

Treatment and surgery for management of urolithiasis

Joe Smith, DVM, MPS, PhD, DACVIM, DACVCP
University of Tennessee College of Veterinary Medicine
Knoxville, TN 37996

Abstract

Urolithiasis is a common condition in steers and bulls due to nutritional and anatomical factors. Prevention practices share common aspects as well as aspects specific to certain urolith types. In this presentation we will discuss the underlying factors and preventive measures for urolithiasis in cattle, as well as surgical management. Restraint, sedation, surgical approaches and postoperative considerations will be discussed for both salvage procedures as well as cattle with breeding potential.

Key words: calculi, tube cystostomy, penectomy, perineal urethrostomy, struvite

Introduction

Feedlot steers are at increased risk of urolithiasis due to the urethral anatomy as well as the nature of feedlot diets. Compared to small ruminants, where nutritional manipulation can be utilized to reduce the risk of urolithiasis, these interventions (eliminating concentrate in the diet, acidification practices for urine, as well as altered mineral feeding) are often impractical for a steer in a feedlot setting. Challenges encountering clinicians in this decision-making process include where the animal is in the progression through the feedlot, current market price, and the degree of concurrent morbidities when the diagnosis is made. Rupture of the distal urethra, resulting in a significant “water belly” of the ventral abdomen, can present difficulties for management if advanced, as large amounts of urine being absorbed into the tissues can lead to necrosis and sloughing if advanced. Similarly, internal rupture of the bladder into the abdomen can be challenging to manage in the field if discovered late in the obstruction process.

There are several factors on physical examination that can be used to identify a urethral obstruction as a diagnosis. In the early stages of an obstruction cattle can be actively in discomfort, exhibiting signs such as kicking at the abdomen, pacing, restlessness and flagging the tail.¹ After this initial period, when either the bladder or the urethra rupture, the pressure from the obstruction abates and the animal may not have significant clinical signs until a bladder rupture contributes to ascites or a urethral rupture results in ventral subcutaneous swelling. Both of these presentations can lead to uremia, which can sometimes be smelled on the breath of an animal in this stage. While uremia can lead to metabolic abnormalities and depression, cattle can tolerate uremia for periods of time, which may delay diagnosis. Other physical examination abnormalities include ballotment of fluid in the abdomen, and a dry prepuce, sometimes which will have small calculi adhered to the hair. Examination with ultrasound can be useful to confirm ascites as well as subcutaneous edema for a bladder rupture or distal urethral rupture respectively.

Calculi and preventive measures

Prevention of urolithiasis in most feedlot environments can be impractical from an economic standpoint. There are an increasing number of cattle with increased value (breeding or companion) for which preventive measures may be considered. One of the keys for prevention is determination of the stone composition. Stone analysis can be performed by the Minnesota Urolith Center (<https://urolithcenter.org/>) or other laboratories. Preventive and management decisions will vary based on the stone's makeup. Struvite (magnesium ammonium phosphate) uroliths typically can be managed with urinary acidification with ammonium chloride (450 mg/kg, total daily dose [titrated to effect], PO). The author will focus on “pulse therapy” by either giving once daily for 3 days, then 4 days off and repeating, or 1 week on, followed by 2-3 weeks without ammonium chloride therapy. The author has used the approach reported for goats² in cattle with some success. Ammonium chloride administration for cattle is often difficult as the amount needed often requires being administered by tube, as it is unpalatable. Clients should be informed that feeds containing ammonium chloride do not include an amount near the dose necessary for urinary acidification. Key to urinary acidification is having the client frequently monitor urine pH with an appropriate low pH paper or instrument. Similar to struvite stones, apatite stones also appear to have excessive excretion of magnesium as a mechanism.³ Management of struvite and apatite stones can also revolve around decreasing concentrate in favor of forage, but this may not fit the goal of the population or individual animal. Calcium carbonate calculi are highly associated with alfalfa feeding, so preventive management should revolve around removing alfalfa from the diet and maintaining an appropriate calcium:phosphorous ration in the ration. Calcium carbonate stones typically do not resolve with urinary acidification. Silica-based uroliths have been reported in some regions and it is thought that urinary pH does not play a major role in their development.⁴

There are non-specific recommendations as well. Increasing salt in the ration can increase diuresis and help expel small calculi before they can become larger. Appropriate vitamin A levels are thought to align with urinary tract health. Delaying castration is hypothesized to lead to increased urethral diameter due to the influence of testosterone, which may contribute to a decreased risk of stones obstructing. From a comparative perspective in small ruminants it appears that animals with a decreased body condition score are less likely to develop obstructive urolithiasis, so preventing overconditioning may also be of benefit.

