs with osteosarcoma at the site of a prior TPLO that were evaluated between January 1, 1997, and December 31, 2011. Dogs were eligible for study inclusion if they had osteosarcoma at the site of a prior TPLO and had undergone TPLO at the same site ≥ 1 year prior to osteosarcoma diagnosis. Dogs that had a TPLO performed < 1 year before osteosarcoma diagnosis were excluded to prevent inclusion of dogs that had preexisting sarcomas at that site. Medical records review—Signalment information collected from the medical records included date of birth, sex, neuter status, breed, and body weight at time of osteosarcoma diagnosis. Additional information recorded included date of osteosarcoma diagnosis, hind limb affected, duration and severity of lameness (if applicable), whether soft tissue swelling was present at the affected site, and other clinically relevant physical examination findings noted at the time of diagnosis. The severity of lameness was characterized as weight-bearing or non–weight bearing on the basis of descriptions in the medical records.

For dogs that had hematologic analysis performed at the time of osteosarcoma diagnosis, the serum total ALP activity was recorded and any CBC or serum biochemical abnormalities were recorded. Serum total ALP activity was considered high if the value exceeded the reference range at the participating institution where the dog was evaluated. The method of osteosarcoma diagnosis (histologic examination of a biopsy sample or cytologic evaluation of a fine-needle aspirate) and clinical stage (II [without metastases] or III [with metastases]) at the time of the diagnosis were recorded.

Details regarding the TPLO were recorded, including the date of surgery, plate manufacturer, and size of plate. Local infection at the TPLO site reported at any time after surgery was recorded with information regarding cultures performed and bacteria isolated, if applicable. If the TPLO plate was removed, the date of removal was recorded. The number of years from the date of TPLO to the date of osteosarcoma diagnosis was calculated.

Any treatment for osteosarcoma, including amputation, radiation therapy, chemotherapy, and other treatments (eg, bisphosphonate administration) and the dates of treatment were recorded. Administration of analgesics was also recorded if these were the only treatments used. If radiation therapy was part of the treatment protocol, the intent (curative vs palliative) and type of radiation therapy (fractionated, stereotactic [SRT], or coarse fractionated), the radiation therapy protocol, and any complications of treatment were recorded. The chemotherapeutic protocol and number of doses administered were noted if applicable.

Outcome information, which included whether metastatic disease was detected during follow-up, the date of detection, and location of any metastases, was obtained by communication with the owner or referring veterinarian. Whether the dog was alive at the time of last follow-up was recorded. For dogs that had died, the date and cause of death were recorded if known.

Statistical analysis—Descriptive statistics were calculated for the following continuous variables: age at TPLO and at osteosarcoma diagnosis, body weight, and interval between TPLO and osteosarcoma diagnosis. The data for these variables were tested for normality by means of a Kolmogorov-Smirnov test. Normally distributed data were described as mean ± SD, and nonnormally distributed data were reported as median (interquartile range). Frequencies (proportion and percentage of dogs) were calculated for categorical variables, including year of TPLO and surgical plate type.

A modified intent-to-treat analysis was used for assessment of treatment outcomes. Dogs that were prescribed curative-intent treatment with amputation or SRT and received ≥ 1 IV dose of a chemotherapeutic agent were categorized as having received curative-intent treatment. This approach was chosen to reduce bias associated with exclu-
tion of dogs in which chemotherapy was terminated early for any reason. Dogs that underwent repair of pathological fractures without chemotherapy, amputation without che-
mo-therapy, or palliative-intent radiation therapy with or without bisphosphonate treatment (eg, pamidronate diso-
dium) or chemotherapy, and those that received analgesic medications alone were classified as receiving palliative-intent treatment. The DFI for dogs that underwent cura-
tive-intent treatment was calculated as the number of days from date of amputation until the date that recurrence or metastasis of osteosarcoma was detected; patients that did not develop local recurrence or metastasis and were still alive or had been lost to follow-up were censored on the day of last contact. Survival times were calculated as the number of days from osteosarcoma diagnosis until death due to any cause or until date of last follow-up. Dogs that were still alive or had been lost to follow-up were censored on the day of last contact. Kaplan-Meier survival curves were generated for dogs that received curative-intent and palliative-intent treatments, MSTs were calculated with the Kaplan-Meier method, and survival curves were compared by means of the Mantel-Cox log rank test.

