Multicenter evaluation of decompressive cystocentesis in the treatment of cats with urethral obstruction

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OBJECTIVE
To investigate whether decompressive cystocentesis (DC) safely facilitates urethral catheterization (UC) in cats with urethral obstruction (UO).

ANIMALS
88 male cats with UO.

PROCEDURES
Cats were randomly assigned to receive DC prior to UC (ie, DC group cats; n = 44) or UC only (ie, UC group cats; 44). Abdominal effusion was monitored by serial ultrasonographic examination of the urinary bladder before DC and UC or before UC (DC and UC group cats, respectively), immediately after UC, and 4 hours after UC. Total abdominal effusion score at each time point ranged from 0 (no effusion) to 16 (extensive effusion). Ease of UC (score, 0 [easy passage] to 4 [unable to pass]), time to place urinary catheter, and adverse events were recorded.

RESULTS
No significant difference was found in median time to place the urinary catheter in UC group cats (132 seconds), compared with DC group cats (120 seconds). Median score for ease of UC was not significantly different between UC group cats (score, 1; range, 0 to 3) and DC group cats (score, 1; range, 0 to 4). Median change in total abdominal effusion score from before UC and DC to immediately after UC was 0 and nonsignificant in UC group cats (range, –5 to 12) and DC group cats (range, –4 to 8). Median change in effusion score from immediately after UC to 4 hours after UC was not significantly different between UC group cats (score, –1; range, –9 to 5) and DC group cats (score, –1; range, –7 to 5).

CONCLUSIONS AND CLINICAL RELEVANCE
DC did not improve time to place the urinary catheter or ease of UC in cats with UO. (J Am Vet Med Assoc 2021;258:483–492)

Urethral obstruction in cats is a common emergency accounting for approximately 10% of emergency room visits.1 Treatment of UO involves IV administration of fluids and medications to correct tissue perfusion abnormalities and metabolic derangements and to alleviate pain, and ultimately involves passage of a urinary catheter to relieve the UO.2–4 Both retrospective and prospective studies5–8 exist that describe the underlying etiology of UC, treatments, and effects of these treatments on outcome such as survival to hospital discharge and incidence of UO. Despite these previous studies, a consensus on the ideal treatment strategy for cats with UO has not been definitively established.

Decompressive cystocentesis prior to UC has been proposed as a safe and advantageous treatment for cats with UO.6,7 The proposed benefits of DC include relieving pain,6 decreasing renal back pressures,6–8 improving urinary bladder wall perfusion,9 and facilitating retrograde urohydropropulsion and placement of a urinary catheter in cats with urethral plugs and urolithiasis by lowering intraluminal urinary bladder pressures.6,9 Additionally, cystocentesis offers the opportunity to obtain a urine sample for urinalysis and bacteriologic culture if indicated. Some institutions consider DC as part of their standard of care for all causes of UO,6,9 whereas other institutions rarely perform DC because of concerns for potential complications related to the procedure including the following: urine leakage into the peritoneum, urinary bladder rupture, risk for hemorrhage, potential to delay the unblocking procedure, increased client cost, and insufficient scientific evidence showing a benefit of DC.

A retrospective study6 describing 47 cats with UO, secondary to idiopathic causes, plugs, or less commonly urolithiasis, that underwent DC revealed that the survival to hospital discharge rate was similar to rates in other studies in which DC was not performed and no cats had reported complications secondary to DC.6 That study6 included cats both with and without azotemia, and only approximately a third of the cats had an elevated serum potassium concentration and ionized hypocalcemia.6 Additionally, approximately half of the cats in that study6 had radiographic evidence of a focal loss of peritoneal detail consistent with abdominal effusion. Similarly, in a prospective study10 evaluating DC in 15 cats that did not
undergo UC, 8 cats had evidence of effusion in the caudal aspect of the abdomen following the initial DC.\textsuperscript{10} On the basis of results of these 2 studies,\textsuperscript{10} the question arises whether the abdominal effusion noted on radiographs is leakage of urine secondary to DC or whether the abdominal effusion is secondary to increased urinary bladder intraluminal hydrostatic pressure and inflammation. In a subsequent study,\textsuperscript{11} in which abdominal ultrasonography was used to detect abdominal effusion in cats with UC treated with DC, 15 of 45 cats were found to have abdominal effusion prior to DC and an additional 7 cats developed abdominal effusion following DC. The development of abdominal effusion following DC seen in that study\textsuperscript{11} suggests that leakage of urine does occur; however, no cats developed a clinically relevant uroperitoneum. Neither of the aforementioned studies\textsuperscript{10,11} had a control group to allow for critical evaluation of their findings, nor were these studies designed to evaluate for the proposed benefits of DC.

The purposes of the randomized, blinded, controlled study reported here were to investigate whether DC facilitates UC in cats with UC and to further evaluate the safety of DC in these cats. We hypothesized that DC would ease UC, resulting in decreased time to place the urinary catheter, and that it is a safe procedure that does not result in increased morbidity or death.

**Materials and Methods**

**Animals**

A convenience sample of male cats admitted to the emergency services at the University of Pennsylvania and at The Ohio State University because of UO from January 2015 to June 2017 were eligible for study inclusion. Urethral obstruction was diagnosed on the basis of abdominal palpation of a firm, nonexpressible urinary bladder in conjunction with a compatible clinical history. Informed owner consent for study enrollment was obtained at the time of hospital admission. Cats were excluded from the study because of previous treatment for UO at another veterinary hospital (ie, cats that had already undergone DC or cats that already had a urinary catheter in place), lack of owner consent to study enrollment, or lack of availability of study personnel to obtain ultrasonographic images. The study protocol was reviewed and approved by the Matthew J. Ryan Veterinary Hospital Privately Owned Animal Protocol, University of Pennsylvania Institutional Animal Care and Use Committee, and The Ohio State University Clinical Research Advisory Committee.

