Canine Compound Urolithiasis: Prevalence, Significance and Management

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“\textit{The best veterinary teaching hospitals in the world not only use contemporary data, they create it.}”

Carl A. Osborne

Compound uroliths (stones with a nucleus composed of one mineral type and outer layers of a different mineral type) occurred in approximately 10% of the canine uroliths analyzed at the University of Minnesota (\textit{Table 38-8}). Common examples include: 1) a nucleus of 100% calcium oxalate monohydrate surrounded by a shell of 80% magnesium ammonium phosphate and 20% calcium phosphate carbonate, 2) a nucleus composed of 95% magnesium ammonium phosphate and 5% calcium phosphate carbonate surrounded by a shell of 95% ammonium acid urate and 5% magnesium ammonium phosphate and 3) a nucleus composed of 95% silica and 5% calcium oxalate monohydrate surrounded by a shell of 100% calcium oxalate monohydrate.

Voiding urohydropropulsion may be used to remove small compound urocystoliths (\textit{Figure 38-5} and \textit{Table 38-7}) (Lulich et al, 1993). Lithotripsy may be considered to remove uroliths lodged in the urethra. For most practitioners, surgery remains the most reliable method to remove large compound urocystoliths.

Because risk factors that predispose patients to precipitation (nucleation) of different minerals vary, the occurrence of compound uroliths poses a unique challenge in terms of preventing recurrence. In the absence of clinical evidence to the contrary, it seems logical to recommend management protocols primarily designed to minimize recurrence of minerals composing the nucleus (rather than those in the outer shells) of compound uroliths (Lulich and Osborne, 2000; Osborne, 2003). (See Chapters 39 through 44 for recommendations). Follow-up studies designed to evaluate efficacy of preventive protocols should include complete urinalyses, radiography or ultrasonography and if available, evaluation of the urine concentration of lithogenic metabolites. Since urinary tract infections are a common underlying cause of outer shells composed of struvite and calcium phosphate carbonate, consider urine cultures in the diagnostic and prevention management of compound uroliths.

\textbf{REFERENCES}

The references for \textit{Chapter 45} can be found at markmorris.org.
Inappropriate Urination in a Pug Cross
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Patient Assessment
An 11-year-old, neutered female pug weighing 7 kg was examined for inappropriate urination. The dog had been urinating in the house during the day while the owners were at work. Sometimes the urine appeared red. Physical examination was normal except for dental calculus and gingivitis. Body condition was normal (body condition score 3/5).

Urinalysis of a voided sample revealed alkaline urine with hematuria, proteinuria, pyuria, bacteriuria and a few struvite crystals (Table 1). A presumptive diagnosis of bacterial urinary tract infection was made. Urine collected by cystocentesis was submitted for aerobic bacterial culture. Pending culture results, the dog was given a combination of amoxicillin and clavulanic acid (14 mg/kg body weight, per os, q12h). Urine culture results identified Staphylococcus intermedius, which was susceptible to the prescribed antimicrobial.

One week later the dog was examined for continued hematuria and dysuria. Bacterial culture of urine was negative indicating that antimicrobial therapy was successful. Survey abdominal radiographs (Figure 1) revealed multiple radiodense urocystoliths with a distinct central core.

Assess the Food and Feeding Method
The dog ate a commercial moist grocery brand food supplemented with milk, turkey and chicken meat.

Questions
1. What is the probable mineral composition of this dog’s urolith?
2. What are the advantages and disadvantages of surgical vs. dietary and medical management of this urolith?

Answers and Discussion
1. Based on the clinical findings, the outer portion of the urolith was probably composed of magnesium ammonium phosphate (struvite) (Table 2). Because of the difference in radiodensity, the nidus may be composed of a different mineral salt, likely calcium oxalate.
2. Although struvite urocystoliths are amenable to dietary and medical dissolution, surgical removal is probably the best treatment option in cases of suspected compound uroliths.

