Dogs undergoing surgical excision of mast cell tumors are not at increased risk of incisional complications

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OBJECTIVE
To retrospectively compare the incidence of incisional complications in dogs undergoing surgery for mast cell tumors (MCTs) and soft tissue sarcomas (STSs).

ANIMALS
218 dogs.

PROCEDURES
Dogs that underwent excision of ≥1 MCT, STS, or both from January 2014 to July 2019 and had ≥30 days postoperative follow-up were included. Signalment; anesthesia and surgery time; administration of propofol; tumor type, grade, location, and size; intended surgical margins; histologic margins; perioperative radiation, chemotherapy, and corticosteroid and antihistamine (MCT group) treatments; and incisional complications (classified as major or minor) were recorded. Follow-up information was obtained from owners or primary care veterinarians, if needed. Incidence and severity of incisional complications were compared between the MCT and STS groups. Potential risk factors were assessed for associations with incisional complications by simple and multiple logistic regression analysis.

RESULTS
The 218 dogs underwent surgery for 293 tumors (209 MCTs and 84 STSs). Complication rates did not differ between MCT (28/209 [13%]) and STS (12/84 [14%]) groups. For the MCT group, incomplete margins (vs complete or narrow), increasing Patnaik tumor grade, and postoperative chemotherapy (yes vs no) were associated with increased odds of incisional complications on simple regression. On multiple logistic regression, postoperative chemotherapy was associated with increased odds of incisional complications for the MCT group and both groups combined.

CONCLUSIONS AND CLINICAL RELEVANCE
On the basis of the results, we suggest that chemotherapy be used with caution ≤30 days after surgery for dogs with MCTs. Corticosteroid administration was not associated with incisional complications for the MCT group in this study.

Mast cell tumors (MCTs) are the most common cutaneous tumors in dogs, accounting for 16% to 21% of all skin neoplasms in this species.1–3 MCTs are highly variable in their gross appearance, biological behavior, and clinical progression. The best predictor of prognosis and outcome is histologic tumor grade (Patnaik or Kiupel schemes).4–8 The treatment of choice for MCTs is wide surgical excision. Recommended surgical margins vary, depending on the histologic tumor grade (if this is known before surgery), but are generally accepted as 2 to 3 cm laterally and 1 fascial plane deep to minimize the risk of leaving residual disease beyond the grossly visible tumor.9,10 Some authors have proposed that 2-cm lateral margins or a proportional margins approach both provide adequate local disease control and may minimize patient morbidity compared with the more traditional recommendation of 2- to 3-cm lateral margins.11,12 Chemotherapy and radiation therapy can be used as adjuncts to surgical excision, particularly in patients with incomplete tumor excision. The etiopathogenesis of MCTs is poorly understood and likely multifactorial. A genetic component has been suggested because some breeds, including Boxers and Boston Terriers, are more commonly affected than others.2

A unique feature of normal and neoplastic mast cells is the presence of granules that contain an array of bioactive compounds, including histamine, heparin, proteases, and cytokines.1,3 Degranulation and release of these bioactive compounds can occur spontaneously or may be stimulated by physical manipulation (eg, during surgical resection), chemotherapeutic agents, or radiation.13 Once released into the local tissue environment, these compounds induce several responses, including vasodilatation, increased vascular permeability, and activation of other effector cells.5 It is widely accepted in veterinary medicine that the presence of bioactive compounds within MCTs contributes to poor wound healing postoperatively. Existing literature supports this idea, but clinical studies have produced conflicting results. Results of a
study by Huttenen et al14 showed that mast cells and their mediators (specifically histamine and heparin) inhibit keratinocyte growth and epidermal regeneration in vitro. Multiple studies have demonstrated that dogs with MCTs have higher circulating concentrations of histamine than healthy dogs.13,15 These studies highlight the importance of bioactive compounds in MCTs, particularly in the case of incomplete excision where microscopic, or even gross, disease is left behind.2,14,16,17 Intuitively, in the event of incomplete excision, residual disease would exert an inhibitory effect on the local tissue environment and result in delayed wound healing. Killick et al18 investigated this hypothesis in a retrospective comparison of wound healing complications in dogs after complete or incomplete excision of MCTs and histiocytomas, but ultimately, they were unable to identify a difference in these outcomes after incomplete versus complete MCT excisions in their study population. In addition, the complication rate after MCT and histiocytoma excisions was similar (~20%).18

