Medical Management of Urinary Stones

What are the most likely urinary stones seen in dogs and cats?

Uroliths are usually diagnosed based on radiography in patients with symptoms of urinary disease or as an incidental finding. Occasionally, owners observe voiding of uroliths. When uroliths are detected anywhere in the urinary tract, the entire urinary tract should be imaged to determine if uroliths are present in other locations. Although most uroliths are radiopaque and are visible on survey abdominal radiographs, some uroliths have the same radiopacity as the surrounding soft tissues (radiolucent). Failure rates for detection of uroliths by survey radiography can be up to 25% depending on the size and composition of the uroliths; ultrasound has a false-negative result of 6%.

Once the number and location of uroliths is determined, the next step is to determine the type of urolith present and formulate a treatment plan. If uroliths are not available for analysis, the chemical composition can often be correctly predicted from signalment, and results of urinalysis and radiographs.

### Characteristics of Common Canine Uroliths

<table>
<thead>
<tr>
<th>COMPOSITION</th>
<th>RADIOGRAPHIC DENSITY</th>
<th>SURFACE CHARACTERISTICS URINE pH</th>
<th>CRISTALLURIA</th>
<th>URINARY TRACT INFECTION</th>
<th>COMMONLY AFFECTED BREEDS* OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium oxalate monohydrate (COM) and/or calcium oxalate dihydrate (COD)</td>
<td>Moderately to markedly radiopaque</td>
<td>Sharp projections, mulberry shaped or smooth round uroliths; COD may appear jackstone shaped</td>
<td>Acidic to neutral</td>
<td>Calcium oxalate dihydrate crystals (square envelope) or calcium oxalate monohydrate crystals (dumbbell or picket-fence shapes)</td>
<td>None or secondary urinary tract infection (UTI) with common uropathogens</td>
</tr>
<tr>
<td>Struvite (magnesium ammonium phosphate hexahydrate)</td>
<td>Moderately to markedly radiopaque; larger uroliths appear more radiopaque</td>
<td>Single-may be smooth or speculated; Multiple-smooth surfaces where uroliths contact each other, often pyramidal shape</td>
<td>Alkaline</td>
<td>Struvite or &quot;triple phosphate&quot; crystals (&quot;coffin lid&quot; appearance)</td>
<td>Urease-producing organisms <em>Staphylococcus</em>, <em>(Proteus</em>, <em>mycoplasma)</em>; sterile struvite uroliths in cocker spaniels</td>
</tr>
<tr>
<td>Urate/xanthine</td>
<td>Radiolucent to faintly</td>
<td>Multiple smooth uroliths</td>
<td>Acidic</td>
<td>Ammonium urate crystals (yellow-brown &quot;thorn</td>
<td>None or secondary UTI with common</td>
</tr>
</tbody>
</table>

*Other*
Do all stones need to be removed?

While it is desirable to obtain a valid stone analysis to determine appropriate dietary and supportive treatments, not all stones need to be removed from a practical sense. Fortunately, struvite stones can be medically dissolved. Non-dissolving stones that are not causing abnormal clinical signs do not necessarily have to be removed especially when associated with patients that have high anesthetic risk, compromised renal function, in stones are located in areas of high surgical risk (kidneys, ureters). Patients that have repeated stone reoccurrences may not need removal if they remain silent.

However, stones that are the cause of renal compromise (pelvic or urethral obstruction), cause of repeated bacterial infection or are associated with significant hematuria or pain/discomfort should be removed.
Is lithotripsy an effective treatment for stones in dogs and cats?

I am commonly asked why we don't recommend lithotripsy in dogs and cats as is often performed in people for stone fragmentation. The answer is expensive, more time consuming compared to surgery, does not always work well for cystic calculi and is not widely available. There are 3 basic types of lithotripsy.

Electrohydraulic lithotripsy (EHL) creates hydraulic shock waves generated within the bladder lumen and can successfully fragment and remove urocystoliths in dogs. The procedure requires cystoscopy and specialized EHL generator and takes from 1 to several hours to complete.

Laser lithotripsy using the holmium laser is faster and can be performed through small-diameter flexible endoscopes and may become more widely available in veterinary medicine for removal of bladder and ureteral stones.

