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Objective—To evaluate the incidence of and potential risk factors associated with development of postoperative infection-inflammation in a large number of dogs with rupture of the cranial cruciate ligament (CCL) that were treated via elective surgery.

Design—Retrospective case series.

Animals—808 dogs that underwent surgery (902 procedures) for rupture of the CCL.

Procedures—Medical records of dogs that underwent extracapsular lateral suture (ECLS) stabilization or tibial plateau leveling osteotomy (TPLO) between January 1, 2005, and December 31, 2006, were reviewed. Data regarding development of postoperative infection-inflammation were obtained. Potential risk factors were identified and recorded.

Results—496 ECLS surgeries were performed, and 406 TPLO surgeries were performed. Infection-inflammation developed in 55 of 902 (6.1%) surgeries within 6 months after surgery. There was a significant difference in infection-inflammation rate after the ECLS surgeries (21/496 [4.2%]), compared with rate after the TPLO surgeries (34/406 [8.4%]). Factors associated with a significantly lower rate of infection-inflammation included the use of suture material other than stainless-steel staples for skin closure and postoperative oral administration of antimicrobials.

Conclusions and Clinical Relevance—TPLO was associated with a significantly higher rate of infection-inflammation than the infection-inflammation rate after ECLS stabilization. The use of suture material other than staples for skin closure and postoperative oral administration of antimicrobials may be protective in minimizing infection-inflammation in dogs with rupture of the CCL that are treated via ECLS or TPLO. (J Am Vet Med Assoc 2010;236:88–94)

C omplete or partial rupture of the CCL is the most common injury affecting the stifle joint in dogs.1 Numerous intra-articular and extra-articular procedures have been developed to stabilize cranial cruciate–deficient stifle joints in dogs.2 Extracapsular lateral suture stabilization is commonly used to inhibit cranial drawer motion and internal rotation of the tibia.3 Tibial plateau leveling ostectomy is effective in returning dogs with CCL rupture to normal function by neutralizing the effects of cranial tibial thrust.4

Postoperative infection can cause patient morbidity, affect the success of initial surgical intervention, delay healing, and incur additional costs for owners. In the veterinary literature, infection rates for clean surgical procedures range from 3.6% to 5.8%.4,4 As reported in 1 study,4 postoperative infection rates in dogs undergoing elective orthopedic surgery can be decreased by the prophylactic use of antimicrobials. General principles have been described for perioperative administration of antimicrobials for prophylaxis in human medicine (Appendix),5–11 and these can be used in developing guidelines for veterinary medicine.

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<table>
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<th>Abbreviations</th>
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<tr>
<td>CCL</td>
<td>Cranial cruciate ligament</td>
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<tr>
<td>CI</td>
<td>Confidence interval</td>
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<td>ECLS</td>
<td>Extracapsular lateral suture</td>
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<td>OR</td>
<td>Odds ratio</td>
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<td>TPLO</td>
<td>Tibial plateau leveling ostotomy</td>
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The purpose of the retrospective case series reported here was to evaluate the incidence of postoperative infection-inflammation in a large number of dogs with rupture of the CCL treated via elective surgery at a referral hospital. We also sought to evaluate potential risk factors associated with the development of postoperative infection-inflammation in these patients. Our hypothesis was that the TPLO procedure would be associated with a higher rate of postoperative infection-inflammation, compared with the rate after the ECLS procedure.

Materials and Methods

Case selection—Medical records of all dogs that underwent ECLS or TPLO procedures as treatment for a ruptured CCL between January 1, 2005, and December 31, 2006, at our referral veterinary hospital were reviewed. Dogs that had concurrent orthopedic surg-
ceral procedures, such as correction of a luxating patella, arthroscopic evaluation of a joint, or angular limb correction, were excluded. Dogs that had bilateral ECLS or TPLO procedures during a single anesthetic episode were also excluded. Dogs that had ECLS or TPLO procedures on both stifles joints during separate anesthetic events were included in the statistical analyses as 2 separate patient interventions, provided other inclusion criteria were met.