Anecdotally, veterinarians report more healing complications in patients after resection of MCTs compared with other tumor types. This observation serves as the rationale for the study reported here. The objective of this study was to retrospectively compare the incidence of incisional complications in dogs after MCT excision with those in dogs after soft tissue sarcoma (STS) excision. The hypothesis was that there would be a significantly greater incidence of incisional complications after excision of MCTs. A secondary objective of the study was to identify risk factors associated with incisional complications. STSs were selected as the comparison group mainly because this tumor type lacks the bioactive compounds found in mast cell granules, and therefore, affected dogs would not be expected to have a risk for developing incisional complications secondary to inflammatory mediators present in the local tissue environment. Additionally, STSs are a commonly encountered neoplasm, representing 8% to 15% of cutaneous tumors in dogs.19 Although STSs comprise several specific tumor types, they are considered together because they have similar biological behaviors. As with MCTs, the treatment of choice for STSs is wide surgical excision.

Materials and Methods

Case selection and study design

Medical records of client-owned dogs that were presented to the University of Georgia Veterinary Teaching Hospital for surgical excision of an MCT or STS over a continuous period from January 1, 2014, to July 31, 2019, were evaluated. Dogs were included when the following criteria were met: a diagnosis of either MCT or STS was made on the basis of histopathologic findings, surgical excision was performed at the University of Georgia Veterinary Teaching Hospital, and follow-up information was available ≥30 days after surgery. Scar revisions, radical excisions, and dogs that underwent multiple surgical excisions within the allotted time were included, as this represented a large proportion of cases treated at this tertiary specialty center. Dogs with multiple concurrent MCTs, subcutaneous MCTs, or concurrent MCTs and STSs were also included.

Medical records review

Information obtained from the medical records included signalment (breed, age, body weight, reproductive status, sex, and breed); anesthesia time (measured from patient intubation to discontinuation of inhalant or injectable anesthetic agents at procedure conclusion); surgery time (measured from initial skin incision to completion of skin closure); whether propofol was used in the anesthesia protocol, tumor type, measurement of the tumor at its greatest diameter, anatomic location of tumor (categorized as limbs, thorax-abdomen, head-neck, or tail-perineum-genitalia); histologic tumor grade (Patnaik [grades 1 to 3 and subcutaneous] and Kiupel [high grade and low grade] schemes for MCTs; Kutz [grades 1 to 3] scheme for STSs); intended surgical margins; histologic margins; perioperative radiation treatment or chemotherapy; perioperative administration of corticosteroids, antihistamines, or both (for the MCT group); a description of any postoperative complications; and interventions for complications. Preoperative chemotherapy and radiation treatment were defined as those administered in the 30 days preceding surgery, and postoperative chemotherapy and radiation treatment were defined as those administered in the 30 days after surgery. For corticosteroid and antihistamine treatments, drug administration was defined as those administered in the 30 days after surgery. Scar revisions, radical excisions, and dogs that underwent multiple surgical excisions were classified as preoperative and postoperative treatment, respectively. Intended surgical margins (ie, those recorded in the surgical report) were considered wide if they were reported as ≥2 cm and marginal if they were reported as <2 cm. Margins were considered as debulking or intralesional if grossly visible tumor tissue remained after surgery and radical if the entire anatomic compartment was excised (eg, by amputation). Histologic margins were defined as complete (>2 mm), narrow (>0 and ≤2 mm), and incomplete.

Follow-up

Follow-up information was obtained from owners, primary care veterinarians, or both through email or telephone communications. Contact was made by the authors or small animal research technicians at the authors’ facility who asked standardized questions about occurrence of complications within 30 days after surgery and what signs were noted by the owner or primary care veterinarian. When a complication was noted to have occurred ≤30 days after surgery, medical records
were requested from the primary care veterinarian for review by the authors.

