CANINE STRUVITE UROLITHS
In almost all dogs, struvite (magnesium ammonium phosphate hexahydrate) forms as a consequence of urinary tract infection with bacteria that produce the enzyme urease. Early eradication and prevention of urinary tract infections are the best strategies to prevent infection-induced struvite uroliths.

**PREVENTION**

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<td>Identify and eradicate structural and functional risk factors for recurrent infections. Culture the urine.</td>
<td>Culture and susceptibility testing provides the most accurate method for selecting effective antimicrobials. Penicillins (e.g. amoxicillin) are usually effective against the most common urease producing bacteria (i.e. Staphylococcus sp.)</td>
<td>Foods with lower protein, phosphorus and magnesium that promote formation of acidic urine are helpful (e.g. Hill’s c/d Multicare, w/d, others). Nutritional management without control of urinary tract infection may not prevent recurrence.</td>
<td>Periodic urine cultures (e.g. every 3 months) to manage recurrent infections before uroliths recur.</td>
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**Review manufacturer’s therapeutic food literature to determine indications/contraindications. For pets with multiple health concerns, consult a veterinary nutritionist to select an optimal food.**

In depth recommendations and references are available on our website: urolithcenter.org under the resources tab.
CANINE STRUVITE UROLITHS

In dogs, struvite (magnesium ammonium phosphate hexahydrate) stones are commonly a consequence of urinary tract infection (UTI) with bacteria that produce urease. This bacterial enzyme is responsible for over-production of urine ammonia and subsequent urine alkalinization. Female dogs (85%) are over represented presumably because they are at greater risk for urinary tract infection.¹

Consider These Facts:

Some veterinarians prefer to remove struvite uroliths surgically instead of medical dissolution due to the perception that medical dissolution is less effective, more expensive, associated with prolonged discomfort, and will result in urethral obstruction as uroliths decrease in size. These are more often misperceptions. Medical dissolution with Prescription Diet® s/d® Canine was 100% effective after just 3 to 6 weeks for sterile struvite uroliths³ and 8 to 12 weeks with antimicrobics for infection-induced struvite uroliths.⁴ Noninvasive medical dissolution is an effective and compassionate choice for dogs without a urethral obstruction.

Although low-protein, dissolution diets are not recommended for immature growing dogs, their short-term use in conjunction with antimicrobics has rapidly dissolved infection-induced struvite uroliths in 9 to 12 days without adverse events.⁵

When feeding Prescription Diet® s/d® Canine, owner/patient compliance is easily and rapidly determined with a urine specific gravity (USG) (mean = 1.008 ± 0.003) and pH (mean = 6.2 ± 0.7).⁶ If urine is inaccessible, the serum concentration of urea nitrogen is also a reliable marker (mean = 3.5 ± 2.4 mg/dl) of dietary compliance.

The struvitolytic diet is relatively high in fat in order to maintain calorie intake while providing lower quantities of protein to reduce urolith precursors (e.g. phosphorus and urea) important for dissolution. High dietary fat is a risk factor for pancreatitis. Likewise, female Miniature Schnauzers (and other breeds) and dogs with hyperadrenocorticism are also risk factors for pancreatitis and urinary tract infections that include urease-producing uropathogens. Be aware of these associations and know how to respond (e.g. discontinue struvitolytic diet, maintain hydration) to adverse events (vomiting/pancreatitis) if they occur. In these patients, consider low-fat alternatives that also acidify urine (e.g. canned Prescription Diet® w/d® Canine) to assist correction of both diseases.

Twenty-six percent of canine nephroliths are composed of struvite.⁷ As with bladder stones, struvite nephroliths can be dissolved medically. Dissolution times are typically longer due to reduced kidney function, reduced urine production, and reduced nephrolith dwell time in therapeutically undersaturated urine.

Medical Considerations:

- Urinary tract infection by urease-producing bacteria is the underlying cause of most canine struvite stones. Therefore, culture urine prior to antimicrobial administration to accurately classify and effectively manage uroliths.
- In some dogs, struvite formation occurs in the absence of urinary tract infections. However, risk factors (distal renal tubular acidosis, hypoxemia, chronic diuretic use, administration of antacids, and hyperaldosteronism) promoting persistent alkaliniuria, hyperphosphaturia and hyperammoniuria are rarely detected.

Nutritional Considerations:

- Diets with reduced protein, phosphorus and magnesium that promote formation of acidic urine (i.e. pH≤ 6.5) reduce struvite precipitation and promote struvite dissolution.
- Extreme and prolonged reductions of some risk factors that minimize struvite urolith formation, (e.g. acidic urine), may increase risk for calcium oxalate (CaOx), calcium phosphate carbonate, and calcium phosphate apatite uroliths, especially in breeds at risk (e.g. Bichon Frise, Miniature Schnauzer, Shih Tzu, Lhasa Apso, Miniature Poodle and others).
- High moisture foods (i.e. canned formulations) are more effective because increased water ingestion is associated with decreased urine concentrations of calculogenic minerals and increased crystal evacuation.

