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Effect of intraoperative positioning on anesthetic variables in cats undergoing a perineal urethrostomy

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Abstract

Objectives Cats undergoing perineal urethrostomy (PU) often have acute kidney injury (AKI). Minimizing additional kidney injury during anesthesia is critical to prevent exacerbation of AKI. The impact of surgical positioning for PU on anesthetic variables is unknown. This study evaluated pre-, intra- and postoperative variables in cats undergoing PU in sternal (SR) or dorsal recumbency (DR). We hypothesized that there would not be a significant difference in anesthetic complications and postoperative serum creatinine (SCr) concentrations in cats positioned in SR compared with those positioned in DR.

Methods Medical records of 97 client-owned cats undergoing PU in SR (n = 55) or DR (n = 42) were retrospectively reviewed. Cats undergoing procedures in addition to PU were excluded. Data collection included signalment, number of preoperative obstructive episodes, pre- and postoperative SCr, surgical and anesthetic duration, drugs in the anesthetic regimen, and presence and duration of intraoperative hypotension, hypertension, bradycardia, tachycardia, hypoventilation and hypothermia. Data were compared using Mann–Whitney U or Fisher's exact tests.

Results A significant difference was detected in the number of preoperative obstructive episodes in cats undergoing PU in SR compared with DR (SR median episodes 2 [range 0–5], DR median episodes 2 [range 1–6]; $P = 0.0074$). No other differences were identified in preoperative or intraoperative variables. Postoperative SCr and change from preoperative SCr did not differ between groups.

Conclusions and relevance Analysis of these data demonstrate no measurable differences in anesthetic parameters or postoperative outcomes in cats undergoing PU in SR or DR. The statistical difference between groups relative to preoperative obstructive episodes does not appear to be clinically relevant. Thus, we accept our hypothesis and conclude that SR or DR positioning should not be a consideration in establishing an optimized anesthetic experience for cats with urethral obstruction-associated AKI. Surgeon preference should continue to be the driving force on positioning for a PU in cats.

Keywords: Perineal urethrostomy; dorsal recumbency; sternal recumbency; anesthesia; creatinine; acute kidney injury; urethral obstruction

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Introduction

Perineal urethrostomy (PU) is a commonly performed surgery in male cats with a history of urethral obstruction (UO) to treat UO and to reduce the risk of recurrence. UOs most commonly result from some component of feline lower urinary tract disease, with cats commonly presenting with acute kidney injury (AKI). A study by Segev et al[1] reported that 85% of cats presenting with UO were azotemic at the time of presentation.

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A cornerstone of management of UO-associated AKI is relief of the obstruction, which often results in rapid resolution of markers of kidney dysfunction. However, little is reported about the long-term consequences of AKI associated with UO or how to optimize ongoing care to minimize further kidney insult and maximize kidney healing. This knowledge is especially lacking in cats that undergo general anesthesia for a PU surgery relatively soon after their AKI event.

Historically, PU surgeries have been performed in sternal recumbency (SR). More recently, dorsal recumbency (DR) positioning for PU surgery has increased in popularity. Several reports have compared outcomes after sternal or dorsal positioning. One group compared postoperative neurological status in cats positioned in SR or DR and found that although the briskness of the perineal reflex was significantly reduced and spinal pain was significantly increased in all cats after PU surgery, no association with operative positioning was observed.[2] Another group compared duration of surgery and anesthesia and likelihood for short- and long-term complications in cats positioned in either SR or DR for PU surgery.[3] That study demonstrated no differences between duration of anesthesia, duration of surgery or occurrence of complications relative to surgical positioning. However, some critical anesthetic factors, including blood pressure, heart rate (HR) and ventilatory data, all of which may impact the progression of kidney disease, were not evaluated. Given the kidney's susceptibility to ischemic injury, variables including blood pressure, HR and ventilation/oxygenation status should be carefully considered, as they may impact renal blood flow and oxygenation and, therefore, impact ongoing kidney injury while under general anesthesia.[4]

