When Grain Creates a Strain

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Introduction

Obstructive urolithiasis is a multi-factorial disease process that occurs when physiologic and nutritional factors create an optimal environment for the formation of calculi that subsequently block the normal flow of urine. Obstructive urolithiasis occurs in many species but is the most common urinary tract disease in small ruminants. If left untreated, the consequential metabolic disturbances can lead to death in as little as 48 hours. In order to manage urinary obstruction in goats, consideration must be given to type and location of stone(s), the integrity of the urinary tract, purpose of the animal, and budgetary confinements. The natural pH of urine and specific anatomy of small ruminants predisposes them to urolith formation and subsequent blockage. Due to their predisposition, prevention through dietary management and owner education is of utmost importance.

History and Presentation

Skip is an approximately 7-month-old, Nigerian Dwarf buck that presented to Mississippi State College of Veterinary Medicine Food Animal emergency service on August 22, 2019 for stranguria and inappetence. Skip was housed with one wether in a barn stall with free access to a pasture. He was fed alfalfa grass hay, commercial goat pellet, and mixed grass hay. Approximately fifteen additional does were housed at the premise, and no other individuals were showing clinical signs. One week prior to presentation, Skip was observed urinating with stranguria. Approximately twelve hours prior to presentation, Skip became anuric and anorexic with signs of colic.

On initial presentation to the emergency food animal service, Skip was depressed, alert, and responsive, with a body condition score of 2.5/5. He consistently postured to urinate and vocalized on abdominal palpation. Skip was tachycardic, tachypneic, and pyrexic with a heart

rate of 140 beats per minute, a respiratory rate of 104 breaths per minute and a temperature of 104.1° Fahrenheit. His bladder was distended and turgid on abdominal palpation. Gritty material was found on the end of his preputial hairs. When the penis was exteriorized, the urethral process was erythematous and painful. An abdominal ultrasound revealed a severely distended bladder containing a significant amount of hyperechoic material. No evidence of fluid in the abdomen was appreciated and the kidneys appeared within normal limits. A cystocentesis was performed under sedation to prevent bladder rupture and provide temporary relief. A total of 120mL of hemorrhagic urine was removed. Skip was given 0.1mg/kg butorphanol intramuscularly for pain, hospitalized, and fasted over night for further diagnostics and treatment the following day.

Pathophysiology

Obstructive urolithiasis is the most common urinary tract disease in small ruminants resulting from a combination of physiologic, nutritional, and management related issues. Male sheep and goats have a unique anatomy that predisposes them to calculi obstruction making medical management difficult. In addition to the sigmoid flexure of the urethra in all ruminants, sheep and goats also have a urethral process at the end of the penis. The urethral process is a narrowing of the urethra that is the most common place for obstruction. The distal sigmoid flexure, near the insertion of the retractor penis muscle is the second most common location for obstruction.[2] Much of the literature reports castrated males, especially if castrated early, are more likely to become obstructed than intact males. The absence of testosterone after castration causes the urethral diameter to remain small. However, intact males are still risk, especially when fed high grain diets.[7]

Nutrition and management practices are considered the biggest contributors to the formation of stones in these animals. Diet determines the type of minerals present in the urine

which will aggregate and form insoluble crystals in excess. The common types of calculi that occur in small ruminants are either phosphatic variants, which can be subject to dissolution via urine acidification, or calcium carbonate, which cannot be dissolved. Diets high in phosphorus and low in calcium, like cereal grains and concentrates, will lead to development of magnesium ammonium phosphate, or struvite uroliths. Diets high in concentrate, such as alfalfa hay, clover, and kudzu are associated with the development of calcium oxalate and calcium carbonate uroliths.[7] In 1965, a study discovered the importance of the calcium: phosphorous ratio in diets associated with calculogenesis. Increased phosphorus in the diet leads to increased phosphate ions in urine. Because calcium opposes intestinal absorption of phosphorus and therefore increases the urinary phosphate load, it was determined that a dietary calcium: phosphorus ratio should be no lower than 2:1. Furthermore, it has so found that a diet with the appropriate Ca: P ratio but high in magnesium promotes the formation of calcium phosphate or apatite stones.[10]

In addition to dietary factors, urine pH and urine concentration are also key contributors to the formation of uroliths. A urolith begins to form with a crystal nidus in the presence of urine supersaturation with calculogenic crystalloids. The urine of small ruminants is typically alkaline and naturally supports the formation of calculi. An increase in urine pH supports precipitation of struvite and calcium phosphate uroliths. Struvite crystallization occurs between a urine pH of 7.2 and 8.4, whereas calcium phosphate, or apatite stones form at a pH of 6.5 to 7.5.[2] Adequate water consumption must be maintained to prevent an increased urine concentration. Concentrated urine will aid in the growth of the uroliths by continually providing crystal deposition.