Univariable analysis was not performed to assess associations of variables with DFI or MST because of the low number of dogs in the study. Values of $P \leq 0.05$ were considered significant. Statistical analysis was performed with a commercially available statistical analysis software program.\textsuperscript{b}

\section*{Results}

\subsection*{Examination of dogs at osteosarcoma diagnosis—}

Twenty-nine dogs met the study inclusion criteria. Sixteen dogs were seen at Colorado State University, 4 at SAGE Centers for Veterinary Specialty and Emergency Care, 3 at Alta Vista Animal Hospital, 2 at University of California-Davis, and 1 each at Melbourne Veterinary Specialist Centre, Ontario Veterinary College, Orchard Road Veterinary Surgery Inc, and Southpaws Specialty Surgery for Animals. At the time of osteosarcoma diagnosis, the mean $\pm$ SD body weight was 45.1 $\pm$ 13.5 kg (99.2 $\pm$ 29.8 lb) and age was 9.2 $\pm$ 2.2 years. There were 19 female dogs (all spayed) and 10 male dogs (all castrated). Breeds represented were Labrador Retriever (n = 6), Rottweiler (4), mixed (4), Golden Retriever (3), Bull Mastiff (2), Great Dane (2), German Shepherd Dog (2), Mastiff (2), and Great Pyrenees (2); 1 Newfoundland and 1 pit bull–type dog were also included.

Lameness was reported in 28 dogs and described as non–weight bearing in 9 dogs and weight bearing in 17; severity was not recorded for 2 dogs. The median duration of lameness prior to osteosarcoma diagnosis was 4 weeks (interquartile range, 1 to 7 weeks). The right limb was affected in 16 dogs and the left in 13. Swelling at the proximal aspect of the tibia was present at the time of osteosarcoma diagnosis in 17 dogs, lameness but no noticeable swelling was reported for 4 dogs, and presence or absence of swelling was not recorded for 8 dogs. Additional physical examination abnormalities were reported for only 6 dogs. The following abnormalities were described for 1 dog each: a cutaneous mass on the neck (results of cytologic evaluation of a fine-needle aspirate were consistent with a mast cell tumor), draining tract at the level of the proximal aspect of the affected tibia, firm and enlarged popliteal lymph node of the affected limb (no evidence of metastatic disease was seen on cytologic evaluation of a fine-needle aspirate), instability at the proximal aspect of the tibia (owing to a pathological fracture of the proximal diaphysis), signs of pain on manipulation of the contralateral hip joint, and high rectal temperature (39.4°C [102.9°F]; reference range, 37.7° to 39.2°C [99.9° to 102.6°F]).

Results of hematologic and biochemical analyses performed at the time of osteosarcoma diagnosis were available for 17 dogs. Serum total ALP activities were high in 11 of 17 dogs for which results were available. Other clinicopathologic abnormalities were reported for 6 of the 17 dogs. One dog each had hyperglobulinemia (4.6 g/dL; reference range, 2.5 to 4.5 g/dL), high alanine transaminase activity (140 U/L; reference range, 10 to 90 U/L), and hypercholesterolemia (438 mg/dL; reference range, 130 to 300 mg/dL). One dog with diabetes had hyperglycemia (373 mg/dL; reference range, 70 to 115 mg/dL). Another dog had high aspartate transaminase activity (47 U/L; reference range, 15 to 45 U/L), with mildly high creatine kinase activity (340 U/L; reference range, 50 to 275 U/L) and hypercholesterolemia (343 mg/dL; reference range, 130 to 300 mg/dL). The remaining dog had high alanine transaminase (696 U/L; reference range, 10 to 90 U/L) and aspartate transaminase (107 U/L; reference range, 15 to 45 U/L) activities.

Radiographs of the affected tibia were obtained for each dog and evaluated by board-certified radiologists at the participating institutions, and all had recorded findings consistent with an aggressive bone lesion involving the proximal aspect of the tibia at the site of a previous TPLO (Figure 1).
Osteosarcoma of the proximal aspect of the tibia was diagnosed on the basis of histologic evaluation in 27 dogs and cytologic evaluation of a fine-needle aspirate in 2 dogs. Histopathologic or cytologic diagnosis of osteosarcoma was made by board-certified pathologists or clinical pathologists, respectively. Stage III disease was diagnosed in 3 of 29 dogs that had staging tests performed at the time of osteosarcoma diagnosis; the remaining 19 dogs had stage II disease (Table 1).  

