Urethral diverticulum and urolithiasis in a female guinea pig (*Cavia porcellus*)

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**CASE DESCRIPTION**  
A 5-year-old sexually intact female guinea pig (*Cavia porcellus*) was referred to a veterinary teaching hospital for evaluation of mild dysuria and the presence of a subcutaneous mass located cranioventral to the urogenital openings.  

**CLINICAL FINDINGS**  
Non–contrast-enhanced CT and surgical exploration of the distal aspect of the urethra revealed a urethral diverticulum with an intraluminal urolith. Analysis revealed that the urolith was composed of calcium carbonate and struvite.

**TREATMENT AND OUTCOME**  
The urolith was surgically removed and ablation of the urethral diverticulum was attempted. Approximately 3 months later, the guinea pig was reevaluated for masses in the perineal region, and positive-contrast urethrocentigraphy revealed 2 uroliths present in the same diverticulum. Uroliths were manually expressed with the patient under general anesthesia. Approximately 2 weeks later, urethroplasty was performed to create an enlarged stoma with the diverticulum, thereby preventing urine from pooling in the diverticulum and potentially reducing the risk of future urolith formation. The urethroplasty site healed well with no reported complications or evidence of urolith recurrence 6 months after surgery.

**CLINICAL RELEVANCE**  
Urolithiasis is common in guinea pigs, and urethral diverticulum and intraluminal urolith formation should be considered as a potential differential diagnosis for a subcutaneous mass along the distal aspect of the urethra. Creation of a urethral stoma from a urethral diverticulum via urethroplasty achieved a successful outcome in this patient. (*J Am Vet Med Assoc* 2017;251:1313–1317)
tissues were closed with 4-0 monofilament polyglyconate suture material in a simple continuous pattern, and the skin was closed with stainless steel skin staples. Recovery from surgery was uneventful, and injectable antimicrobial and oral NSAID treatments were initiated as the guinea pig recovered. Feeding with a commercial herbivore diet was started 2 hours after anesthetic recovery and oral antimicrobial treatment with trimethoprim sulfamethoxazole, (30 mg/kg [13.6 mg/lb], PO, q 12 h) was started concurrently.

The guinea pig was discharged from the hospital on the day after surgery; the owners were instructed to continue syringe feedings until normal food consumption had resumed and to administer meloxicam (0.5 mg/kg, SC, once, and then PO, q 24 h, for 7 days) and trimethoprim sulfamethoxazole (at the previously described dosage) for 7 days. No dysuria, stranguria, or hematuria was observed during hospitalization after surgery or reported by the owners during follow-up 11 days later.

Results of histopathologic evaluation of the mucosa sample revealed dense collagenous connective tissue lined by keratinizing stratified squamous epithelium that was multifocally eroded and replaced with serocellular crust composed of degenerate neutrophils and eosinophilic cellular debris. There were also a few areas of hemorrhage present. The findings were interpreted as consistent with a urethral diverticulum with mechanical irritation from the urolith (Figure 2).

The results of urolith composition analysis confirmed a mix of calcium carbonate (90%) and magnesium ammonium phosphate (struvite; 10%). With these results, the guinea pig’s diet was reviewed with the owner, and no source of excess calcium could be identified. The owners were counseled about the risks for recurrence of uroliths and the diverticulum.

Approximately 3 months after surgery, the guinea pig was returned for evaluation of 2 palpable firm masses in the region of the previous urolith. The masses were similar to that present at the time of the initial examination; each was approximately 3 mm in diameter and suspected to be within the previously diagnosed urethral diverticulum.

Positive-contrast urethrocytography was performed with the patient anesthetized by use of a protocol similar to that described previously. Urine was removed from the bladder by passing a 5 F red rubber catheter through the urethra in a retrograde direction, and approximately 4 mL of iohexol was instilled into the bladder via a 3.5 F tomcat catheter in the same manner. Fluoroscopy revealed persistence of the diverticulum (approximately 1 x 1.5 cm), which contained 2 (3-mm-diameter) uroliths, and a slight dilation of the urethra just proximal to the persistent diverticulum (white arrow), the diverticulum (black arrow), and 2 uroliths (stars) within the diverticulum (Figure 3). Both uroliths

![Figure 1](image1)

Figure 1—Sagittal CT image of a 5-year-old sexually intact female guinea pig (Cavia porcellus) that was evaluated because of mild dysuria and a subcutaneous mass cranioventral to the urogenital openings. A large, mineral-attenuating mass (arrow) is present ventral to the abdominal wall.

![Figure 2](image2)

Figure 2—Representative photomicrograph of a histologic section from a mucosal sample obtained during surgery to remove the first urolith and address the urethral diverticulum of the same guinea pig in Figure 1. Stratified squamous keratinizing epithelium and submucosal fibrocollagenous tissue from the urethral diverticulum are moderately hyperplastic (arrows). H&E stain; bar = 200 µm.

