Urolithiasis

OBJECTIVES

Clinical problems related to this section include dysuria, hematuria and urinary tract infection. At the end of this section, the student should be able to:

1. define urolith.

2. list the 3 most common types of uroliths in dogs and cats.

3. discuss the predisposing cause(s) for formation of the 3 most common types of uroliths.

4. state how one determines the type of urolith present.

5. discuss how one diagnoses the presence of uroliths.

6. discuss the treatment of uroliths, both general principles of treatment and specific therapy to prevent recurrence of the 3 most common types of uroliths.

7. discuss the prognosis for a dog or cat with uroliths

Additional Resources

Urologic Surgery Pages: 70-75, 145-148, 161-173
Textbook of Veterinary Internal Medicine, 6th edition, Chapters 266, 267
Canine and Feline Nephrology and Urology, Chapters 41, 42

Urolithiasis

I. Urolith: a stone within the urinary tract, can be in the renal pelvis, ureters, bladder, or urethra

Table A. Location of Uroliths

	Dogs (%)	Cats (%)
Kidneys	1.26	2.8
Ureter	0.3	1
Bladder	84	70
Urethra	7	8
Bladder/Urethra	6	10
Voided/Unknown	0	9

The reports of nephroliths and ureteroliths in cats have increased markedly in the past 10 years.

II. Pathophysiology of Urolith Formation: Urine Supersaturation

A. Urine concentration
B. Urine concentration of crystalloid
C. Urine pH
D. Crystallization inhibitors/promoters
E. Proteinaceous matrix

III. To determine the type of urolith: qualitative and quantitative assessment is important as purely qualitative methods (Oxford Stone Kit) are inaccurate; also important to analyze the center (nidus) of the urolith; how does one get a stone to analyze: some stones are voided and collected, voiding urohydropulsion, cystoscopy and collection, surgery;

Table B. Data on incidence of various types of uroliths in dogs and cats from the Minnesota Urolith Center

Type of Urolith	**Percentage of Dogs**	**Percentage of Cats**
Struvite	50	42
Calcium Oxalate	31	46
Calcium Phosphate	1	1
Urate	8	6
Cystine	1	0.2
Silica	1	<0.1
Mixed or Compound	8	4
Matrix	0.1	1

Between 1981 and 1999, the percentage of calcium oxalate uroliths in cats increased from 1% to 55% and the percentage of struvite uroliths decreased from 78% to 32%.

Table C. Types of Nephrolith/ureteroliths

	Dogs (%)	**Cats (%)**
Calcium oxalate	39	43
Struvite	35	5
Calcium Phosphate	4	15
Purines	8	0
Matrix	2	25
Other	12	7

A recent (2005) study of ureteroliths in cats found that 91/93 were calcium oxalate and 2/93 were calcium phosphate.

IV. Clinical signs

A. Urethroliths: complete or partial urethral obstruction (dysuria, stranguria with a partially to completely full bladder; post-renal uremia with complete urethral obstruction); suspected by clinical signs; may be palpable in male dogs behind the os penis; may be felt when passing a urinary catheter; may be seen on radiography; some require urethrography (radiolucent)

B. Cystoliths: signs similar to cystitis (dysuria, hematuria), some cases are clinically silent; may be palpable, especially in dogs, but rarely in cats; may be seen on radiography or bladder ultrasound

C. Ureteroliths: much more common in cats than dogs; currently most common cause of acute uremia in cats due to complete ureteral obstruction either bilateral or unilateral if the animal only has one functional kidney; most cats with ureteroliths also have chronic renal failure which usually makes the uremia a combination of renal and post-renal; chronic partial obstruction of the ureter leads to renal injury via hydronephrosis; most cats with ureteral stones also have nephroliths and a few also have cystoliths (all of this makes sense as the uroliths are moving!); most common signs in cats are poor appetite, vomiting, lethargy and weight loss; less common signs are PU/PD, hematuria, abdominal pain and inappropriate urination; some cases are clinically silent; only able to be diagnosed by imaging

D. Nephroliths: usually no signs, predispose to chronic pyelonephritis, predispose to obstructive renal injury, can result in renal failure if bilateral and large or obstructive in the renal pelvis, only able to be diagnosed by imaging

V. Data Base for Dogs/Cats with Uroliths

A. Urinalysis: urine pH, presence of crystals, evidence of UTI; remember that

storing urine for > 60 minutes and cooling urine increase in vitro crystal formation; storage time and temperature do not significantly affect urine pH and urine specific gravity; in a recent study (2005) of upper tract uroliths in cats, of 124 cats with ureteral stones, only 8 had calcium oxalate crystals found on a UA;

B. Urine Culture

C. Abdominal Radiographs

B. Serum Chemistry: calcium, BUN, creatinine

VI. Educated Guess as to Urolith Type

A. Urine pH

B. Urine crystals

C. UTI (causative organism)

D. Radiographic characteristics

E. Serum calcium (hypercalcemia)

VII. General Treatment of Uroliths

A. Removal: either surgical or by urohydropulsion or by cystoscopy

1. Voiding urohydropulsion

a. done with stones in the bladder

b. stones must be smaller than urethral diameter (must not have caused urethral obstruction)

c. done under anesthesia as described in Table D

2. Retrograde urohydropulsion

a. done with stones in the urethra to relieve urethral obstruction

b. done under anesthesia

c. in dogs, requires one person to obstruct urethra temporarily by rectal palpation and one person to inject fluid in distal urethra; in cats done by retrograde flushing of sterile fluid.

d. removes the stones from the urethra, but not from the urinary tract

3. It has been found that even board certified surgeons inadvertently leave uroliths in the bladder after cystotomy (about 14% of surgeries in dogs and 20% in cats); this is because small stones get trapped in the mucosal folds of the bladder where the surgeon cannot see them; thus, it is important to warn owners of this pre-surgically and to do a radiograph immediately post-operatively to see if stones are still present; if so, one usually waits for the stone analysis to be returned to determine what therapy should be tried

next.

