



Approaches to Urolithiasis Treatment

Marilyn Dunn, DVM, MVSc, DACVIM (SAIM); Matthew Kornya, BSc, DVM; Jody Lulich, DVM, PhD, DACVIM (SAIM)

Urolith management was once the sole province of the veterinary surgeon. However, a better understanding of the causes and risk factors of urolith formation have changed the treatment landscape. Therapeutic diets, miniaturization of equipment, and advanced technologies have provided a unique opportunity for veterinarians to practice advanced compassionate care that was not available in the past. The challenge for clinicians today is to move beyond traditional surgery and consider less invasive alternatives. The following are patient-centered, research, and experience-supported recommendations for the treatment of cystoliths in cats.

How do You Know if a Cat has Stones?

Depending on the size, location, and contour of uroliths, clinical signs vary from asymptomatic to life-threatening urethral or ureteral obstruction. Bladder stones are often associated with hematuria and bladder pain causing cats to urinate more frequently and often outside of the litter pan.¹ Kidney and ureteral stones are also associated with hematuria but changes in urination are uncommon. Instead, cats exhibit abdominal pain, irritability, and signs secondary to azotemia (e.g. decreased appetite).

Medical imaging remains the gold standard for urolith detection. Anecdotally, many urinary stones are detected incidentally in animals having imaging performed for unrelated reasons. Most uroliths are radiopaque and visible by survey radiography. Ultrasound has the advantage of detecting less-radiopaque stones like those composed of mineralized blood and urate, but it is challenging to image uroliths in the urethra and mid-ureter. Detection of urolithiasis increases when radiography and ultrasonography are employed together.

What Types of Uroliths are Common?

Between 1985 and 1995, struvite was the most common urolith, accounting for approximately 80% of feline urinary tract stones.^{2,3} During that time, the prevalence of calcium oxalate was steadily increasing. By 1995, calcium oxalate surpassed struvite and remained the most common feline stone for a decade. The reason for the shift is unknown, however over-acidification

of commercial cat foods was considered a primary factor because urine acidification reduced struvite precipitation and increased urinary calcium excretion. Now that diet manufacturers modulate urine acidification, the prevalence of struvite and calcium oxalate are about equal with struvite slightly over represented.

The most common urocystoliths in cats are composed of calcium oxalate or struvite (magnesium ammonium phosphate); with approximately equal numbers and accounting for 90 to 95% of uroliths in cats around the world.⁴⁻⁷ Urate stones are the next most common (~5% of feline uroliths); other types such as cystine, xanthine, dried solidified blood, and others are less common and are not discussed here.

While definitive diagnosis of the type of urolith requires ex-vivo analysis, there are some radiographic, urinalysis, and systemic characteristics that may be used to suggest the type of stone present.

Why Predict Urolith Composition Prior to Removal?

Therapeutic options for urolith removal and prevention are based on the prediction of urolith composition. For example, struvite uroliths can be dissolved rapidly with an appropriate therapeutic diet. In addition, urolith composition may be a biological marker for diseases such as portosystemic shunts. Knowing stone composition is essential prior to stone removal to minimize adverse sequela and strengthen prevention strategies to lower the chance of recurrence.



This AAFP Consensus Statement provides patient-centered, research, and experience-supported recommendations for the treatment of cystoliths in cats.



What is the Best Strategy to Predict Urolith Composition?

Radiographic appearance of uroliths is the gold standard for predicting urolith composition (Table 1). Each stone type has a characteristic shape, opacity, and surface contour that is discernible radiographically (Figure 1). An Android and iOS app is available which incorporates breed, age, and stone prevalence to assist urolith prediction (z.umn.edu/mnurolithapp). Urinalysis characteristics such as crystal type and urine pH are also helpful.

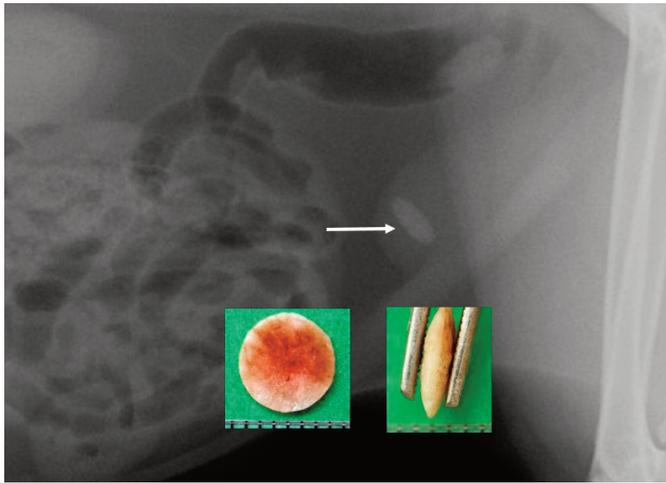


Figure 1. Radiograph of a struvite stone in a 5-year-old female DSH cat. Insert shows the variation in the radiographic shape (round or elongated oval) depending on its orientation in the urinary bladder. *Image courtesy of Jody Lulich*