Medical records review—Information was extracted from the medical records. Data recorded included surgical procedure (ECLS or TPLO), signalment (sex, age, breed, and body weight), limb affected, concurrent infections (eg, urinary tract, skin, or other location), use of concurrent NSAIDs, duration of anesthesia (defined as approximate time from initiation of surgical scrub until extubation), experience of surgeon, type of CCL rupture (partial or complete), surgery (ECLS or TPLO), method of skin closure, perioperative and postoperative administration of antimicrobials (defined as any antimicrobial given within 24 hours of surgery and for any length of time > 24 hours after surgery, respectively), and time to follow-up evaluation (days until suture removal and weeks until recheck examination).

The definition of postoperative surgical site infection has varied among reports. By use of all follow-up information available from the medical record, appearance of the incision at the time of suture removal (within 21 days after surgery) was characterized as grossly normal or infected-inflamed. On the basis of a definition in another study, a wound was classified as infected-inflamed when purulent wound drainage, abscessation, or fistulation were detected or when ≥ 3 of the following were evident simultaneously: redness, swelling, signs of pain, heat, serous wound drainage, or wound dehiscence. Signs suggestive of infection-inflammation at the time of recheck examination (within 6 months after surgery) included the aforementioned factors with the addition of joint effusion, moderate to severe lameness, and pain evident during palpation of the tissues over the implants. Because radiography was not routinely performed at the recheck examination for patients that underwent ECLS surgery, radiographic evidence of osteomyelitis was not included in the evaluation. Positive results for bacterial cultures were useful in determining infection, but a negative culture result did not preclude the classification of infected-inflamed when the other criteria were met. Patients were lost to follow-up monitoring when they were not returned to our facility for examination within 6 months after the ECLS or TPLO procedure.

Anesthesia was induced with propofol (4 to 6 mg/kg [1.8 to 2.7 mg/lb], IV, to effect), and dogs were anesthetized to an adequate depth of anesthesia to allow performance of surgical procedures; slight variations in premedications, anesthetics, and analgesics were not considered relevant for this study and therefore were not reported. All dogs received cefazolin (22 mg/kg [10 mg/lb], IV) prophylactically at induction and every 120 minutes thereafter until the end of anesthesia. The hind limb was clipped and aseptically prepared for surgery in a routine manner by trained veterinary technicians. The ECLS procedure was performed via modifications of a technique described elsewhere. Briefly, a lateral parapatellar incision was made. Lateral arthrotomy was performed to remove remnants of the CCL and to enable the surgeon to inspect the menisci. The stifle joint was then stabilized with 1 or 2 circumfemoral-tibial monofilament nylon sutures secured with hand ties or metal crimps. The biceps fascia was imbricated, and the subcutaneous tissues and skin were closed in a routine manner. The TPLO procedure was performed as described elsewhere, with minor variations in accordance with surgeon preference. Briefly, a medial parapatellar incision was made. Medial arthrotomy was performed to remove remnants of the CCL and to enable the surgeon to inspect the menisci. A bivalved saw was used to perform an osteotomy of the proximal portion of the tibia, and the tibial plateau was rotated and secured with a specially designed bone plate and cortical bone screws. The fascia was closed to cover the implants, and the subcutaneous tissues and skin were closed in a routine manner.

Administration of antimicrobials after surgery was at the discretion of the primary surgeon. Reasons for use of antimicrobials and the type of antimicrobial chosen were based on surgeon preference, a recorded break in sterile technique, evidence of concurrent potential infection, or other factors that could not be determined from the medical record.

Statistical analysis—All analyses were performed by use of statistical software. Associations between qualitative variables were tested via χ² tests of independence or a Fisher exact test. Associations between quantitative and qualitative variables were tested via 1-way ANOVA, t tests, or both, as appropriate. Logistic regression was used to determine any predisposing factors that would affect the odds of infection-inflammation and to determine the extent to which variables increased the odds of developing infection-inflammation in a particular patient. For all analyses, a value of P < 0.05 was considered significant. All descriptive data were reported as mean ± SD.

Results

Sample population—Records of 1,263 dogs that underwent surgery because of rupture of the CCL during the 2-year period were evaluated, and 1,088 surgical interventions were eligible for inclusion in the study. Of these, 186 were lost to follow-up monitoring. The remaining 902 surgeries were included in the statistical analysis. Of these, 496 (55.0%) were the ECLS procedure and 406 (45.0%) were the TPLO procedure.