Pharmacological Considerations:

- While waiting for urine culture results, consider antimicrobics (e.g. beta-lactam) with high efficacy for eradicating common, urease-producing uropathogens (e.g. staphylococcal sp.).
- Consider dl-methionine (100mg/kg q12 hr) or ammonium chloride to acidify urine and assist urolith dissolution in patients unable to consume therapeutic diets and in dogs whose urine remains alkaline following appropriate therapy.²
MEDICAL DISSOLUTION OF STRUVITE UROLITHS IN DOGS

**Therapy:** Struvitolytic Diet
- Appropriate antimicrobics for infection-induced uroliths

**Monitor:** Urinalysis and medical imaging every 4 to 6 weeks.

- USG < 1.020
  - Urine pH < 6.5
  - 20% Reduction in Stone Size
  - (These parameters are ideal for successful struvite dissolution.)

- USG > 1.020
  - Urine pH > 6.5
  - Bacteriuria
    - Culture urine to verify infection and antimicrobial administration
    - If positive, administer appropriate antimicrobial by an accepted route

- **Inadequate Control of UTI**
  - Administer antimicrobics throughout the entire period of dissolution

- **Incomplete Dietary Compliance**
  - To verify, measure using pH meter
  - Minimize confounding post-prandial alkalinuria by sampling urine just prior to meals or >8 hrs after meals

- **Incorrect or Incomplete Prediction of Mineral Composition**
  - Consider minimally invasive or surgical methods to remove uroliths

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PREVENTION OF INFECTION-INDUCED STRUVITE UROLITHS

Therapy: Control of urinary tract infection and appropriate antimicrobial administration is essential to prevent recurrence.

Diets with reduced protein, phosphorus and magnesium that promote formation of acidic urine are helpful, but cannot be used as a substitute for appropriate control of urinary tract infections.

Monitor: Urine culture and urinalysis in 1 month and then every 3 to 6 months. Consider medical imaging every 6 months or sooner in patients with recurrent urinary signs.

Positive Culture

- Repeat Culture and urinalysis every 3 to 6 months.
- Repeat culture with any signs of emerging infection (e.g. excessive licking of vulva, urinating in house, pollakiuria, hematuria, etc.)

Struvite Crystalluria

- Clinically insignificant in dogs with negative urine cultures
- Consider dissolution for recurrent struvite uroliths and minimally invasive techniques or surgery for other types

Negative Culture

- Identify and eradicate structural (vaginourethrocystoscopy, contrast vaginourethrocystography, and ultrasonography) and functional (urine cortisol to creatinine ratio, serum biochemical and thyroid profiles, and neurological exam) risk factors for recurrent infections
- Initiate antimicrobial therapy based on susceptibility results.
- Verify antimicrobial effectiveness (culture urine during therapy)
- With additional recurrent infections, administer full dose antimicrobics for 4 weeks and then consider low-dose (1/3 to 1/2 daily dose), long-term (9 to 12 months), nightly antimicrobics; monitor with periodic urine cultures

Calcium Oxalate (CaOx) Crystalluria

- Verify persistent, in vivo crystalluria by reevaluating an appropriately collected (in hospital) fresh urine sample analyzed within 30 minutes
- If persistent and in breeds (Bichon Frise, Miniature Schnauzer, Yorkshire Terrier, Shih Tzu, Lhasa Apso, others) at increased risk for CaOx uroliths, discontinue diets that promote formation of acidic urine and consult recommendations for CaOx prevention

Uroliths

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PREVENTION OF STERILE STRUVITE UROLITHS IN DOGS

**Therapy:** Long-term use of diets specially formulated with reduced levels of protein, phosphorus and magnesium that promote formation of acidic urine are essential to prevent these potentially highly recurrent uroliths.

**Monitor:** Urinalysis and medical imaging in 1 month and then every 3 to 6 months; or sooner in patients with recurrent urinary signs.

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**Urine pH < 6.5 and No Struvite Crystalluria**

(These parameters are ideal for successful struvite prevention.)

- Continue therapy and monitor every 3 to 6 months

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**Urine pH ≥ 6.5**

- To verify, measure using pH meter
- Minimize confounding post-prandial alkaliniuria by sampling urine just prior to meals or >8 hrs after meals

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**Struvite Crystalluria**

- Verify persistent, in vivo crystalluria by reevaluating an appropriately collected (in hospital) fresh urine sample analyzed within 30 minutes

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**Calcium Oxalate (CaOx) Crystalluria**

- With persistent CaOx crystalluria and especially in breeds at increased risk for CaOx uroliths (i.e. Bichon Frise, Miniature Schnauzer, Yorkshire Terrier, Shih Tzu, Lhasa Apso, others), discontinue high-sodium diets (ie. > 200mg-250mg/100 kcal) that promote calcium excretion. Encourage additional water consumption to minimize all mineral types.
- For additional information consult calcium oxalate recommendations.

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**Persistent Struvite Crystalluria**

- Encourage compliance with diets designed to minimize struvite (Prescription Diet® c/d® Canine) and/or consider urinary acidifiers (e.g. methionine) to achieve a lower pH

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- Consider dissolution for recurrent struvite uroliths and minimally invasive techniques or surgery for other urolith types.
- Submit retrieved stones for quantitative analysis.

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**Uroliths**

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