Cats undergoing a PU in SR are typically placed in a Trendelenburg-like position, with the head lower than the body. The forelimbs are extended forward and the hindlimbs hang off the end of the table with ample padding in the inguinal area. The tail is secured cranially, exposing the perineum. Cats undergoing PU in DR are more commonly placed in a flat dorsal position. The forelimbs are pulled cranially, and the hindlimbs are also pulled cranially and slightly laterally. Occasionally, padding may be placed under the pelvis to raise it slightly off the table. Understanding how anesthetic variables differ relative to surgical position is an important consideration. Surgical position is known to influence blood pressure in anesthetized cats.[5] In animals where the head is positioned below the heart, venous return to the heart is improved, which may impact blood pressure.[6] Conversely, ventilation may be impaired in animals positioned in SR with the abdomen elevated above the thorax, as is often the case in cats undergoing a PU in SR.[6] In cats with moderate or severe AKI, in particular, selecting a patient position that optimizes these parameters may lessen ongoing AKI and result in lower postoperative serum creatinine (SCr) concentrations.

Therefore, the primary aim of this study was to evaluate intraoperative anesthetic variables, including blood pressure, HR, temperature and ventilation, as well as postoperative SCr concentrations in cats undergoing PU in SR or DR. We hypothesized there would not be a significant difference in anesthetic complications and postoperative SCr concentrations in cats positioned in SR compared with those positioned in DR.

Materials and methods

Case selection

Electronic medical records from the University of Georgia Veterinary Teaching Hospital were searched to identify cases of client-owned cats with UO undergoing PU surgery between 2009 and 2024. Data were collected from the time of admission to final discharge. Cats undergoing other surgeries in addition to PU, including cats that had concurrent cystotomies, and those with incomplete medical records were excluded. Records were considered incomplete if they did not include pre- and postoperative SCr concentrations and a completed anesthetic record. Medical records were retrospectively reviewed.

Medical records review

Recorded data included age, breed, sex/neuter status, number of preoperative obstructive episodes, admission and postoperative SCr concentrations, difference in SCr from preoperative to postoperative, total surgery and anesthesia duration, and drugs utilized in the anesthetic regimen. Owing to the retrospective nature of the study, postoperative SCr measurements were not obtained at standardized time points. The timing of postoperative SCr concentrations was at the discretion of the attending surgeon.

Intraoperative anesthetic complications were recorded, including presence and duration of hypotension, hypertension, bradycardia, tachycardia, hypoventilation and hypothermia. The lowest recorded blood pressure and body temperature were also recorded. Preoperative complications were recorded, including urethral tear, urethral stricture and uroabdomen. Postoperative complications, including the development of a urinary tract infection, stranguria, incisional dehiscence and postoperative urethral tear, were recorded.

An obstructive episode was defined as an episode of stranguria with minimal to no urine output, an event requiring urinary catheter placement or the need for a repeat urinary catheterization after resolution of a previous episode. Instances in which the patient removed their own urinary catheter and it was immediately replaced were not classified as recurrent obstruction. However, if the catheter was removed by the patient and intentionally not replaced and a subsequent obstruction

Table 1 Preoperative and postoperative variables in cats undergoing perineal urethrostomy in dorsal or sternal recumbency

Variable	Sternal	Dorsal	*P* value
Age (months)	48 (12–197)	48 (5–166)	0.9062
Number of neutered males	54 (98.1)	40 (95.2)	0.5770
Creatinine at presentation (mmol/l)	0.13 (0.07–1.4)	0.15 (0.08–1.4)	0.5336
Number of preoperative obstructive episodes	2 (0–5)	2 (1–6)	0.0074
Creatinine at discharge (mmol/l)	0.1 (0.07–0.14)	0.1 (0.07–0.18)	0.9183
Change in creatinine (mmol/l)	–0.07 (–1.3 to 0.03)	–0.05 (–1.3 to 0.03)	0.9402

Data are n (%) or median (range)

occurred thereafter, the episode was classified as recurrent obstruction.

