Obstructive urolithiasis is a vexing, complex problem affecting castrated and intact male goats. Mineral concretions develop and aggregate within the bladder and urethra. Urolith formation occurs when mucoproteins in the urine coalesce and precipitate with crystals in urine supersaturated with minerals. Stones and sediment lodge in the urethra, obstructing urine flow. Females rarely develop obstructive urolithiasis due to their shorter, wider urethra. Castrated males are most at risk because their urethrae are the narrowest. Dwarf African breeds are also overrepresented. Obstructions in goats most commonly occur at the urethral process or vermiform appendage. The distal sigmoid flexure may also be obstructed in goats.

Obstructive urolithiasis is an urgent emergency because the sequelae of this disease are fatal without medical/surgical intervention. Prolonged urinary obstruction may result in hydronephrosis, urinary bladder rupture and subsequent uroperitoneum, urethral rupture, azotemia, and hyperkalemia. Biochemical abnormalities are common in goats with obstructive urolithiasis. George et al. reported on 107 cases of caprine urolithiasis and the accompanying biochemical abnormalities (mean ± standard deviation).1 Affected goats had higher blood urea nitrogen (BUN = 73.2 ± 68 mg/dL) and blood concentrations of creatinine (6.3 ± 5.2 mg/dL), phosphorous (4.0 ± 3.2 mg/dL), potassium (4.5 ± 1.2 mmol/L) and glucose (149.3 potassium (4.5 ± 1.2 mmol/L) 62.8 mg/dL) and lower sodium (144.6 ± 5.3 mmol/L) and chloride (101.6 ± 9.2 mmol/L) compared to goats with nonrenal disease.1 These metabolic derangements are generally responsive to fluid therapy. Generally, goats obstructed < 24 hours may be mildly dehydrated with mild azotemia. Goats suffering prolonged obstruction > 48 hours may have severe acid base abnormalities, azotemia, and hyperkalemia. These biochemical abnormalities require correction with fluid therapy (0.9% NaCl or normal saline, 20–30 mL/kg) once intravenous access is achieved and some method of urine diversion is achieved. Patients must be stabilized prior to considering general anesthesia.

Surgical interventions for obstructive urolithiasis include amputation or removal of the urethral process, cystocentesis (one time percutaneous or placement of basket catheter), tube cystotomy and perineal urethrostomy. General anesthesia is required for abdominal exploration and cystotomy if the urinary bladder is ruptured, requiring repair, or if stones are present within the urinary bladder, necessitating removal. Urethral and urethral process surgical procedures may also be performed under general anesthesia or following sedation and epidural. Perioperative antimicrobial therapy is
warranted. Choices include procaine penicillin G (22,000 IU/kg IM or SC q 12 h or ceftiofur 2.2 mg/kg, IM).

**Urethral process amputation** – The urethral process is 1–2 cm extension of the urethra from the distal aspect of the glans penis. Examination of the urethral process is recommended because this is the most common site for obstruction in goats. Epidural anesthesia, sedation with diazepam (0.1–0.2 mg/kg, IV) or general anesthesia can be performed. Sit the goat on its buttocks, supporting its back. The penis is extended by pushing the sigmoid, allowing the glans to exit the sheath. If manipulation of the penis does not facilitate exteriorization, the penis can be carefully grasped with Allis tissue forceps. Palpation of the exteriorized urethral process may reveal a single stone or sand. Amputation is performed with scissors or a scalpel, taking care not to damage the glans penis. Hemorrhage is self limiting but may temporarily reduce fertility. Sexual rest is recommended for intact males for 2–3 weeks after the process is removed. Urethral process amputation should restore urine flow in about 50% of goats. Owners should be cautioned that re-obstruction might occur if more stones are present within the bladder. Dietary consultation is recommended.

A catheter can be passed retrograde following urethral process amputation in urination is not restored and the clinician is suspicious of more proximal obstruction. Catheterization is facilitated by flushing the urethra with 2% lidocaine or mepivacaine hydrochloride and using lubrication on the catheter. Pulse sterile saline (warm) under pressure through the catheter by sealing the end of the penis with a forceps. Hydropulsion may dislodge a calculus and flush the obstruction into the bladder. This technique is easier in dogs, cats, and pigs compared to goats. Also, the catheter will generally lodge in the urethral diverticulum rather than passing into the urinary bladder. Rectal palpation and guidance of the catheter across the ischium may aide in passing the catheter into the urinary bladder. If the obstruction is flushed into the bladder, restoring urination, cystotomy is recommended to evacuate the urinary bladder, limiting re-obstruction.

