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Nutritional Management of Urolithiasis

P Profile

Definition

Calcium oxalate and magnesium ammonium phosphate (struvite) uroliths have consistently represented the greatest proportion of urolith types in dogs and cats.^{1,2} The prevalence of these urolith types, however, has fluctuated over the past 10 to 25 years.

- Between 1981 and 2001, the proportion of calcium oxalate uroliths increased from 1% to 31% in female dogs and 18% to 82% in male dogs. At the same time, struvite uroliths decreased from 97% to 68% in female dogs and 79% to 16% in male dogs. In 1998, the rate of change began to level off, and appeared to have plateaued by 2001.¹
- Similar shifts occurred in cats between 1985 and 2001; the proportion of struvite uroliths decreased from approximately 80% to 32% and the proportion of calcium oxalate uroliths increased from approximately 12% to 62%.² During the last 3 years of the study (2002–2004), the percentage of struvite uroliths (44%)

was higher than the percentage of calcium oxalate uroliths (40%), suggesting a reverse in the trends seen over previous years.

Signalment/Causes/Risk Factors

Struvite (Dogs)

- **Age:** 6 ± 2.9 years (range, 1–19 years)¹
- **Sex:** Female (85%)¹
- **Breed:** Reported in 157 different breeds; mixed-breed dogs predominate, followed by shih tzu, bichon frise, miniature schnauzer, Lhasa apso, and Yorkshire terrier¹
- Most commonly associated with urinary tract infections (UTIs) with a urease-producing organism

Struvite (Cats)

- **Age:** < 7 years of age²
- **Sex:** Female (57%)²
- **Breed:** Domestic longhair, Manx, and Siamese cats had significantly more struvite-containing calculi.²
- Approximately 70% of struvite uroliths in cats form in sterile urine.³

Calcium Oxalate (Dogs)

- **Age:** 8.5 years (range, 6–15 years)¹
- **Sex:** Male (> 70%)¹
- **Breed:** Miniature schnauzer, Lhasa apso, Cairn terrier, Yorkshire terrier, cocker spaniel, bichon frise, shih tzu, miniature poodle¹
- Smaller dog breeds may be predisposed⁴ due to:
 - Lower urine volumes
 - Less frequent micturition
 - Increased mineral concentrations in the urine.



Calcium Oxalate (Cats)

- **Age:** 4 to 15 years (more common in cats > 7 years of age when compared with cats developing struvite stones)²
- **Sex:** Male (58%)²
- **Breed:** Domestic shorthair, Persian, and Himalayan²

Dx Diagnosis

Presentation

- Lower urinary tract signs:
 - Hematuria
 - Pollakiuria
 - Dysuria
 - Stranguria
- If the urolith is located within the kidney or urethra, lower urinary tract signs may not be appreciated.

Laboratory Findings/Imaging

- Identify urolith by imaging techniques (eg, radiography or ultrasonography).
- A complete urinalysis and urine culture are recommended in all cases.

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- Serum biochemical profile and complete blood count should be conducted to help identify underlying conditions.
 - If hypercalcemia is present, further diagnostics should be performed to identify the underlying cause.
 - If renal disease is present, dietary therapy should include an appropriate therapeutic renal diet with a high-moisture approach.

Definitive Diagnosis

- Confirm urolith composition by laboratory analysis (Figures 1–4). The urolith may be composed of multiple layers; therefore, analysis of both the outer shell layers and the core is required. It is interesting to note that stones of similar mineral composition can vary in color.
- Urolith culture is recommended.

Differential Diagnosis

- Urinary tract infection
- Bladder mass
- Idiopathic cystitis

Tx Treatment

Nutritional Treatment: Struvite Uroliths

- **Antibiotic Therapy:** Because struvite uroliths are almost always identified in dogs with a UTI, the primary treatment is antibiotic therapy.
- **Urine Concentration**
 - Increased dietary moisture promotes a reduction in urine specific gravity and is one of the most important nutrient strategies for all urolith types.
 - A canned diet should be selected or water can be added to the food (~2 cups per 1 cup dry food or ~1/4 cup per 1 cup canned food).
 - Increased dietary sodium can be used to promote increased water intake.
- **Dietary Measures (Table 1, page 50)**