Signalment—Sex, age, and breed did not significantly affect the rate of infection-inflammation. Mean weight of dogs undergoing the ECLS procedure (25.4 kg [55.88 lb]) was significantly (P < 0.001) less than that of dogs undergoing the TPLO procedure (42.2 kg [92.84 lb]). Of the 902 surgeries, 492 (54.5%) were on the left limb and 410 (45.5%) were on the right limb. The mean duration of anesthesia for the ECLS surgeries (62 minutes) was significantly (P < 0.001) less than the mean duration of anesthesia for the TPLO surgeries (125 minutes). Neither mean body weight nor mean duration of anesthesia differed significantly between
dogs that developed infection-inflammation and those that did not (Table 1).

**Surgical procedure**—Infection-inflammation developed after 55 of 902 (6.1%) surgeries within 6 months after surgery. The infection-inflammation rate for the ECLS procedure (21/496 [4.2%]) was significantly (P = 0.010) less than that for the TPLO procedure (34/406 [8.4%]). Consistent results were obtained when evaluating ORs. The overall odds of developing postoperative infection-inflammation, regardless of surgical procedure, were 6.49. There was a significant difference between the 2 procedures: the odds of developing infection-inflammation after TPLO was 0.0914, whereas the odds of developing infection-inflammation after ECLS surgery was 0.0442. Thus, the OR of TPLO to ECLS surgery for the development of infection-inflammation was 2.068.

Duration of anesthesia and body weight—Mean duration of anesthesia and mean body weight differed significantly with respect to the procedure; therefore, they could have been confounding variables. To test this, the data for duration of anesthesia were stratified (10-minute intervals) and examined at the interval where the number of ECLS and TPLO surgeries was most balanced. Results for infection-inflammation rate on the basis of surgical procedure during this interval were nearly the same as that for all dogs, with the infection-inflammation rate after TPLO being 1.98 times that after ECLS surgery. A similar test was then performed by stratifying the data by 10-kg (22-lb) intervals of body weight. In the interval with the greatest overlap, the infection-inflammation rate after TPLO was 2.5 times that after ECLS surgery, which was higher than for all 902 surgeries. These ORs suggested that mean duration of anesthesia and mean body weight were not confounding variables.

**Closure of the skin**—Nonabsorbable nylon suture was used to close the skin after 644 (71.4%) surgeries, stainless-steel staples were used to close the skin after 231 (25.6%) surgeries, and an intradermal suture pattern without skin sutures was used after 27 (3.0%) surgeries. There was a significant (P = 0.027) difference in the rate of infection-inflammation between the use of skin staples and the other methods of skin closure; 21 of 231 (9.1%) surgeries with staples developed infection-inflammation, compared with 34 of 671 (5.1%) surgeries with other suture materials. The odds of developing postoperative infection-inflammation were 1.9 times as high when stainless-steel staples were used to close the skin than when other methods of skin closure were used.

Of the 496 ECLS surgeries, 39 (7.9%) received staples, and of the 406 TPLO surgeries, 192 (47.3%) received staples. There was a significant (P < 0.001) difference between these 2 percentages, and the proportion of TPLO surgeries with stainless-steel staples was 6.7 times as high as the proportion of ECLS surgeries with stainless-steel staples. For the ECLS surgeries, 3 of 39 (7.7%) with staples developed infection-inflammation, compared with infection-inflammation in 18 of 457 (3.9%) that had other methods of skin closure. For the TPLO surgeries, 18 of 192 (9.4%) with stainless-steel staples developed infection-inflammation, compared with infection-inflammation in 16 of 214 (7.5%) that had other methods of skin closure.

Within the ECLS or TPLO surgeries, there was no significant difference in the rate of developing infection-inflammation between the use of skin staples and the use of other suture materials (P = 0.223 and 0.491 for ECLS and TPLO surgeries, respectively). Despite the lack of a significant difference, the use of staples with ECLS surgeries increased the risk of developing infection-inflammation by a factor of 1.96, and for TPLO surgeries, use of staples increased the risk of developing infection-inflammation by a factor of 1.25. There was no significant (P = 0.739) difference in the number of surgeries with staples that became infected-inflamed between the ECLS and TPLO procedures. Similarly, there was no significant (P = 0.051) difference in the number of surgeries without staples that became infected-inflamed between the ECLS and TPLO procedures. Although not significantly different, OR calculations revealed that TPLO increased the risk of developing infection-inflammation by a factor of 1.2 when staples were used and by a factor of 1.8 when staples were not used.