Related to intraoperative variables, hypotension was defined as a systolic arterial pressure (SAP) less than 80 mmHg, a mean arterial pressure (MAP) less than 60 mmHg or diastolic arterial pressure (DAP) less than 40 mmHg for at least 5 mins.[7,8] Hypertension was defined as SAP greater than 180 mmHg or MAP greater than 140 mmHg for at least 5 mins. Doppler blood pressure was recorded as MAP.[9] The method of blood pressure measurement was variable and at the discretion of the attending anesthesiologist for each case. SAP and DAP were measured using oscillometric devices, which were applied to every patient as long as readings were considered reliable by the attending anesthesiologist. Blood pressure measurements were recorded every 5 mins. In addition to oscillometric methods, blood pressure monitoring was augmented with Doppler, routinely, and direct arterial blood pressure measurement less commonly. Bradycardia was defined as HR less than 100 bpm for at least 5 mins. Tachycardia was defined as HR greater than 200 bpm for at least 5 mins. Intraoperative HR was determined from both ECG and pulse oximetry. All patients were monitored with capnography, and hypoventilation was defined as an end-tidal carbon dioxide greater than 55 mmHg for at least 5 mins. Ventilation modes during anesthesia included spontaneous, assisted and mechanical ventilation. Lastly, hypothermia was defined as an esophageal body temperature less than 36.7°C for at least 5 mins. All anesthetic episodes were performed under the supervision of an America College of Veterinary Anesthesia and Analgesia diplomate.

Data were collected until discharge from the hospital. Follow-up after hospital discharge was not performed.

Statistical analysis

Data from cats in SR or DR were compared. Continuous variables were tested for normality using the Shapiro–Wilk test. The vast majority of data was not normally distributed. Therefore, continuous data were compared between cats positioned in SR or DR using the Mann–Whitney U-test, and categorical data were compared using Fisher's exact test. Values of $P<0.05$ were considered significant. Data are described using median (range).

Results

Medical records of 127 client-owned cats (n = 58 sternal, n = 69 dorsal) were identified. Of those, 30 cats were excluded because of concomitant cystotomy or other abdominal surgical procedure during anesthesia, leaving 97 medical records from cats undergoing PU in SR (n = 55) or DR (n = 42) available for review.

Preoperatively, no significant difference was detected in age, sex/neuter status or presenting SCr concentrations (Table 1). A significant difference was detected in the number of preoperative obstructive episodes in cats undergoing PU in SR compared with DR (SR episodes 2 [range 0–5], DR episodes 2 [range 1–6]; $P=0.0074$). The most common indication for a PU was UO (n = 96/97). One cat did not experience a complete obstructive episode before surgery but exhibited stranguria due to urolithiasis. Intraoperative data are detailed in Tables 2 and 3. No significant differences were identified in anesthetic or surgical duration, presence or duration of hypotension, hypertension, bradycardia, tachycardia, hypoventilation or hypothermia (Table 2) between groups. Furthermore, no significant differences were detected in lowest recorded blood pressure or body temperature between SR and DR groups (Table 2). A total of 47 cats underwent mechanical ventilation for hypoventilation (SR = 27, DR = 20), and there were no significant differences observed in ventilation modes under general anesthesia between SR and DR groups. No differences were identified in the use of various anesthetic agents between groups as part of the preoperative, induction or maintenance regimens (Table 3). No significant differences were detected in postoperative SCr or change in SCr concentrations (Table 1). Lastly, no significant differences were noted in postoperative complications between SR and DR groups (Table 4).

Discussion

Analysis of these data demonstrates no measurable differences in anesthetic parameters or perioperative

Table 2 Intraoperative variables in cats undergoing perineal urethrostomy in dorsal or sternal recumbency

