Calcium Oxalate Ureteroliths in Cats: 
Big Kidney-Little Kidney Syndrome
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Objectives
- To discuss calcium oxalate nephrosis, a clinical syndrome that is occurring with increasing frequency in cats using clinical data and several case examples.
- To review diagnosis and pre/postoperative management of uroperitoneum and upper urinary tract obstruction including:
  - Antegrade pyelography
  - Ultrasonography
  - Radiography
- To describe medical and surgical techniques for management of ureteral obstruction, focusing on techniques such as:
  - Nephrostomy tube placement
  - Stents
  - Ureteral anastomosis
  - Neoureterocystostomy
  - Nephrectomy/nephrotomy
- To review postoperative complications and success rates in upper urinary tract surgery

Key points
- Upper urinary tract obstruction is associated with a slow onset of non-specific clinical signs. Therefore diagnosis of upper urinary tract lesions often requires a high index of suspicion and pursuit of advanced diagnostic techniques.
- Use of advanced diagnostics such as high frequency abdominal ultrasound, antegrade pyelography and computerized tomography have improved our ability to diagnose and characterize ureteral lesions earlier in the course of disease.
- By the time that lesions of the upper urinary tract are diagnosed in veterinary patients, severe metabolic derangements are often present, making pre and postoperative medical management important components of a successful outcome.
- Surgical therapy for ureteral obstruction is fraught with a high complication rate and requires meticulous operative technique.

Pathophysiology
Etiology
- A shift has occurred such that the majority of calculi isolated from cats are now composed of calcium oxalate
- Calcium oxalate calculi are more likely to be located in the upper urinary tract than in the bladder and urethra (as was the case for struvite). In fact, nearly 100% of ureteral calculi isolated from cats are calcium oxalate. 1,2
- Calcium oxalate is not amenable to dietary or pharmacologic dissolution

Risk factors
- Acidifying diet
- Dry cat food
- Obesity
- Breed (Persians)
- Indoor cats

Conclusion
If a radiopaque calculus is detected in the kidney or ureter of a cat, one can assume that it is composed primarily of calcium oxalate and cannot be medically dissolved.

Diagnosis
- Rapid diagnosis of ureteral obstructions is essential
  - Permanent renal injury occurs as the duration of ureteral obstruction exceeds 24-36 hours, making early and efficient diagnosis a priority.
  - In animals with bilateral renal disease, progressive metabolic derangement occurs in direct proportion to the duration of ureteral obstruction.
- Diagnosis of obstruction or rupture of the upper urinary tract requires a high index of suspicion
  - Unilateral ureteral obstruction causes no evidence of azotemia in animals with normal contralateral renal function
Uroliths that cause ureteral obstruction in cats are often so small that they are difficult to detect using standard radiographic techniques.

Ureteral obstructions can cause variable clinical syndromes ranging from the standard cat with chronic weight loss, anorexia and CRF to animals with acute “ureteral colic”, characterized by intensive vomiting and abdominal pain.

Specific tests for upper urinary tract lesions involve advanced imaging

Due to the treatable nature of upper urinary tract obstruction and the vague clinical signs, it is my belief that all animals presenting with signs of acute OR chronic renal failure should be evaluated with advanced imaging techniques before they are doomed to palliative medical therapies:

- Survey radiography
  - Survey radiography is readily available to nearly all private practitioners and should serve as the part of the initial screening process for ureteral obstructions
  - Radiography has 60-80% sensitivity and nearly 100% specificity for detection of ureteral obstructions in cats.1,2 Thus, radiography is not a perfect screening test, but is highly reliable when radiopaque calculi are visible.
  - In order to maximize diagnostic efficacy for survey radiography, the colon should be emptied or displaced to improve visualization of the retroperitoneal space.

- Ultrasound
  - High definition ultrasound is also readily available to most practitioners.
  - Ureteral obstruction causes hydronephrosis and progressive dilation of the ureter beginning at the renal pelvis and progressing in a cranial to caudal direction. As a result, serial ultrasonographic examinations with daily measurement of the renal pelvis can be extremely helpful in documenting active obstruction.
  - Using hydronephrosis as the criteria for diagnosis, abdominal ultrasound has a high sensitivity (100%) and low specificity (33%) for detection of ureteral obstructions in cats.1 Thus it is an excellent screening test, but other supportive imaging studies are often required to rule out other causes of hydronephrosis (ie pyelonephritis, diuresis due to iv fluid therapy, etc).

- Intravenous pyelography (IVP)
  - IVP has the advantage of being readily available at most practices, but does require significant effort (enemas, multiple series of films, etc) to obtain high quality studies
  - IVP may not provide good filling of the ureters in animals with low GFR due to chronic obstruction or pre-existing renal disease
  - Intravenous contrast material can cause acute renal injury in patients with pre-existing renal injury and may best be avoided in severely azotemic animals.