![Figure 3](image3)

Figure 3—Representative sagittal fluoroscopic image obtained during positive-contrast urethrography of the same guinea pig in Figure 1 approximately 3 months after the initial surgery. The patient was reevaluated at this time because of palpable masses in the region of the previously diagnosed diverticulum. Notice slight dilation of the urethra just proximal to the persistent diverticulum (white arrow), the diverticulum (black arrow), and 2 uroliths (stars) within the diverticulum.
were manually massaged out of the diverticulum. The patient recovered uneventfully and was discharged from the hospital.

Eighteen days later, a urethroplasty was performed to create a new urethral stoma and potentially eliminate pooling of urine predisposing the guinea pig to urolith formation. The anesthetic protocol included premedication with oxymorphone (0.1 mg/kg [0.045 mg/lb], IM) and midazolam (0.8 mg/kg [0.36 mg/lb], IM) and induction with isoflurane in oxygen delivered via facemask. Epidural anesthesia was also provided with 0.1 mg of preservative-free morphine sulfate. The epidural technique used was identical to that previously described for use in ferrets. Briefly, after aseptic preparation of the area from the sacrum to the level of the spinous process of L2, a 25-gauge needle was placed in the palpable intervertebral space between L6 and S1 perpendicular to the vertebral column and advanced slowly. Because of the small volume present in the epidural space of guinea pigs, a typical hanging-drop technique would also not be expected, in the authors’ experience, to allow confirmation of appropriate needle placement. For this reason, once the needle appeared appropriately placed, the syringe containing the 0.1 mL of preservative-free morphine was affixed to the needle with a small bubble of air present between the morphine and the plunger of the syringe. As the syringe was lightly pushed to dispense the morphine, the air bubble was monitored for deformation, and lack of compression of the air bubble was interpreted as an indicator that flow of medication was effortless enough for the epidural space to have been definitively entered.

Following epidural anesthetic administration, the guinea pig was placed in dorsal recumbency, the hair around the perineum was clipped, and the surgical site was aseptically prepared. A 5 F red rubber catheter was introduced into the urethra and diverticulum (Figure 4). A 1-cm incision was made beginning at the cranial aspect of the urethral stoma and extending cranially along the ventral midline. The diverticular lumen and the communication with the urethral lumen was exposed. A 5-mm sample of urethral mucosa was surgically removed for histopathologic evaluation; the incised edges of the urethral mucosa and diverticulum were apposed to the associated perineal skin with absorbable (7-0 polyglactin 910) suture material in a simple interrupted pattern. A 3.5 F red rubber catheter was passed through the enlarged urethral opening into the urinary bladder. No uroliths or strictures were identified. Recovery was uneventful, and the same postsurgical care given after the initial procedure was again provided. Histopathologic evaluation revealed findings similar to those of the previous biopsy, although overall the inflammation appeared less severe.

The urethroplasty site healed without complications (Figure 4). Six months after surgery, the guinea pig was reportedly doing well with no evidence of urolith recurrence or other signs of urinary tract problems.

**Discussion**

Urolithiasis, including urethrolithiasis, is a common problem in guinea pigs. The predominant chemical component is calcium carbonate, with struvite being the next most common. One study found that guinea pigs developed uroliths at a median age of 3 years. Previous investigations indicated that bacterial lower urinary tract infections might predispose guinea pigs to urolithiasis; however, no definitive cause of urolithiasis in this species was identified. Sex is another factor that has been suggested as a contributing factor in the development of uroliths in guinea pigs, with results of one study indicating that female guinea pigs may be more prone to urolithiasis, whereas findings in another study did not support this conclusion. It has also been hypothesized that consumption of too little water, leading to very concentrated urine and stagnation of urine in the bladder, could contribute to urolith formation. However, this was refuted by another study, in which investigators concluded that guinea pigs with urolithiasis had isosthenuria. Another hypothesis described for urolith formation in guinea pigs was that excess dietary calcium could potentially be a predisposing factor, since guinea pigs excrete a large amount of calcium in their urine. However, a previous report involving hystricomorph rodents indicated that the amount of calcium excreted in urine is not influenced by the amount of dietary calcium.

To the authors’ knowledge, a urethral diverticulum has not been previously reported in a guinea pig. Urethral diverticula are uncommon in all mammals, but have been described in human females as well as in rabbits and swine. No mention of a urethral dilation, or outpocketing, was
mentioned in published descriptions of guinea pig anatomy.\textsuperscript{12,13} Urethral diverticula can be congenital or acquired, with the acquired form in human patients hypothesized to be associated with repeated bacterial infections of the paraurethral glands, which rupture and epithelialize.\textsuperscript{9} Paraurethral glands are not described in guinea pigs, but a similar syndrome to the human condition cannot be ruled out.\textsuperscript{14} It was presumed that the urethral diverticulum in the guinea pig of this report was acquired later in life, considering the owners’ diligence in observing changes in its physical condition. With no history of clinical signs referable to the lower urinary tract, it seemed unlikely that chronic urinary tract infection preceded development of the diverticulum. Whether the diverticulum collected urine sediment leading to urolith formation, or whether a urolith led to a urethral stricture or partial obstruction with progressive dilation of the proximal portion of the urethra and eventual diverticulum formation, could not be determined.