Incisional complications and interventions
Incisional complications were defined as the presence of any incisional discharge, foul odor, or dehiscence for which an intervention was performed. Interventions were defined as minor (antimicrobial treatment, placement of additional sutures or skin staples, or placement of a bandage) or major (revision surgery, negative pressure wound treatment, surgical placement of an active suction drain, or hospitalization for daily wound care). Incisional complications were classified by the type of intervention required (major vs minor).

Statistical analysis
Histograms and quantile-quantile plots of data for all dogs and by tumor type were used to assess data for normality. Descriptive statistics were reported as mean ± SD for data that were normally distributed and as median and interquartile (25th to 75th percentile) range (IQR) for skewed variables. Although some dogs had multiple tumors, in the authors’ judgment, an incisional complication in 1 tumor does not increase the odds of a complication in another tumor. Thus, presence of complications for tumors within the same dog was assumed to be independent in the analyses.

Simple logistic regressions were used to assess whether tumor type was associated with odds of incisional complications and whether other potential risk factors were associated with the odds of incisional complications in dogs with MCTs (MCT group), dogs with STSs (STS group), and all dogs combined. Breed was not included in this analysis. Subcutaneous Patnaik scores were not included in the analyses, so the remaining Patnaik scores were analyzed as ordinal data. In dogs with incisional complications, simple logistic regression was also performed to assess potential associations between tumor type and the odds of a major (vs minor) incisional complication. Because of quasi-separation and the small numbers of dogs in each subcategory, the Firth bias-reduced penalized logistic regression method was used for analysis of anatomic location of the tumor for the STS group and surgical margins for the MCT group to obtain model convergence.

Multiple logistic regression models were developed to assess the odds of incisional complications in the MCT group and all dogs combined to account for potential confounding factors. At least 10 complications/factor were required to support initial multiple logistic models. Not enough complications existed in the STS group (n = 13) to support a multiple logistic regression model, and the model for the MCT group (n = 28) was limited to 2 factors for inclusion in the initial model. For the model that included all dogs combined, all risk factors with values of P < 0.10 on univariable analyses were initially entered into the multiple logistic regression model. For both multiple logistic regression models, the highest risk factor with a value of P > 0.05 in the initial model was removed, and this was iterated until all remaining factors were significant.

Fisher exact test (for categorical variables), Welch t test (for continuous variables that were normally distributed), and Mann-Whitney test (for continuous variables that were skewed) were used to compare potential risk factors between the MCT and STS groups. Time to detection of an incisional complication was compared between the MCT and STS groups by means of negative binomial regression. For all analyses, values of P < 0.05 were considered significant.

Results
Dogs
Two hundred eighteen dogs with 293 tumor excisions (209 MCTs and 84 STSs) met the inclusion criteria. Thirty-two of 138 (23%) dogs in the MCT group had > 1 MCT, and 2 of 80 (3%) dogs in the STS group had > 1 STS. Two dogs (2/218 [0.9%]) had both an MCT and an STS. The mean age for dogs in the MCT and STS groups was 8.1 ± 2.8 years and 9.4 ± 2.6 years, respectively, with those in the STS group significantly (P < 0.001) older than those in the MCT group. There were 118 female dogs (117 [99.2%] spayed) and 100 male dogs (91 [91.0%] castrated). No difference between the MCT and STS groups was found with regard to sex distribution (P = 0.65). Dogs in the MCT and STS groups had mean body weights of 26.0 ± 13.7 and 31.2 ± 11.7 kg, respectively, with no significant (P = 0.98) difference between groups. For all dogs combined and dogs in the STS group, the odds of incisional complication increased by 20% and 40%, respectively, for every 5-kg increase in body weight on simple regression analysis (Table 1). For the MCT group, mixed-breed dogs were most common (n = 46), followed by Boxers (30) and Labrador Retrievers (17). For the STS group, mixed-breed dogs were also most common (n = 24), followed by Labrador Retrievers (11) and Golden Retrievers (10).

