VOIDING UROHYDROPROPULSION

Lessons From 5 Years of Experience

Jody P. Lulich, DVM, PhD, Carl A. Osborne, DVM, PhD,
Sherry L. Sanderson, DVM, Lisa K. Ulrich, CVT,
Lori A. Koehler, CVT, Kathleen A. Bird, CVT,
and Laura L. Swanson, CVT

Until recently, most uroliths in the urinary bladder were managed either by surgical removal or medical dissolution. Five years ago, however, we developed a technique of voiding urohydropropulsion to remove urocystoliths small enough to pass through the urethral lumen (Table 1).\(^1\) By using the effect of gravity on the position of uroliths in the urinary bladder and by taking advantage of dilation of the urethral lumen during the voiding phase of micturition, this simple technique facilitates expulsion of urocystoliths through the urethra.

Over the past 5 years, we have used voiding urohydropropulsion to remove urocystoliths from more than 100 dogs. When properly performed, voiding urohydropropulsion has proved to be an effective and safe method to remove small to moderately sized urocystoliths of any mineral composition. The primary objective of this review is to answer questions that we are commonly asked by our colleagues regarding how to maximize the effectiveness of voiding urohydropropulsion.

**HOW CAN THE SIZE OF UROCYSTOLITHS THAT PASS THROUGH THE URETHRA BE DETERMINED?**

The relationship between the size, shape, and surface contour of urocystoliths and the luminal diameter of the urethra is an important factor in the selection of patients for voiding urohydropropulsion. Logically, uroliths larger
Table 1. PERFORMING VOIDING UROHYDROPROPULSION

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Anesthetize the patient</td>
</tr>
<tr>
<td>2</td>
<td>Distend the bladder with a sterile physiological solution injected through a transurethral catheter</td>
</tr>
<tr>
<td>3</td>
<td>Remove the catheter; if fluid is expelled prematurely, the vulva or urethra can be gently pinched closed using a thumb and finger</td>
</tr>
<tr>
<td>4</td>
<td>Position the patient so that the vertebral column is approximately vertical</td>
</tr>
<tr>
<td>5</td>
<td>Gently agitate the urinary bladder by palpation to promote gravitational movement of all urocystoliths into the bladder neck</td>
</tr>
<tr>
<td>6</td>
<td>Apply steady digital pressure to the urinary bladder to induce micturition; once voiding begins, the bladder is more vigorously compressed; the object is to sustain maximum urine flow through the urethral lumen to keep it dilated as long as possible</td>
</tr>
<tr>
<td>7</td>
<td>Repeat steps 2 through 6 if the number of uroliths voided is less than that previously detected by radiography; if uroliths detected by radiography were too numerous to count, repeat voiding urohydropropulsion until uroliths are no longer detected in the expelled fluid</td>
</tr>
</tbody>
</table>

than the smallest diameter of any portion of the distended urethral lumen cannot pass through it.

Compared to uroliths with an irregular contour, smooth uroliths are more readily passed through the urethra. This may be related, at least in part, to the fact that uroliths with sharp or irregular surface projections are more likely to adhere to the urethral mucosa.

In addition, in some cases, contact of the entire surface of smooth uroliths with the urethral mucosa tends to form a more effective seal, which reduces the escape of saline around the stone during voiding. Thus, during voiding, fluid passing through the urethra that cannot easily leak around smooth-surfaced stones is at a higher intraluminal pressure and is therefore more likely to propel the stone through the lumen. When uroliths with an irregular surface contour are present, fluid passing through the urethra has a greater tendency to leak around them with less stone movement.

In our series of clinical cases, diameters of the largest uroliths expelled from urinary bladders were (1) 7 mm from a 7.4-kg female dog, (2) 5 mm from a 9.0-kg male dog, (3) 5 mm from a 4.6-kg female cat, and (4) 1 mm from a 6.6-kg male cat. In male cats, uroliths greater than 1 mm in diameter may be voided through the urethra modified by perineal urethrostomy. As a guideline, smooth urocystoliths less than 5 mm in diameter can usually be removed by voiding urohydropropulsion in dogs weighing more than 18 lb.