**Study design**

Cats were randomly\textsuperscript{a} assigned in blocks of 10 to receive either DC prior to UC (ie, DC group cats) or UC only (ie, UC group cats). Sample size for this study was determined on the basis of a study\textsuperscript{6} that found 56% of cats had evidence of abdominal effusion on abdominal radiographs following DC. To detect an increase of abdominal effusion following DC of 2.5% with a power of 0.8 and an α of 0.05, it was determined that ≥31 cats should be in each group. The cat owner and the veterinary staff, who performed UC and scored the ease of UC, were blinded to the cat group. The study investigator performing DC was not blinded to the cat group.

**Data collection**

An IV catheter was placed in all cats. Blood samples were collected and submitted for venous blood gas analysis and measurement of PCV, serum total protein concentration, and plasma ionized calcium, potassium, BUN, and creatinine concentrations. Measurements of PCV, serum total protein concentration, and plasma ionized calcium, BUN, and creatinine concentrations were repeated every 8 to 12 hours during hospitalization.

Prior to sedation, cats underwent an ECG and noninvasive SBP measurements by use of the Doppler technique. At the time of hospital admission, age, body weight, heart rate, respiratory rate, urinary bladder size on abdominal palpation (ie, small, medium, or large), and presence or absence of cardiac arrhythmias were recorded. Additionally, housing status (indoor, outdoor, or both) and whether the cat had a history of lower urinary tract signs or urinary tract obstruction were recorded. Treatment for hyperkalemia or hypotension, if present, was performed at the discretion of the attending clinician. Treatment for hyperkalemia that resulted in cardiac arrhythmias involved administration of calcium gluconate (50 to 100 mg/kg [22.7 to 45.5 mg/lb], IV). Additionally, 1 unit of regular insulin combined with 50% dextrose solution (0.5 g/kg [0.23 g/lb]) or terbutaline sulfate (0.1 mg/kg [0.045 mg/lb]) was administered IV. Hypotension was treated with IV administration of fluids.

Cats were not sedated until their cardiovascular measurements were stabilized (ie, heart rate, 160 to 220 beats/min; noninvasive SBP measurement, > 90 mm Hg; and an improvement or resolution of cardiac arrhythmias). All cats were sedated with a combination of methadone hydrochloride (0.2 to 0.4 mg/kg [0.09 to 0.18 mg/lb], IV) and midazolam (0.2 to 0.4 mg/kg, IV). Incremental amounts of propofol (1 mg/kg [0.45 mg/lb], IV) were administered if needed while abdominal ultrasonography, DC, and UC were performed.

**Abdominal effusion score**

All cats had serial abdominal ultrasonography\textsuperscript{b,c} performed to obtain images of the urinary bladder. A standardized ultrasonographic protocol was performed at each of the following time points: before DC and UC (DC group cats) or before UC only (UC group cats), immediately after UC, and at 4 hours after UC (Figure 1). Serial ultrasonographic examination of the urinary bladder was chosen to monitor for abdominal effusion, the most likely complication of DC. Cats were placed in dorsal recumbency, and 3-second periods of ultrasonographic images of the urinary bladder were video recorded. Images were obtained with an 8-MHz curvilinear ultrasound probe in both transverse and longitudinal planes at 4 urinary bladder sites, as follows: the apex (ie, cranial aspect), left side, right side, and trigone (ie, caudal aspect), left side, right side, and trigone (ie, cranial aspect), left side, right side, and trigone (ie, cranial aspect), left side, right side, and trigone (ie, cranial aspect),
aspect). The ultrasonographic images were saved and retrospectively reviewed by a board-certified veterinary radiologist (JNS) who was blinded to the treatment group. Each urinary bladder site at each time point was scored on a scale of 0 to 4, as follows: 0, no abdominal effusion; 1, a single, small, triangular focal area of abdominal effusion or scant abdominal effusion; 2, mild abdominal effusion present along < 50% of 1 side of the urinary bladder wall; 3, moderate abdominal effusion present along 50% to 75% of 1 side of the urinary bladder wall; and 4, extensive abdominal effusion extending along > 75% of the urinary bladder wall. A total abdominal effusion score for each time point (score range, 0 to 16) was calculated, and the change in total abdominal effusion score from the previous ultrasonographic examination was recorded for each cat (such that a negative change in total abdominal effusion score indicated a decrease in the amount of abdominal effusion, and a positive change indicated an increase in the amount of abdominal effusion).

**DC and UC procedures**

Decompressive cystocentesis was performed by a board-certified specialist in emergency and critical care medicine or an emergency and critical care resident trained in performing DC. Cats were placed in lateral recumbency, and a 1 X 1-cm area of hair was clipped over the urinary bladder and aseptically prepared. The urinary bladder was isolated with one hand, and with the other hand, a 1.5-inch, 22-gauge needle attached steriley to an extension set, a 3-way stopcock, and a 10-mL syringe was percutaneously advanced at a 45° angle into the ventral and caudal aspect of the urinary bladder. Once the needle was in the urinary bladder, an assistant removed the urine from the urinary bladder by aspirating with the syringe until the urinary bladder was small and soft and no additional urine was obtained. Care was taken to not advance the needle through the opposite urinary bladder wall during the procedure. Only 1 urinary bladder needle puncture was allowed. The total volume of urine removed was recorded. Urine obtained during DC was collected for urinalysis and bacteriologic culture and was submitted for evaluation at the discretion of the attending clinician. Any adverse effects that occurred during or immediately following the procedure were recorded. An adhesive bandage was applied over the DC area.

