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SUCCESSFUL MANAGEMENT OF CANINE UROLITHS

Key points

- The most plausible explanation for recurrence of calcium oxalate uroliths within days to months following cystotomy is incomplete surgical removal of uroliths during the previous surgery.
- Recurrence of small uroliths in the urinary bladder can be removed non-surgically by voiding urohydropropulsion.
- Most clients lack the training and experience to appropriately collect urine at home. Don't waste time relying on these inappropriate samples for making accurate medical decisions.
- Dogs at risk for both struvite (and calcium phosphate carbonate) and calcium oxalate uroliths can be successfully managed by modifying the diet to minimize calcium oxalate and by controlling urinary tract infection to minimize struvite.
- Recommendations to prevent urolith recurrence is just a keystroke away. Go to http://www.cvm.umn.edu/depts/minnesotaurolithcenter/home.html . Our Online system provides easy stone submission for analysis, electronic retrieval of results, easy step by step recommendations to assist in urolith management, and videos of procedures including voiding urohydropropulsion. We even have an App for that-MN Urolith, but you will have to register on line for full use.

Uroliths are solid concretions (stones) that form in any portion of the urinary tract. Urolith formation is abnormal because the urinary system is designed to dispose of liquid wastes not solid stones. However, during urolith formation, sustained alterations in urine composition promote supersaturation of one or more substances eliminated in urine that results in their precipitation and subsequent growth. The degree of urine supersaturation is influenced by the renal excretion of crystalloids, the renal excretion of water, urine pH, and other factors that inhibit crystal formation and crystal aggregation. Urolithiasis should not be viewed conceptually as a single disease with a single cause, but rather as a sequela of multiple interacting physiologic and pathologic processes that progressively increase the risk of precipitation of excreted metabolites in urine to form stones. Therefore, detection of urolithiasis is only the beginning of the diagnostic process. Essential to urolith prevention is identification of their composition and the diseases and risk factors underlying their formation, retention and growth.
Regardless of the process of urolith formation, uroliths have the potential to disrupt normal urinary tract function. The mere presence of uroliths in the urinary system does not always necessitate their removal; however, those resulting in clinical signs (dysuria, hematuria, urinary tract infection, incontinence, obstruction, or azotemia) should be appropriately managed.

When should urolithiasis be included in your list of differential diagnoses?
Clinical signs associated with urolithiasis vary depending on location of uroliths in the urinary tract and the degree to which uroliths disrupt normal urinary tract function. Hematuria and pollakiuria are common signs of lower urinary tract disease associated with uroliths in the urinary bladder. However, some dogs and cats with urocystoliths are asymptotic. Uroliths lodged in the urethra may cause more severe and persistent dysuria. Urethroliths resulting in complete urethral obstruction may present with life threatening post-renal azotemia.
Most patients with kidney stones are asymptotic or present for persistent hematuria. Complete unilateral ureteral obstruction can also be asymptotic if the contralateral kidney has sufficient function to maintain serum biochemical homeostasis. Nonspecific pain is inconsistently reported in patients with ureteroliths.

What tests are essential for detection of urolithiasis?
Abdominal palpation is not a reliable method of urolith detection. For example, in one study of 30 episodes of urocystolithiasis in cats, stones were detected by palpation in only 3 (10%). Likewise, it is not possible to detect uroliths located in the renal pelvis by palpation through the abdominal wall. Therefore, radiographic (survey or CT) or ultrasonographic evaluation of the urinary tract is required to detect uroliths consistently.
The primary objective of radiographic or ultrasonographic evaluation of patients is to verify urolith presence, location, number, size, density and shape. Radiographs should include all portions of the urinary tract. As a reminder, imaging the urethra usually requires taking radiographic views more caudal than for routine abdominal evaluation.