**TPLO information**—All study dogs underwent TPLO between 1998 and 2007, and 11 of the 29 surgeries had been performed at the participating institutions. Mean ± SD age at the time of TPLO was 4.0 ± 2.6 years. The TPLO plate type was known for 22 dogs; 3.5-mm plates were used in all of these cases. In most dogs (n = 18), 1 type of cast stainless steel TPLO plate was used; all of these surgeries were performed between 1998 and 2006. Four dogs had wrought stainless steel plates placed (2 dogs received plates [broad in one and narrow in the other] made by one manufacturer, and 2 received plates made by another source) in 2007. The plate type was not reported for 7 dogs that underwent TPLO. Four dogs had a history of infection at the TPLO site, and a positive culture result was reported for 1 dog (Staphylococcus pseudintermedius was isolated). The TPLO plate was removed in 7 dogs; plate removal was performed 527 and 1,403 days prior to osteosarcoma diagnosis because of infection in 2 dogs and at the time of osteosarcoma diagnosis (when biopsy samples were obtained) in 5 dogs. The mean ± SD interval between TPLO and osteosarcoma diagnosis was 5.3 ± 2.3 years (range, 1.0 to 10.7 years).  

**Treatments for osteosarcoma**—Twenty-three of 29 dogs underwent treatment for osteosarcoma at a previous TPLO site. Eleven dogs received curative-intent treatment (amputation and adjuvant chemotherapy or SRT and adjuvant chemotherapy). Twelve dogs received palliative-intent treatment, consisting of palliative-intent (coarse-fractionated) radiation therapy, palliative-intent radiation therapy followed by amputation, amputation without chemotherapy, pathological fracture repair, or treatment with analgesic medications alone.  

**Curative-intent treatments**  
Ten dogs underwent amputation of the affected limb and adjuvant chemotherapy. The only chemotherapeutic agent administered was carboplatin (300 mg/m², IV, q 3 wk) for 6 of these dogs. The remaining 4 dogs received alternating carboplatin (300 mg/m², IV, q 6 wk) and doxorubicin hydrochloride (30 mg/m², IV, q 6 wk) treatment. Two of the 10 dogs had metastasis to the popliteal lymph node diagnosed on the basis of histopathologic findings after limb amputation but did not have evidence of metastatic disease at other sites prior to or immediately following surgery. For dogs that had amputation with carboplatin as the sole chemotherapeutic agent, the number of doses administered was 4 (n = 4), 3 (1), or 1 (1). Three of the 4 dogs that received alternating carboplatin and doxorubicin chemotherapy had 3 doses of each drug administered, and 1 dog received only 1 dose of each drug.  

One dog received SRT, with 3 radiation fractions administered (a total dose of 34.3 Gy was administered to 95% of the planned target volume). One dose of pamidronate (1.0 mg/kg [0.45 mg/lb], IV, given over 2 hours) was administered prior to SRT, and carboplatin (300 mg/m², IV) was administered every 3 weeks starting at the time of SRT. Six doses of carboplatin were planned, but only 5 doses were given because the treatment was discontinued when pulmonary metastatic disease was detected.  

**Palliative-intent treatments**  
Of 4 dogs that received palliative-intent radiation therapy, 3 had no adjunctive chemotherapy. Two of these 3 dogs each received two 8-Gy radiation fractions administered on consecutive days; one of the 2 had suspected metastases to the proximal aspect of the right humerus and left fourth rib and was also treated with pamidronate (1.0 mg/kg, IV). This dog later underwent limb amputation because of extensive soft tissue swelling in the proximal aspect of the tibia. The radiation dose per fraction was not recorded for the third dog. One dog had four 8-Gy radiation fractions administered weekly and received adjunctive chemotherapy via a continuous SC infusion that delivered 300 mg/m² of carboplatin over 3 days.  

One dog had pathological fracture of the proximal tibial diaphysis, which was stabilized with a plate (type not recorded) placed on the medial aspect of the tibia. No adjuvant chemotherapy was administered following surgery. Five dogs underwent amputation to treat primary tumor pain with no adjuvant chemotherapy. Two dogs received oral analgesic medications alone, including tramadol hydrochloride (3.0 to 5.0 mg/kg [1.36 to 2.27 mg/lb], PO, q 8 h) and gabapentin (5.0 mg/kg, PO, q 6 wk) treatment. Two of the 10 dogs had metastasis to the popliteal lymph node diagnosed on the basis of histopathologic findings after limb amputation but did not have evidence of metastatic disease at other sites prior to or immediately following surgery. For dogs that had amputation with carboplatin as the sole chemotherapeutic agent, the number of doses administered was 4 (n = 4), 3 (1), or 1 (1). Three of the 4 dogs that received alternating carboplatin and doxorubicin chemotherapy had 3 doses of each drug administered, and 1 dog received only 1 dose of each drug. One dog received SRT, with 3 radiation fractions administered (a total dose of 34.3 Gy was administered to 95% of the planned target volume). One dose of pamidronate (1.0 mg/kg [0.45 mg/lb], IV, given over 2 hours) was administered prior to SRT, and carboplatin (300 mg/m², IV) was administered every 3 weeks starting at the time of SRT. Six doses of carboplatin were planned, but only 5 doses were given because the treatment was discontinued when pulmonary metastatic disease was detected.  

