Obstructive Urolithiasis in Small Ruminants: Medical & Surgical Management
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Urolithiasis is a common metabolic disease in all small ruminants, but urinary obstruction due to calculi formation is almost exclusively a disease of males as females have a short distensible urethra. The disease is multifactorial, the most important factor being the development of soluble minerals in urine that aggregate to form insoluble crystals. The amount and type of minerals present in the urine to contribute to crystal formation is determined by diet, environment, and management practices. Diets high in concentrate feeds or alfalfa hay as well as inadequate water intake particularly predispose to this disease. Urine pH also plays a role in the development of urolithiasis as some types of uroliths are less soluble in alkaline urine (struvite, calcium phosphate, calcium carbonate); however, some types of uroliths are not affected by pH or else the effects of pH on their formation are still unclear (calcium oxalate, silicate).

Special considerations in determining how to manage cases of obstructive urolithiasis include type of calculi, location of the obstruction or obstructions, the intended use of the animal (breeding, pet, show, commercial/slaughter), potential presence of a concurrent cystitis (although this is not commonly associated with the development of obstructive urolithiasis in small ruminants; it is usually a postoperative complication following surgical treatment), and budgetary constraints of the client. A thorough physical examination should be performed prior to subjecting the animal to anesthesia. Severe and sometimes life-threatening electrolyte, acid-base, and fluid imbalances may be present and should be addressed before proceeding with treatment for the obstruction; in small ruminants, these can include hyperkalemia, hyponatremia, hypochloremia, acidemia, hypovolemia, and azotemia which can be confirmed on a routine biochemistry or minichemistry panel. During the examination, the veterinarian should also try to determine whether the integrity of the urinary tract has been compromised. Peripenile subcutaneous swelling that pits upon digital pressure is suggestive of a ruptured urethra and the prognosis for salvage of the urinary tract is grave. Bilateral ventral abdominal distention suggests either a ruptured urinary bladder or leakage of urine across the bladder wall resulting in uroabdomen, which can be confirmed with ultrasonography and abdominocentesis and requires additional treatment.

Examination of the penis can be performed with the patient ‘set up’ (as is done in sheep) or in lateral recumbency with the hind limbs pulled forward to facilitate extrusion. Sedation, an ischial penile block, a lumbosacral epidural, or a combination of these increase ease of exteriorization of the penis. For sedation, xylazine should be avoided due to its diuretic effects and a midazolam/butorphanol combination used instead. Care should be taken during this procedure as a very distended bladder may rupture with any form of mild abdominal trauma. In young animals, particularly those that were castrated early, a frenulum may be present making penile exteriorization more difficult. Animals with previous urethral rupture or external ulcerative posthitis may also be challenging to exteriorize.
Medical Treatment

The urethral process is the most common location of urinary obstruction in sheep and goats and should be amputated immediately following exam of the penis. Because of the likelihood of multiple stones being present in the urinary tract, this procedure alone results in long-term urethral patency in <25% of animals. The majority of patients will reobstruct within 3 days. A urethral catheter should be passed following amputation of the process to determine if other calculi or strictures are present and to determine the location of the obstruction. Starting with a small (3.5 French, ‘Tomcat’) catheter and a small amount of 1% lidocaine mixed with sterile lube and instilled gently into the urethra facilitates catheter passage. Polyurethane canine urethral catheters can be used but because of the urethral diverticulum located at the level of the ischial arch they cannot be passed into the bladder. Alternatively, angiographic catheters that have a soft C-shaped curve to the tip and become flexible once passed into the urethra can often be passed into the bladder allowing for direct urinary acidification, provided the urinary bladder is intact and there is no evidence of uroabdomen; the cost for these catheters is approximately $20 each. If additional calculi are present in the urethra inhibiting catheter passage, retrograde hydropulsion of 1% lidocaine while occluding the pelvic urethra may result in relief of the obstruction. Aggressive catheterization and/or hydropulsion is not desirable, as this increases the likelihood of urethritis or urethral rupture. If this is unsuccessful, the options are limited to percutaneous catheter or tube placement into the urinary bladder, or else surgical intervention, for urinary diversion or, in a salvage animal, instillation of an acidifying solution directly into the bladder.