Incisional complications
Incisional complications were recorded for 40 of 293 (14%) tumors (29/40 [73%] minor and 11 [28%] major). No dog experienced > 1 complication. The complication rate for the MCT group (28/209 [13%]) was not significantly (P = 0.646) different from that for the STS group (12/84 [14%]). The proportion of complications in the MCT and STS groups classified as major (9/28 [32%] vs 2/12 [17%], respectively; P = 0.240) and mean time to detection of an incisional complication after surgery (13.7 ± 8.7 vs 8.7 ± 5.4 days, respectively; P = 0.07) were also not significantly different.
Tumor characteristics

Thirty-four of 209 (16%) tumor excisions in the MCT group and 16 of 84 (19%) tumor excisions in the STS group were scar revisions. Tumor diameter data were available for 139 tumors in the MCT group and 66 tumors in the STS group. The greatest tumor diameter for the STS group (median, 5.2 cm [IQR, 3.0 to 8.4 cm]; range, 0.4 to 30.0 cm) was significantly (\( P < 0.001 \)) larger than that for the MCT group (median, 1.5 cm [IQR, 1.0 to 2.4 cm]; range, 0.3 to 7.0 cm). However, this variable was not significantly associated with incisional complications, regardless of tumor type (Table 1).

The distribution of tumor locations was similar between the MCT and STS groups. MCTs were most commonly located on the limbs (81/209 [39%]), followed by the thorax-abdomen (67 [32%]), head-neck (32 [15%]), and tail-perineum-genitalia (26 [12%]) locations. The locations of 3 (1%) MCTs were not provided in the medical records. STSs were also most commonly located on the limbs (49/84 [58%]), followed by the thorax-abdomen (23 [27%]), head-neck (8 [10%]), and tail-perineum-genitalia (4 [5%]) locations. Tumor location was not significantly associated with incisional complications in either group (Table 1); however, tumor location was significantly associated with incisional complications on simple logistic regression analysis when both tumor types were combined. Specifically, tumors located on the limbs were more likely to have incisional complications than tumors in head-neck or tail-perineum-genitalia locations.

Patnaik scheme grades were available for 197 of 209 (94%) MCTs, and Kiupel scheme grades were available for 163 (78%) MCTs. MCTs were classified by use of the Patnaik scheme as grade 1 (14/197 [7%]), grade 2 (140 [71%]), grade 3 (10 [5%]), and subcutaneous (33 [17%]) and by use of the Kiupel scheme as low grade (151/163 [93%]) and high grade (12 [7%]). Increasing Patnaik scheme grade was significantly associated with incisional complications in the MCT group on simple regression analysis (Table 1). Kiupel grade was not significantly associated with this outcome. Kuntz scheme grades were available for 76 of 84 (90%) STSs. STSs were classified as grade 1 (42/76 [55%]), grade 2 (26 [34%]), and grade 3 (8 [11%]); tumor grade was not significantly associated with incisional complications for these tumors.

Surgical and histologic margins

Intended surgical margins were recorded for 188 of 209 (90%) MCTs; 105 of these 188 (56%) were classified as wide, 80 (43%) as marginal, 2 (1%) as radical, and 1 (1%) as debulking or intralesional. Intended surgical margin data were available for 82 of 84 (98%) STSs; 24 of these 82 (29%) were classified as wide, 39 (48%) as marginal, 12 (15%) as radical, and 7 (9%) as debulking or intralesional. The proportion of tumors with intended radical margins was lower for STSs than for MCTs (15% vs 21%, respectively), which was likely due to the lower Kiupel and Kuntz grades for STSs compared with MCTs. Histologic margins were classified as complete, narrow, or incomplete. Tumors with incomplete margins were more likely to have incisional complications than those with complete margins (Table 1), regardless of tumor type. Incomplete margins were more likely to have incisional complications than narrow margins (Table 1).
was significantly \((P < 0.001)\) greater for STSs than for MCTs. The intended surgical margin category was not significantly associated with incisional complications, regardless of tumor type (Table 1).

Histologic margin data were available for 206 of 209 (99%) MCTs and 84 of 84 (100%) STSs. Most histologic margins for MCTs were complete (116/206 [56%]), and 54 (26%) were incomplete and 36 (17%) narrow. The histologic margins for 38 of 84 (45%) STSs were complete, and 36 (43%) were incomplete and 10 (12%) narrow. For the MCT group, a histologically incomplete margin was associated with a significantly increased odds of a complication, compared with those for narrow or complete histologic margins, on simple regression analysis (Table 1). Histologic margin category was not significantly associated with incisional complications for the STS group or all dogs combined.