Urethroplasty was performed in this guinea pig as an indirect means of addressing the urethral diverticulum, with the goal of preventing urine accumulation that would predispose the patient to recurrent urolith formation in the dependent portion of the diverticulum. In addition, urethroplasty avoided the risks of stricture or dehiscence that accompany a more technically challenging resection of the diverticulum and reconstruction of the urethra. To obtain the most favorable results, accurate apposition of the urethral mucosa and the skin is necessary and should be completed with a fine monofilament suture and optical magnification as appropriate. In addition, tension on the anastomosis should be kept to a minimum and recatheterization avoided after surgery to minimize trauma to the urethroplasty site.

Urethroplasty is not a particularly common surgical technique in small animal medicine. However, many different urethroplasty-type procedures have been described to address recurrent urolithiasis and to reduce the risk for distal urethral obstruction.\textsuperscript{15-17} For example, urethroplasty was described as a procedure for widening the urethral opening to relieve strictures secondary to urolithiasis in male cats.\textsuperscript{18} However, perineal urethrostomy is more commonly performed in male cats, and this involves creation of a wider opening to the urethra in a more proximal location,\textsuperscript{19} which parallels the procedure performed in the female guinea pig of this report.

Hystricomorph rodents have specialized genital anatomy with 3 external openings in females (the anus, urethral opening, and vaginal orifice).\textsuperscript{15} Male guinea pigs additionally have unique external genital anatomy, with scrotal swellings surrounding the prepuce and a perineal sac surrounding the anus, such that the anus is not directly in contact with the external environment. This arrangement in male guinea pigs can lead to substantial debris building up in this area leading to scrotal plugs, posthitis, and cloacal impactions.\textsuperscript{20,21}

The separation of the urinary and reproductive tracts in female guinea pigs simplified the surgical approach to the urethra and made the described surgical procedure more similar to previously described surgical procedures in male cats, rather than urethroplasties in female dogs and cats. This affords a distinct surgical advantage when addressing urethroliths in female guinea pigs. Urogenital surgery in guinea pigs raises concern because of the challenges of anesthesia in this species\textsuperscript{22} as well as the concern for potential stricture associated with urethral surgery. Although cystoscopy and endoscopic removal of uroliths in female guinea pigs were recently described,\textsuperscript{23} in cases such as this where the original urolith was too large for endoscopic removal or for patients in which strictures have already developed or are deemed very likely, a similar urethroplasty procedure may be an option, regardless of whether a diverticulum is present. The unique anatomy of these animals allows this to be an option for addressing urethroliths in female guinea pigs.

Urolithiasis remains an important problem in guinea pigs and should be included as a differential diagnosis for dysuria and stranguria. In the patient of this report, urethroplasty proved successful in preventing further urolith formation for 6 months after surgery, and this procedure should be considered a viable option for similar cases.

**Footnotes**

b. Hospira, Lake Forest, Ill.
c. Fort Dodge Animal Health, Fort Dodge, Iowa.
d. Minrad, Inc, Orchard Park, NY.
e. Covidiem, Dublin, Ireland.
g. Hi-Tech Pharmacal Inc, Amityville, NY.
h. Norbrook Laboratories, Newry, Northern Ireland.
i. Mila International, Erlanger, Ky.
k. Smiths Medical, Gary, Ind.
l. Endo Pharmaceuticals, Chadds Ford, Pa.
m. Hospira, Lake Forest, Ill.
n. Ethicon Inc, Somerville, NJ.

**References**


From this month’s AJVR

In vivo evaluation of effects of sedation on results of acoustoelastography of the superficial digital flexor tendons in clinically normal horses

Diego De Gasperi et al

**OBJECTIVE**
To assess the effects of sedation on results of acoustoelastography of the superficial digital flexor tendons (SDFTs) in clinically normal horses.

**ANIMALS**
27 clinically normal horses.

**PROCEDURES**
For each horse, the pathology index (PI) for the SDFT of each thoracic limb was determined by use of acoustoelastography at 4 locations (5, 10, 15, and 20 cm distal to the accessory carpal bone). Horses were evaluated before and after they were sedated with a combination of detomidine hydrochloride (0.01 mg/kg, IV) and butorphanol tartrate (0.01 mg/kg, IV). A repeated-measures ANOVA was used for statistical analysis.

**RESULTS**
Overall, the PI was lower after sedation than before sedation. In addition, the PI was lower at more distal locations than at more proximal locations. There was not a significant effect of limb (left or right). Differences among individual horses accounted for the largest variance effect.

**CONCLUSIONS AND CLINICAL RELEVANCE**
Sedation with detomidine and butorphanol facilitated acoustoelastography; however, it decreased the SDFT PI in clinically normal horses and should be used consistently in prospective studies. Variance associated with each individual horse in the sample population had the greatest effect on the PI. (Am J Vet Res 2017;78:1421–1425)