The veterinary staff (ie, a veterinarian, veterinary technician, or veterinary student with direct supervision of a veterinarian) performing UC was not present for the DC, and urinary bladder palpation by this individual was not allowed prior to UC. Cats that were not randomized to undergo DC also had a 1 X 1-cm area of hair clipped on the lateral aspect of the abdomen and an adhesive bandage applied so the outward appearance of cats was the same for both groups. The investigator waited approximately 5 minutes before alerting the needed veterinary staff to return to perform UC.

In preparation for UC, the prepuce and perineal area were clipped of hair and aseptically prepared and a sterile drape with a center hole was placed allowing for exposure of the penis. Urethral catheterization was performed by use of a 3.5-F, 25-cm, open-ended polyurethane catheter with or without a removable stylet. The experience of the individual placing the urinary catheter was recorded and categorized in terms of the number of previous placements of urinary catheters, as follows: 0, 1 to 25, 26 to 50, and > 50. Once the UO was relieved, the urinary catheter was passed into the urinary bladder and a representative urine sample was collected for urinalysis and bacteriologic culture for cats that had not undergone DC (at the clinician’s discretion). Next, the urinary bladder was emptied completely.
and the volume of urine removed was recorded. Ten milliliters of sterile saline (0.9% NaCl) solution was infused into the urinary bladder and then evacuated, and this process was repeated a minimum of 5 times until the urine appeared grossly clear or no further improvements in urine color or clarity were accomplished by additional flushing. The urinary catheter was secured to the patient and attached to a closed collection urinary drainage system.6

**Ease-of-UC score**

The amount of time it took to place the urinary catheter (ie, time from placement of the catheter into the urethra at the tip of the penis until the catheter was advanced into the urinary bladder and urine was obtained) was recorded. Ease-of-UC scores were determined on a scale of 0 to 4, as follows: 0, successful and easy passage of the urinary catheter without the need for retrograde urohydropropulsion; 1, successful but moderately difficult passage of the urinary catheter, which included retrograde urohydropropulsion with 1 or 2 flushes with sterile saline solution; 2, successful but very difficult passage of the urinary catheter that included retrograde urohydropropulsion (> 2 flushes) and may have required multiple attempts to pass the urinary catheter; 3, successful but extremely difficult passage of the urinary catheter that included retrograde urohydropropulsion (> 2 flushes) and multiple attempts to pass a urinary catheter, possibly including the use of radiography or fluoroscopy for assistance; and 4, inability to pass a urinary catheter. Additionally, a subjective assessment for the presence or absence of urethral spasms (ie, the sensation of the urethral muscles tightening during urinary catheter placement) was made by the individual that placed the urinary catheter.

**Hospitalization and follow-up data**

During hospitalization, recurrence of UO and duration of UC were recorded. Duration of hospitalization and final outcome for each cat (ie, survived to hospital discharge, euthanized, or died) were also recorded. In cats requiring surgical intervention, the type of surgery and the reason for surgery were recorded. Owners were contacted at 1 week following hospital discharge, either by phone or electronic survey, to answer a standardized questionnaire. Owners were asked to describe their cat’s urination in terms of straining (on a scale of 0 to 4, where 0 = no straining, 1 = straining noted 1 time, 2 = straining to urinate once daily, 3 = straining to urinate multiple times daily, and 4 = continuous straining to urinate). Owners were also asked whether their cat had hematuria, was urinating outside of the litterbox, or had rUO.

**Statistical analysis**

Continuous variables were assessed for normality by use of the Shapiro-Wilk test. Continuous variables were described as mean ± SD or median (range) values depending on whether the data were normally distributed or not normally distributed, respectively. Unpaired t tests or Wilcoxon rank sum tests were used to compare variables between groups depending on whether they were normally or not normally distributed, respectively. For nonparametric variables, the Wilcoxon rank sum test was used to make comparisons between groups. Cat breeds, experience level of the individual placing the urinary catheter, and complications were considered categorical variables and expressed as proportions with percentages; the χ² test or Fisher exact test (if the expected count within any cell was < 5) was used to compare these variables between groups. The Spearman correlation coefficient was used to evaluate an association between experience of the individual placing the urinary catheter, ease-of-UC score, and time to place the urinary catheter. A value of P < 0.05 was considered significant for all comparisons. All analyses were performed by use of a statistical software program.1

**Results**

Eighty-eight male cats (84 castrated and 4 sexually intact) were included in the study, with 44 cats in the DC group and 44 cats in the UC group. Of the 88 cats, 58 were enrolled at the University of Pennsylvania and 30 were enrolled at The Ohio State University. Seventy-one were domestic shorthairs, 11 were domestic longhairs, and 2 were Maine Coon cats. There was 1 cat of each of the following breeds: Himalayan, Siamese, Russian Blue, and Savannah (Table 1). No significant difference was found at the time of hospital admission between the 2 groups of cats with regard to type of housing (ie, indoor and outdoor vs indoor only), history of previous lower urinary tract signs or UO, age, body weight, heart rate, respiratory rate, urinary bladder size, noninvasive SBP measurement, or presence of cardiac arrhythmias. Only rectal temperature at the time of hospital admission was significantly (P = 0.023) lower in UC group cats, compared with DC group cats, but it was still within the reference range. Of the hematologic variables measured at the time of hospital admission, median BUN concentration was significantly (P = 0.015) higher in UC group cats (39.25 mg/dL; range, 17 to 251 mg/dL), compared with DC group cats (25.5 mg/dL; range, 15 to 202 mg/dL). All other hematologic measurements (ie, blood pH and plasma ionized calcium, creatinine, and potassium concentrations) were not significantly different between groups. No significant difference was found between DC and UC group cats in the median dosage of midazolam, methadone, or propofol administered for sedation. Finally, no significant (P = 0.393) difference was found in the experience of the individual placing the urinary catheter in UC group cats versus DC group cats. The experience of individuals placing the urinary catheter was as follows: placement of 0 catheters for 9 UC group cats and 12 DC group cats, placement of 1 to 25 urinary catheters for 8 UC group cats and 9 UC group cats and 6 DC group cats, placement of 26 to 50 urinary catheters for 8 UC group cats and
4 DC group cats, and placement of >50 urinary catheters for 17 UC group cats and 22 DC group cats. The experience of the individual placing the urinary catheter was not recorded for 1 UC group cat.