**Administration of antimicrobials after surgery**—Of the 902 surgeries, dogs for 771 (85.5%) were receiving orally administered antimicrobials after surgery at the time of discharge, whereas 131 (14.5%) dogs were not. Of those dogs prescribed antimicrobials after surgery, 586 (76.0%) received a first-generation cephalosporin, 68 (8.8%) received a fluoroquinolone, 64 (8.3%) received a third-generation cephalosporin, 43 (5.6%) received an amoxicillin-clavulanic acid combination, and 10 (1.3%) received other antimicrobials or a combination of the aforementioned drugs. Duration of treatment ranged from 3 to 14 days. Surgeries for which the dog was receiving orally administered antimicrobials at the time of discharge, regardless of the type of antimicrobial or duration of administration, had a rate of infection-inflammation of 5.1% (39/771), whereas those for which the dogs were not receiving orally administered antimicrobials at the time of discharge had a

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**Table 1**—Factors potentially associated with development of infection-inflammation at the surgical site following 902 procedures in 808 dogs in which rupture of the CCL was treated via an ECLS or TPLO procedure.

<table>
<thead>
<tr>
<th>Factor</th>
<th>P-value*</th>
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<tbody>
<tr>
<td>Sex</td>
<td>0.851</td>
</tr>
<tr>
<td>Age†</td>
<td>0.736</td>
</tr>
<tr>
<td>Breed</td>
<td>0.960</td>
</tr>
<tr>
<td>Body weight†</td>
<td>0.155</td>
</tr>
<tr>
<td>Limb (left vs right)</td>
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<tr>
<td>Procedure (ECLS vs TPLO)</td>
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<tr>
<td>Concurrent infection‡</td>
<td>0.746</td>
</tr>
<tr>
<td>Concurrent use of NSAID</td>
<td>0.842</td>
</tr>
<tr>
<td>Duration of anesthesia†</td>
<td>0.207</td>
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<tr>
<td>Surgeon experience</td>
<td>0.821</td>
</tr>
<tr>
<td>Type of CCL rupture (partial vs complete)</td>
<td>0.228</td>
</tr>
<tr>
<td>Use of crimps (ECLS only)‡</td>
<td>0.095</td>
</tr>
<tr>
<td>Type and size of nylon implant (ECLS only)</td>
<td>0.854</td>
</tr>
<tr>
<td>Type and size of plate (TPLO only)</td>
<td>0.952</td>
</tr>
<tr>
<td>Skin closure (staples vs other)</td>
<td>0.027</td>
</tr>
<tr>
<td>Postoperative oral administration of antimicrobials</td>
<td>0.006</td>
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Results are for Pearson χ² tests, unless indicated otherwise.

*Values were considered significant at P < 0.05. †Results are for t-tests. ‡Results are for the Fisher exact test.
rate of infection-inflammation of 10.7% (14/131). These values differed significantly (P = 0.006). There was no significant (P = 0.386) difference in the infection-inflammation rates among the various antimicrobials.

Other factors—Concurrent infection, concurrent use of NSAIDs, experience of the primary surgeon performing the procedure, partial versus complete rupture of the CCL, use of metal crimps, and type and size of nylon or metal implants were not found to significantly affect the proportion of surgeries in which dogs developed postoperative infection-inflammation (Table 1).

Logistic regression analysis—Logistic regression analysis was used to investigate a model for predicting the odds of developing infection-inflammation, given the aforementioned set of factors. Two methods were used. For the first method, only those factors with significant P values were used, whereas all factors were used in the second method. A backward elimination process was used for both methods, with a value of P < 0.2 as the cutoff for entry. In both methods, a cross-validation technique was used, and the results for both were the same.