Temporary percutaneous placement of a Bonnano suprapubic catheter into the urinary bladder to facilitate medical management of obstructive urolithiasis or stabilization of a patient prior to surgical intervention has recently been described by Chigerwe et al. These catheters are curved once placed into the bladder and can remain in place for up to 4 days; but due to the small diameter of the lumen, they are likely to become obstructed by uroliths or cellular debris and are not intended to remain in place long-term. Cost for one of these at this time is approximately $90.

Ultrasound-guided cystocentesis and instillation of Walpole’s solution (a commercially available acetic acid solution with a pH of 4.5) has been described by Janke et al. as an alternative medical treatment for urethral obstruction. In this procedure, the animal is restrained and a sterile cystocentesis performed with a 3.5 inch needle. Ensure that the needle used is well-seated within the lumen of the bladder, and that once urine is removed the bladder does not shrink down and allow the needle to pull out. Between 120 and 500 mL of urine is removed and the pH determined, after which 50 mL of Walpole’s solution is injected back into the bladder via the cystocentesis needle. This is repeated until the urine pH is 4-5, and it may require 50 to 250 mL of Walpole’s to achieve this objective. In one study, 80% of goats had resolution of urethral obstruction following this procedure and were discharged from the hospital. The inherent risks are the potential for development of a chemical peritonitis following leakage of the solution from the bladder, and 30% chance of reoccurrence of the obstruction in less than a year. This procedure is generally considered in a patient only if no other treatment options are available or affordable. It should be noted that struvite uroliths are most amenable to chemical dissolution, and other types of uroliths may not respond adequately to relieve the obstruction.
Urethral strictures can be treated with balloon dilation with moderate success depending on the length and number of strictures present. A single easily accessible stricture (i.e., the distal glans) is optimal. The balloon catheter is inserted to the level of the stricture, and the balloon inflated for 1 minute at 30 mmHg. The urethra is allowed to rest for 45 seconds, and the procedure is repeated 2 more times at the same intervals. This procedure may need to be repeated at a later date in some animals.

**Surgical Treatment**

**Urethrostomy**
This procedure should only be utilized in animals intended for salvage (particularly those with ruptured urethras), as the stoma will eventually stricture in small ruminants. Approximately 75% of these will reobstruct due to stricture formation within 1 year, and in some cases this can occur as early as 6 weeks post-surgery. A recent report by Oman et al. indicated that stricture or reobstruction was most likely in the first two months after surgery. If the animal is young or moderately azotemic, a low perineal urethrostomy should be performed as these are a more permanent method of urinary diversion that should allow the animal more time to grow, or to allow the azotemia to resolve (cases with severe azotemia should not be sold for slaughter for approximately 3 weeks following complete relief of urinary obstruction). A penectomy can be done at the same time, and is more easily performed on animals with a fairly chronic urethral rupture as the tissues begin to slough allowing for easier manipulation of the penis. A high perineal urethrostomy may also be performed to allow a catheter to be passed into the urinary bladder with the use of a curved stylet and sutured in place; this is a short-term procedure and should be performed in animals that are to be marketed in 3-4 weeks. The high PU can also be used if a previous low PU has strctured. If no additional ‘room’ is left after performing two perineal urethrostomies, a prepucic urethrostomy can be done instead. Alternatively, a modified proximal perineal urethrostomy in goats (similar to the procedure performed in cats) was described in 2013 by Drs. Tobias and Van Amstel; this procedure has resulted in good long term outcomes, even in animals with previous urethrostomy sites that strictured. Salvage animals with ruptured bladders may be treated with a high PU, and if the tear is dorsal it may heal spontaneously with urinary diversion and drainage of the uroabdomen.