**Table 1**—Summary of clinical staging results at the time of diagnosis in 24 of 29 dogs that developed osteosarcoma at a previous TPLO site.  

<table>
<thead>
<tr>
<th>Clinical staging test</th>
<th>No. of dogs that had the test performed</th>
<th>No. of dogs with metastases</th>
<th>Site of metastases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoracic radiography</td>
<td>22</td>
<td>1</td>
<td>Lungs</td>
</tr>
<tr>
<td>Abdominal ultrasonography</td>
<td>8</td>
<td>1</td>
<td>Liver and kidney</td>
</tr>
<tr>
<td>Full-body nuclear scintigraphy</td>
<td>4</td>
<td>1</td>
<td>Proximal aspect of the right humerus and left fourth rib</td>
</tr>
<tr>
<td>Lymph node (cytologic or histologic) evaluation</td>
<td>16</td>
<td>2</td>
<td>Popliteal lymph node</td>
</tr>
</tbody>
</table>

Five dogs had stage III (metastatic) disease.
One of the 2 dogs that received analgesic treatment alone had documented evidence of metastatic disease in the liver and spleen.

**Outcomes**—The date of death was known for 22 dogs: 17 were euthanized because of poor quality of life or progressive disease, 3 were euthanized for other reasons (including fecal incontinence, development of an atrial tumor, and progressive myelopathy), and 2 died of unknown causes (no necropsies were performed). Two dogs were still alive at the time of last follow-up (14 and 1,388 days). Five dogs were lost to follow-up (4 immediately after the diagnosis of osteosarcoma and 1 at 241 days after the diagnosis).

The median DFI for the 11 dogs that received curative-intent treatment was 195 days (range, 13 to 587 days). The median DFI for the 10 dogs treated with amputation and chemotherapy was also 195 days (range, 13 to 587 days; [Figure 2](#)). The 1 dog that underwent SRT and chemotherapy had a DFI of 116 days before pulmonary metastases were detected.

The MST for all dogs was 222 days (range, 5 to 1,388 days). The MST for dogs that received curative-intent treatment was 222 days (range, 96 to 1,388 days), and that for dogs in this group that underwent both amputation and IV chemotherapy was 313 days (range, 96 to 1,388 days). Survival time of the dog that underwent SRT and chemotherapy was 141 days. The 4 dogs that received palliative-intent radiation therapy had survival times of 67, 165, 316, and 387 days. There was no significant ($P = 0.68$) difference between the MSTs of dogs that received palliative- and curative-intent treatments (Figure 3). The 6 dogs that did not receive treatment were all euthanized ≤ 14 days after the diagnosis of osteosarcoma.

**Discussion**

Results of the present study supported that osteosarcoma should be a differential diagnosis for dogs with a history of TPLO that later develop lameness and swelling at the previous surgical site. Diagnostic tests such as radiography, with cytologic or histologic evaluation of samples, can be used to confirm the diagnosis.2 The MST for dogs treated with amputation and adjuvant chemotherapy was 313 days in the present study, which is comparable to MSTs of 235 to 540 days previously reported for dogs with osteosarcoma treated by means of amputation and adjuvant chemotherapy.27–41

The ages of dogs at the time of osteosarcoma diagnosis and TPLO in the present study were similar to those of dogs at the time of treatment for appendicular osteosarcoma and cranial cruciate ligament rupture, respectively, in other reports.1,42–49 The study population predominantly comprised large-breed dogs, which is a consistent finding in other studies1,42–49 of treatment of appendicular osteosarcoma and cranial cruciate ligament rupture. In the present study, all dogs were neutered and most dogs were females, which may reflect the higher prevalence of cranial cruciate ligament rupture that has been reported for these groups, compared with the prevalence for other dogs.50

Most TPLO plates used for the surgery in this case series were cast stainless steel plates from a single source; this reflects the exclusive availability of this specialized surgical plate through part of the study period and is attributable to a patent for this plate in the late 1990s and early 2000s together with the long interval commonly observed between fracture or implant placement and the development of fracture- or implant-associated osteosarcoma.15 These TPLO plates differ from other stainless steel TPLO plates in that they are made of cast rather than wrought stainless steel. One case report23 raised concerns about the metallurgy of this specific type of TPLO plate and formation of sarcoma at the site of a TPLO. In that case report,22 intra- and extracellular debris was found within the tumor that was assumed (on the basis of appearance) to have originated from the plate; additionally, osteolysis was present immediately beneath the plate. Analysis of the plate following amputation of the affected limb revealed a degree of pitting and loss of metal on the side of the plate that had been in contact with the tibia, indicating the presence of corrosion.22