Diagnostic Approach

Ruminants can typically be diagnosed with obstructive urolithiasis based off history and physical examination. The diagnostic approach of a goat presenting with signs of a urinary obstruction should begin with a physical exam and assessment of the patient for dehydration, electrolyte imbalances, or acid-base disturbances. Associated clinical signs can be divided into categories of an early stage with unspecific signs, a painful stage with frequent straining, expression of pain and reduced general condition, and an advanced stage of lateral recumbency. In a study that assessed clinical findings in small ruminants with obstructive urolithiasis, most animals presented during the painful stage with stranguria.[2] Other clinical abnormalities on presentation include tachycardia, tachypnea, colic, abdominal distension, and dehydration. Since Skip appeared to be moderately painful, but in a stable condition and adequately hydrated, the integrity of the urinary tract was assessed. Visualizing the abdomen for apparent bilateral ventral distension or peripenile subcutaneous swelling are signs of bladder rupture and urethral rupture, respectively.[7] An ultrasound can be used to confirm the bladder and urethra are intact and determine evidence of free fluid. Skip's bladder was severely distended but intact. No free fluid was noted, and the kidneys appeared within normal limits on ultrasound. When goats are born, the urethral process is adhered to the preputial mucosa and eventually breaks down with maturity. If the attachment does not break down, it is called a persistent frenulum and can limit the ability to exteriorize the penis for examination.[8] Skip was sedated with 0.1mg/kg acepromazine, intramuscularly to help exteriorize the penis and a frenulum was noted. Once exposed, the urethral process was amputated as it is the most common site of obstruction in goats. Occasionally, a single small stone can become lodged at the urethral process, and amputation is attempted to temporarily allow stones to pass. If no further treatment is provided, most animals will re-obstruct within three days.[8]

The following day, a CBC and chemistry were submitted in preparation for surgery, and all results were within normal limits. The degree of blood work abnormalities is associated with stage of disease. The most common chemistry abnormality in a study of 270 small ruminants with obstructive urolithiasis was a variable azotemia, defined as an increase in BUN or creatinine, or both. These values were significantly lower in animals with clinical signs present for less than 24 hours.[7] If the disease process progresses to a uroperitoneum, serum chemistry levels can show significant increases in packed cell volume, plasma protein, potassium, blood urea nitrogen, and creatinine.[7]

Treatment and Management

Medical management of obstructive urolithiasis in small ruminants is typically unsuccessful, and most will require surgery. Urethral process amputation is a necessary step to begin medical management. In other species, retrograde catheterization can relieve the obstruction, however in sheep and goats, the urethral diverticulum at the level of the ischial arch will often prevent access to the bladder. If catheter placement is achieved, retrograde hydropulsion has been attempted to remove additional calculi from the urethra. Repeated attempts at retrograde catheterization is not recommended and increases the likelihood of urethritis or urethral rupture.[2] Urethral process amputation followed by urethral catheterization alone is successful in less than 25% of patients, and most will re-obstruct within three days.[8] If no other treatments are available or affordable, ultrasound-guided cystocentesis and instillation of Walpole's solution can be successful in relieving obstruction in individuals with struvite urolithiasis with potential risk of complications. Walpole's solution is a commercially available acetic acid solution with a pH of 4.5.[8] A study published in 2009 proved this method worked in 20 of 25 goats. Of the 20 goats treated successfully, 6 presented again for reoccurrence of obstruction.[3]

Several surgical options exist for treatment of obstructive urolithiasis including a perineal urethrostomy, urethrotomy, tube cystotomy, and bladder marsupialization. Perineal urethrostomy is a salvage procedure in small ruminants not intended for use in breeding males. This procedure allows for urine diversion by incising the urethra through the skin and creating a new opening. The urethrostomy can be performed anywhere along the perineum depending on the location of the blockage or urethral rupture. Stricture of the stoma or reobstruction will likely occur within one year and most likely within the first six weeks post-operatively.[8] A urethrotomy is a possible surgical option in cattle but is considered suboptimal in small ruminants due to the likelihood of urethral strictures. This has been reportedly successful in some small ruminant patients, but again, the urethra will most likely stricture or become re-obstruct. Perineal urethrostomy and urethrotomy are possible corrective options but incomparable to the success of tube cystotomy.

