Management of Feline Cystic/Urethral Calculi
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Additional information on this topic can be found in the textbook ‘Small Animal Surgery’ edited by Teresa Fossum, published by Elsevier. If you would like an instructive DVD of this topic, go to www.ivseminars.net and click on Video Vet.

Key Points
• Patients with urethral calculi present with stranguria
• Retropulsion of urethral calculi into the urinary bladder simplifies management of urethral calculi
• Aggressive lavage of the urethra and bladder should be performed during cystotomy
• Permanent urethrostomy is an acceptable method of managing chronic stone formers

Definition: Cystic and urethral calculi have various compositions (i.e., oxalate, struvite, urate) and may be present in the urinary bladder or lodged in the urethra, respectively. They may be multiple, single, or may cause partial or complete obstruction (i.e., urethral), and may require surgical manipulation for removal.

DIAGNOSIS
Clinical presentation:
   Signalment: There is no age, sex or breed predisposition.
   History: Patients generally present with a history of urinary obstruction and/or signs of urinary tract infection. Common complaints include difficulty urinating, straining to urinate, hematuria, blood tinged urine in the litter pan, and/or a distended abdomen. Patients that present several days after complete obstruction may have a distended and painful abdomen and a history of anuria. These patients may be so compromised that they present in shock.
   Clinical signs: The most frequently reported clinical signs in patients with cystic and urethral calculi include unproductive straining to urinate, blood tinged urine seen in the litter pan, hematuria, and/or polyuria. Severity of clinical signs may vary with the degree of urethral obstruction and duration of obstruction prior to presentation. Patients with complete obstruction for several days may show signs of post-renal azotemia (i.e., severe depression, recumbent, shocky).
   Physical examination: Abdominal palpation may reveal a full urinary bladder; occasionally, calculi within the bladder may be palpable.
   Patients with severe clinical signs (i.e., presented several days after complete obstruction) may show azotemia, shock, and/or severe depression. Abdominal palpation generally reveals a large, turgid urinary bladder and may result in discomfort to the patient.
   Laboratory findings: Results of a complete blood count and serum chemistry profile are generally normal in patients presenting acutely; urinalysis may show evidence of urinary tract infection and/or crystalluria.
   Patients presenting after several days of complete obstruction may have significant changes in their biochemical profile including increased BUN, increased creatine, metabolic acidosis, and severe electrolyte abnormalities. Urine is generally grossly hemorrhagic and urinalysis may show signs of urinary tract infection and crystaluria.
   Radiography: Survey radiographs may show presence of radiodense calculi in the urethra and/or urinary bladder as well as a distended urinary bladder. Occasionally, radiolucent calculi occur and can only be visualized using retrograde contrast cystourethrography. Careful evaluation of the kidneys and ureters should be done to rule out renal and ureteral calculi.
   Ultrasonographic examination of the bladder, ureters, and kidneys may be helpful in diagnosis of cystic, ureteral, or renal calculi.
   Differential diagnosis: Any disorder causing urinary obstruction, including urethral neoplasia, granulomatous urethritis, urethral stricture, and urethral trauma. Definitive diagnosis is based on clinical signs, inability to pass a catheter, and evidence of calculi on survey or contrast radiographs.

MEDICAL MANAGEMENT:
**Immediate care:** In animals with complete obstruction of a duration long enough to cause azotemia, temporary urinary diversion is provided by performing a prepubic cystostomy (see technique described below) or frequent cystocentesis (i.e., tid to qid). Azotemia is treated with crystalloid IV therapy prior to calculus removal.

**Calculus removal:** Retrograde hydropulsion: This technique should result in a 80-85% success rate of retropulsing urethral calculi into the urinary bladder!