The logistic regression was performed on a random sample of 615 surgeries, with the remaining 287 surgeries being used to validate the model. At the end of the backward elimination procedure, 2 factors were significantly associated with development of infection-inflammation. Those factors were surgical procedure (OR = 0.407; 95% CI, 0.200 to 0.830 [P = 0.013]) and postoperative administration of antimicrobials (OR = 0.287; 95% CI, 0.137 to 0.624 [P = 0.002]). Ninety-three percent of the surgeries were classified correctly in both the model sample and validation sample. The Omnibus χ² value was 12.81 (P = 0.002), which indicated significant coefficients in the logistic regression model, and the Hosmer-Lemeshow χ² statistic was < 0.001 (P = 0.986), which indicated a good fit between expected and actual observations. Results for this model suggested that the odds of developing infection-inflammation decreased by a factor of 0.407 when the ECLS procedure was used, compared with the odds when the TPLO procedure was used (in other words, dogs not administered antimicrobials after surgery were 2.45 times as likely to develop infection-inflammation after TPLO). It also suggested that postoperative administration of antimicrobials decreased the odds of developing an infection-inflammation by a factor of 0.287, compared with the odds when no antimicrobials were used (in other words, dogs not administered antimicrobials after surgery were 3.48 times as likely to develop an infection-inflammation). The combined effect of the use of the ECLS procedure and postoperative administration of antimicrobials would reduce the odds of infection-inflammation by a factor of 0.117, compared with odds for the use of the TPLO procedure without postoperative administration of antimicrobials (in other words, a dog that underwent the TPLO procedure and did not receive orally administered antimicrobials after surgery was approx 8.5 times as likely to develop infection-inflammation as was a dog that underwent the ECLS procedure and received orally administered antimicrobials after surgery).

Furthermore, logistic regression analysis for ECLS surgeries revealed that administration of antimicrobials after surgery significantly (P = 0.003) reduced the odds of developing infection-inflammation by a factor of 0.199 (95% CI, 0.070 to 0.570), thereby reducing the odds of developing infection-inflammation by 80% (Omnibus χ² value = 7.8 [P = 0.02]; Hosmer-Lemeshow χ² statistic = 0.273 [P = 0.873]). Logistic regression analysis for only TPLO surgeries revealed that the odds of developing infection-inflammation were significantly (P = 0.017) reduced by a factor of 0.327 (95% CI, 0.131 to 0.816), thereby reducing the odds of developing infection-inflammation by 67.3% (Omnibus χ² value = 4.88 [P = 0.027]; Hosmer-Lemeshow χ² statistic = 2.7 [P = 0.909]).

Discussion

The overall rate of infection-inflammation in the study reported here was 6.1% (55/902). This is slightly higher than infection and infection-inflammation rates (3.6% to 5.8%) reported4–6 for clean surgical procedures in veterinary medicine. As described in 1964 by the National Academy of Sciences National Research Council,415 a clean surgical procedure is one in which the gastrointestinal or respiratory tracts are not entered surgically; no apparent inflammation is encountered, and there is no break in aseptic technique. Proposed explanations for the higher infection-inflammation rate in our study include a larger sample population, the use of propofol for induction,16 and inclusion of dogs that were receiving antimicrobials before surgery or that may have had a concurrent bacterial infection (ie, urine or skin). Bacterial culture of urine samples was not typically performed to determine a urinary tract infection, and dental or skin infections may not have been recorded at the time of surgery; so the number of dogs with concurrent infections may have been falsely low. Our interval for follow-up monitoring was 6 months, which may have allowed for the identification of late signs of infection or inflammation associated with the surgical implants, as opposed to including only immediate postoperative changes to the skin incision. The altered definition of infection to include cases with incisinal inflammation may also have contributed to our higher infection-inflammation rate. Incisinal inflammation can be caused by patient self-trauma, external sources of trauma, clipper burn, or traumatic tissue handling during surgery. Had positive results of bacterial culture been used as the determinant for development of a postoperative infection at any stage, our total infection rate would likely have been lower. Bacterial culture and antimicrobial susceptibility testing were not routinely performed after surgery at the time of suture removal or recheck examination, unless the implants were being removed and submitted for bacterial culture or the initial surgical wound was being revised. In our opinion, the small number of dogs for which bacterial culture was performed did not offer a large enough sample size to accurately assess the infection rate at suture removal or recheck examination. Thus, the use of the infected-inflamed definition may offer more clinically relevant insight into this complication of elective orthopedic surgery.