Table 1. Predicting Mineral Composition of Feline Uroliths Based on Radiographic Appearance^{8,9}

Mineral	Radiopacity Compared to Soft Tissue	Surface Contour	Shape	Usual Number	Approx Size
CaOx monohydrate	+++ to ++++	Smooth, occasionally bosselated	Round/rosette	>5	1 to 5mm
CaOx dihydrate	+++ to ++++	Rough to smooth	Rosettes	>3	1 to 7mm
Sterile MAP	++ to +++	Slightly rough	Round or discoid	1 to 3, occasionally many	3 to 10mm
Infection MAP	+ to +++	Smooth to slightly rough	Round to faceted	Few to many	2 to >7mm
Urate	- to ++	Smooth	Round to ovoid	Usually 1, but up to 5	2 to 10mm
CaP	+++ to ++++	Rough	Too rare to comment	Too rare to comment	1 to 4 mm
Cystine	- to +++	Rough	Round	Many, but some with few	1 to 4 mm
Silica	++ to ++++	Too rare to comment	Too rare to comment	Too rare to comment	1 to 4 mm
Xanthine	- to +	Smooth	Round to ovoid	1 to 3	1 to 5 mm

CaOx = calcium oxalate, CaP=calcium phosphate, MAP = magnesium ammonium phosphate.

Radiographic appearance of uroliths is the gold standard for predicting urolith composition.



What is the Correct Approach to Dissolution?

Dissolution of a urolith should be attempted prior to any surgical intervention. The approach to dissolution of any cystolith entails decreasing relative supersaturation of the urine for the type of cystolith in question. Factors directly influencing relative supersaturation include the urinary concentration of mineral precursors and pH, which can impact solubility.¹⁰ Struvite stones are readily dissolvable when they occur within the urinary bladder; urate stones may be dissolvable, though generally not in animals with ongoing liver disease. Oxalate uroliths cannot be dissolved medically.

For any stone type, increasing water intake and decreasing the urine specific gravity will aid in stone dissolution. As such, feeding a canned diet or adding water to food may be recommended.

Dissolution of struvite uroliths can be achieved by feeding urine-acidifying diets restricted in magnesium.¹¹ Acidification of the urine will increase the risk of oxalate stones and as such aggressive acidification should not be relied on as the sole method of therapy.¹² Many commercial diets are available with struvite dissolution claims; note that diets should not be “mixed and matched” as they have different compositions. They should be fed as 100% of the cat’s diet or with compatible treats. Dissolution of stones generally takes 14 - 21 days and is impacted by diet related factors, patient factors, and stone size. In some cats, dissolution may take up to 56 days.^{10,11} The risk of urinary obstruction during the dissolution is extremely low, even in males.¹²

Urate stones may be dissolved through alkalinisation of the urine and treatment with allopurinol (a xanthine oxidase inhibitor) to decrease the formation of uric acid.¹³ It is important to feed a low-purine diet during the dissolution as this will reduce the risk of xanthine stone formation. Most feline “Renal” diets are alkalinizing and low in purines, and as such are acceptable for this use. Note that cats with active liver disease (such as portosystemic shunts) rarely respond to dissolution until the underlying disease is controlled.¹⁴

Antibiotics are not indicated as a component of the dissolution of feline uroliths.¹⁵ Other supportive therapy such as analgesia may be indicated if the cat is experiencing clinical signs of disease.