HOW MUCH URINE OR FLUID SHOULD BE IN THE BLADDER LUMEN TO ENHANCE THE EFFECTIVENESS OF VOIDING UROHYDROPROPULSION?

Successful voiding urohydropropulsion requires that urinary bladders be maximally distended with urine or sterile isotonic solutions such as lactated Ringer’s solution or normal saline solution. Maximal luminal distension facilitates rapid and forceful digital compression of the bladder and thus enhances the intraluminal pressure needed to propel the stones through the urethra. For most dogs, we fill the bladder lumen with saline injected through an 8-French flexible rubber transurethral catheter. We determine the degree of bladder disten-
voiding by abdominal palpation. Sometimes, the fluid begins to leak around the catheter before the bladder is sufficiently distended. When this occurs, we try to digitally occlude the distal urethral orifice. If fluid continues to leak through the urethra after the catheter is removed, it may be helpful to continue to occlude the distal urethral orifice by digital compression.

For dogs with smooth uroliths less than 2 to 3 mm in diameter, maximal bladder distension is not required for complete urolith removal. In this situation, voiding urohydropropulsion is initiated when the bladder lumen becomes filled with urine. Unfortunately, the bladder of dysuric patients usually does not become filled with a sufficient volume of urine to allow voiding urohydropropulsion without injection of saline into the bladder lumen.

**IF A UROLITH IS OBSTRUCTING THE URETHRA, IS VOIDING UROHYDROPROPULSION LIKELY TO BE EFFECTIVE?**

Voiding urohydropropulsion is not likely to be effective in patients with uroliths lodged in the urethra at the time of diagnosis. Uroliths obstructing the urethral lumen have usually been subjected to considerable pressure during attempts by the patient to void. Therefore, attempts to induce voiding of a fluid-filled urinary bladder via abdominal palpation are unlikely to create additional pressure sufficient to move the obstruction (Fig. 1). In addition, if complete urethral obstruction and bladder overdistension are associated with underlying disease that has weakened the bladder wall, digital pressure applied to the bladder could result in bladder rupture. For patients with uroliths lodged in the urethra, we recommend that uroliths be returned to the urinary bladder by

![Figure 1](image_url)  
*Figure 1*. Lateral survey radiograph of an 8-year-old male Lhasa Apso with uroliths occluding the urethral lumen. It is unlikely that voiding urohydropropulsion could create additional force promoting further urethral dilation and urolith expulsion. Other methods of urolith removal should be considered in this patient.
retrograde urohydropropulsion and dissolved medically or removed by cystotomy.

**WHAT TYPE OF ANESTHESIA IS OPTIMAL?**

Anesthesia is not necessary to perform voiding urohydropropulsion in all patients. For most patients, however, we recommend anesthesia to facilitate positioning of the patient as well as localization, palpation, and compression of the urinary bladder.

When anesthetics are used, we recommend agents that provide analgesia and muscle relaxation. In our experience, voiding urohydropropulsion is easiest and safest to perform in patients receiving inhalation anesthetics (isoflurane or halothane). We generally include a narcotic as one of the preanesthetic drugs to minimize pain. For small urocytoliths unlikely to induce any urethral discomfort, we typically use a combination of intramuscularly administered oxymorphone (0.1–0.2 mg/kg) followed by intravenously administered propofol titrated to effect instead of inhalant anesthetics. In some dogs, we have used propofol as the sole anesthetic agent. Propofol-induced anesthesia is easily titrated, and recovery is rapid and smooth. Drugs to minimize pain following the procedure are usually not needed.

**CAN VOIDING UROHYDROPROPULSION BE PERFORMED SUCCESSFULLY IN MALE DOGS?**

The success of voiding urohydropropulsion is not dependent on whether patients are male or female but on whether uroliths are of sufficiently small size to pass through the urethral lumen. Because the diameter of the urethra in male dogs appears to be smaller than that in female dogs of comparable weight and because the os penis in male dogs restricts expansion of the urethral lumen, larger uroliths can be voided from female dogs compared to male dogs of similar size. For example, we reported that the largest urolith removed from a 9-kg male dog was 5 mm in diameter, whereas the largest urolith removed from a 7.4-kg female dog was 7 mm in diameter.