UTI = urinary tract infection



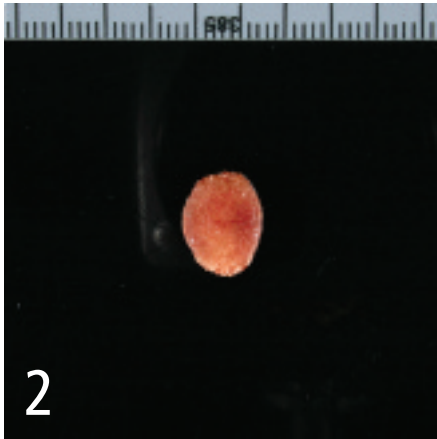
Struvite uroliths collected from a dog

- Struvite uroliths are composed of magnesium, ammonium, and phosphate ($MgNH_4PO_4 \cdot 6H_2O$). Diets designed for struvite dissolution and prevention provide a reduced magnesium, phosphorus, and protein content (source of ammonium). In general, feline diets provide only moderate protein restriction (if any) when compared to canine diets.
- In addition, struvite solubility is reduced in urine with pH greater than 6.7. Some diets acidify urine and help dissolve uroliths.
- Frequent monitoring of dissolution progress is required (at least once every 4 weeks).
- The expected time frame for dissolution is 3 to 4 weeks for a sterile struvite urolith, and up to 20 weeks for an infection-induced urolith.
- Antibiotic treatment should be continued until the urolith is completely dissolved because bacteria within the urolith can be released during the dissolution process.
- **Diet Cautions**
 - Dietary modification may be used for

- dissolution but is not routinely recommended for preventing struvite uroliths unless sterile struvite uroliths have been confirmed.
- Because of the restricted protein level and the acidifying effect of dissolution diets, they should never be fed to growing, pregnant, or lactating animals.
- Some dissolution diets (such as Hill's Prescription Diet s/d, hillspet.com) should be fed only on a short-term basis, never as a preventive diet.
- Caution should be observed when considering use of calculolytic diets because urethral obstruction is always a risk with this method.

Nutritional Treatment: Calcium Oxalate Uroliths

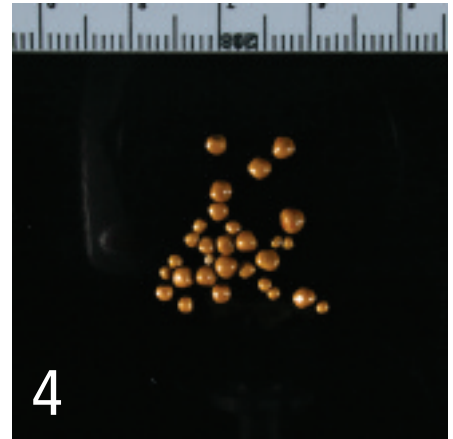
- **Urine Concentration:** See treatment for struvite uroliths
- **Dietary Measures (Table 2, page 50)**
 - **Calcium:** Normal dietary calcium levels are recommended.⁵ High dietary calcium may result in increased urinary calcium excretion. Low dietary calcium may result in an increased absorption of



Struvite urolith collected from a cat



Knife-edged and abraded calcium oxalate dihydrate crystals are visible on the surface of this calcium oxalate urolith removed from a dog



Multiple calcium oxalate monohydrate uroliths removed from a cat

oxalate from the gastrointestinal tract.

- **Oxalate:** Foods that contain high-oxalate ingredients should also be avoided. Ingredients that are high in oxalate generally include vegetables, whole grains, legumes, nuts, and some fruits, such as blackberries and figs. See ohf.org (Oxalosis and Hyperoxaluria Foundation) for a more thorough list of the oxalate content of common foods.
- **Magnesium** acts as a calcium oxalate urolith inhibitor by forming a soluble salt with oxalate. Diets designed for managing both calcium oxalate and struvite urolithiasis use a moderate magnesium approach.
- **Citrate** can play a similar inhibitory role by binding with calcium to form a soluble salt. Potassium citrate has also been used as an alkalizing agent, but it has only modest effects on urinary pH in dogs.⁶
- **Vitamin B6** deficiency has been shown to cause calcium oxalate crystals in cats; therefore, vitamin B6 adequacy should be assured with a complete and balanced diet.
- **Low-fat:** Some dogs with calcium oxalate uroliths may benefit from a low-fat food. Little research has been done in this area in dogs and cats, but epidemiologic studies in humans have

shown an association between the risk for calcium oxalate uroliths and high-fat diets.⁷

