opioid drugs have been known to cause urinary retention in human and veterinary patients whether given by the intrathecal, epidural, or IV route.\textsuperscript{1–9} Epidural administration of opioid medications decreases parasympathetic firing in the sacral region by acting on $\mu$ and $\delta$ fibers, thereby decreasing afferent inputs from the urinary bladder to the spinal cord.\textsuperscript{10,11} A similar effect occurs following IV or IM administration of opioids through their action on $\mu$ receptors in the spinal cord, inhibiting the release of acetylcholine from parasympathetic sacral nerves that control detrusor tone.\textsuperscript{10,12}

Urinary retention following epidural opioid analgesia is a well-documented phenomenon in humans undergoing a variety of surgical and medical procedures.\textsuperscript{1–4} Although urinary retention after spinal administration of opioids has been documented clinically and experimentally in dogs, epidural administration has not been evaluated.\textsuperscript{6} A few case reports\textsuperscript{5–8} and 1 report of a large retrospective study\textsuperscript{9} describe complications associated with epidural analgesia including urinary retention in the veterinary population, yet urinary retention is often listed as an adverse effect of this route of administration of medication in textbooks and review articles.\textsuperscript{12,13} In humans, development of urinary retention can increase the length of hospital stay and cost of care, in addition to increasing morbidity by increasing the risk for urinary tract infection and adding to patient discomfort.

There is presently no universally accepted clinical definition of urinary retention in human medicine, and a meaningful definition is absent in the veterinary literature. Urinary retention in humans can be broadly classified into 2 categories: overt urinary retention (failure to initiate voiding, regardless of whether the need to urinate is perceived), and covert urinary retention (failure to fully void urine volume following micturition attempts).\textsuperscript{3,14} Changes in micturition volume thresholds have been detected experimentally in dogs following both spinal (subdural) and systemic opiate administration.\textsuperscript{6} Although an increase in the micturition volume was detected in that study\textsuperscript{6} with both methods of opioid administration, epidural administration was not evaluated.

Effect of epidural analgesia with opioids on the prevalence of urinary retention in dogs undergoing surgery for cranial cruciate ligament rupture

Nathan W. Peterson, DVM; Nicole J. Buote, DVM; Philip Bergman, DVM, PhD

Objective—To determine whether epidural administration of opioids was associated with clinically important urinary retention in dogs undergoing elective orthopedic procedures.

Design—Retrospective cohort study.

Animals—179 client-owned dogs undergoing elective surgery for cranial cruciate ligament rupture.

Procedures—Medical records of 179 dogs that underwent surgical correction for cranial cruciate rupture between January 2009 and October 2012 were reviewed; 120 received epidural administration of opioids and 59 did not. Signalment, type of procedure, administration of epidural analgesia, time to first postanesthetic urination, and number of urinations during the first 24 hours were evaluated and compared between groups.

Results—Administration of preservative-free morphine into the epidural space was not significantly associated with time to first urination following anesthetic recovery or the total number of urinations within the first 24 hours of anesthetic recovery. Administration of a hydromorphone bolus IV following surgery was significantly associated with urinary retention, compared with administration of either morphine boluses or fentanyl constant rate infusions following surgery. No other variables were significantly associated with urinary retention.

Conclusions and Clinical Relevance—Administration of preservative-free morphine into the epidural space was not associated with clinically important urinary retention in dogs undergoing elective orthopedic procedures. Systemic administration of opioids may be associated with urinary retention. (J Am Vet Med Assoc 2014;244:940–943)

Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tr>
<td>CCL</td>
<td>Cranial cruciate ligament</td>
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<td>CRI</td>
<td>Constant rate infusion</td>
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<tr>
<td>TPLO</td>
<td>Tibial plateau leveling osteotomy</td>
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<td>TTA</td>
<td>Tibial tuberosity advancement</td>
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The purpose of the study reported here was to retrospectively determine whether epidural administration of opioids for analgesia in dogs undergoing elective orthopedic procedures resulted in clinically important overt urinary retention defined as failure to initiate urination during the first 24 hours following anesthetic recovery.