Extracorporeal shock wave lithotripsy (ESWL) is fragmentation of uroliths using shock waves that are generated outside the body. ESWL is better for fragmentation of uroliths fixed in one location such as nephroliths or ureteroliths but cystic calculi have been fragmented with this technique.

Can I perform voiding urohydropropulsion in my practice?

Voiding urohydropropulsion is useful to remove smaller urocystoliths via induced voiding while a patient sedated/anesthetized and positioned vertically so that urocystoliths pass with the voided urine. Sedation or general anesthesia facilitates urethral relaxation and makes the procedure easier and safer to perform. To perform this technique the urinary bladder is distended with sterile saline via urethral catheterization. The patient is positioned so that the spine is roughly perpendicular to the effects of gravity. The bladder is palpably agitated and time is allowed for the urocystoliths to settle in the trigone. The bladder is palpated with gentle manual on the bladder to initiate a detrusor contraction. Once voiding begins, the bladder is compressed more firmly to attempt to maintain maximum urine flow rates, dilate the urethra, and flush out the urocystoliths. The procedure is repeated until all stones are removed. Postprocedural radiographs are performed to confirm complete removal of the urocystoliths.

This technique is ideal for patients that develop recurrent stones; however, to be successful the stones must be small enough to pass through the urethra so frequent follow-up imaging is needed for early detection.

Why does dissolution diet therapy not always work for me?

Medical dissolution of struvite stones requires a combination of appropriate antimicrobial and calculolytic dietary therapy. Antibiotic selection should be based on urine culture and antibiotic-susceptibility testing from urine obtained by cystocentesis. Antimicrobial therapy must be given
throughout the entire dissolution period because viable bacteria are contained within each layer of struvite uroliths.

Two commercial calculolytic diets are available for dissolution of struvite uroliths in dogs: (1) Hill's Prescription diet s/d® and (2) Royal Canin Canine S/O Lower Urinary Tract Support Diet. Feline s/d and Royal Canin Dissolution Turkey in Gravy are appropriate for struvite dissolution in cats.

Antimicrobial and dietary therapy should continue approximately 1 month beyond radiographic resolution of struvite urolithiasis because uroliths too small for radiographic detection may still be present. Average time for dissolution of canine infection-induced struvite stones is often 2-4 months.

A common cause of failure to effectively dissolve struvite uroliths is inadequate control of the UTI. Therefore if therapeutic attempts fail or cease, urinalysis and urine culture should be repeated. Another common cause of dissolution failure is poor diet compliance by the patient (or the owner). Also if the urolith contains layers of calcium apatite, carbonate apatite, or calcium oxalate, this may prevent dissolution of the struvite component of the urolith. If the suspected struvite urolith is composed of another mineral obviously dissolution will fail as well.

What is the best way to prevent recurrent struvite stones?

The key to prevention of infection-induced struvite stones is complete and effective resolution of the underlying UTI. Antibiotic therapy should be continued for 3 to 4 weeks after removal or dissolution. Urine culture should be repeated soon after discontinuation of antibiotic therapy and again 4-6 weeks later to confirm resolution of the UTI.

The role of dietary therapy for prevention of struvite urolithiasis in dogs is complex. For dogs with sterile struvite urolithiasis, dietary therapy can be used long-term to prevent urolith recurrence; however, sterile struvite uroliths are uncommon. For dogs with infection-induced struvite urolithiasis, dietary therapy designed to prevent recurrence of struvite is likely unnecessary as prevention and control of recurrent UTI is usually effective regardless of diet. Many of the breeds predisposed to struvite stones are also predisposed to calcium oxalate stones and dietary therapy to prevent struvite (Science Diet C/D) promote urinary acidification and magnesium restriction which may contribute to formation of calcium oxalate stones.

Cats are metabolically predisposed to struvite formation so long-term dietary therapy is appropriate. Royal Canin S/O Lower Urinary Tract Support Diet may be fed long-term in breeds or cats predisposed to both calcium oxalate and struvite stones because it is designed for prevention of both types of stones.
What are the best ways to prevent recurrent calcium oxalate stones?