Surgical management

Depending on the conditions of the obstruction and complications from the rupture, several surgical corrections are options. While the cost-benefit of procedures requiring general anesthesia is often not economical for feedlot steers, there are other procedures that could be considered for show steers or companion steers.

Setup and sedation

Prior to undertaking a surgical correction clinicians need to consider conditions for restraint, local anesthesia, as well as sedation protocols. A head catch and chute or similar stocks is ideal for positional restraint. Preoperative analgesia can decrease nociceptive windup,⁵ but caution should be exercised for cases that may have been obstructed for extended periods of time as NSAIDs like flunixin meglumine may exacerbate existing renal pathology. Opioids such as butorphanol or morphine could be considered in these cases. Care should be used with alpha₂ adrenergic agonists such as xylazine and detomidine as these drugs can cause a transient diuresis³ which can put more pressure on an obstructed urinary tract and potentially lead to rupture. Epidural anesthesia should be employed for all standing procedures via a caudal epidural, as a cranial (anterior) epidural will lead to recumbency. The dose of 2% lidocaine used for caudal epidurals is approximately 0.5 mL per 100 lb (45 kg) of bodyweight.⁶ Table 1 displays sedation protocols to consider for work up as well as for standing procedures.⁷

Procedures

When selecting procedures, the role of the animal should be considered. While multiple options exist, generally only the tube cystostomy will allow an animal to maintain breeding function. As such, other procedures should be considered when breeding status is not a consideration. The information below is a summary of these procedures, and more in-depth references are available in the listed reference section.

For feedlot animals

Perineal urethrostomy

For this procedure, the urethra is approached on midline incision as distal as possible, immediately caudal to the scrotum if possible. The penile retractor muscles can be transected to reduce tension on the urethra, as this tension may contribute to deterioration of the stoma site.⁸ Once the penis is dissected free, it is stabilized to the skin with horizontal mattress sutures. After this stabilization has occurred the urethra is opened with a longitudinal incision and the edges of the incision are stabilized to the skin forming a stoma.⁸ While the procedure can be performed much higher up, an initial distal attempt may be useful in the event of stricture formation at the stoma. For those cases where a stricture occurs, the procedure can be repeated cranial to the initial stoma.

Penectomy

The approach for the penectomy is similar to the perineal urethrostomy with respect to initial positioning and retraction of the penis, but instead of creating a stoma with the urethra, the entire penis is transected.⁸ After transection the proximal penis is stabilized to the skin with mattress sutures, with several centimeters extending past the incision. The distal penis can be left in place or removed.

Urethrotomy

A urethrotomy can be performed by itself or in conjunction with a tube cystostomy. Radiography is essential to identify the location of the calculi, and once the location is known the urethrotomy can be performed immediately over the calculus or the calculus may be able to be repulsed with retrograde saline infusion into the urethra, so the incision can be performed over healthier

Table 1: Sedation protocols for urolithiasis workup as well as standing procedures

Agent	Dose	Route	Note
Acepromazine	0.01 mg/lb (0.02 mg/kg)	IV/IM	Can be combined with 0.01 mg/lb (0.02 mg/kg) xylazine
"Butorphanol-Xylazine-Ketamine" Stun, Intravenous			
Butorphanol	0.05 mg/lb (0.01 mg/kg)	IV	5 mg for most adult cattle; short-acting
Xylazine	0.01 mg/lb (0.02 mg/kg)	IV	10 mg for most adult cattle; short-acting
Ketamine	0.025 to 0.05 mg/lb (0.05 to 0.1 mg/kg)	IV	20 mg for most adult cattle; short-acting
"Butorphanol-Xylazine-Ketamine" Stun, Intramuscular/Subcutaneous			
Butorphanol	0.0075 to 0.01 mg/lb (0.015 to 0.02 mg/kg)	IM/SC	10 mg for most adult cattle*
Xylazine	0.015 to 0.02 mg/lb (0.03 to 0.04 mg/kg)	IM/SC	20 mg for most adult cattle*†
Ketamine	0.03 to 0.04 mg/lb (0.06-0.08 mg/kg)	IM/SC	40 mg for most adult cattle*†

* Peak effect reached in 25 to 50 minutes

† Sedation can be extended with re-administration of 25 to 50% of initial dose

tissue. Urethral tissue that undergoes surgery commonly will stricture, so delicate tissue handling is imperative. The incision may be allowed to heal with or without suturing, although suturing generally will allow for the incision to heal faster.⁸