Variable	Sternal	Dorsal	*P* value
Anesthesia duration (mins)	146 (77–294)	151 (89–238)	0.2883
Surgical duration (mins)	72 (30–187)	78 (38–144)	0.1611
Presence of hypotension	31 (56.4)	22 (52.4%)	0.8371
Duration of hypotension (mins)	5 (0–65)	5 (0–80)	0.8861
Lowest mean arterial pressure (mmHg)	52 (20–80)	52 (17–69)	0.7128
Presence of hypertension	4 (7.3)	3 (7.1)	>0.9999
Duration of hypertension (mins)	0 (0–35)	0 (0–10)	0.7910
Presence of bradycardia	21 (38.1)	18 (42.9)	0.6800
Duration of bradycardia (mins)	0 (0–65)	0 (0–110)	0.5139
Presence of tachycardia	4 (7.3)	2 (4.8)	0.6952
Duration of tachycardia (mins)	0 (0–55)	0 (0–30)	0.5764
Presence of hypoventilation	19 (34.5)	19 (45.2)	0.3023
Duration of hypoventilation (mins)	0 (0–105)	0 (0–100)	0.2655
Presence of hypothermia	47 (85.5)	33 (78.6)	0.2807
Duration of hypothermia (mins)	75 (0–180)	75 (0–180)	0.5807
Lowest recorded body temperature (°C)	35.8 (33.8–37.6)	35.7 (34.1–37.4)	0.7566

Data are n (%) or median (range)

Table 3 Anesthetic agents used in cats undergoing perineal urethrostomy in dorsal or sternal recumbency

Anesthetic agent	Sternal	Dorsal	*P* value
Premedication drugs			
Alfaxalone	12 (21.8)	8 (19.0)	0.8041
Dexmedetomidine	20 (36.4)	10 (23.8)	0.2676
Hydromorphone	29 (52.7)	20 (47.6)	0.6842
Methadone	12 (21.8)	13 (31.0)	0.3537
Midazolam	10 (18.2)	10 (23.8)	0.6139
Ketamine	6 (10.9)	6 (14.3)	0.7578
Buprenorphine	2 (3.6)	2 (4.8)	>0.9999
Acepromazine	0 (0)	1 (2.4)	0.433
Local anesthesia			
Epidural	46 (83.6)	34 (81.0)	0.7912
Induction drugs			
Midazolam	5 (9.1)	3 (7.1)	>0.9999
Ketamine	24 (43.6)	18 (42.9)	>0.9999
Propofol	25 (45.5)	26 (61.9)	0.1508
Alfaxalone	17 (30.9)	14 (33.3)	0.8289
Inhalant anesthetic			
Isoflurane	51 (92.7)	41 (97.6)	0.3850
Sevoflurane	5 (9.1)	1 (2.4)	0.2298

Data are n (%)

Table 4 Postoperative complications in cats undergoing perineal urethrostomy in dorsal or sternal recumbency

Postoperative complications	Sternal	Dorsal	*P* value
Urinary tract infection	13 (23.6)	9 (21.4)	>0.9999
Stranguria	1 (1.8)	0 (0)	>0.9999
Dehiscence before discharge	0 (0)	1 (2.4)	0.4330
Urethral tear	1 (1.8)	1 (2.4)	>0.9999

Data are n (%)

outcomes in cats undergoing PU in SR or DR. Thus, we accept our hypothesis. Based on these data, SR or DR positioning should be based on surgeon preference and patient factors.

There was a significant difference in the number of preoperative obstructive episodes; however, the median value of obstructive episodes was identical between groups, suggesting this may be a type 1 statistical error and is likely not clinically significant. Importantly, other preoperative variables were not different, including preoperative SCr, which was identical between groups.

The study included cases performed by multiple faculty surgeons and surgical residents, and positioning was based on surgeon preference. This study supports conclusions in the previous study by Nye et al[3] that there is no difference in surgical and anesthetic duration between cats positioned in SR or DR for PU. In that study, the authors included cats that underwent concurrent cystotomy, which occurred in approximately 10% of their cases and added approximately 46 mins to the mean surgical time.[3] We elected to exclude these cases as changing positions during the procedure for cats undergoing PU in SR would confound our data.

There is limited literature within veterinary medicine on the effect of patient position and anesthetic parameters in feline anesthesia. A study performed by Foo et al[10]

evaluated the effect of positioning in sternal, left lateral and right lateral recumbencies and time on CT imaging of lung volume and attenuation in healthy anesthetized cats. This may be germane because reduced ventilation during anesthesia may lead to tissue hypoxia and new or continued ischemic kidney injury. Researchers found the dependent lungs of those cats positioned in lateral recumbency underwent rapid reduction in volume and increased lung attenuation.[10] Unsurprisingly, there was no difference in lung attenuation seen on CT between the right and left lung lobes when patients were positioned in SR.[10] Researchers did not evaluate cats positioned in DR in this study; therefore, it is unknown if there are any differences in lung volume in DR compared with those positioned in SR.