Materials and Methods

Selection of case and control animals—Dogs that underwent surgery between January 2009 and October 2012 for CCL rupture were identified in the hospital database with a search for charge codes associated with TPLO, TTA, lateral suture stabilization, and minimally invasive CCL procedures. Records that were incomplete were excluded from evaluation. Dogs were excluded if they had any history of thoracolumbar or lumbosacral myelopathy or previous detrusor atony, if they had any additional surgical procedures performed during the same anesthetic event, or if urethral catheterization was performed within the first 24 hours of anesthetic recovery. Cases animals received epidural analgesia with morphine and controls did not.

Medical records review—Records were reviewed for completeness. Information collected from the medical records included body weight, sex, type of procedure, epidural analgesia (yes vs no), time from anesthetic recovery to first recorded urination, number of recorded urinations within the first 24 hours, and whether postoperative IV fluid therapy was administered. All preanesthetic and anesthetic medications were recorded, including drug, dose, and route. All postoperative analgesic medications were recorded, including drug, dose, and route. Records were further reviewed for evidence of complications associated with epidural or injectable analgesia, including vomiting and bladder management procedures (urethral catheterization or bladder expression). Pain scores were not consistently recorded so were not included.

All dogs were hospitalized overnight in the critical care unit for continuous monitoring. In accordance with institutional protocol, all dogs were evaluated for urination, defecation, and vomiting hourly and the results were recorded on a hospital treatment flow sheet. When the first urination was not observed directly by the nursing staff, the hour at which it was discovered and recorded on the treatment sheet was used. The number of urinations during the first 24 hours was determined by counting the number of urinations recorded in the hourly treatment flow sheet during the first 24 hours following anesthetic recovery. Although the hospital used a subjective, semiquantitative notation system when recording urinations, the authors did not attempt to account for this during statistical analysis. All positive notations in the urination column of the treatment sheet were considered to be equivalent.

Statistical analysis—Descriptive statistics, including mean, median, and SD, were calculated for all variables. A χ² test was used to examine associations between nominal variables (sex, epidural injection received, urinary retention, opioid premedication, opioid bolus IV after surgery, opioid CRI IV, anticholinergic administration, acpemazine administration, benzodiazepine administration, vomination, and IV fluid therapy after surgery). An ANOVA was used to examine associations between nominal and continuous variables (weight, procedure, time from recovery to first urination, number of urinations within the first 24 hours, opioid premedication dose, opioid postoperative dose, opioid type, premedication route [IV, SC, or IM], number of opioid bolus doses in first 24 hours, opioid CRI dose, CRI duration, fentanyl patch size, anticholinergic dose [number and frequency], acepromazine dose [number and frequency], and benzodiazepine dose [number and frequency]). Due to the large sample size, normality was assumed and statistical evaluation of normality was not performed. Visual inspection of histograms was performed, and the data appeared to be normally distributed. All statistical analyses were completed with the aid of a commercial software program. For all statistical analyses, values of P ≤ 0.05 were considered significant.

Results

Records of 272 dogs were identified. Seventeen were excluded because they had a procedure other than those listed (arthrodrosis, 1; medial patella luxation, 3). 78 were excluded because they were incomplete, and 3 were excluded because of urinary catheterization for undocumented reasons, leaving 179 (64 castrated males, 3 sexually intact males, 102 spayed females, and 10 sexually intact females) cases for inclusion. One hundred twenty dogs received epidural analgesia, and 59 dogs did not. All dogs that received epidural angesis received preservative-free morphine (0.1 mg/kg [0.045 mg/lb]) only. All dogs received systemically administered opioids during anesthetic recovery and hospitalization. Median weight for all dogs was 27.9 kg (61.4 lb; range, 3.0 to 75.9 kg [6.5 to 167.1 lb]). There was a significant (P < 0.001) difference in median body weight between dogs that received an epidural injection (30.5 kg [67.1 lb]) and those that did not (14.1 kg [31.0 lb]). Tibial plateau leveling osteotomy was the most common procedure (n = 123 dogs) followed by lateral suture stabilization (42), TTA (11), and a minimally invasive technique (3). Dogs that underwent TPLO or TTA were more likely to receive epidural analgesia than those undergoing lateral suture (P < 0.001).