For higher-value animals

Tube cystostomy

This procedure is employed to allow the urethra to become patent or to allow time for the urethra to heal. A foley catheter is placed in the bladder and urine drains from this route during this time.⁸ Performed in dorsal recumbency under general anesthesia, a midline or paramedian incision is made in the parallel vicinity to the prepuce. A cystotomy incision is performed and the bladder is flushed. A retrograde catheter can be placed prior to surgery and once the bladder is opened, an assistant can flush saline in to try to relieve an obstruction. Once the bladder is emptied a rubber catheter can be advanced normo-grade in an effort to pulse an obstruction from that fashion. Care should be taken with these flushes to not over pressure the urethra as it can be very reactive tissue, and excessive trauma can lead to future stricture formation. A foley catheter is then placed into the bladder through a separate stab incision and secured with purse-string sutures. Once the incision is closed the foley catheter is left in place for 10-14 days to allow for fibrin formation around it from the bladder to the body wall. During this time or towards the end of this time frame the animal is challenged by obstructing the foley and observing for normal urination. When the foley has been obstructed and normal urination has been observed for 24-48 hours the author will deflate the foley and pull it. The benefit of this procedure is the ability for the patient to obtain normal breeding function post procedure. While the majority of these are performed in dorsal recumbency, the author is aware of several cases of a tube cystostomy being performed via a flank laparotomy (Mulon, personal communication). Refinement of this approach would allow for more field application for the tube cystostomy procedure.

Bladder marsupialization

Performed in dorsal recumbency under general anesthesia, bladder marsupialization can be considered for cases where tube cystostomy is not an option or has previously failed. The apex of the bladder is fixed to a stoma to allow for continuous urine drainage.⁹ For this technique, 2 paramedian or 1 paramedian and 1 midline incisions are made parallel to the prepuce. One incision is used to manipulate the bladder and the paramedian incision is used to fix the bladder in position. Partial thickness stay sutures are placed for manipulation and the bladder is then fixed in position with 4 mattress sutures at the cranial, caudal, medial and lateral positions to the body wall. Then, the bladder is reinforced to the body wall with an additional mattress suture placed between each one previously placed. Care should be taken to make partial thickness bites through the bladder wall. Then the bladder is opened and the edges reflected to the skin in a tight continuous pattern. Unlike the mattress sutures the continuous pattern is not meant for loading, but rather to seal the bladder to the skin. The other incision is then closed. The author prefers PDS-type suture for these purposes due to the strength and knot memory, as well as absorbable nature. Occasionally a short (female) foley catheter can be placed in the marsupialization for several days if the opening is small and becomes obstructed with blood clots.

Vesiculoprepuccial anastomosis (VPA)

The VPA was reported in 2016 for goats with urethral obstructions that did not resolve with employment of tube cystostomy.¹⁰ Performed in dorsal recumbency under general anesthesia, this is a specific form of marsupialization where the bladder is joined to the prepuce. The result is an animal with an externally appearing normal ability to urinate, although this is a constant dribble rather than controlled streams, as sphincter function is lost. This technique is not widely employed in cattle; there is a case of it being used in a show steer with acceptable short-term results.¹¹ Long term complications involving stricture formation have been observed with this technique in goats, so clients should be informed of this risk before this procedure.

Postoperative complications

Common postoperative complications include hemorrhage, infection and urethral stricture.¹ PU procedures can require the placement of a rubber or silicone catheter for several days while the surgery site heals. Care should be taken to keep any catheters originating from the urinary tract clean, as bacterial colonization with multiple antimicrobial species has been reported with foley catheters following tube cystostomy procedures in goats.¹² Urine scald can be a concern from the procedures where urine drains from an abnormal location, and clinicians should consider protecting the surrounding skin with petroleum jelly post operatively.

Postoperative considerations

When treating for postoperative complications and pain from urolithiasis surgery, clinicians should consider drugs with short withdrawal times due to the salvage nature of these procedures in some settings. Ampicillin trihydrate is commonly used by the author for this prophylactic purpose due to the short withdrawal time, although ceftiofur could be considered once infection is observed. These antimicrobials have the additional benefit of being excreted in the urine, which enhances contact with the urinary tract. For NSAID coverage intravenous or transdermal flunixin will have considerably shorter withdrawal periods than oral meloxicam (30+ days per the author's last FARAD request). Antimicrobial coverage should be made with similar withdrawal considerations in mind.

When considering these options for postoperative pain and inflammation management, as well as practices to reduce infection, it should be noted that no drugs are currently labeled in North America for these purposes with respect to urolithiasis procedures in cattle. As such, use for these applications would be considered extralabel and clinicians should consult FARAD (www.farad.org; U.S.) or CgFARAD (<https://cgfarad.usask.ca/language.php>; CAN) for extralabel drug withdrawal recommendations.

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