- Thoroughly mix 20 cc of sterile saline and 5 cc of Surgilube or KY Jelly in a 35 cc syringe and attach the syringe to a 3.5 - 5.0 French soft rubber catheter.
- Anesthetize the animal, extrude the penis and pass the lubricated urinary catheter in the urethra, up to and against the calculus. Place a dry gauze sponge around the extruded tip of the penis and occlude the penis around the catheter by squeezing it with thumb and finger.
- Using a back and forth action on the catheter, simultaneously inject the saline/lubricant mix under extreme pressure.
  
  a) During injection, the calculi and urethra are lubricated by the saline/lubricant mix while the viscosity of the mixture (i.e., KY jelly and saline) encourages the calculus to dislodge and become retropulsed into the urinary bladder.
  
  b) This technique is attempted, and generally successful, regardless of how many stones are in the urethra and no matter where they are lodged.

If the above technique fails, use a stiffer catheter (i.e., open or closed ended Tom cat catheter) and repeat the above maneuvers. Use care when manipulating the catheter against the stone.

**Surgical treatment:**

The objective of surgical treatment is to remove all retropulsed calculi from the urinary bladder and any remaining urethral calculi that were unable to be retropulsed. Bladder calculi are removed via cystotomy, urethral calculi are removed via urethrotomy, and patients that are frequent stone formers may benefit form a permanent urethrostomy to allow continual passage of small urethral calculi.

**Preoperative management:** Patients that present acutely can be anesthetized immediately and retropulsion attempted (see above described technique). If urinary tract infection is suspected, preoperative treatment with antibiotics may be instituted.

Patients that present after several days of complete obstruction should be treated medically until the azotemia resolves, blood gas abnormalities resolve, and electrolytes return to normal. The patients electrocardiogram should be monitored if hyperkalemia is present preoperatively. Medical treatment may consist of intravenous fluids, systemic antibiotics, continuous ECG monitoring, and bladder decompression. Bladder decompression may be accomplished via multiple cystocentesis (i.e., tid or qid), or placement of a antepubic cystostomy tube (described in detail below).

**Anesthesia:** Routine general anesthesia is performed in patients that present acutely without signs of azotemia. Azotemic, shocky patients with moderate to severe biochemical abnormalities should be treated as described above until these abnormalities return to normal.

**Surgical anatomy:** The male feline penile urethra consists of urethral mucosa (i.e., urothelium) surrounded by corpus cavernosum urethra, which is in turn surrounded by tunica albuginea. Because of the fluid filled corpus cavernosum urethra (blood) and the tough fibrous connective tissue tunica albuginea, the urethra can withstand tremendous pressure (e.g., as with aggressive retropulsion) without the fear of urethral rupture.

The urinary bladder consists of the following layers; serosa, muscular, submucosa and mucosa. The bladder is lined with transitional epithelium.

**Positioning:** Patients are positioned in dorsal recumbancy for retropulsion, cystostomy tube placement, and cystotomy.

**Surgical technique:** The surgical techniques vary depending upon the procedure chosen, and are described in detail below:

- **Retropulsion:** The technique for retropulsion of urethral calculi is described above in medical management.

- **Percutaneous cystostomy tube placement:** Occasionally, it may be necessary to perform a percutaneous antepubic cystostomy to decompress the urinary bladder whilst treating a severely azotemic patient until they become a better anesthetic and surgical risk.
The patient is sedated and placed in dorsal recumbancy. A 3-4 cm incision is centered between the umbilicus and pubis. Subcutaneous tissues are dissected to expose the ventral midline (i.e., linea alba). A 2-3 cm incision is made in the linea alba and the bladder wall located. A 12 – 14 French Foley catheter is advanced through a skin incision 2-3 cm lateral to the abdominal incision, tunneled in the subcutaneous tissue and brought into the abdominal cavity at a location just lateral to the midline abdominal incision. A pursestring suture is placed in the bladder wall at the proposed site of Foley catheter placement with 3-0 monofilament absorbable suture. A 1 cm incision is made into the bladder lumen and the Foley catheter advanced. The pursestring suture is carefully tightened to create a water-tight seal, but not to tight as to create bladder wall necrosis. The bladder wall is pexied to the abdominal wall at the point of entry of the Foley catheter with 3-0 monofilament absorbable suture in a simple interrupted pattern. The abdominal wall is closed in a routine fashion. The cystostomy catheter is held in place with a Chinese finger trap friction suture technique using #1 monofilament nonabsorbable suture and attached to a closed collection system to avoid urinary tract infection. The cystostomy tube remains in place until the patient is ready for definitive surgical treatment.