In our study, the TPLO procedure was associated with a significantly higher infection-inflammation rate,
compared with that for the ECLS procedure. On the basis of our logistic regression model, dogs undergoing TPLO surgeries were 2.45 times as likely to develop postoperative infection-inflammation as were dogs undergoing ECLS surgeries. To the authors’ knowledge, this has not been reported previously. We speculate that this is attributable, in part, to the increased tissue dissection required to perform the tibial osteotomy and for placement of the bone plate. Mean duration of anesthesia was twice as long for TPLO as for ECLS surgeries (125 and 62 minutes, respectively). Although mean duration of anesthesia was not directly associated with an increase in infection-inflammation in our study, we believe that the significantly longer duration of anesthesia required to perform a TPLO surgery could have contributed to the higher infection-inflammation rate. In other reports,6,8-17,18 investigators have detected an increase in the risk of developing postoperative infection with increasing duration of surgery and duration of anesthesia. For a surgical wound to become infected, a critical amount of contamination (> 105 organisms/g of tissue) is required.19 Surgeries of a longer duration expose the surgical wound to host and environmental microbial populations for a longer period and therefore increase the risk for reaching that critical contaminant threshold.8,10 An increased duration of anesthesia can lead to suppression of the immune system and can predispose patients to postoperative complications with wound healing and bacterial wound infection.17,18 Longer anesthetic times (for surgery, radiography, or other procedures), larger incisions, and more extensive tissue handling are required with TPLO procedures. There is also less soft tissue covering the implant, and the larger implant may incite more of a foreign body reaction. The larger surface area of the bone plate and screws used in TPLO procedures may allow adherence of more bacteria and creation of a more prominent bacterial biofilm. These may all have been contributing factors that led to an increased infection-inflammation rate after TPLO surgeries, compared with the rate after ECLS surgeries.

Another possible reason for the increased rate of infection-inflammation after TPLO surgeries may have been the significantly heavier body weight of the dogs that underwent that surgical procedure. Although not a variable with a significant effect in our study, heavier body weight was significantly associated with postoperative surgical site infections in dogs in another study.10 The authors of that study8 speculated that this may have been attributable to the more intense mechanical stress on surgical wounds in heavy, stronger dogs or in behavioral differences between small- and large-breed dogs.

For nearly 100 years, stainless-steel staples have been used to close skin incisions in humans. According to reports26–29 in the human literature, skin closure with metal staples provides advantageous results, including a decreased inflammatory response, faster wound closure times, and a tighter skin seal to decrease migration of bacteria on the skin surface through the incision. However, investigators in a recent study24 detected a severe inflammatory response to metal staples placed in the skin of pigs and reported that incisions closed with metal staples had a higher incidence of bacteria detected via histologic assessment of the incisions, compared with that for absorbable subcuticular staples and absorbable sutures. It has also been reported25 that the reaction to nylon in infected surgical wounds is minimal, compared with the reaction to stainless steel.

Analysis of our results also suggested that the use of skin staples was associated with a higher incidence (1.9 times as high) of postoperative infection-inflammation than that after the use of nonabsorbable skin sutures (nylon) or absorbable subcuticular sutures. Several reports26-29 in the human medical literature have provided similar findings. The noncompliant nature of metal staples could be a cause of increased irritation. Dogs in which staples are used for skin closure may be more likely to lick or chew at the incision, which would subsequently introduce a higher number of bacteria into the surgical site. In turn, this could increase the overall risk of infection. It has been recommended10 that staples only be used for skin closure when it is possible to maintain a minimum distance of 4.0 to 6.5 mm between the stapled skin surface and underlying bone or viscera. Because staples were used in all sizes of dogs in our study, it is possible that smaller dogs had less soft tissue between the staples in the skin and the medullary aspect of the tibia. Therefore, inappropriate use of staples in some dogs is another possible reason for the higher incidence of infection when staples were used in the dogs of our study.

We did not detect a significant difference in the infection-inflammation rate after TPLO surgeries when the use of staples was compared with the use of other skin closure methods. Although not significantly different, use of TPLO with staples increased the risk of developing infection-inflammation by a factor of 1.2 when compared with the risk for use of ECLS with staples, and use of TPLO with sutured closures increased the risk of infection-inflammation by a factor of 1.25 and after ECLS surgery by a factor of 1.9. The smaller increase in the risk of infection-inflammation after TPLO surgery by a factor of 1.2 is similar to the proportional increase in infection-inflammation after ECLS surgery. Logistic regression analysis helped add validity to our results and suggested that the higher incidence of infection-inflammation associated with TPLO procedures cannot be explained by the more frequent use of staples for skin closure with that procedure.

