Chapter 45

Canine Compound Urolithiasis: Prevalence, Significance and Management

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"The best veterinary teaching hospitals in the world not only use contemporary data, they create it."
Carl A. Osborne

Compound uroliths (nucleus composed of one mineral type and shells of a different mineral type) occurred in approximately 7% of the canine uroliths analyzed at the University of Minnesota (Table 38-8). Examples include: 1) a nucleus of 100% calcium oxalate monohydrate surrounded by a shell of 80% magnesium ammonium phosphate and 20% calcium phosphate, 2) a nucleus composed of 95% magnesium ammonium phosphate and 5% calcium phosphate 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 (Figure 38-5 and 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 designed primarily to minimize recurrence of minerals composing the nucleus (rather than those in shells) of compound uroliths (Lulich and Osborne, 2000; Osborne, 2003). (See specific chapters for recommendations [Chapters 39 through 44]). Followup 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.

REFERENCES

The references for **Chapter 45** can be found at www.markmorris.org.

CASE 45-1

Inappropriate Urination in a Yorkshire Terrier Cross

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Patient Assessment

An 11-year-old, neutered female Yorkshire terrier cross weighing 5 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 a large solitary radiodense urocystolith with a distinct central core (outside diameter = 2.9 cm, core diameter = 1.3 cm). The urolith core was denser than the outer layer. A urinalysis was not performed.

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.

Progress Notes

Results of a serum biochemistry profile were normal. The urolith was removed surgically

Table 1. Urinalyses of an 11-year-old female Yorkshire terrier crossbred dog with inappropriate urination.*

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

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).

Table 2. The advantages and disadvantages of dietary and medical urolith dissolution and surgical urolith removal can be accurately assessed after the mineral composition of the urolith is known or predicted. This table lists factors used to predict mineral composition of radiodense uroliths when no uroliths are available for quantitative analysis vs. clinical findings in the patient described in this case.*

Factors	MAP	CaOx	CaP	Silica	Cystine
Typical urinary pH	Yes	No	Possible	No	No
Typical crystalluria	Yes	No	No	No	No
Typical urine culture	Yes	No	No	No	No
Typical radiographic density	Yes	Yes	Yes	Yes	No
Typical radiographic contour	Yes	Possible	Possible	No	No
Typical breed	No	Yes	Yes	No	No
Typical gender	Yes	No	No	No	No
Typical age	No	Yes	Yes	No	No

Key: MAP = magnesium ammonium phosphate, CaOx = calcium oxalate, CaP = calcium phosphate.
*Characteristics of urate uroliths were not considered because they are typically radiolucent.

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.

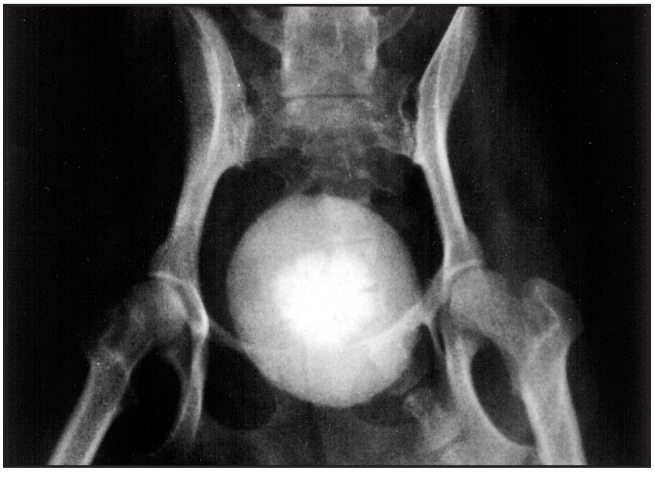

Figure 1. Survey abdominal radiograph (ventrodorsal view) showing a solitary urocystolith. Note that the urolith nidus is radiographically denser than the outer layer.

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 alkalinization of urine, which minimizes calcium excretion and augments citrate excretion. Although urine alkalinization 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[a]) 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

Osborne CA, Lulich JP, Bartges JW, et al. Canine and feline urolithiasis: Relationship of etiopathogenesis to treatment and prevention. In: Osborne CA, Finco DR, eds. Canine and Feline Nephrology and Urology. Baltimore, MD: Williams & Wilkins, 1995; 798-888.