The radiographic or ultrasonographic appearance of uroliths is influenced by urolith size, mineral composition, location, and number. Most uroliths greater than 3mm have varying degrees of radiopacity and therefore can be detected by survey abdominal radiography. Uroliths less than 3mm in size may not be visualized unless very dense. Double contrast cystography can be used to enhance resolution of uroliths. Compared to radiographic density of soft tissue, uroliths composed of magnesium ammonium phosphate, calcium oxalate; calcium phosphate, silica, and cystine are often radiopaque. Those composed of urate and cystine are usually radiolucent, and are often not detected by survey radiography unless they are larger.
However, crystalluria is not synonymous with urolith formation. Crystalluria can be observed in patients without uroliths, and absent in patients with uroliths.

Why is determination of urolith composition necessary?
Knowledge of urolith composition is important because contemporary methods of detection, treatment, and prevention of uroliths and their underlying causes are based primarily on knowledge of urolith composition. This poses a problem when uroliths are not available for quantitative mineral analysis. To overcome this problem we recommend predicting urolith composition on the basis of breed, gender, and age of the animal; radiographic appearance of uroliths; and urinalysis and serum chemistry profile results. As an alternative to prediction of mineral composition, small uroliths in the urinary bladder can be retrieved using nonsurgical methods (collection via spontaneous passage, catheter retrieval, voiding urohydropropulsion). Once retrieved, uroliths should always be submitted for quantitative analysis.

Do all uroltihs require therapy?
Uroliths may spontaneously pass through various parts of the urinary tract, spontaneously dissolve, continue to grow, or become inactive (no growth occurs). Not all persistent uroliths are associated with clinical signs. In our experience, most inactive uroliths are not associated with urinary tract infection. Nonetheless, if uroliths remain in the urinary tract, dysuria, hematuria, urinary tract infection, partial or total urinary obstruction, are probable sequelae.

Medical management
The objectives for medical management of uroliths are to promote dissolution, arrest further growth and prevent recurrence. For therapy to be effective it must induce undersaturation of urine with calculogenic crystalloids. This can be achieved by (1) reducing the quantity of calculogenic crystalloids excreted in urine, (2) increasing the solubility of crystalloids in urine, and/or (3) increasing the volume of urine in which crystalloids are contained. Change in diet is one method available to reduce the quantity of calculogenic crystalloids in urine. Attempts to increase the solubility of crystalloids in urine often includes administration of medications designed to change urine pH. Increasing urine volume decreases the concentration of calculogenic substances. Feeding canned foods or adding water to dry food is a safe method of promoting diuresis to increase urine volume

Surgical Removal
Although surgery (cystotomy, urethrotomy, etc.) to remove uroliths is not technically difficult, these invasive procedures are being replaced (lithotripsy) or modified (percutaneous cystolithotomy) by less invasive methods.

Nonsurgical Urolith Removal
Historically, surgery has been considered the only practical method of eliminating uroliths from the lower urinary tract, especially uroliths refractory to medical dissolution. At the University of Minnesota, we have developed two practical alternatives (voiding urohydropropulsion, basket retrieval). These nonsurgical procedures permit safe and rapid removal of small urocystoliths. When uroliths are too large to pass through the urethra, we use laser lithotripsy to break them into smaller fragments that can be removed nonsurgically.