- Antegrade pyelography (AP)
  - AP involves insertion of a long needle into the renal pelvis using ultrasound guidance, to allow contrast injection directly into the collecting system. Contrast injection is typically observed by fluoroscopy.
  - AP does require general anesthesia and some risk of injury to the renal pelvis or vascular pedicle
  - AP has a 100% sensitivity and specificity when appropriate studies are obtained, but the results may be confused by contrast leakage around the needle in a significant portion of cases.1
  - AP does not involve a risk of contrast induced nephropathy and may be particularly useful in animals with pre-existing renal insufficiency

**Therapy**

**Preoperative therapy for metabolic disorders**

Bicarbonate may be required to treat acidosis and hyperkalemia. Dose is based on body weight and on bicarbonate deficit, which may be calculated from total CO2, Bicarbonate concentrations or Base Excess.

- Bicarb deficit = Normal Total CO2 (I use 24) – Patient CO2
- Bicarb dose = 0.3 x Body weight (kg) x Bicarb deficit
- Give ½ dose SLOWLY IV over 20 minutes and rest of dose over several hours. Rapid infusion can cause hyperosmolarity and paradoxical cerebral acidosis.

**Fluid therapy**

- 0.9% NaCl is the standard for patients with hyperkalemia secondary to urinary tract obstruction
- Careful monitoring of patient body weight (twice a day) and respiratory rate is required to avoid inadvertent fluid overload in anuric or oliguric patients
Urine drainage

- Percutaneous nephrostomy tube placement may be used to drain a hydronephrotic kidney until definitive surgical repair is performed.
- In surgeon’s hands nephrostomy tubes have been associated with a high complication rate and many have ceased to use them.

Surgery of the ureter is technically demanding and requires adherence to good surgical technique

- Meticulous apposition of mucosal surfaces to avoid scarring/stricture
- Preservation of ureteral blood supply
- Monofilament suture materials, knots outside the lumen
- Stents may provide support for migration of urothelium and divert urine during healing

Surgical technique is dependent upon the level of the obstruction, but in general it is preferable to perform neoureterocystostomy (ureteral implantation into the bladder) or ureterotomy than it is to perform ureteral resection and anastomosis

- Neoureterocystostomy is performed for obstructions in the mid to distal ureter
- Renal descensus and cystopexy can be performed to minimize the distance traversed by a shortened ureteral segment
- Ureterotomy and primary closure is used for calculus obstruction in the proximal 1/3 of the ureter or in the renal pelvis
- Ureteral resection and anastomosis may be used when the obstruction is not removable from the ureteral lumen (e.g., a stricture, granuloma or neoplasm)
  - Spatulation may be used to increase luminal size at the anastomotic site
  - Disparity in luminal size may be profound with chronic dilation of the proximal segment

- Complications are frequent (31% in one large study)
  - Uroperitoneum (16%)
  - Stenosis and re-obstruction (6%)
  - Recurrence of calculi should also be discussed
  - Complications did not seem to be higher for ureteral surgery than for ureteral reimplantation into the bladder

- Equipment
  - I use 3.5x magnifying loupes for dog ureteral surgery (In truth, I use them for almost all soft tissue surgery and recommend them to others). For cats, use of an operating microscope is preferred.
  - Micro-instruments that I use are JP-3 jeweler’s forceps, adventitial scissors and a curved tip micro needle holder. These must be treated with great care and placed in separate packs from larger instruments because they are very delicate.
  - Suture material
    - I use 7-0 PDS for ureteral surgery in dogs on a small cardiovascular needle (BV)
    - In cats, I use 8-0 Nylon on a BV needle. It is not absorbable, but the needle size and handling are excellent. This suture material is extremely small and delicate, requiring an operating microscope for adequate visualization.

Prognosis

- 12 month survival was 66% after medical treatment and 91% after surgical treatment in a study that included 166 cats

- Prognostic factors for ureteral obstructions
  - Chronicity of obstruction (degree of structural damage to kidney and ureter is estimated by severity of hydronephrosis and hydroureter on ultrasound)
  - Presence of bilateral obstructions
  - Presence of urinary tract infection
  - Severity of azotemia at presentation for surgery
  - Need for nephrostomy tube or dialysis

Conclusion

Ureteral obstruction is a treatable cause of acute or chronic renal failure. Unfortunately, clinical signs are non-specific and prognosis is dependent upon early diagnosis and treatment. As result, abdominal radiography and ultrasound are recommended in all animals with unexplained azotemia to rule out ureteral obstruction. Advances in microsurgical technique have improved the success rate of ureteral surgery in animals, improving the quality of life in affected animals.
References