Nine of 179 (5%) dogs did not have a recorded urination within the first 24 hours of anesthetic recovery (4 received epidural analgesia and 5 did not). The prevalence of urinary retention in dogs that received epidural analgesia (4/120 [3.3%]) was not significantly different than for dogs that did not (5/59 [8.5%]). There was no significant (P = 0.336) difference in the time from recovery to first urination between dogs that received epidural analgesia (9.2 hours) and those that did not (10.2 hours). The median number of urinations in the first 24 hours were the same for dogs in the no epidural analgesia group (median, 3; range, 0 to 6) and the epidural analgesia group (median, 3; range, 0 to 9). There was no significant (P = 0.1053) difference in the number of urinations in the first 24 hours between dogs that received epidural analgesia (3.1) and those that did not (2.7).

Seventy dogs received hydromorphone as the main postoperative analgesic drug, whereas 44 received mor-
phine and 64 received fentanyl. There was a significant ($P = 0.032$) difference in the time from anesthetic recovery to first urination in dogs that received an IV bolus of hydromorphone after surgery (10.3 hours), compared with dogs that received an IV bolus of morphine (8.3 hours). Similarly, dogs that received morphine epidurally and hydromorphone as an IV bolus had a significantly ($P = 0.025$) longer time to first urination (12.7 hours) than dogs that received morphine epidurally and as an IV bolus (10.4 hours). Of the 9 dogs that did not have a recorded urination, none were catheterized or had any other bladder management treatments performed during hospitalization. None of these dogs had any reported complications after discharge from the hospital.

**Discussion**

A human study revealed that systemic opioid administration impairs perception of bladder fullness and the urge to urinate. A recent meta-analysis of the human medical literature revealed that postoperative urinary retention is directly related to the dose of opioid used systemically in the postoperative period. The findings of the present study suggested that a similar phenomenon occurred in dogs that underwent surgery for cranial cruciate ligament rupture. The only variable identified that was significantly associated with time to urination was the IV administration of hydromorphone as the main postoperative analgesic. Different intrinsic properties of the opioids used during this study may explain the differences in time to urination observed among hydromorphone, morphine, or fentanyl when used as the main postoperative analgesic drug. An association between administration of fentanyl via CRI and urinary retention was not found. This was in contrast to humans in which the prevalence of urinary retention is higher in patients that receive opioids via CRI or patient-controlled analgesia after surgery. It is possible that the dose of fentanyl administered as a CRI allowed for a lower cumulative dose of opioid to be administered. It is also possible that opioid type influenced the results. Evidence in the human literature suggests that some opioids have a greater effect on urination than others, with fentanyl causing less urinary retention, compared with morphine, in humans after orthopedic surgery.

The overall urinary retention rate in the present study was 5%. Although the difference was not significant, the prevalence of urinary retention in dogs that received epidural analgesia (3%) was less than in dogs that did not (8%). All dogs were systemically administered opioids for analgesia, regardless of whether they received epidural analgesia, so a possible explanation for this apparent discrepancy is that dogs that received epidural analgesia had more complete analgesia and were therefore more comfortable ambulating and posturing to urinate. Unfortunately, due to the retrospective nature of the study, it was not possible to determine whether pain scores were different between the 2 groups. There is presently no definition in the veterinary literature for postoperative urinary retention. However, this syndrome has been extensively investigated in the human literature, with specific criteria needed for a diagnosis. Due to the paucity of information available in the veterinary literature, the authors chose to define urinary retention as failure to urinate within the first 24 hours of anesthetic recovery. Our findings were similar to those of Troncy et al., who identified urinary retention in only 7 of 242 (2.8%) dogs that received epidural analgesia, and those in the human literature (3.8%). Unfortunately, a definition for urinary retention was not provided by Troncy et al., so a direct comparison with our data cannot be made. None of the dogs described in either study had any long-term complications associated with epidural analgesia.

Dogs that underwent CCL surgery were chosen for this study because they were the most likely patients in the authors’ hospital to receive epidural analgesia. Additionally, human patients who undergo orthopedic procedures appear to have high risk of postoperative urinary retention with rates of 21% to 55% of knee arthroplasties and 11% to 48% of hip arthroplasties. Covert urinary retention, in which a large residual volume is left in the bladder following attempts at voiding, may be more common but is difficult to accurately diagnose in a veterinary population. A single case report of urinary retention in a dog following removal of total hip implants was consistent with covert urinary retention. In the dog of that report, the owner witnessed successful attempts at urination but the volumes of urine were reported to be less than normal and the owner reported urine leakage at home.