**Urethrostomy**: Urethrostomy is generally performed in patients that are recurrent stone formers. It provides a permanent opening that is large enough to accommodate passage of most urethral calculi/crystals and mucoid debris.

**Perineal urethrostomy** is the location of choice for urethrostomy in cats. It is a convenient location for surgical manipulation, the urethral diameter will accommodate passage of most urethral calculi, and there is less urine scald postoperatively.

Prior to surgery a urethral catheter is passed, if possible. After a routine castration, the subcutaneous tissues are dissected to expose penile urethra. The penile urethra is dissected free from surrounding connective tissue. The ventral attachment of the pelvic urethral to the pubis (i.e., ischiocavernosus m.) is identified and transected. The penile urethra is freed from its connective tissue attachments to the pelvic floor using blunt digital dissection. The retractor penis muscle is identified on the dorsal aspect of the penis, dissected from its attachment on the penis and used to develop a dorsal plane of dissection to separate the pelvic urethra from its dorsal connective tissue attachments. Once the urethra is dissected enough to visualize the dorsolaterally located bulbourethral glands, penile dissection can stop. The penis is catheterized and the urethral orifice identified. An incision is made from the penile urethra to the pelvic urethral to the level of the bulbourethral glands. The urethral orifice at the level of the bulbourethral glands is generally large enough diameter to accept the flange of a tomcat catheter.

After incision of the urethra, the glistening urethral mucosa is identified. 5-0 nonabsorbable monofilament suture with a swaged on cutting or taper-cut needle is recommended by the author. The first urethrostomy suture is placed at the dorsal aspect of the urethrostomy incision on the right or left side at a 45o angle to include urethral mucosa and skin (suture split thickness of skin). The suture is tied leaving the end without the needle 3-4 cm long to act as a stay suture. The second suture is placed opposite the first suture and tied as described for the first. A third urethrostomy suture is placed directly on the dorsal midline to hold the dorsal margin of urethral mucosa to skin. Alternating sutures from dorsal to ventral are placed until approximately one half of the penile urethra has been sutured to skin. The remainder of the penis is amputated and the subcutaneous tissue and skin are closed routinely. Fine ophthalmic instruments make tissue handling and suturing easier. Use of a magnifying louppe (about 2x) and head lamp light source enhances visualization of the urethral mucosa and facilitates accurate suturing. It is critical that the surgeon recognize glistening urethral mucosa and suture it to skin. This will decrease (or eliminate) the chance of urethral stricture. It has been shown that a continuous suture pattern incorporating the urethral mucosa and tunica albuginea (i.e., squeezes the cavernous tissue) results in less postoperative hemorrhage.

**Cystotomy**: After successful retropulsion of urethral calculi into the bladder, the catheter used to retropulse calculi is passed into the urethra and bladder, and left in place. The catheter exiting the penis is cut. Leaving a catheter indwelled in the urethra ensures that remaining cystic calculi will not roll back into the urethra during patient transfer to the surgery suite and during patient prep. The patient is place in dorsal recumbancy with the hind legs tied gently cranially.

Just prior to aseptic preparation of the abdomen a soft, 5-8 French red rubber catheter or feeding tube is placed into the prepuce and a prepucal douche is performed with 120 cc of a
0.01% solution of betadine. This aseptically prepares the penis and prepuce so they can remain in the surgical field throughout the cystotomy procedure.