A tube cystotomy is considered the gold standard for obstructive urolithiasis in small ruminants used for pets or breeding purposes. This surgical approach diverts urine and relieves obstruction without causing additional trauma or irritation to the urethra. A paramedian incision is made to gain access to the bladder. A cystotomy is performed to remove any uroliths present, and a foley catheter is passed through a stab incision in the body wall. The catheter is sutured in place with the cuff inflated to prevent accidental removal from the bladder. The tube remains in place for 7-14 days to allow adequate healing time for the urethra. During this time, the tube can be occluded to challenge the patient to void appropriately. The animal must be observed closely while the catheter is in place to ensure patency. When normal urination occurs, the tube should be left in place and clamped for 24-48 hours before removing.[2, 7, 10] In a retrospective study of 63 small ruminants, all goats with an intact urethral process, absence of free fluids, and a serum potassium less than 5.2 mEq/L were successfully treated and managed after tube cystotomy.[1]

Bladder marsupialization is another salvage procedure in which a permanent stoma is created between the bladder mucosa and the exterior of the ventral abdomen. The benefits of this method compared to the tube cystotomy are cost and duration of post-operative hospitalization.[9] The management and complications that occur with this salvage procedure ultimately lead to poor owner satisfaction, namely consistent urine scald and incontinence. Cystitis, stricture formation, reobstruction, and prolapse have also been reported complications of marsupialization.[8]

When performing any of these corrective surgeries, appropriate intra- and post-operative management must be maintained in order for success. This includes antimicrobials, urine acidification, and intravenous fluid administration for hospitalized patients. Antibiotics that are excreted in the urine are imperative to prevent cystitis or ascending infection for a minimum of one week after surgery or one week after catheter removal in tube cystotomies.[2] Intravenous fluids, specifically 0.9% sodium chloride should be given to correct electrolyte abnormalities.[10] Acidification of the urine can be achieved with ammonium chloride supplementation and frequent monitoring of urine pH. The target pH is between 5.5 and 6.5 in which phosphatic and calcium based calculi are unlikely to form.

Case outcome

On August 23, 2019, Skip was anesthetized, placed in dorsal recumbency, and underwent a tube cystotomy. A moderate amount of urine was noted within the abdomen, but the bladder was intact. Several small, spherical, white calculi were removed from the bladder with largest measuring approximately 2.5 cm within the trigone area consistent with the appearance of struvite uroliths. During surgery he was given 1.1 mg/kg flunixin meglumine intravenously and administered 0.9% NaCl IV fluids at twice maintenance rate. To prevent infection, 300,000 IU of procaine penicillin G was administered subcutaneously, daily. The following day, urinary

acidification was implemented with 500 mg of daily oral ammonium chloride, and his urine pH was monitored to ensure adequate acidification. When IV fluids were discontinued 3 days post-op, his water intake was measured every 6 hours, and he was given a supplemental salt block. The foley catheter was clamped 13 days post-operatively to challenge Skip to urinate normally. An ultrasound was used every 4 hours to check for bladder distension. On day 15, Skip was urinating on his own and his catheter was pulled 48 hours later. He was discharged on September 10th and sent home with instructions to continue ammonium chloride for 7 days and feed a strictly hay diet.

Two days later on September 12, 2019, Skip re-presented for difficulty urinating, straining, and urine dripping from the foley catheter fistula. When catheter placement was attempted, it was determined that Skip had a stricture at the location of the urethral process amputation. The glans penis was numbed with 1% lidocaine and the urethral stricture was sharply removed via more proximal amputation of the urethral process. Once the stricture was cleared, the urinary catheter was advanced retrograde into the urinary bladder and sutured in place. The catheter was removed 2 days later, and he was sent home to recover. On October 18, 2019, Skip returned once more for a recheck and reported weight loss. On presentation, he was bright, alert, and responsive with normal vital signs. He had a BCS of 3/9 and was diagnosed with nutritional weight loss. It was recommended to supplement his ration with Purina Goat Chow, with a Ca: P ratio of 2:1 to support growth. When urinating, Skip still appeared to be straining and producing drops of urine opposed to a stream, however he voided a normal volume of urine. His bladder also appeared normal on ultrasound. Since his last discharge, Skip has returned to a normal body condition and urinates normally. He has matured into a healthy, happy buck, and successfully sired 6 kids in the last month!

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