**Anesthesia time, surgery time, and propofol use**

Anesthesia time for the MCT group (n = 209; median, 166 minutes [IQR, 130 to 224 minutes]) was significantly \((P = 0.001)\) greater than that for the STS group (84; median, 140 minutes [IQR, 110 to 190 minutes]). Surgery time for the MCT group (n = 209; median, 85 minutes [IQR, 49 to 120 minutes]) was also significantly \((P = 0.002)\) greater than that for the STS group (84; median, 59.5 minutes [IQR, 42 to 98 minutes]). Propofol was used as part of the anesthesia protocol in 125 of 209 (60%) MCT and 58 of 84 (69%) STS excisions. The proportion of surgeries in which propofol was used did not differ between groups. Anesthesia time, surgery time, and propofol use were not significantly associated with incisional complications, regardless of tumor type (Table 1).

**Chemotherapy and radiation treatment**

Dogs underwent chemotherapy preoperatively for 29 of 209 (14%) MCTs and postoperatively for 56 (27%) MCTs; the preoperative chemotherapeutic agents included vinblastine \((n = 27)\) and toceranib (2). Postoperative chemotherapeutic agents included vinblastine \((n = 42)\), toceranib \((11)\), lomustine \((2)\), and chlorambucil \((1)\). Chemotherapeutic agents were used as single agents or used successively if an agent failed. Dogs underwent preoperative and postoperative chemotherapy for 0 and 1 (1%) STS, respectively, with doxorubicin administered in the latter case. For the MCT group, postoperative chemotherapy was significantly associated with an increased odds of incisional complications on simple regression analysis (Table 1). This analysis could not be performed for the STS group.

Dogs underwent postoperative radiation treatment for 4 of 209 (2%) MCTs and 6 of 84 (7%) STSs. No preoperative radiation treatments were performed for either group. Owing to the small sample size, these data were not analyzed for association with incisional complications.

**Corticosteroid and antihistamine treatment of dogs with MCTs**

For dogs of the MCT group, preoperative treatments included an antihistamine without a corticosteroid \((103/209 [49%] \text{ tumors})\), an antihistamine with a corticosteroid \((40 [19%])\), and an antihistamine without an antihistamine \((4 [2%])\). Postoperative chemotherapeutic agents included vinblastine \((n = 42)\), toceranib \((11)\), lomustine \((2)\), and chlorambucil \((1)\). Neither preoperative nor postoperative treatment with antihistamines \((P = 0.566 \text{ and } 0.768, \text{ respectively})\), corticosteroids \((P = 0.715 \text{ and } 0.869, \text{ respectively})\), or both types of treatments \((P = 0.829 \text{ and } 0.928, \text{ respectively})\) was significantly associated with incisional complications.

**Multivariable analysis of potential risk factors for incisional complications**

Variables included in the multiple logistic regression model are summarized in Table 2. For the MCT group, postoperative chemotherapy was significantly associated with an increased odds of incisional complications in this analysis. For all dogs combined, increasing body weight, postoperative chemotherapy,

### Table 2—Summary of multiple logistic regression analysis of selected factors for association with incisional complications in 218 dogs that underwent surgical treatment for MCTs or both MCTs and STSs.

<table>
<thead>
<tr>
<th>Variable</th>
<th>MCT</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(P) value (multiple)</td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td>Patient factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body weight</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Tumor factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anatomic location of tumor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limbs vs head-neck</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Limbs vs tail-perineum-genitalia</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>MCT tumor grade (Patnaik scheme)</td>
<td>0.110</td>
<td>4.3 (1.2–15.2)</td>
</tr>
<tr>
<td>Propofol use (yes vs no)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Postoperative chemotherapy (yes vs no)</td>
<td>0.028</td>
<td>2.7 (1.2–6.2)</td>
</tr>
</tbody>
</table>

See Table 1 for key.
and anatomic location of tumor on the limbs (vs the head-neck or tail-perineum-genitalia locations) were each significantly associated with an increased odds of incisional complications.