The median volume of urine obtained by DC from cats in the DC group was 68.5 mL (range, 15 to 162 mL). In the 44 DC group cats, DC resulted in the following volumes of urine removed: ≤50 mL for 12 cats, 51 to 100 mL for 20 cats, and >100 mL for 12 cats. The median volume of urine obtained following UC was significantly (<0.001) greater for cats in the UC group (88 mL; range, 10 to 500 mL), compared with that of cats in the DC group (27 mL; range, 0 to 135 mL).

One DC group cat was euthanized because of the development of persistent, non-fluid-responsive hypotension secondary to hemorrhage (SBP, 60 mm Hg) immediately following DC and UC. Point-of-care hematologic testing revealed that the cat had developed anemia (PCV, 19% after procedures vs 30% at hospital admission) and hypoproteinemia (serum total protein concentration, 5.0 g/dL after procedures vs 7.4 g/dL at hospital admission). The case-UC score for this cat was 0, and the time to place the urinary catheter was 10 seconds. On abdominal ultrasonography, the cat had abdominal effusion scores of 2 at all 4 urinary bladder sites prior to performing DC and UC, and the total abdominal effusion score did not increase immediately following UC. No blood clots had been seen within the urinary bladder before DC and UC or immediately after UC on ultrasonographic images. Abdominal ultrasonography by a board-certified veterinary radiologist at approximately 1 hour following urinary catheter placement revealed a large blood clot in the urinary bladder, severe cystitis, chronic bilateral kidney changes, and abdominal effusion. The cat received a transfusion of packed RBCs, IV fluid therapy, and a dopamine infusion. Euthanasia was performed at

### Table 1—Variables of cats with UO at hospital admission that underwent either DC and UC (DC group cats) or UC only (UC group cats).

<table>
<thead>
<tr>
<th>Variables</th>
<th>UC group cats</th>
<th>DC group cats</th>
<th>P value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical findings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (y)</td>
<td>4.48 (1–11.5)</td>
<td>4.1 (0.81–16.5)</td>
<td>0.879</td>
</tr>
<tr>
<td>Body weight</td>
<td></td>
<td></td>
<td>0.970</td>
</tr>
<tr>
<td>Kilograms</td>
<td>5.83 (3.48–8.82)</td>
<td>6.05 (4.1–9.4)</td>
<td>—</td>
</tr>
<tr>
<td>Pounds</td>
<td>12.83 (7.66–19.4)</td>
<td>13.31 (9.02–20.68)</td>
<td>—</td>
</tr>
<tr>
<td>Heart rate (beats/min)</td>
<td>200 (130–288)</td>
<td>200 (152–240)</td>
<td>0.255</td>
</tr>
<tr>
<td>Respiratory rate (breaths/min)</td>
<td>40 (12–144)</td>
<td>40 (24–100)</td>
<td>0.343</td>
</tr>
<tr>
<td>Body temperature</td>
<td></td>
<td></td>
<td>0.023</td>
</tr>
<tr>
<td>°C</td>
<td>38.1 (34.9–39.3)</td>
<td>37.8 (33.4–40.7)</td>
<td>—</td>
</tr>
<tr>
<td>°F</td>
<td>100.7 (94.8–102.8)</td>
<td>100.1 (92.1–105.3)</td>
<td>—</td>
</tr>
<tr>
<td>SBP (mm Hg)</td>
<td>138 (48–210)</td>
<td>140 (50–210)</td>
<td>0.962</td>
</tr>
<tr>
<td>Cardiac arrhythmias</td>
<td>3/44 (6)</td>
<td>4/44 (9)</td>
<td>1.000</td>
</tr>
<tr>
<td>History</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Of lower urinary tract signs</td>
<td>25/44 (57)</td>
<td>21/43 (48)</td>
<td>0.456</td>
</tr>
<tr>
<td>Previous UO</td>
<td>9/44 (20)</td>
<td>10/43 (23)</td>
<td>0.752</td>
</tr>
<tr>
<td>Hematologic values</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCV (%)</td>
<td>45 (30–55)</td>
<td>45 (30–58)</td>
<td>0.341</td>
</tr>
<tr>
<td>Serum total protein (g/dL)</td>
<td>7.7 (6.4–9.6)</td>
<td>7.6 (6.4–10.0)</td>
<td>0.735</td>
</tr>
<tr>
<td>Blood pH</td>
<td>7.35 (7.11–7.41)</td>
<td>7.33 (7.09–7.43)</td>
<td>0.100</td>
</tr>
<tr>
<td>BUN</td>
<td></td>
<td></td>
<td>0.015</td>
</tr>
<tr>
<td>mg/dL</td>
<td>25.5 (15–202)</td>
<td>39.25 (17–251)</td>
<td>—</td>
</tr>
<tr>
<td>mmol/L</td>
<td>9.10 (5.35–72.11)</td>
<td>14 (6.07–89.61)</td>
<td>—</td>
</tr>
<tr>
<td>Plasma ionized calcium (mmol/L)</td>
<td>1.09 (0.77–1.38)</td>
<td>1.09 (0.84–1.35)</td>
<td>0.744</td>
</tr>
<tr>
<td>Plasma creatinine</td>
<td></td>
<td></td>
<td>0.115</td>
</tr>
<tr>
<td>μmol/L</td>
<td>137 (70.7–1.768)</td>
<td>159.1 (79.6–1.794.5)</td>
<td>—</td>
</tr>
<tr>
<td>mg/dL</td>
<td>1.55 (0.8–20)</td>
<td>1.8 (0.9–20.3)</td>
<td>—</td>
</tr>
<tr>
<td>Serum potassium (mmol/L)</td>
<td>4.37 (3.4–10.56)</td>
<td>4.63 (3.29–9.94)</td>
<td>0.159</td>
</tr>
<tr>
<td>Sedatives</td>
<td></td>
<td></td>
<td>0.155</td>
</tr>
<tr>
<td>Midazolam</td>
<td>0.2 (0.2–0.2)</td>
<td>0.2 (0.2–0.3)</td>
<td>—</td>
</tr>
<tr>
<td>mg/kg</td>
<td>0.09 (0.09–0.09)</td>
<td>0.09 (0.09–0.14)</td>
<td>—</td>
</tr>
<tr>
<td>Methadone</td>
<td></td>
<td></td>
<td>0.705</td>
</tr>
<tr>
<td>mg/kg</td>
<td>0.4 (0.1–0.4)</td>
<td>0.4 (0.2–0.5)</td>
<td>—</td>
</tr>
<tr>
<td>mg/lb</td>
<td>0.18 (0.05–0.18)</td>
<td>0.18 (0.09–0.23)</td>
<td>—</td>
</tr>
<tr>
<td>Propofol</td>
<td></td>
<td></td>
<td>0.834</td>
</tr>
<tr>
<td>mg/kg</td>
<td>4 (0–9)</td>
<td>3.7 (1.5–12.9)</td>
<td>—</td>
</tr>
<tr>
<td>mg/lb</td>
<td>1.8 (0–3.6)</td>
<td>1.68 (0.68–5.86)</td>
<td>—</td>
</tr>
</tbody>
</table>