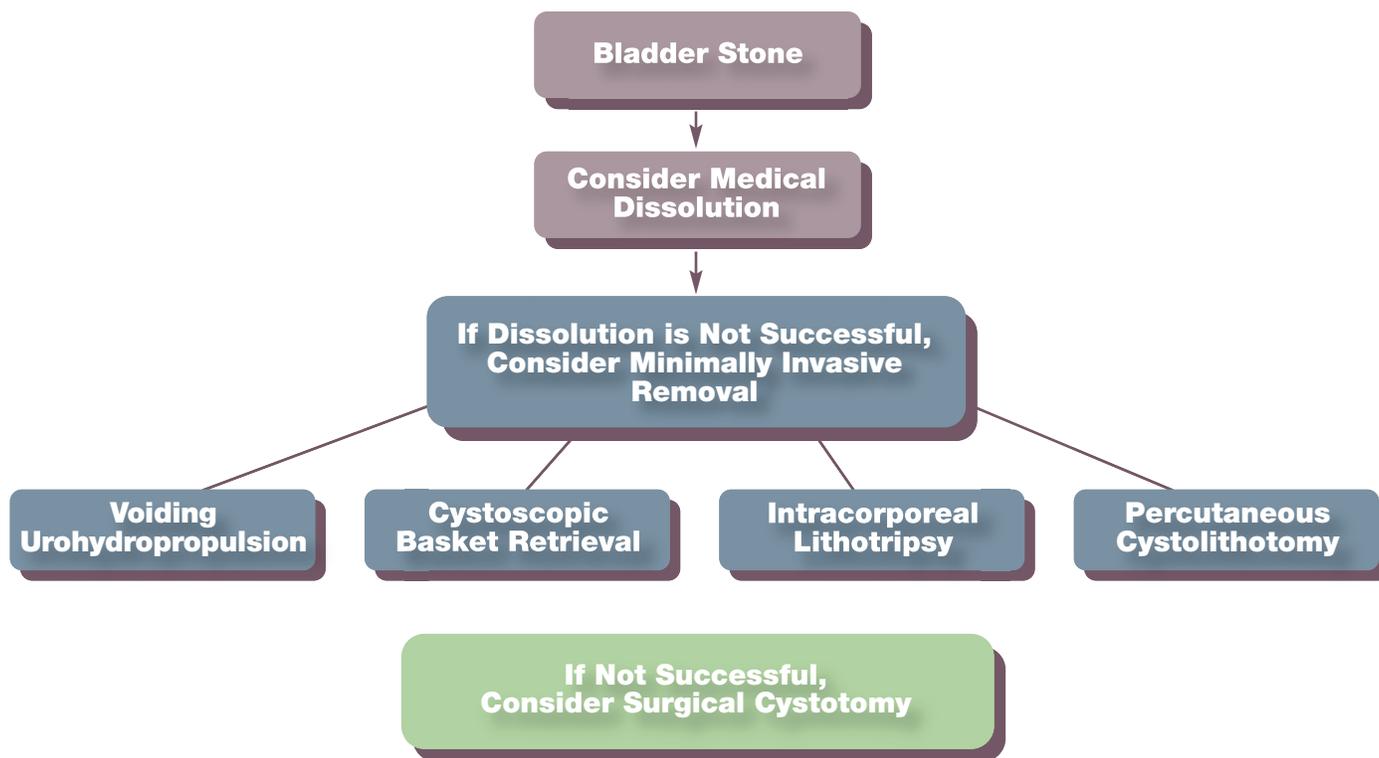


Figure 2. Algorithm for the recommended approach to bladder urolith removal in cats.

What Minimally Invasive Options Are Available to Remove Bladder Uroliths?

Lower urinary tract stones, not amenable to medical dissolution, can be removed through various minimally invasive methods. Stone removal is generally recommended as their presence can induce inflammation, obstruction, or recurrent infection. Surgical removal of uroliths by cystotomy or urethrotomy has been the traditional method of choice. However, surgical cystotomy and urethrotomy have been associated with complications such as urine leakage, wound dehiscence, bleeding, stricture formation, and incomplete stone removal in 20% of canine patients alone. Suture material within the urethra or bladder wall may serve as a nidus for future stone formation in stone-forming patients. Upon analysis of recurrent lower urinary tract stones in patients having undergone surgical cystotomy, 9.4% were suture-induced.¹⁶ Recently, complications associated with traditional surgical cystotomy, regardless of closure method, were reported in 37% to 50% of cases,¹⁷ with a mean duration of hospitalization of four days. Minimally invasive approaches have a multitude of advantages over standard surgery such as shorter hospitalization times, little to no recovery time and less discomfort. In small animals, minimally invasive treatment options for lower

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urinary tract stones consist of voiding urohydropropulsion (VUH), cystoscopic stone basket retrieval, intracorporeal lithotripsy, and percutaneous cystolithotomy (PCCL).

Minimally invasive urolith removal should be considered, discussed, and offered to caregivers of cats suffering from urinary tract conditions after attempting a dissolution approach. While at times appearing technically simple, these procedures have been associated with serious complications when performed by inadequately trained personnel and should be referred to a formally trained and experienced specialist.