**HOW CAN VOIDING UROHYDROPROPULSION BE PERFORMED IN LARGE DOGS?**

To facilitate vertical positioning of large dogs for voiding urohydropropulsion, we use examination tables designed to tilt. The patient is positioned in lateral recumbency while the urinary bladder is being filled. The patient is then placed on its back. With one person supporting the forelimbs and another person supporting the rear limbs of the animal, the table is tilted approximately 55° from the horizontal. Once voiding has been completed, the table is returned to a horizontal position, and the patient can rest in lateral recumbency.

**IS IT PRACTICAL TO SHRINK THE SIZE OF THE UROLITH BY MEDICAL MANAGEMENT PRIOR TO VOIDING UROHYDROPROPULSION?**

If medical therapy is effectively dissolving urocystoliths within a reasonable time, we know of no reason to interrupt successful management to remove
voiding urohydropropulsion. If the success of therapy is interrupted because the patient no longer accepts therapy (e.g., refusal to eat a special diet), if therapy places the patient at risk for complications (e.g., xanthine urolith formation following allopurinol administration without appropriate purine reduction), or if a client is no longer willing or able to administer therapy, voiding urohydropropulsion can be considered to complete management, assuming that the size of the uroliths has been reduced sufficiently to allow them to pass through the urethra.

We have also used voiding urohydropropulsion to manage compound uroliths with an outer layer of magnesium ammonium phosphate and an inner core of calcium oxalate (Figs. 2 to 4).

Patient selection was based on radiographic appearance of uroliths. Because calcium oxalate is more radiodense than magnesium ammonium phosphate, the radiographic density of the center of the urolith was greater compared to that of the outer layer. In one patient, after administering therapy to dissolve magnesium ammonium phosphate for 6 weeks, the calcium oxalate cores were removed by voiding urohydropropulsion.

WHAT STRATEGY SHOULD BE USED IF UROLITHS BECOME LODGED IN THE URETHRA DURING VOIDING UROHYDROPROPULSION?

If uroliths are too large to easily pass through the urethral lumen, they may become lodged in the urethra during voiding urohydropropulsion. For most patients, when this occurs, uroliths are easily flushed back into the urinary bladder by retrograde hydropropulsion. If the urinary bladder is still distended

Figure 2. Lateral survey radiograph of a 4-year-old female Miniature Poodle with three urocystoliths. The center of each urolith is more radiodense than the outer layer, consistent with a compound urolith.
Figure 3. Lateral radiograph of the 4-year-old female Miniature Poodle in Figure 2. After 6 weeks of therapy designed to dissolve struvite uroliths, only the more radiodense urolith cores remain. These smaller urolith-cores were removed nonsurgically by voiding urohydropropulsion.

Figure 4. Lateral double-contrast cystogram was performed to verify complete removal of urolith cores. Quantitative urolith analysis revealed that the core of each urolith was composed of 100% calcium oxalate dihydrate.
with the fluid, however, retrograde urohydropropulsion may be difficult. The excessive intravesicular pressure that is created as the bladder is filled with fluid to perform voiding urohydropropulsion forces uroliths to move distally along the urethra. Therefore, successful retrograde urohydropropulsion of uroliths may first require that the bladder be emptied by decompensative cystocentesis (consult the article in this issue on retrograde urohydropropulsion for further details).

Once uroliths have been returned to the urinary bladder, determining the need for their surgical removal requires knowledge of the likelihood that uroliths may reobstruct the urethra, of the degree of patient discomfort, and of urolith composition. Surgery should be considered if repeated reobstruction follows successful retrograde urohydropropulsion. When surgery is necessary, we recommend that uroliths be removed by cystotomy rather than by urethrotomy, because urethral strictures and urinary tract infections may be sequelae to urethrotomies.

Uroliths amenable to medical dissolution that remain in the bladder can be dissolved using medical protocols. Asymptomatic uroliths not amenable to dissolution that remain in the bladder usually do not require treatment until they become clinically active.

WHAT COMPLICATIONS HAVE BEEN ENCOUNTERED WITH VOIDING UROHYDROPROPULSION?