Values are reported as median (range) values or numbers (%).

*A value of P < 0.05 indicates a significant difference between DC and UC group cats.

— = Not applicable.
the request of the owner because of likely impending cardiopulmonary arrest, and a necropsy was declined.

The median score for ease of UC was not significantly ($P = 0.964$) different between the UC group cats (score, 1; range, 0 to 3), compared with DC group cats (score, 1; range, 0 to 4). The subjective presence or absence of urethral spasms during UC was not significantly ($P = 0.596$) different between the 2 groups of cats. No significant ($P = 0.874$) difference was found in the median time it took to place the urinary catheter in the UC group cats (132 seconds; range, 8 to 900 seconds), compared with the DC group cats (120 seconds; range, 10 to 1,200 seconds). Additionally, no significant differences were found in the median time to place the urinary catheter ($P = 0.454$) or ease-of-UC score ($P = 0.452$) between the 2 groups of cats when just data from inexperienced individuals (ie, those who had placed $\leq 25$ urinary catheters) were evaluated. A significant ($P < 0.001$) and negative correlation ($\rho = -0.4085$) was found between the experience of the individual placing the urinary catheter and the time to place the urinary catheter. No significant differences were found between cat groups in PCV, blood pH, serum concentration of total protein, and plasma ionized calcium, BUN, creatinine, or potassium concentrations at the 8- to 12-hour or 24-hour time points after hospital admission. Also, no significant differences were found in the duration of UC or hospitalization between the groups of cats.

One cat in the UC group had suspected uroperitoneum secondary to urinary bladder rupture. Abdominal effusion was not evident in this cat on ultrasonographic images of the urinary bladder before UC. Contrast cystography, performed after UC, revealed urine leakage and a defect in the craniodorsal aspect of the urinary bladder. This cat was euthanized and no necropsy was performed. No cats in the DC group had a diagnosis of uroperitoneum.

Sixty-seven cats (34 DC group cats and 33 UC group cats) had abdominal ultrasonographic videos of the urinary bladder available for review. Thirteen cats at the University of Pennsylvania did not have videos of the urinary bladder because of a hard drive failure of the ultrasound machine, and an additional 8 cats did not have videos of the urinary bladder because they were either not saved to the hard drive or lost. Therefore, these 21 cats were excluded from the ultrasonographic evaluation of abdominal effusion.

The median total abdominal effusion score before DC and UC for all cats was 3 (range, 0 to 13). Before DC and UC, only 5 of 67 (7%) cats had no evidence of abdominal effusion present on ultrasonographic images of the urinary bladder, whereas 62 (93%) cats had abdominal effusion noted ultrasonographically in $\geq 1$ site on the urinary bladder. The total median abdominal effusion score prior to DC and UC was not significantly ($P = 0.057$) different in the DC group cats (score, 5; range, 0 to 13), compared with the UC group cats (score, 3; range, 0 to 11). However, before DC and UC, the DC group cats did have significantly higher median abdominal effusion scores at the cranial (score, 1.5 [range, 0 to 3]; $P = 0.006$) and caudal (score, 2 [range, 0 to 4]; $P = 0.032$) urinary bladder sites, compared with the UC group cats (cranial score, 0 [range, 0 to 2]; caudal score, 1 [range, 0 to 3]). No significant differences were found in the median abdominal effusion score between cat groups at the left urinary bladder site (UC group cats, score, 1 [range, 0 to 3]; DC group cats, 1 [range, 0 to 3]; $P = 0.057$) or right urinary bladder site (UC group cats, score, 1 [range, 0 to 4]; DC group cats, 1 [range, 0 to 4]; $P = 0.888$).