**Urethrotomy**
Although this can be a viable alternative to acute urethral obstructions in cattle, small ruminants’ urethras are much less forgiving and much more likely to stricture following direct surgical manipulations. Thus if the lower urinary tract is to remain functional this procedure has typically been considered suboptimal. Radiography may greatly assist in the decision-making process, including contrast studies. Some surgeons prefer to open the urethra proximal to the obstructing calculi, remove the stone with a pair of hemostats or atraumatic forceps, and leave the urethra and the incision to heal by second intention. In the hands of some surgeons, 50% of cases can heal without complications using this method.

The incision and urethrotomy can also be closed primarily. This has recently been done on several occasions at CSU, in a combined procedure of cystotomy, tube cystostomy, and targeted
urethrotomy with the intent to ’leave no stone behind’. The long-term prognosis for continued normal urination following this technique is still largely unknown.

An alternative to urethrotomy is to identify the location of the stone and attempt to crush it transcutaneously with a pair of towel clamps, but some types of stones (calcium carbonate, silicate) are virtually impossible to crush. Again, these procedures are all very risky in terms of long-term success in sheep or goats.

**Tube Cystostomy**
This is considered the ‘gold standard’ treatment for obstructive urolithiasis unresponsive to medical management in breeding animals and pets. Additionally, this is the optimal treatment in cases of ruptured bladder in which the bladder wall cannot be adequately sutured closed to prevent leakage. The need for general anesthesia and intensive aftercare make this option very expensive ($1500-2000). During the course of this procedure, a cystotomy is performed and allows the surgeon to evaluate the integrity of the bladder as well as remove any cystoliths present. Occasionally these are adhered to the wall of the bladder within a blood or fibrin clot and may need to be removed with the use of a sterile spoon. Normograde and sterile retrograde hydropulsion can also be done at this time, but numerous attempts to catheterize the urethra may result in severe trauma; if urethral patency cannot be quickly or easily achieved after 2-3 attempts at hydropulsion it should be abandoned. If the cystotomy and urethral flushing completely relieve the obstruction, all cystoliths have been evacuated, and normal patency of the urethra is achieved, the patient can be recovered without additional therapy but the possibility of urinary reobstruction by cellular debris (including blood clots), unrecovered uroliths, urethral spasm, or urothelial swelling cannot be discounted. Otherwise, a Foley catheter is placed into the bladder and exits the body wall lateral to the prepuce (of note, the largest possible latex Foley catheter should be used, ideally a 24-French). A closed urine collection system can be attached to the Foley catheter steriley, to maintain sterility of the inside of the catheter and decrease the likelihood of ascending urinary tract infections. Urine can then be diverted for 7-14 days allowing the urethra time to heal. At 7 days, the Foley catheter can be occluded and the animal observed closely to determine if normal voiding is occurring. If normal urination is seen, the tube should be left clamped for 24-48 hours and the tube removed if urethral patency persists; a sterile stent bandage can be placed over the stoma until it closes in 1-2 days by second intention, or the stoma can be cleaned and left open to drain. If urethral patency is not confirmed, the tube can be unplugged and the animal given more time. After 5 days to allow for a fibrin seal and providing the bladder was intact and healthy at surgery, chemical chemolysis of remaining calculi can be attempted; only struvite or calcium apatite stones usually dissolve with this method. Either hemiacidrin (acidic gluconocitrate solution with magnesium carbonate, pH 3.8) or Walpole’s solution can be infused into the bladder via the cystostomy tube, which is then clamped off for 30 minutes. This is done twice per day until urethral patency is achieved. The inside of the tube must be kept sterile to prevent ascending urinary tract infections. The prognosis for tube cystostomy is 75% providing that the urethra is not ruptured or strictured. There are anecdotal reports of Foley catheters being left in place for extended lengths of time (up to a year) to allow for ruptured urethras to heal and the animal to urinate normally. Tube cystostomies result in bacteriuria 100% of the time based on a study by Chigerwe et al.; maintaining patients with such a tube on appropriate antimicrobials is recommended.
A technique describing ultrasound-guided percutaneous tube cystostomy has also been described. In experienced hands, this procedure has approximately the same prognosis as the tube cystostomy but is usually about \( \frac{1}{2} \) the cost of the surgical cystostomy (cost incurred is primarily hospitalization and treatment afterward). Complications associated with this approach include intra-abdominal placement, trauma to adjacent viscera/vasculature, bladder rupture, uroabdomen, and rapid dislodging of the catheter. Type of catheter used can have a significant influence on the number of complications associated with this procedure. A Cook Urological Rutner Suprapubic 16 French catheter with a 4 mL balloon (the largest size available) has been successfully used as the sole method of urinary diversion for treatment of sheep and goats with dissolvable uroliths by the authors on a number of occasions (cost is approximately $75-132 per catheter at this time). Alternatively, a Lawrence Supra-Foley Suprapubic Catheter Introducer, Utah Medical (www.utahmed.com/suprafoley.htm, 16 French; individual cost $20-30) can be used to allow for a larger standard Foley catheter to be placed into the bladder; this technique has been successfully used at Colorado State to allow for temporary stabilization and/or medical treatment of small ruminants with urethral obstructions.