Many of the limitations of this study were associated with its retrospective nature. Because urination events were being extracted from hospitalization records, it was not possible to determine whether every urination event was initiated voluntarily. It is possible that some of the recorded events were due to bladder overflow or urinary incontinence. An additional limitation was the inability to determine whether urination was complete. Some of the dogs may have had covert urinary retention. However, the purpose of the study was to determine the prevalence of clinically important overt urinary retention. A prospective study would be necessary to measure residual volumes of urine following attempts at urination to determine whether covert urinary retention was occurring. It is also possible that some urination events were missed or not recorded in the medical record; however, the authors believe this is unlikely given the nursing practices and minimum staffing requirement of the critical care unit (2 technicians at all times) that were in place within the hospital.

Three records were excluded because the dogs underwent urethral catheterization after surgery. Of these cases, 2 dogs were catheterized 10 hours after surgery and 1 dog was catheterized 12 hours after surgery, possibly because of perceived urinary retention or behavior consistent with anxiety. It is also possible that the decision was based on nursing care needs or a desire to force immobility on these patients after surgery. Unfortunately, the rationale for the urethral catheterization in these cases could not be determined from the medical record. Because the authors chose to define urinary retention as failure to urinate within the first 24 hours
after surgery, these cases were excluded because they were not allowed to reach this endpoint naturally.

Another limitation of this retrospective study was the inability to confirm delivery of the analgesic drug into the epidural space. Hospital practice during the dates of the study was to confirm placement of the spinal needle within the epidural space by the hanging drop method. If any resistance was met during administration of medication, the needle was removed and placement was reconfirmed by the hanging drop method or bubble compression evaluation. The prevalence of epidural injection failure in dogs has been reported to be 7%. Assuming a similar success rate in our hospital, it is unlikely that epidural injection failure would substantially affect the results.

On the basis of the results of this study, the administration of epidural opioid analgesia did not result in clinically important overt urinary retention. Additionally, opioid epidural analgesia appeared to be safe, well tolerated, and without complications.

References


From this month’s AJVR

High-resolution manometric evaluation of the effects of cisapride and metoclopramide hydrochloride administered orally on lower esophageal sphincter pressure in awake dogs

Jennifer Kempf et al

Objectives—To evaluate the effects of cisapride and metoclopramide hydrochloride administered orally on the lower esophageal sphincter (LES) resting pressure in awake healthy dogs.

Animals—6 adult Beagles.

Procedures—Each dog was evaluated after administration of a single dose of cisapride (0.5 mg/kg), metoclopramide (0.5 mg/kg), or placebo (empty gelatin-free capsule) in 3 experiments performed at 3-week intervals. To measure LES pressure, a high-resolution manometry catheter equipped with 40 pressure sensors spaced 10 mm apart was used. For each experiment, LES pressure was recorded during a 20-minute period with a virtual electronic sleeve emulation before treatment (baseline) and at 1, 4, and 7 hours after drug or placebo administration. A linear mixed-effects model was used to test whether the 3 treatments affected LES pressure differently.

Results—In the cisapride, metoclopramide, and placebo experiments, median baseline LES pressures were 29.1, 30.5, and 29.0 mm Hg, respectively. For the cisapride, metoclopramide, and placebo treatments, median LES pressures at 1 hour after administration were 44.4, 37.8, and 36.6 mm Hg, respectively; median LES pressures at 4 hours after administration were 50.7, 30.6, and 31.1 mm Hg, respectively; and median LES pressures at 7 hours after administration were 44.3, 28.5, and 33.3 mm Hg, respectively. The LES pressures differed significantly only between the placebo and cisapride treatments.

Conclusions and Clinical Relevance—Results suggested that orally administered cisapride may be of benefit in canine patients for which an increase in LES pressure is desirable, whereas orally administered metoclopramide did not affect LES resting pressures in dogs. *(Am J Vet Res 2014;75:361–366)*