Table 1. Urinalyses of an 11-year-old female neutered Pug dog with inappropriate urination.*

<table>
<thead>
<tr>
<th>Factors**</th>
<th>Day 1</th>
<th>Day 14***</th>
<th>Day 28</th>
<th>Day 60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific gravity</td>
<td>1.028</td>
<td>1.035</td>
<td>1.005</td>
<td>1.007</td>
</tr>
<tr>
<td>pH</td>
<td>8.0</td>
<td>6.0</td>
<td>7.0</td>
<td>7.5</td>
</tr>
<tr>
<td>Protein</td>
<td>2+</td>
<td>Trace</td>
<td>Trace</td>
<td>Trace</td>
</tr>
<tr>
<td>RBC††</td>
<td>3-6</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>WBC††</td>
<td>30-40</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Epithelial cells††</td>
<td>Occ</td>
<td>Occ</td>
<td>None</td>
<td>Few</td>
</tr>
<tr>
<td>Bacteria††</td>
<td>Moderate</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Crystals†††</td>
<td>Struvite</td>
<td>None</td>
<td>None</td>
<td>Few</td>
</tr>
<tr>
<td>Aerobic bacterial culture</td>
<td>S. intermedius</td>
<td>Neg</td>
<td>Neg</td>
<td>Neg</td>
</tr>
</tbody>
</table>

Key: RBC = red blood cells, WBC = white blood cells, Occ = occasional, Neg = negative.

*Samples collected by cystocentesis on Days 14, 28 and 60.
**Glucose, bilirubin and acetone were not detected in any specimen.
***Dietary therapy was initiated on Day 14.
†Values represent semiquantitative evaluations based on a scale of 0 to 4; urine volume was not considered.
††Per high power field (x450).
†††Per low power field (x100).
Progress Notes

Results of a serum biochemistry profile were normal. The urolith was removed surgically and antimicrobial therapy was continued for an additional two weeks. Quantitative mineral analysis of the urolith by polarizing light microscopy and infrared spectroscopy revealed that the nidus was composed of 100% calcium oxalate monohydrate and the outer layer was composed of 95% magnesium ammonium phosphate and 5% calcium phosphate carbonate.

Further Questions

1. How does a compound urolith develop?
2. How can recurrence of urolithiasis be minimized in this patient?

Answers and Discussion

1. Although the exact mechanisms responsible for calcium oxalate urolith formation are unknown, supersaturation of urine with calcium and oxalic acid is a prerequisite. The calcium oxalate nidus probably disrupted local defense mechanisms predisposing this patient to a staphylococcal bacterial infection of the urinary bladder. These bacteria produce the enzyme urease, leading to urine alkalinity and oversaturation with struvite.

   The calcium oxalate nidus served as template for struvite crystal deposition (heterogeneous nucleation).

2. Some strategies designed to prevent calcium oxalate urolith formation increase the risk for struvite urolith formation. The reverse is also true. When managing patients with compound uroliths containing both mineral salts, minimizing calcium oxalate urolith recurrence is given priority over minimizing struvite urolith formation because struvite uroliths can be nutritionally and medically dissolved. At present, there is no strategy to dissolve calcium oxalate uroliths.

   Dietary recommendations to minimize recurrence of calcium oxalate uroliths include reducing calcium, oxalate, protein and sodium, providing additional water and citrate and maintaining adequate phosphorus and magnesium. One therapeutic goal to prevent calcium oxalate recurrence is alkalization of urine, which minimizes calcium excretion and augments citrate excretion. Although urine alkalization increases saturation for struvite, other factors appear to have a greater impact on struvite urolith formation in dogs. In this patient, struvite formed as a result of a urinary tract infection with bacteria that produce urease. Therefore, it is unlikely that struvite will reform without recurrence of a urease-positive urinary tract infection. Urine cultures should be evaluated periodically to detect and eradicate urinary tract infections early so that struvite uroliths do not form.

Progress Notes

A commercial veterinary therapeutic food (Prescription Diet u/d Canine[6]) was recommended (one-half can per day, 375 kcal [1.57 MJ]) and the owners were instructed to avoid feeding human foods, commercial dog treats and vitamin-mineral supplements (especially those containing vitamins C and D and calcium). Urinalysis, urine culture and survey abdominal radiographs were recommended at regular intervals (i.e., every six months).

Endnote

a. Hill’s Pet Nutrition Inc., Topeka, KS, USA

Bibliography