Discussion

In this study, we did not identify a difference between the incidence of incisional complications after MCT excisions and STS excisions in dogs. Although we considered that the ability of MCTs to cause intense peritumoral inflammatory responses would likely result in a greater incidence of incisional complications for these patients, the lack of a significant difference in this outcome could have been partially attributable to STSs being significantly larger than MCTs in this study. A larger tumor size results in a larger tissue defect after surgical excision, which may contribute to increased tension across the wound. Tension across a wound is a known risk factor for dehiscence; therefore, the causes for complications could have differed between the 2 groups, which was outside the scope of our retrospective study. Large tumor resections may also require reconstruction to minimize tension; however, investigation of this variable was also beyond the scope of this study.

The frequency of major complications did not differ between tumor types and may have been attributable to the small number of incisional complications that developed in the study sample. With a larger number of cases, any differences between tumor types may become more apparent. Our study was limited to a 5.5-year period because changes in standard operating procedures for the institution had occurred at the end of 2013 as a result of the opening of a new hospital facility.

MCT excisions that had incomplete histologic margins had a greater odds of incisional complications than those with narrow or complete histologic margins on simple regression analysis. This finding was in contrast to the results for this variable on multiple regression analysis as well as to the results of a previous study that did not identify an increased rate of complications after incomplete versus complete MCT excision. One possible explanation for this finding is that assessment of excision completeness is difficult, particularly for lower-grade tumors, because the mast cells at the edge of the lesion cannot be categorized as neoplastic or inflammatory. Bioactive compounds in mast cell granules could be expected to be released into the local wound environment after incomplete MCT resection and possibly contribute to delayed wound healing by interfering with keratinocyte growth and epidermal regeneration. Additionally, normal mast cells have been proposed to be recruited to the site of the tumor and be mistakenly assessed as residual disease. The presence of these cells would also be expected to increase the potential for incisional complications, such as dehiscence and infection.

Postoperative chemotherapy in the MCT group was associated with a greater odds of incisional complications than when not elected on simple and multiple logistic regression analysis. These analyses were not performed for the STS group because dogs that undergo surgery for STSs do not routinely receive adjunctive chemotherapy owing to the locally invasive nature of these tumors. Only 1 dog received a chemotherapeutic agent after excision of an STS. Chemotherapeutic agents have a number of cytotoxic mechanisms of action and preferentially target cells that undergo rapid division; however, any tissues, including the cells responsible for wound healing, are susceptible to these agents’ effects. Chemotherapy in the immediate postoperative period may interfere with wound healing, thus increasing the possibility of incisional complications (eg, dehiscence). Results of human medical studies support this idea, but recent literature on the subject is lacking. To our knowledge, this concept has not been directly investigated in veterinary medicine. More recently, a paradigm shift has been proposed in human medicine that suggests that postoperative chemotherapy (≤ 24 to 36 hours after surgery) may be beneficial in some cases. This clinical paradigm suggests that excision of the gross tumor activates the wound healing cascade, which may promote or disseminate neoplastic cells hematogenously. In a surgical wound, the mechanisms for binding neoplastic cells to the vasculature may be enhanced by the presence of inflammatory mediators. Under these conditions, perioperative chemotherapy may reduce the overall neoplastic burden and prolong the disease-free interval by targeting neoplastic cells before they metastasize. We are unaware of any large-scale clinical trials that are investigating this concept. It was standard operating procedure at our institution to delay the initiation of postoperative chemotherapy until after the time of complete surgical wound healing; therefore, postoperative chemotherapy was not initiated < 2 weeks after tumor excision in the present study.

In the present study, the confounding effect of tumor grade on the decision to use chemotherapy must be considered. The likelihood of postoperative chemotherapy may have been greater after excision of high-grade tumors because of these tumors' more aggressive behavior and higher metastatic rate. Increasing Patnaik tumor grade was significantly associated with incisional complications in the MCT group on simple regression analysis. The same type of association was not identified for the simplified Kiupel grading scheme. This finding may have been attributable to a lack of power because not all MCTs had a Kiupel grade reported in addition to the Patnaik grade. However, no significant impact of increasing Patnaik grade on the odds of incisional complications was observed on multiple logistic regression analysis. This finding suggests that postoperative chemotherapy was likely the more important factor for
development of incisional complications, but given the relatively small number of incisional complications that developed in this study (28/209 excised tumors in the MCT group), a more definitive conclusion could not be made about the relationships between these factors and incisional complications. Additional studies with a larger number of cases should be performed to further elucidate this relationship.