If patients are carefully selected and good technique is used, voiding urohydropropulsion is a safe procedure. Visible hematuria is the most common complication of voiding urohydropropulsion, but it resolves in most dogs within several hours.1 Hematuria that develops following the use of this technique is probably induced by manual compression of inflamed urinary bladders. If patients with uroliths have concomitant urinary tract infection, we recommend treatment with antimicrobial drugs for several days prior to performing voiding urohydropropulsion.

Urethral obstruction with uroliths can occur if voiding urohydropropulsion is performed in dogs with uroliths too large to pass through all segments of the urethral lumen. When this occurs, uroliths are easily flushed back into the urinary bladder by retrograde urohydropropulsion. If uroliths cannot be medically dissolved, cystotomy may be needed to prevent reobstruction.

Filling the urinary bladder by means of transurethral catheterization is a risk for urinary tract infection; however, we have not observed bacterial urinary tract infection in any of our patients in association with voiding urohydropropulsion. This may result from the fact that we provided prophylactic antimicrobial agents for 3 to 5 days following urethral catheter placement. Likewise, because uroliths are a risk factor for urinary tract infection, it is logical to assume that urolith removal restores the normal host defenses necessary to prevent bacterial invasion of the urinary tract.

In performing voiding urohydropropulsion for 5 years in over 100 dogs, surgery was needed once to repair a ruptured urinary bladder. This occurred in a female dog with a recent urethral obstruction. After 24 hours of dysuria, this dog passed the urolith that completely obstructed the urethra. Voiding urohydropropulsion was then attempted to remove the remaining uroliths. During the procedure, another urolith obstructed the urethra; manual compression of an inflamed bladder wall contributed to bladder rupture. Uroliths were surgically removed, the bladder wall was repaired, and the patient made a satisfactory recovery.
WHAT IF I DID NOT REMOVE ALL UROLITHS DURING SURGERY? HOW LONG SHOULD I WAIT BEFORE I CAN PERFORM VOIDING UROHYDROPROPULSION?

Voiding urohydropropulsion performed within days to weeks of cystotomy is not recommended. Within this period, it is unlikely that the surgical incision site in the bladder wall has regained sufficient integrity to accommodate the intravesicular pressures created during voiding urohydropropulsion.

Two months after cystotomy, we removed small uroliths by voiding urohydropropulsion in a Dalmatian with recurrent urate uroliths. Double-contrast cystography following voiding urohydropropulsion confirmed that the integrity of the bladder wall was not disrupted. Likewise, excessive hemorrhage did not occur following the procedure.

WHAT ROLE DOES VOIDING UROHYDROPROPULSION PLAY IN RECURRENT UROLITHIASIS?

Voiding urohydropropulsion is an effective nonsurgical method for managing recurrent urocystoliths. Voiding urohydropropulsion has been especially useful in managing uroliths for which preventive therapy was not possible and when owner compliance with preventive therapy was less than adequate to prevent recurrence. Likewise, management of highly recurrent uroliths such as those composed of calcium oxalate can be improved by this technique.

Successful management of recurrent urocystoliths by voiding urohydropropulsion requires their detection when they are still small enough to pass through the urethral lumen. This is the optimum time to quickly and completely remove urocystoliths by voiding urohydropropulsion. Therefore, we recommend radiographic imaging of the urinary tract every 3 to 6 months following cystotomy even if patients do not have urinary tract signs. If patients are re-evaluated only when clinical signs associated with uroliths are recognized, the uroliths are often too large to pass through the urethra by that time.

HOW CAN ONE LEARN TO PERFORM VOIDING UROHYDROPROPULSION?

To help minimize the anxiety associated with a new technique, consider performing voiding urohydropropulsion in a dog that you have scheduled for cystotomy. For your first attempt, select a patient that in all probability is likely to have a successful outcome. Choose a medium-sized female dog with relatively smooth uroliths equal to or less than 5 mm in diameter. Sedate the patient as if a cystotomy is going to be performed; however, first try voiding urohydropropulsion. If difficulty is encountered in catheterizing the urethra or if all the urocystoliths cannot be voided, the patient is already prepared for surgery. Even if the urinary bladder ruptures, which is not likely if proper technique is used, the patient is prepared for surgery.

References


Address reprint requests to
Jody P. Lulich, DVM, PhD
Department of Small Animal Clinical Sciences
College of Veterinary Medicine
University of Minnesota
St. Paul, MN 55108