Table 1. Performing Voiding Urohydropropulsion

1. Anesthetize the patient	They type of anesthesia selected may vary based on the likelihood of success and gender of the patient. Consider reversible short acting anesthetics (e.g. Propofol) for patients with very small uroliths that are easily removed. Patients likely to go to surgery/lithotripsy should be placed under inhalation anesthesia. Consider epidural anesthesia to facilitate relaxation of the urethra in male dogs. Just before voiding administer 0.5mg/kg of Propofol IV and then induce voiding. Avoid anesthetics that may increase urethral tone (e.g. dexmedetomidine).
2. Attach a 3-way stopcock to the end of the urinary catheter	The 3-way stopcock facilitates control of the volume of fluid entering the bladder and containment of fluid once the bladder is filled.
3. Fill the urinary bladder	Sterile physiologic solutions (LRS, normal saline) are injected through a transurethral catheter to distend the bladder. If fluid is expelled prematurely around the catheter prior to adequate bladder filling, the vulva and/or urethra can be gently occluded using your thumb and first finger. Placement of additional fluid may not be needed.
4. Position the patient such that the spine is approximately vertical	Repositioning the patient allows uroliths to accumulate at the neck of the bladder facilitating their expulsion. Anatomically, the urethra does not become vertical until the caudal spine is 20 to 25 degrees anterior of vertical, but this may not be clinically important.
5. Agitate the bladder	Agitating the urinary bladder left and right is performed to dislodge uroliths loosely adhered to the bladder mucosa.
6. Express the urinary bladder	Apply steady digital pressure to the urinary bladder to induce micturition. Once voiding begins, the bladder is more vigorously compressed. Compress the urinary bladder dorsally and cranially (toward the back and head of the patient). Movement of the urinary bladder caudally toward the pelvic canal may cause the urethra to kink preventing maximal urethral dilation.
7. Repeat steps 2 through 6	The bladder is flushed repeatedly until no uroliths are expelled.
8. Medical Imaging	Radiography provides an appropriate method of assessing successful expulsion of uroliths. To enhance detection of remaining small uroliths consider a double-contrast cystography (only the lateral view is needed).

Below are answers to common questions to improve your efficiently and accuracy of disease management.

1. Is crystalluria a reliable method of predicting urolith type? Crystals can be helpful but in most cases the survey abdominal radiograph is your best tool for predicting mineral composition of stones. Why so, because struvite crystal formation is very pH dependent and is found in most urine that is neutral to alkaline, even if the patient has never formed stones. Once stones form, crystalluria decreases. If the urine sample is refrigerated, crystals (primarily calcium oxalate) form that were not present in the patient.
2. If stones are detected via ultrasound, are additional methods of medical imaging needed? Ultrasound is a very sensitive test for detecting stones, but it is very poor tool for determining urolith size and number. In addition, stones in the urethra will be missed.
3. Is nutritional management (i.e. therapeutic diets) the best method for preventing struvite uroliths in dogs and cats. The answer is no and yes depending on the type of struvite urolith. Controlling urinary tract infection is the best management to prevent infection-induced struvite. For sterile struvite uroliths, low phosphorus and magnesium diets that acidify the urine are the treatment of choice. General guidelines based on the species affected, in the dog, your primary method would be to control urinary tract infection; and in the cat, your primary treatment would be a therapeutic food.
4. Is medical imaging essential following urolith removal? Based on results of several studies, surgical removal of stones is about 80% effective. Surgical patients should be re-radiographed immediately following surgery to determine if the abdomen needs to be re-opened to remove stones that were left in (approximately 20%).
5. How to manage a compound stone composed of a nidus of calcium oxalate and outer layer of struvite in the dog. In most cases, the calcium oxalate stone formed first which predisposes the patient to a secondary bacterial infection that caused struvite to precipitate over the calcium oxalate nidus. Manage the calcium oxalate with appropriate nutrition (canned, neutral to alkaline pH diets), and control urinary tract infection to prevent struvite. Because urine acidification, high dietary sodium and dietary low magnesium are risk factors for calcium oxalate; do not feed diets for struvite prevention because they are likely to speed-up recurrence of calcium oxalate uroliths.

Preventing Urolith Recurrence

Preventative strategies are designed to eliminate or control the underlying causes of various types of uroliths (table 4). When causes cannot be identified, preventative strategies encompass efforts to minimize risk factors associated with stone formation. These strategies commonly include dietary modification to reduce the urine concentration of calculogenic minerals. Feeding canned formulations of foods (moist foods contain approximately 70 to 80% water compared to dry kibble which contains 8 to 12% water) increase urine volume, reduce urine concentration of calculogenic minerals, and promote evacuation of crystals and microliths. Therefore, when selecting a diet, canned formulations are preferred over dry kibble foods.

Additional information can also be retrieved on-line at urolithcenter.org. Activate the tab for resources and the tab for "recommendations". On the recommendations page activate the tab corresponding to the urolith type.