On abdominal ultrasonography, the median total abdominal effusion score immediately after UC was not significantly ($P = 0.216$) different in the UC group cats (score, 4; range, 0 to 12), compared with the DC group cats (score, 6; range, 0 to 16). After UC, there continued to be a significant ($P = 0.034$) difference in the median abdominal effusion score at the cranial urinary bladder site in the DC group cats (score, 2; range, 0 to 4), compared with that of the UC group cats (score, 1; range, 0 to 3). However, no significant difference was found in the median abdominal effusion score at the caudal, left, or right sites of the urinary bladder between cat groups. The median change in the total abdominal effusion score from before DC and UC to immediately after UC was 0 and nonsignificantly ($P = 0.271$) in both the UC group cats (range, –5 to 12) and the DC group cats (range, –4 to 8). Of the 67 cats, 27 (40%; 16 cats in the UC group and 11 cats in the DC group) had a positive change in the total abdominal effusion score from before DC and UC to immediately after UC.

At 4 hours after UC, ultrasonography revealed that the total abdominal effusion score was significantly ($P = 0.013$) higher in the DC group cats (score, 4; range, 1 to 14), compared with the UC group cats (score, 2; range, 0 to 14). However, the median change in total abdominal effusion score from immediately after UC to 4 hours after UC was not significantly ($P = 0.605$) different between DC group cats (score, –1; range, –7 to 5) and UC group cats (score, –1; range, –9 to 5). At 4 hours after UC, no significant difference was found in the abdominal effusion score at the left, right, or cranial urinary bladder sites between DC and UC group cats but the abdominal effusion score at the caudal site was significantly ($P = 0.034$) higher in the DC group cats (score, 2; range, 0 to 4), compared with the UC group cats (score, 1; range, 0 to 3). An evaluation of the 27 cats that had a positive change in total abdominal effusion score from before DC and UC to immediately after UC revealed no significant ($P = 0.765$) change in total abdominal effusion score from immediately after UC to 4 hours after UC between UC group cats (score, –3 [range, –9 to 1]; n = 16) and DC group cats (score, –2 [range, –7 to 4]; 11).

Eighty of 88 (91%) cats survived to hospital discharge. Eight cats (5 DC and 3 UC group cats) were euthanized after study enrollment. Of the 3 UC group cats, 1 was euthanized because of hypotension and azotemia after 20 hours of hospitalization, 1 was eu-
thanized because of urinary bladder rupture after 15 hours of hospitalization (cat already described), and 1 was euthanized because of persistent azotemia and fluid overload after 60 hours of hospitalization. None of these UC group cats underwent necropsy. For 1 cat in the DC group that was euthanized, a urinary catheter could not be passed into the urinary bladder; on necropsy a urethral tear was found. One DC group cat was euthanized after 8 hours of hospitalization because of severe azotemia and financial concerns; necropsy revealed severe transmural urinary bladder necrosis with mural and serosal hemorrhage and neutrophilic inflammation (an infarct) and severe multifocal acute urethral mucosal necrosis with mural and serosal hemorrhage. Another DC group cat was euthanized after 26 hours of hospitalization because of financial concerns; necropsy revealed moderate diffuse acute transmural hemorrhagic cystitis with edema, moderate multifocal to coalescing hemorrhagic urethritis, and mild multifocal acute hemorrhage in the renal pelvis of the left kidney. One DC group cat was euthanized because of rUO at 3 hours after urinary catheter removal; necropsy revealed severe diffuse acute hemorrhagic and necrosuppurative transmural cystitis and urethritis. Another DC group cat was euthanized because of severe hypotension and anemia at 7 hours following hospitalization (cat already described and no necropsy performed).

Eight cats (6 UC group cats and 2 DC group cats) developed rUO in the hospital, yielding an in-hospital rUO rate of 9% (8/88). Only 1 cat was euthanized as a result of rUO. The in-hospital rUO rate was not significantly ($P = 0.147$) different between UC and DC group cats. Thirteen cats had a perineal urethrostomy performed either for rUO that developed during hospitalization (4 cats) or to prevent future episodes of UO (9 cats) because of multiple previous episodes of UO or client preference. At the 1-week follow-up time point, 1 additional cat (UC group) developed rUO. No significant differences were found between UC and DC group cats during the 1-week follow-up period in the straining-to-urinate score (median score of 0 in both DC and UC group cats; $P = 0.602$), presence of macroscopic hematuria ($P = 0.559$), or incidence of periuria ($P = 0.372$).

Discussion

The purpose of the present study was to investigate the usefulness and safety of performing DC prior to UC in cats with UO. Although the BUN concentrations at hospital admission were significantly higher in the UC group cats, compared with the DC group cats, the remainder of the hematologic variables (ie, blood pH and plasma potassium and creatinine concentrations), SBP, and the presence of cardiac arrhythmias were not significantly different between groups, suggesting that the 2 cohorts of cats had a similar degree of illness. The range of metabolic derangements (ie, blood pH and plasma BUN, creatinine, and potassium concentrations) found in both groups of cats in the present study was consistent with findings in a previous study describing electrolytes, acid-base measurements, and renal variables in 223 cats with UO. Additionally, the 2 groups of cats in the present study were similar with regard to a history of lower urinary tract signs and UO. In the present study, performing DC prior to UC was not found to improve ease of UC or the time to place the urinary catheter in cats with UO. Additionally, no differences were found with regard to subsequent hematologic variables and duration of UC and hospitalization. These findings suggested that relieving pressures earlier within the urinary tract by performing DC followed by UC, compared with not performing DC, did not affect resolution of metabolic derangements. This is likely caused in part by reduced glomerular and tubular function (ie, reduced excretion of potassium and hydrogen) that occurs as a result of the urinary obstruction. The reduction in kidney function persists beyond the immediate relief of the obstruction, and it can take hours to days for full recovery. Therefore, immediate decompression of the urinary tract, whether with a urinary catheter or DC, is unlikely to lead to a substantial immediate change in hematologic variables. In obstructed cats with severe metabolic derangements, stabilization measures prior to urinary decompression should be focused on antagonizing the effects of blood potassium on cardiac cells (ie, through the administration of calcium gluconate), causing translocation of blood potassium intracellularly (through the Na+/K+ ATPase pumps), and diluting blood potassium concentration through IV administration of fluids until adequate kidney function resumes and allows for the excretion of potassium and acids.