- **Diet Comments & Cautions**

- **Low-protein:** A traditional approach is to feed a low-protein diet to promote neutral to alkaline urine pH. However, protein restriction to promote alkaline pH is probably unnecessary because the risk for calcium oxalate formation is unaffected by urine pH values as low as 5.9 to 6.4 in dogs and cats.⁸
- **Acidifying diets** can induce metabolic acidosis, which results in bone resorption, leading to increased calcium excretion in the urine. Acidification also contributes to decreased citrate excretion, thereby reducing the levels of a potential inhibitor in the urine.
- **Vitamin C supplementation** should be avoided because excess vitamin C is metabolized within the liver to oxalate and excreted in the urine.⁹
- **Phosphorus** restriction should be avoided because it can lead to decreases in urinary pyrophosphate, which is an inhibitor of calcium oxalate.^{10,11}
- **Sodium:** The use of sodium is controversial. Historically, reduced-sodium diets were recommended for managing

calcium oxalate because sodium is known to increase calcium excretion in the urine. More recent studies have shown that the increased urine volume seen with higher-sodium diets leads to decreased urine calcium concentration despite the increase in total calcium excretion.¹² Critics argue that high-sodium diets may harm the kidneys, especially in cats. This argument is supported by one study that reported increases in serum urea nitrogen, creatinine, and phosphorus concentrations in cats fed a high-sodium diet.¹³ However, a follow-up study failed to reproduce the same harmful effects.¹⁴

- **Stone Removal:** Calcium oxalate uroliths do not respond to medical dissolution; therefore, they must be mechanically removed.



Follow-Up

- Recheck urinalysis and urine culture within 3 to 4 weeks of initiating new dietary plan.
- Depending on response, continue monitoring every 3 to 4 months.
- For both high-moisture and high-sodium diets, seek to reduce urine specific gravity

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to less than 1.02 for a dog and 1.025 for a cat.

In General

Relative Cost

- Initial workup (diagnostic tests and imaging): \$\$\$\$
- Surgical removal of urolith: \$\$\$\$\$
- Follow-up monitoring: \$\$
- Therapeutic diet: \$

Cost Key

\$ = < \$100	\$\$\$\$ = \$500–\$1000
\$\$ = \$100–\$250	\$\$\$\$\$ = > \$1000
\$\$\$ = \$250–\$500	

Prognosis

- Prognosis can vary with individual cases.
- Complete prevention of recurrence is difficult in some patients; however, diet can help increase the time intervals between episodes of urolith formation. ■

Table 1. Veterinary Therapeutic Diets—Struvite Urolith Management

Diet	Dissolution	Prevention
CANINE		
Hill’s Prescription Diet s/d	■	
Hill’s Prescription Diet c/d		■
Royal Canin Veterinary Diets SO	■	■
FELINE		
Eukanuba Veterinary Formula Urinary Low pH/S		■
Hill’s Prescription Diet s/d	■	
Hill’s Prescription Diet c/d Multicare		■
Purina Veterinary Diets UR St/Ox		■
Royal Canin Veterinary Diet Dissolution	■	
Royal Canin Veterinary Diet SO	■	■

Table 2. Veterinary Therapeutic Diets—Calcium Oxalate Urolith Management

CANINE		
Hill’s Prescription Diet u/d		
Royal Canin Veterinary Diet SO		
FELINE		
Eukanuba Veterinary Formula Urinary Moderate pH/O		
Hill’s Prescription Diet c/d Multicare		
Hill’s Prescription Diet x/d		
Purina Veterinary Diets UR St/Ox		
Royal Canin Veterinary Diet SO		

Tx at a Glance

Struvite Urolithiasis

- **Antibiotics:** In dogs, treat UTI; no dietary modification needed to prevent infection-induced struvite uroliths.
- **Reduce urine concentration**
 - Increase dietary moisture
 - ± Increase dietary sodium
- **Modify urolith precursors or components**
 - Follow reduced-magnesium diet
 - Follow reduced-phosphorus diet
 - Follow reduced-protein (source of ammonium) diet (primarily for dogs)
- **Reduce urine PH**
- **Stone solubility:** Stones can be dissolved with special dissolution diets

Calcium Oxalate Urolithiasis

- **Reduce urine concentration**
- **Modify urolith precursors or components**
 - Maintain normal dietary calcium level
 - Reduce dietary oxalate
- **Other factors**
 - Avoid aggressive magnesium and phosphorus restriction
 - Consider citrate supplementation
 - Avoid vitamin C supplementation
 - Consider fat restriction in patients with hyperlipidemia
- **Stone solubility:** Calcium oxalate uroliths do not respond to medical dissolution and must be mechanically removed.

UTI = urinary tract infection

See Aids & Resources, back page, for references, contacts, and appendices. Article archived on cliniciansbrief.com