Two studies31,32 have assessed the material composition of the same type of cast stainless steel TPLO
plate used in the present study, with different findings: Boudrieau et al reported that not all plates examined met specifications for chemical composition of cast surgical implants (American Society for Testing Materials standard 745) and that tissues surrounding the plate had evidence of adverse reactions consistent with corrosion. In contrast, Lackowski et al found consistent composition of all cast TPLO plate’s evaluated. Charles and Ness examined TPLO plates of this type following explantation and found evidence of crevice corrosion that may have been initiated in surface irregularities and pores of the plates resulting from their casting manufacture.

One case report has documented osteosarcoma following TPLO in which a wrought stainless steel TPLO plate was placed. Results of the present case series further confirm that osteosarcoma can develop at the site of previous TPLO when wrought stainless steel TPLO plates are used for fixation. Further study is needed to determine the incidence of osteosarcoma at the proximal aspect of the tibia following TPLO with plates of various types.

The interval from TPLO to diagnosis of osteosarcoma at the previous TPLO site in dogs of the present study was 5.3 years, with a range of 1.0 to 10.7 years. This is similar to previously reported postsurgical intervals for the diagnosis of sarcomas at TPLO sites (3.0 to 6.5 years). Reported mean time to diagnosis of fracture-associated sarcoma (5.8 years [range, 1 to 12 years]), for osteosarcoma at site of a triple pelvic osteotomy (11 years), and for osteosarcoma at the site of total hip replacement (8 years) following surgery are similar. This similarity in time to the development of sarcomas may imply similar causal factors. Several inciting or causal factors have been proposed for development of fracture- or implant-associated sarcoma, including chronic infection and inflammation, local tissue reaction to the implant, corrosion of the implant and resultant corrosion products effects on local tissue, delayed bone healing, and decreased vascularity of the fractured bone.

Prevalence of fracture-associated osteosarcoma has been reported as 4.5% (12/264 dogs). Although the incidence of osteosarcoma at previous TPLO sites in dogs has yet to be investigated in a peer-reviewed study, it is thought to be low (< 1%). The present case series was designed to elucidate the clinical characteristics and outcome in a group of dogs with this condition; we did not estimate incidence, which would be outside of the scope of the case series design. Because the study focused on dogs with a diagnosis of osteosarcoma following TPLO at different institutions, this case series did not include evaluation of dogs that underwent TPLO and did not develop osteosarcoma, which would allow an estimate of incidence to be calculated. The findings from the present study, particularly the interval between TPLO and diagnosis of osteosarcoma, will be important for design of a cohort study to assess the incidence and any potential causal relationship between TPLO and osteosarcoma at the proximal aspect of the tibia.

Five dogs in the present study received radiation treatment, and 2 of these dogs had the TPLO plate removed prior to treatment as part of a biopsy procedure. However, in the authors’ experience, both SRT and palliative-intent radiation therapy can be performed adequately without plate removal with the guidance of a medical radiation physicist. Interestingly, 2 of 10 dogs that received curative-intent treatment had metastasis to a regional lymph node, which is uncommonly reported in dogs with appendicular osteosarcoma (10/228 [4.4%] in 1 study) and has been associated with a poorer prognosis (MST, 59 days and 318 days for dogs with and without metastases to lymph nodes, respectively). The 2 dogs with metastases to popliteal lymph nodes in the present study had survival times (405 and 1,388 days) that were longer than the MST. A wider-scale, multi-institutional study would be useful to determine whether the prevalence of metastases to lymph nodes is higher in dogs with TPLO-site osteosarcoma than in other dogs with appendicular osteosarcoma and whether survival time differs significantly between these groups.

The limitations of the present study should be considered when interpreting the results. These data were collected from multiple institutions to maximize the number of cases that could be described for a rare problem; however, there is no knowledge that treatment advice and treatment protocols used likely varied. The retrospective nature of the study could also have contributed to difficulty in obtaining complete data for each dog. Another limitation of the study was that the radiographic, cyto- logic, and pathological examinations were performed by different radiologists, clinical pathologists, and anatomic pathologists, which introduces variability in reporting and interpretation. The specific relationship between TPLO and osteosarcoma was not investigated, and further research is needed to evaluate the incidence of osteosarcoma in dogs treated with this procedure. The results of this study suggest osteosarcoma should be a differential diagnosis for dogs with a history of TPLO that later develop lameness and swelling at the previous surgical site.

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