Great question but difficult answer! Calcium oxalate stones recur in most dogs, with recurrence rates of up to 50% within 3 years of initial diagnosis. Expanded diagnostic information should be evaluated in these patients to examine for hypercalcemia, metabolic acidosis and hyperadrenocorticism as they may contribute to reoccurrence. Dietary changes should be attempted and medications used if persistence of calcium oxalate crystalluria or recurrence of stones are noted.

Addition of water to the diet or changing to a predominantly canned diet should be implemented as the first step in prevention of calcium oxalate stones in dogs. This will effectively dilute calculogenic substances in the urine and the increased voiding helps remove free crystals in the urinary tract. The ideal diet for prevention of calcium oxalate stones is unknown with conflicting recommendations in the literature. The commercial diets recommended to reduce the risk of calcium oxalate stones are Waltham® Canine S/O Lower Urinary Tract Support Diet and Hill's Prescription diet u/d®. Prescription diet u/d® should be avoided in dogs with history of pancreatitis, obesity, diabetes mellitus, or hyperlipidemia due to its increased fat content. An alternative diet suggested for these animals is Hill's Prescription diet w/d® with supplementation of oral potassium citrate to achieve a urine pH of 6.5 to 7.0.

When dietary therapy alone does not prevent calcium oxalate recurrence supportive medications could be considered. Thiazide diuretics have been suggested to reduce urinary calcium excretion but clinical results and experimental support is lacking. Potassium citrate supplementation may reduce recurrence of calcium oxalate stones but conflicting opinions exist. Potassium citrate supplementation has been recommended at a dose of 50 to 75 mg/kg orally every 12 hours if the urine pH is acidic or if calcium oxalate crystals are still present despite dietary therapy. A goal is to achieve a urine pH of 6.5 to 7.0.

Supplementation of vitamin C or vitamin D should be avoided in dogs with calcium oxalate urolithiasis. Because vitamin C is converted to oxalate, excessive vitamin C may contribute to hyperoxaluria and increased risk of calcium oxalate urolithiasis. Vitamin D supplementation increases intestinal absorption of calcium, thereby promoting hypercalciuria and increased risk of calcium oxalate urolithiasis. Vitamin B₆ has been recommended but no data supports any benefit from vitamin B₆ for prevention of calcium oxalate stones in dogs.

How do I manage ammonium urate stones in Dalmations?

Urate uroliths dissolution involves combining dietary modification, urine alkalization and control of secondary infections if present. Protein restriction, particularly purine restriction, is the foundation of medical management. Currently there are the two veterinary diets marketed for this purpose in dogs (Prescription diet u/d, Hills Pet Nutrition; Urinary UC Low Purine Formula, Royal Canin Veterinary diet). These diets are also formulated to maintain alkaline urine. Protein restriction lowered blood urea nitrogen content, which limits concentrating ability. Feeding a canned diet or adding water to dry formulations further increases urine volume. Potassium citrate (initial dose 40–90 mg/kg PO q12hr) may be used to alkalinize the urine if
necessary. Urine pH values over 7.5 may predispose to the formation of calcium phosphate uroliths.

Xanthine oxidase inhibitors are used to decrease uric acid production. Allopurinol inhibits the conversion of hypoxanthine to xanthine and of xanthine to uric acid. The bioavailability of allopurinol is not affected by food. Caution should be used with allopurinol in animals with hepatic or renal dysfunction. The initial dose of allopurinol is 15 mg/kg PO BID for 4 weeks followed by evaluation of calculi size, shape and number. On average, dissolution occurs over 3.5 months (range 1–18 months). Allopurinol should not be used in patients with portosystemic shunts. Allopurinol should only be used in conjunction with a protein-restricted diet. Excessive purine precursors in the diet may predispose to xanthinuria and the formation of xanthine uroliths. If xanthine urolithiasis occurs, allopurinol should be discontinued for 1 to 2 months with continued dietary therapy to allow for xanthine dissolution.

**What is the significance of ammonium urate stones in non-Dalmation breeds?**

If urate-containing calculi are found in non-Dalmatian dogs, a search for an underlying portovascular anomaly should be performed.