In our sample population, the proportion of TPLO surgeries with staples for skin closure was 6.7 times as high as the proportion of ECLS surgeries with staples for skin closure. Although not significantly different, the use of staples increased the risk of developing infection-inflammation after TPLO surgery by a factor of 1.25 and after ECLS surgery by a factor of 1.9. The smaller increase in risk for TPLO with staples may have been attributable to TPLO procedures already increasing the infection-inflammation rate; thus, additional complications caused by staples alone may have been masked. These results suggest that even after the ECLS procedure, the use of staples typically increased the risk of developing infection-inflammation, compared with the risk for other methods of skin closure. They also indicate that our increased risk of developing infection-inflammation with stapled closure was not confounded by the increased
infection-inflammation rates for TPLO procedures. The small number of infections (n = 3) observed after ECLS surgeries with staples may weaken the inference, and more study on this topic is warranted.

Analysis of the results suggested that oral administration of antimicrobials after surgery can decrease the risk for developing infection-inflammation after both ECLS and TPLO procedures. This is in contrast to a recommendation in the human literature, which suggests that for clean procedures, prophylactic antimicrobial agents should be discontinued within 24 hours after the end of surgery. Although most of the dogs in our study were treated with first-generation cephalosporins, our results indicated a decreased frequency of infection-inflammation, regardless of which antimicrobial class was administered. Statistical analyses did not reveal an increase in the rate of infection-inflammation for dogs with concurrent diseases or infections. It is possible that postoperative administration of antimicrobials may have affected these results and thereby led us to detect an overall lower infection rate in dogs treated after surgery, rather than detecting an increase in the infection rate in dogs with increased risks (eg, pyodermia or urinary tract infections). Potential breaks in sterile technique during patient preparation or during the surgical procedure may not have been recorded, and these also may have contributed to the obvious benefit evident with the postoperative administration of antimicrobials in those dogs. It is also possible that antimicrobials may have cured early infections before they became clinically apparent. To the authors’ knowledge, oral administration of antimicrobials after surgery has not been reported to decrease the risk for developing infection-inflammation in veterinary patients, and further evaluation is warranted.

The main limitation of the study reported here is its retrospective nature because complete information may not have been included in the medical records. Certain factors, such as concurrent disease and concurrent medications being administered, may have affected the overall rate of infection-inflammation but may not have been recorded in the medical records; therefore, they could not be statistically analyzed. Also, referring veterinarians may have evaluated the dogs because of signs related to postoperative infection-inflammation, and this information may not have been available for inclusion in the statistical analysis. As in any retrospective study, there were confounding variables. We attempted to account for these variables and found that they had minimal effect on the results reported. However, additional studies are needed to completely exclude them as confounders.

Analysis of the results of this study suggested that the risk of postoperative infection-inflammation after both ECLS and TPLO procedures can be reduced by the use of skin closure methods other than skin staples and by the postoperative administration of antimicrobials. Our results also suggested that a dog that underwent a TPLO procedure and did not receive orally administered antimicrobials after surgery had an 8-fold increase in the risk for developing postoperative infection-inflammation, compared with the risk for a dog that underwent an ECLS procedure and received orally administered antimicrobials after surgery. Further consideration of newer procedures, such as tibial tuberosity advancement, which often have a similar functional outcome to that of TPLO but are considered less invasive, may be warranted.31

References

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e. TPLO plate, New Generation Devices, Glen Rock, NJ.
f. SPSS, version 16, SPSS Inc, Chicago, Ill.
g. Ethilon, Ethicon, Somerville, NJ.
h. Week Visstat 35W, Teleflex Medical, Research Triangle Park, NC.


Appendix
General principles of perioperative administration of antimicrobials for prophylaxis in human medicine.5,9–11

Use antimicrobials only in patients with clean-contaminated, contaminated, or dirty procedures.

Administer the first dose 1 hour before the first incision.*

Readminister antimicrobials during surgery if the procedure is still ongoing after 2 half-lives of the drug have elapsed.

Restrict treatment to the duration of surgery or < 24 hours, except in certain situations (ie, gross contamination or preexisting infection).

Avoid the use of newer broad-spectrum antimicrobials.

*For a limited number of antimicrobials used in human medicine, different timing is recommended.