Minimizing further AKI in the preoperative and perioperative periods is imperative for successful outcomes in cats undergoing surgery for UO. Maintaining renal blood flow and glomerular filtration rate through adequate hydration and rapid resolution of the UO will reduce the likelihood of further AKI and preserve renal function.[4,11] Maintaining appropriate hydration is considered the mainstay of treatment for cats with AKI.[4,11]

Another major anesthetic goal to prevent further kidney damage includes the prevention of hypotension. Inhalant anesthetics, including isoflurane and sevoflurane, cause hypotension by reducing peripheral vascular resistance and therefore reducing renal blood flow.[12] A balanced approach with optimal analgesics to enable the lowest possible inhalant level is recommended to prevent the reduction in glomerular filtration that occurs with high inhalant doses.[12] In a retrospective study comparing cats de-obstructed under injectable sedation with those de-obstructed utilizing inhalant anesthesia, no differences were found in complication rates or recurrence of UO between groups.[13] These findings suggest that, with appropriate monitoring and management, general anesthesia with inhalant anesthetics does not increase the risk of complications in cats with UO.[13] However, the duration of inhalant anesthesia required for urinary catheterization is generally shorter than that reported in the present study for cats undergoing PU. The advantage of total intravenous anesthesia in PU has not yet been investigated.

The addition of multimodal analgesia can help to reduce the inhalant doses during general anesthesia and therefore reduce further AKI during the perioperative period. The use of epidurals has been supported to be an effective analgesic technique in cats with UO.[14,15] Although these studies evaluated cats treated with urinary catheterization for UO, the same technique can be applied to cats undergoing PU for this condition. In the current study, 80/97 (82.5%) cats received an epidural, with the goal of reducing inhalant requirements during surgery.

This article has several limitations. The retrospective design inherently carries the risk of incomplete or inaccurate data. Postoperative SCr measurements were not obtained at standardized time points, and the timing of postoperative SCr concentrations was determined at the discretion of the attending surgeon. Non-invasive blood pressure measurements in cats are often imprecise and may have contributed to measurement inaccuracies in this study. Management of hypoventilation was dependent on the anesthetist and anesthesiologist, as no standardized protocol dictated when intervention was required. Similarly, the choice of ventilation mode (spontaneous, assisted or mechanical) was left to the discretion of the attending anesthesiologist. The sample size was relatively small, particularly after the removal of cats with other concurrent surgeries. In addition, the study was conducted at a veterinary teaching hospital, where surgeries were performed by multiple surgeons with varying levels of experience. Similarly, although anesthetic drugs varied among individual cases based on the preferences of the attending anesthesiologists, there was no difference in the use of various anesthetic drugs between groups. Furthermore, the anesthetic episode may have been immediately supervised by technicians of variable training, veterinary students or house officers.

Conclusions

This article supports the idea that positioning for PU in cats does not have a significant impact on anesthetic and postoperative complications or SCr concentrations. The likelihood that AKI will be exacerbated by surgical positioning in cats undergoing PU appears to be of little concern based on the findings from these data. Surgeon preference and patient factors, such as the need for concurrent cystotomy, should influence positioning choices. Continued investigation is warranted to better understand the impact of positioning on anesthetic and postoperative outcomes to improve patient care.

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Ethical approval The work described in this manuscript involved the use of non-experimental (owned or unowned) animals. Established internationally recognized high standards ('best practice') of veterinary clinical care for the individual patient were always followed and/or this work involved the use of cadavers. Ethical approval from a committee was therefore not specifically required for publication in *JFMS*. Although

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Informed consent Informed consent (verbal or written) was obtained from the owner or legal custodian of all animal(s) described in this work (experimental or non-experimental animals, including cadavers, tissues and samples) for all procedure(s) undertaken (prospective or retrospective studies). No animals or people are identifiable within this publication, and therefore additional informed consent for publication was not required.

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