Perioperative corticosteroid administration had no association with incisional complications for the MCT group. This finding was in contrast to what is generally understood about corticosteroids and how they affect wound healing. Corticosteroids exert a potent anti-inflammatory effect; however, the inflammatory phase is a critical and necessary step in wound healing. Corticosteroids are known to negatively affect wound healing by inhibiting production of several proinflammatory cytokines, such as tumor necrosis factor-α, transforming growth factor-β, and insulin-like growth factor 1, ultimately impeding collagen deposition. It is possible that no association was detected because of the small number of MCTs for which dogs received preoperative or postoperative corticosteroid treatment (44/209 [21%] and 55 [26%], respectively). Corticosteroids also exert an antitumoral effect, although the exact mechanism is not well understood. This antitumoral effect, as well as decreased inflammation, may have had a protective effect against development of related incisional complications.

Perioperative antihistamine administration had no association with incisional complications for the MCT group. First-generation type 1 antihistamines, such as diphenhydramine, competitively inhibit histamine H1 receptors and are commonly used clinically to prevent systemic and local tissue reactions to the release of histamine produced by MCTs. Theoretically, antihistamine treatment may provide some protective benefit against an incisional complication by blocking the action of histamine at the local tumor excision site. However, 1 study found that IV diphenhydramine administration had no significant effect on circulating plasma histamine concentrations in dogs undergoing MCT excision, and we found in the present study no protective effect of antihistamine treatment against incisional complications in the MCT group. Further studies are warranted to investigate the potential clinical benefits of antihistamine treatment for dogs with MCTs.

Increasing body weight was associated with an increasing odds of incisional complications on multiple logistic regression analysis for all dogs combined. Body weight may have been a confounding factor for the STS group because these dogs were typically heavier than those in the MCT group, although mean body weight was not significantly different between groups. Another study revealed a similar connection, and the authors speculated that heavier body weight may have contributed to increased mechanical stress on surgical wounds and that signs of inflammation were noted more readily in larger dogs because of their size. It is unclear whether an association between incisional complications and body weight could reflect differences in tumor behavior in small-breed versus large-breed dogs or a relationship with nutritional status. Body condition score and nutritional status were not assessed in the present study, which prevented further elucidation of the relationship.

Anesthesia and surgery times for MCT excisions were significantly longer than those for STS excisions in our study. One possible explanation for prolonged anesthesia time was that a number of dogs in the MCT group underwent preoperative imaging, such as a CT scan, during the same anesthetic event. Prolonged anesthesia and surgery times have been associated with an increased odds of surgical site infections in other studies. However, the clinical significance of this finding in the present study is questionable because the differences in mean anesthesia and surgery times between the 2 groups were 10 minutes and 6 minutes, respectively. Additionally, despite the differences in anesthesia and surgery times, no difference in incisional complication rates was found between the 2 groups.

Propofol use has been identified as a risk factor for surgical site infections in previous studies, where it has been proposed that the lipid-based emulsion provides an environment suited for microbial growth and may contribute to surgical wound infection. In the present study, propofol administration was not associated with incisional complications.

As with any retrospective study, the present study had several limitations. We relied on accurate and complete representation of the relevant data within the medical records. Many records were missing results for ≥ 1 variable(s), which could have affected the statistical findings. Reliance on owners' reporting of incisional complications was also a limitation, as the data could have been affected by reporter bias, inaccurate or incomplete recall, inability to recognize a complication, incorrect classification of a complication, or a combination of these factors.

On the basis of the results of the present study, we suggest that adjunctive chemotherapy be used with caution ≤ 30 days after excision of MCTs in dogs because such treatment was associated with an increased odds of incisional complications, although tumor grade was likely a factor in the decision to include chemotherapy in the treatment plan. Corticosteroid use was not associated with incisional complications in this study and appears to be safe for perioperative use in dogs with MCTs. Further prospective studies are required to investigate the antitumor effects of corticosteroids in dogs.

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