Removal of lower urinary tract stones is amenable to various interventional approaches depending on the sex of the cat, type of stone present, and stone burden (number and size of stones). Considering minimally invasive approaches to stone removal in lieu of surgical cystotomy is recommended. Correct measurement of stone size is critical in the selection of the most appropriate intervention. Uroliths should be measured by standard radiography (or contrast radiography for radiolucent stones) using a radiopaque marker rather than by ultrasound which tends to overestimate urolith size and underestimate the number of uroliths.

	Size and Number of Uroliths	Sex of Cat	Advantages	Disadvantages
Voiding urohydropulsion	Stones < 2.5 mm in female cats	<ul style="list-style-type: none"> Female cats Not indicated in male cats as risk of urethral obstruction 	<ul style="list-style-type: none"> Quick Low-cost equipment Can be done in general practice 	<ul style="list-style-type: none"> Stones may remain in the bladder Larger and spiculated stones may obstruct the urethra
Percutaneous cystolithotomy (PCCL)	No restrictions	No restrictions	<ul style="list-style-type: none"> Excellent visualization of the entire lower urinary tract in females, and up to the distal urethra in males Easy retrograde stone removal 	<ul style="list-style-type: none"> Specialized equipment Access to lithotripsy may be necessary for embedded stones
Retrograde cystoscopic basket retrieval	Stones < 3 mm in female cats	<ul style="list-style-type: none"> Female cats Not possible in male cats as penile urethra is too small to allow scope retrieval 	<ul style="list-style-type: none"> Quick No suture material in the bladder 	<ul style="list-style-type: none"> Specialized equipment Not suitable for large stones
Retrograde cystoscopic Intracorporeal lithotripsy	Low stone burden preferable	<ul style="list-style-type: none"> Female cats Not possible in male cats 	No suture material in the bladder	<ul style="list-style-type: none"> Specialized equipment Long procedural length risk of urethral trauma while removing stone fragments

Table 2. Minimally Invasive Bladder Urolith Removal Types

Summary of minimally invasive options and guidelines for patient selection for the removal of bladder uroliths in cats.

What are the Steps to Urolith Prevention?

Urolith formation is based on several factors, including genetic predisposition, diet, hydration status, and concurrent diseases. Some factors (such as genetic predisposition) obviously cannot be altered, however others can be and may play a role in the prevention of urolith recurrence.

Increasing the moisture content of diets helps to decrease specific gravity of the urine and as such the saturation of minerals that may form crystals and stones. Encouraging increased drinking of water using various strategies, feeding canned food, and adding moisture to food may help to reduce the recurrence of urolith formation. Many cats will exhibit water intake preferences based on factors such as freshness, temperature, taste, movement, and container shape.¹⁸

Feeding diets with a claim to urinary stone prevention will decrease the saturation of minerals and reduce the risk of stone formation.¹² Most commercial “urinary” diets available today have claims for the prevention of both struvite and oxalate stones. Other stone types, such as urates, may require specific diets as discussed above.

Some cats with recurrent oxalate stones may require additional management, such as urinary alkalinisation (generally with potassium citrate)¹⁹ or thiazide diuretics (which decrease specific gravity and reduce calciuresis).¹²

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SUMMARY POINTS

- Attempt to predict urolith composition based on patient, radiographic results, and urinalysis factors
- Dissolution should be attempted prior to surgical intervention
- Minimally invasive techniques should be recommended prior to open cystotomy

Control of any concurrent disease may help to control urolith formation (i.e., ligation of a portosystemic shunt or treatment of idiopathic hypercalcemia). Idiopathic hypercalcemia is diagnosed by measuring ionized calcium. As mentioned above, adult cats rarely form infection induced struvite stones. Some data has suggested that increased dietary polyunsaturated fatty acids may reduce urolith formation.²⁰

For further reading, see the *ACVIM Small Animal Consensus Recommendations on the Treatment and Prevention of Uroliths in Dogs and Cats*.



Conflicts of Interest

Jody Lulich performed clinical research in 2009 and is a current speaker for Hill's Pet Nutrition. Hill's Pet Nutrition donates partial support to the Minnesota Urolith Center at the University of Minnesota of which Jody Lulich is the Director. Marilyn Dunn is a member of the Royal Canin Urinary Advisory Board. The other member of the Task Force has no conflicts of interest to declare.

Funding

This Consensus Statement was supported by an educational grant to the AAFP from Hill's Pet Nutrition, Purina Pro Plan Veterinary Diets, and Royal Canin. The Task Force members received no financial support for the research, authorship, and/or publication of this article.

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