In the present study, serial abdominal ultrasonography was performed to assess for leakage of urine or urinary bladder rupture as a result of DC. Because of technical issues (ie, hard drive failure or failure to save images to the ultrasound hard drive), not all of the study cats had ultrasonographic images available for review. However, enough cats had serial ultrasonographic examinations performed to detect a 2.5% increase in urinary bladder effusion on the basis of our power calculation. Interestingly, in the present study, 93% of cats had pericystic abdominal effusion present on the ultrasonographic images and 40% of cats developed an increase in the total abdominal effusion score (ie, a positive change) following UC. The incidence of pericystic abdominal effusion noted on ultrasonographic images obtained before UC was higher than in 2 studies that found 33%\(^\text{11}\) and 59.8%\(^\text{16}\) of cats had pericystic abdominal effusion on abdominal ultrasonography. In the first study, a 4-quadrant abdomino-ultrasonographic technique was used (focused assessment with sonography in trauma, or FAST\(^\text{17}\)) and performed by 2 board-certified emergency and critical care specialists. As such, only 2 planes at the cystocolic location were obtained by that technique, and images were not reviewed by a radiologist. In the second study, ultrasonographic examinations were
performed following UC and at nonstandardized time points during hospitalization. The higher rate of pericystic abdominal effusion found in our study prior to DC and UC was likely the result of the timing of the abdominal ultrasonography, the increased number of urinary bladder sites ultrasonographically examined, and the fact that the ultrasonographic images were reviewed by a board-certified veterinary radiologist. The cause of the pericystic abdominal effusion and worsening of the abdominal effusion following UC in some cats in the present study was unknown because samples of abdominal effusion were not collected for evaluation. However, it has been hypothesized that pericystic abdominal effusion results from increased intravesicular pressures resulting in lymphatic obstruction, inflammation associated with cystitis, or potentially transudation of urine through the urinary bladder wall.\(^9\)

Performing DC did not appear to increase the risk for urine leakage and uroperitoneum when evaluating the change in total abdominal effusion scores from before DC and UC to immediately after UC and at 4 hours after UC. Compared with the UC group cats, the DC group cats did have significantly higher abdominal effusion scores at the cranial and caudal urinary bladder sites prior to DC and UC, at the cranial urinary bladder site immediately after UC, and at the caudal site at 4 hours after UC. The increased amount of abdominal effusion seen prior to DC and UC at the cranial and caudal urinary bladder sites in the DC group cats was likely the cause of the significant difference found in the total fluid score between the UC and DC group cats immediately after UC rather than as a result of the cystocentesis. The change in total abdominal effusion score, with a negative score indicating decreasing amounts and a positive score indicating increasing amounts of pericystic abdominal effusion, is arguably a better evaluation for possible leakage of urine in the abdomen. In both groups of cats at the time points immediately after UC and 4 hours after UC, the median change in fluid score was negative (supportive of decreasing amounts of abdominal effusion) and not significantly different between the 2 groups of cats.

One study cat developed cardiovascular collapse and was euthanized for hemorrhagic shock following DC and UC. Cystocentesis is a common procedure used in veterinary practice to obtain sterile urine samples for urinalysis and bacteriologic culture. Complications related to performing cystocentesis are rare in the veterinary literature but include aorti lacerations resulting in severe hemorrhagic shock in a dog,\(^8\) septic uroperitonitis following DC in a dog,\(^9\) and presumed vasovagal reactions in 2 cats.\(^10\) The hemorrhagic shock and intravesicular blood clot identified in the cat of the present study could have been related to performing DC, as it was not noted to be present on the ultrasonographic images obtained before DC and UC and the cat’s PCV and serum total protein concentration acutely decreased following the procedure. There is also the possibility that the blood loss into the urinary bladder occurred independent of DC and may have been related to UC. Severe anemia requiring blood transfusions resulting from urinary bladder hemorrhage has been previously reported in a small number of cats with UO that did not have DC performed.\(^21\) The urinary bladder hemorrhage that can be seen in cats with UO is postulated to occur secondary to mucosal injury resulting from high intravesicular pressures or inflammation or potentially secondary to urinary catheter placement.\(^21\)

Along these lines, it is also possible that the reduction in intravesicular pressure after DC, rather than DC itself, could have precipitated the hemorrhagic event.

There was also 1 cat in the UC group that developed complications related to its treatment of UO, specifically uroperitoneum secondary to urinary bladder rupture. This cat was not noted to have abdominal effusion prior to UC; therefore, the urinary bladder rupture was thought to be most likely related to the UC procedure and overdistension of the urinary bladder during retrograde urohydropropulsion. Urinary bladder rupture, in addition to urethral trauma and rupture, is a known potential complication of UC. To the authors’ knowledge, there are no veterinary studies reporting the incidence of urinary bladder rupture following UC in cats with UO. In a retrospective study\(^22\) of 26 cats with uroperitoneum caused by either urinary bladder or urethral rupture, 4 (2 cats with trauma and 2 cats with UO) had urinary bladder rupture following UC. In 2 other prospective studies of 47\(^23\) and 88\(^24\) cats, no cats developed a urinary bladder rupture as a complication of UC. In the present study, the incidence of urinary bladder rupture secondary to UC was low at 1% (1/88). Additionally, 1 cat in the DC group had a urethral tear. Owners should be warned of these rare risks of UC.