**Cystotomy and Tube cystotomy** – General anesthesia is performed and the goat is positioned in dorsal recumbency. The ventral abdomen and inguinal area are aseptically prepared. If hyropulsion is required, the penis may be exteriorized and positioned to one side. A 10–20 cm linear incision is made distal to the umbilicus through the skin and subcutaneous tissue, just lateral to the penis. The incision can be made through the rectus sheath or the penis can be pushed laterally and the abdomen entered through the linea alba. If the urinary bladder is very large, suction of urine may be performed to facilitate exteriorization of the urinary bladder. Once the urinary bladder is exteriorized, 2 stay sutures are placed 3–4 cm apart on the ventral surface. A cystotomy incision is made with a scalpel and the urine aspirated. The calculi can be removed by gentle suction, flushing or by use of calculi spoons. Save some of the stones for analysis and possible culture and sensitivity. If calculi are suspected within the urethra, hydropulsion from the penis with sterile saline is performed to flush the stones back toward the bladder. A 5–10 French polypropylene
catheter can be passed into the trigone of the urinary bladder to the urethral for antegrade hydropulsion. If a tube cystotomy is performed, the Foley catheter (12–28 depending on the size of the goat) is passed through a stab incision in the body wall, after the balloon has been tested and deemed intact. The catheter is grasped with an instruction inserted through the laparotomy incision and the tip of the catheter passed through a small stab incision in the urinary bladder. The balloon is then inflated. A purse string suture is tied, securing the bladder serosa around the catheter using 2’0 monocryl or vicryl. The cystotomy incision is then closed using 2’0 monocryl in a double inverting pattern, taking care not to expose suture within the lumen of the urinary bladder. Gentle traction is placed on the Foley catheter so that the urinary bladder sits against the ventral body wall, taking care not to trap any viscera. The body wall or linea is closed 0 vicryl or PDS, simple continuous pattern and the subcutaneous and skin layers are closed routinely. The Foley catheter is secured to the body wall with a Chinese finger knot. A one-way valve (Heimlich or glove finger tip) is secure to the end of the catheter to minimize retrograde contamination or the urinary bladder.

Modified proximal perineal urethrostomy (PU) – The Tobias Technique or modified proximal perineal urethrostomy can be performed in nonbreeding goats. The goat is positioned in sternal recumbency following general anesthesia. If cystotomy is required, the cystotomy can be performed before or after the PU. Towels may be placed under the caudal abdomen for positioning. A purse string suture may be placed in the anus to prevent fecal contamination of the surgery site. The ischial tuberosities are palpated. A 6–8 cm incision is made along midline beginning 2 cm distal to the anal osteum, at the level of the ischial tuberosities. The penile body is palpated and dissected free from the surrounding tissues with blunt and sharp dissection. Electrocautery is useful at this stage to minimize bleeding. The retractor penis muscles are identified and transected. The dorsal penile artery is retracted cranially (if it is seen). The penile body is transected at the caudal aspect of the proximal end of the sigmoid flexure, 4–8 cm distal to the caudal edge of the pubis. Over-sew the distal penile segment with mattress sutures to minimize hemorrhage. Vessels can be cauterized and/or ligated to minimize hemorrhage. The proximal penis is grasped with Allis tissue forceps to facilitate manipulation and elevation. The ventrolateral penile attachments to the pelvic brim are transected using electrocautery if available, or sharp dissection. These attachments are largely composed of the ischiocavernosus muscles. These attachments are quite fibrous and thick. The V-shape of the caprine pelvic brim makes this step difficult. Mayo or cartilage scissors or a periosteal elevator may be used. When these attachments are completely severed, the penile body is straightened and the urethra catheterized. The catheter should be passed into the urinary bladder. The distal end of the urethra is incised longitudinally along its dorsal midline for 2 cm with Metzenaum or sharp scissors. It is important to incise the urethra to the level of the pelvic urethra to maximize the urethrostomy stoma size. The spatulated end of the urethra is then sutured to the perineal skin with absorbable monofilament suture, starting dorsally. First, a mattress suture may be placed on either side through the penile fascia to the subcutaneous tissue to hold the penis in place. Then, the urethral mucosa at the dorsal aspect of the urethral incision
is apposed to the skin with 2 interrupted sutures on each side. The remaining mucocutaneous apposition is performed along each side of the urethra with a simple continuous or interrupted pattern to create a urethral spatulation 2 cm in length. Monocryl (3’0) is used. Additional interrupted sutures may be added as needed to fill in any gaps in mucocutaneous apposition. Tunica albuguinea was not included in the mucocutaneous apposition but may be used when placing the 1st stay sutures from the tunic to the subcutaneous tissue. Any remaining gaps in the subcutaneous tissues dorsal and ventral to the urethrostomy site are closed with simple interrupted sutures of absorbable monofilament.³ The skin is apposed as needed with absorbable monofilament suture in an interrupted intradermal pattern or polypropylene in a simple interrupted or cruciate pattern.³ An 8 or 10F catheter should easily be passed into the urinary bladder. Apply an ice pack to the urethrostomy site for 10–15 minutes to limit post operative swelling.

References