A caudal midline incision is made from umbilicus to pubis. The bladder is exteriorized and examined. Stay sutures of 3-0 suture are placed in the apex and neck of the bladder. A scalpel blade is used to penetrate the ventral aspect of the bladder and enter the lumen. The ventral cystotomy incision is extended with metzenbaum scissors. The bladder should be opened from apex to neck to allow proper visualization of bladder mucosa and calculi. Stay sutures are placed on each side of the incision at its midpoint to facilitate visualization of the bladder interior. Large hemostats are placed on the stay sutures to help retract the bladder margins. A cystotomy spoon is used to scoop the bladder neck for calculi. This is performed several times. When no more calculi can be removed with the spoon, digital palpation of the bladder neck is performed to identify presence of further calculi. If further calculi are palpated further attempts are made to retrieve the calculi. Once no more calculi can be spooned or palpated, the indwelling urethral catheter placed after retropulsion is removed.

Next, a 3.5 - 5 French urethral catheter is placed in the penile urethra (i.e., retrograde). A dry sponge is used to grasp the extruded penis to create a water tight seal around the catheter. A 35cc syringe filled with sterile saline is injected through the catheter under moderate pressure. The stay sutures on the bladder incision are retracted to enable visualization of the bladder lumen during lavage. Suction or intermittent spooning is performed during lavage in an attempt to identify and remove any remaining stones. After several lavages and negative results in obtaining stones, the catheter is placed from the bladder to the bladder neck and pelvic urethra (i.e., normograde). Lavage is once again performed in an attempt to identify and remove any remaining stones. After several lavages and negative results, the catheter is advanced until it can be seen coming out of the penile urethra. The catheter is run back and forth in the urethra several times to ensure that there are no remaining calculi (i.e., gritty feeling while passing the catheter).

Finally, a piece of bladder mucosa is excised for culture and susceptibility testing. The interior of the bladder is examined for urachal diverticulum, masses, etc. and biopsied as necessary. The bladder wall is closed with 3-0 or 4-0 absorbable monofilament suture material using a swaged on taper or taper-cut needle in a simple continuous or simple interrupted appositional suture pattern. Only one layer closure is necessary. Abdominal closure is routine.

**Suture material/special instruments:** Urinary catheters of various sizes, Foley catheter, head lamp light source, 2X loupes, ophthalmic instruments, 4-0 or 5-0 monofilament nonabsorbable suture material.

**POSTOPERATIVE CARE AND ASSESSMENT:**
Postoperative care varies depending upon procedure performed:

**Percutaneous cystotomy tube:** It is important to keep the percutaneous cystotomy tube attached to a closed collection device. The tube can be connected to a sterile collection bag via a sterile intravenous catheter connection set. An elizabethan collar may be necessary in some patients to prevent iatrogenic removal of the cystotomy catheter. Careful management is important to control catheter related urinary tract infection.

**Perineal Urethrostomy:** An Elizabethan collar should be considered, especially in patients that may be prone to self-mutilation. Patients should be kept quiet and away from other animals.

**PROGNOSIS**
The prognosis for surgical management of urethral and cystic calculi is dependant upon preoperative management of azotemic patients prior to anesthesia, success of retropulsion of urethral stones into the urinary bladder, care in removing all stones via cystotomy, and care of ensuring urethral mucosa to skin apposition during urethrostomy.

Patients that have successful retropulsion of urethral calculi and do not require urethrostomy have a excellent prognosis. If careful attention is paid during cystotomy to ensure that no calculi are left behind (see discussion on cystotomy technique), the prognosis for cure is excellent. Long term prognosis is dependant on evaluation of calculus composition, dietary management, management of urinary tract infection, and attention to urine pH.

Patients that have an elective perineal urethrostomy have a favorable prognosis if attention is paid to proper surgical technique (i.e., urethral mucosa is sutured to skin). Occasionally, chronic stone forming patients will form a calculus that is to large to pass through the urethrostomy stoma.