Decompressive cystocentesis did not appear to impact the risk for rUO during hospitalization or during the week following hospital discharge. No significant differences were found between UC and DC group cats in straining to urinate, periuria, or hematuria at the 1-week follow-up time point. This suggested that performing DC did not cause additional inflammation or contribute to lower urinary tract signs that can be seen in some cats after hospital discharge. However, our study was not designed or powered to investigate an effect of DC on rUO and lower urinary tract signs; therefore, results should be interpreted cautiously.

Potential limitations to the present study included the fact that ultrasonographic images were obtained by use of a standard multipurpose ultrasound unit by study investigators rather than by a board-certified radiologist, resulting in variable image quality. Ultrasonographic images were retrospectively reviewed and were not available for review on all study cats. Additionally, the abdominal effusion score used in the present study may not have been sensitive enough to identify small amounts of urine leakage as a result of DC. However, our study results suggested that even if a small vol-
ume of urine leaked as a result of the cystocentesis, it did not appear to affect clinical outcome. Additionally, the ease-of-UC score used in the present study has not been validated or assessed for interobserver or intraobserver variability. As with the ultrasonographic images, this score may not be sensitive enough to assess for improvements in the case of UC that may result. However, the time to place the urinary catheter was not significantly different between the 2 groups of cats and was used as a secondary objective measure. Overall, the median time it took to place the urinary catheter in both groups of cats was short (approx 2 minutes), with a median of 120 seconds in the DC group and 130 seconds in the UC group. We also investigated whether DC would be helpful with urinary catheter placement primarily by inexperienced individuals. Again, we found no significant difference in either the ease-of-UC score or the time to place the urinary catheter. It is possible that, with a larger number of study cats, this difference might have become significant. However, a catheter time that is different by seconds (not minutes) is likely not impactful from a clinical standpoint. Finally, we evaluated a heterogeneous group of cats with UO with various degrees of illness, and underlying causes of obstruction were not determined (eg, secondary to plugs, urolithiasis, or idiopathic causes). There is a possibility that DC may be more useful in a subpopulation of cats with UO. Future studies may consider investigating DC and its effect on urinary catheter placement in a more uniform population of cats, such as only cats with urinary obstruction secondary to urolithiasis.

Our study findings suggested that there was no evidence for or against the use of DC as part of the standard treatment of cats with UO. Decompressive cystocentesis is a reasonable treatment option to consider in cats when there is an unavoidable delay in urinary catheter placement (eg, caused by a lack of owner consent or deficiency of veterinary personnel), in cats that are not responding to treatment for cardiac arrhythmias and hypotension and are determined to be too unstable for urinary catheter placement, when a urinary catheter cannot be passed, or until either urinary diversion or surgical intervention, such as a cystotomy or perineal urethrostomy, can be performed. Additionally, in our experience, there are also rare cases of cats with UO in which a urinary catheter cannot be passed on first attempts but can subsequently be passed successfully after DC. However, as with any cystocentesis, pet owners should be advised of the potential rare but severe complications that can occur with DC in these instances.

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Footnotes
d. SonoSite M Turbo or SonoSite SII, Fujifilm SonoSite, Bothell, Wash.
e. Mila International Inc. Erlanger, Ky.
f. Sta, version 14.0 for Mac, Statra Corp, College Station, Tex.

References

From this month’s *AJVR*

**Evaluation of duodenal endoscopic and histologic findings, including counts of forkhead box P3-positive regulatory T cells, in dogs with immunosuppressant-responsive enteropathy**

Elena Benvenuti et al

**OBJECTIVE**

To prospectively evaluate the clinical and prognostic importance of duodenal endoscopic and histologic findings, including duodenal mucosal counts of forkhead box P3-positive regulatory T cells (Foxp3+ Tregs), in dogs with immunosuppressant-responsive enteropathy (IRE).

**ANIMALS**

57 client-owned dogs with IRE.

**PROCEDURES**

The canine chronic enteropathy clinical activity index (CCECAI) was used to assess each dog when IRE was diagnosed (T0) and at 1, 3, 6, and 12 months later. Dogs were grouped on the basis of clinical response (responder group vs nonresponder group) and 12-month long-term outcome (responded to treatment and did not relapse [good outcome group] vs did not respond to treatment or had relapsed [bad outcome group]). At T0, dogs underwent gastrointestinal endoscopy and endoscopic biopsy, with results for variables of duodenal endoscopic and histologic evaluations scored and compared across groups.

**RESULTS**

At T0, the overall median CCECAI score was 7. CCECAI score was not associated with clinical response or relapse. Dogs had significantly greater odds of being in the bad outcome group (vs the good outcome group) if they had a histologic score of 3 (OR, 3.5; 95% CI, 1.09 to 11.3). No differences in the counts of Foxp3+ Tregs were detected between groups.

**CONCLUSIONS AND CLINICAL RELEVANCE**

In dogs with IRE, results indicated that the evaluation of Foxp3+ Tregs did not have prognostic value, whereas a duodenal histologic score of 3 could be a negative prognostic factor for response and relapse, and higher severity scores for intraepithelial lymphocytes and lamina propria lymphocytes and plasma cells in duodenal biopsy samples may be negatively associated with response. (*Am J Vet Res* 2021;82:218–224)