B. Encourage water intake for all stone types (reduces urine concentration of minerals)

Table D: Voiding Urohydropropulsion

1	Begin an appropriate antimicrobial prior to the procedure. UTI should be under control before urohydropropulsion is done.
2	Anesthetize the animal (we usually use propofol).
3	Catheterize the urinary bladder.
4	Moderately distend the bladder by infusing sterile isotonic fluid (LRS or 0.9% saline); 4-6 ml/kg in an empty bladder is recommended but palpation should also be used to monitor distention of the bladder.
5	Remove the urinary catheter.
6	Hold the dog or cat upright (as if the animal was walking as a human).
7	Agitate the bladder by palpation and by moving the animal up and down so that the uroliths move to the bladder neck by gravity.
8	Manually express the bladder.
9	Count the number of uroliths expressed and compare the number to the number seen radiographically. Repeat the procedure until the number expressed equals or exceeds the number seen on radiographs.
10	Repeat radiographs to insure complete urolith removal.
11	Continue the antimicrobial for 48 hours after the procedure if the urine was sterile prior to it and for 2-6 weeks (depending on the degree of bladder wall thickness and the chronicity of the infection) if the urine was infected.
12	Hematuria is common following urohydropulsion but usually resolves within 24 hours. Rupturing of the bladder is extremely rare and only reported in animals which have had a prior cystotomy.

C. Uroliths tend to recur ("once a stone former, always a stone former"). Usually (but not always) recurrences are with the same type of urolith. Each affected animal must be placed on preventative therapy for the specific type of stone that animal formed for life and should be monitored for recurrence. The goal is to find recurrent stones while they are small enough to be removed by non-surgical methods.

VIII. Pathophysiology of formation of struvite uroliths, calcium oxalate uroliths, and urate uroliths is important in specific therapy and prevention of recurrence

A. Struvite (Ammonium Magnesium Phosphate) Uroliths

1. Infected: most common type in dogs; infection is with urea splitting organisms (Staph and Proteus) which alkalinize the urine; struvite is less soluble in alkaline urine. Radiodense

2. Non-infected: most common type in cats; postulated to occur due to the cat's highly concentrated urine; stones are smaller and less dense than infected struvite stones because less mineral precipitates when urine is either acidic or minimally alkaline.

3. Can be medically dissolved with diet alone (if non-infected) or diet/antibiotic therapy if infected. The stones must be in the bladder or in the renal pelvis to be dissolved medically. Stones in the ureter or urethra cannot be dissolved medically because stones in these areas are not in a "fluid bath". The diet used is Hill's s/d. The duration of therapy is at least 4 weeks beyond radiographic resolution. Time to dissolution varies from 2-28 weeks based on location (longer time for renal stones); shortest time is for cats with "sand"

4. Reasonably effective preventative procedures exist.

a. monitoring urine pH in infection stones; if urine becomes alkaline, urine culture to document infection and treat appropriately before stones reform

b. mildly acidifying diets if not associated with infection (most cats)

B. Calcium Oxalate Uroliths

1. Mechanisms: calcium is thought more important than oxalate in dogs and cats

a. hypercalcemia (more common in cats with calcium oxalate stones than dogs but occurs in both; 14% of cats with upper tract stones were found to be hypercalcemic (total serum calcium); 40% were found to be hypercalcemic when ionized calcium was measured but this test was done in fewer cats; take home message is that measuring ionized calcium is important in cats with calcium oxalate stones which, remember, is almost all cats with upper tract stones;

b. normocalcemia (most common in dogs and cats):

1. aciduria and academia increase calciuria

2. diet – high protein, low phosphorus, low magnesium

3. urine concentration

c. radiodense; may be ragged

2. Cannot be medically dissolved; must be removed surgically or by voiding urohydropulsion or cystoscopy if small and in lower urinary tract;

3. High recurrence rates; preventive measures are always instituted but efficacy is unproven. The most common preventative measures are to increase water intake and to use diets specifically formulated for calcium oxalate. Thiazide diuretics may be used in recurrent oxalate stone forming dogs, but you must monitor for hypercalcemia as these drugs work by decreasing renal calcium excretion. Urine pH should be kept neutral or slightly alkaline. Potassium citrate is often used for this purpose.

4. Because preventative measures are unproven, it is recommended to repeat survey abdominal radiographs at three month intervals so the recurrence can be detected when stones are still small enough to remove by voiding uro-hyrdropulsion.

C. Urate Uroliths

1. Mechanism:

    a. Dalmatians: decreased ability to oxidize uric acid to allantoin in the liver, decreased renal reabsorption of uric acid. English Bulldogs also predisposed; may be similar to Dalmatians but not as well studied.

    b. Portovascular anomalies in dogs and cats

    c. Idiopathic in cats

2. Can be medically dissolved with diet in dogs (low purine diets such as Hill's u/d) and drugs (allopurinol) as long as stones are in the bladder. Average time to dissolution is 3-4 months.

3. Preventive measures are reasonably effective: increasing water intake and a lower dose of allopurinol or continued use of an alkalinizing diet. Urine should be kept slightly alkaline.