**Bladder Marsupialization**

This technique should not be used on breeding animals or pet animals that are kept indoors. During this procedure, the seromuscular layer of the apex of the bladder is secured to the abdominal wall, and the serosa of the bladder is sutured to the skin. The appropriate location of marsupialization is as cranially as possible to avoid urine scald, which is the most frequently reported disadvantage to this procedure. A cystitis may also develop, and if unchecked can create an ascending pyelonephritis. Stricture formation, reobstruction, and bladder prolapse have all been associated with bladder marsupialization, although a 64-88% success rate has been reported. Due to the higher rate of morbidity associated with this technique it is not typically used as a first-line treatment. More recently, vesiculpreputial anastomosis (anastomosis of the urinary bladder into the preputial cavity) has shown promise, as stricture and urine scald are not commonly associated with this procedure. Long-term outcomes following vesiculopreputial anastomosis are often better than those following bladder marsupialization through the ventral body wall based on a small number of cases.

Preoperative management should include antimicrobials. Procedures performed under general anesthesia should include intraoperative fluids. Any type of urinary catheter left in place acts as a foreign body and predisposes animals to the development of bacterial cystitis at a minimum; urinary excreted antimicrobials are generally recommended as long as these catheters remain in place. Postoperative management also includes IV fluids as needed for diuresis and to correct electrolyte imbalances, and NSAIDs once any azotemia has resolved and providing that renal function is not compromised. Phenazopyridine is a urinary-specific analgesic that can be obtained over the counter and administered orally at 4 mg/kg twice per day; however, this should not be used in the face of renal compromise and if used the animal should never enter the food chain, as FARAD will not place a meat or milk withdrawal on this product at this time.

**Prevention**

Urinary acidification following any of these procedures should be used if the offending uroliths are magnesium ammonium phosphate (struvite) or calcium phosphate. The previously
The recommended dose of ammonium chloride to achieve aciduria was 200 mg/kg by mouth once per day. A more recent study has suggested doses as high as 400 mg/kg once per day. Pulse dosing of this medication (4 days on, 3 days off) should achieve the same effects and is probably less likely to cause osteopenia. Alternatively, Biochlor or SoyChlor (feed additives) have been suggested to cause urinary acidification and is much more palatable than ammonium chloride. Recommended doses for Biochlor range from 1 ounce once a day by mouth for a 110 pound animal, up to 2 ounces twice a day for larger patients. Research has not yet been performed to determine the appropriate dose or interval of administration, however, and animals tend to become less inclined to voluntarily ingest therapeutic amounts over time in the authors’ experience.

References: