NONSURGICAL STONE REMOVAL: VOIDING UROHYDROPROPULSION

Until recently, most uroliths in the urinary bladder were either medically dissolved or surgically removed. However, at the University of Minnesota, we developed a new technique to remove urocystoliths, called voiding urohydropropulsion (table 1). By taking advantage of the effect of gravity on urolith position in the urinary bladder and dilation of the urethral lumen during the voiding phase of micturition, this simple technique allows uroliths to be rapidly flushed out of the urinary tract.

Over the past 5 years, voiding urohydropropulsion has been used to remove uroliths in over 100 dogs. We have found voiding urohydropropulsion to be an effective and safe method to remove small to moderately sized urocystoliths of any mineral composition. What follows are answers to the questions that we believe are most important to effectively perform voiding urohydropropulsion in your patient.

How Can I Determine What Size of Urolith Can Be Voided?

Proper selection of patients for voiding urohydropropulsion will enhance removal of urocystoliths. The relationship of the size, shape, and surface contour of urocystoliths to the luminal diameter of the urethra are important factors. Uroliths that are larger than the smallest diameter of any portion of the distended urethral lumen are unlikely to be voided. In our clinical experience, diameters of the largest uroliths expelled from the urinary bladder were 7 mm from a 7.4 kg female dog, 5 mm from a 9 kg male dog, 5 mm from a 4.6 kg female cat, and 1 mm from a 6.6 kg male cat. It is logical to hypothesize that uroliths greater than 1 mm in diameter could be voided from a male cat with a perineal urethrostomy. As a guideline, we assume that smooth uroliths, less than 5 mm in diameter can be removed by voiding urohydropropulsion in any dog weighing more than 18 pounds.

How Much Fluid or Urine Should be in the Bladder for Voiding Urohydropropulsion to be Effective?

Assuring successful voiding urohydropropulsion requires that urinary bladders be maximally distended with urine or sterile isotonic solutions (Ringer’s solution, normal saline, other isotonic intravenous solutions). Maximal bladder distention allows the urinary bladder to be rapidly and forcefully compressed, creating sufficient intravesicular pressure to evacuate uroliths. For most dogs, we fill the urinary bladder with an 8 french, flexible rubber catheter inserted in the urethra. We achieve maximal distention by palpating the urinary bladder during filling. Sometimes we continue to fill the bladder until fluid begins to leak around the catheter. When this occurs, we often have to pinch the vulva or prepuce between our thumb and forefinger to occlude the distal urethra to maintain maximal bladder distention even after the catheter has been removed from the urethra.

If a Urolith is Obstructing the Urethra, is Voiding Urohydropropulsion Likely to be Effective

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Voiding urohydropropulsion is NOT likely to be effective in patients with uroliths lodged in the urethra at the time of diagnosis.

**Can Voiding Urohydropropulsion be Performed Successfully in Male Cats**

The success of voiding urohydropropulsion is not dependent on whether patients are male or female, but whether uroliths are sufficiently size to pass through urethral lumens. Because the diameter of the urethra in male cats is extremely small, voiding urohydropropulsion should not be performed unless the cat has a perineal urethroscopy.

**What Should I do 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 urohydropropulsion. However, if the urinary bladder is still distended with the fluid, retrograde urohydropropulsion may be difficult. 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 decompressive cystocentesis.

**If I have Never Performed Voiding Urohydropropulsion, How do I Get Started**

To help minimize the anxiety associated with a new technique, perform voiding urohydropropulsion on a dog that you have scheduled for cystotomy. For your first attempt, select a patient, that in all probability, is likely to result in a successful outcome. In other words, choose a medium size, female dog with relatively smooth uroliths equal to or less than 5mm in diameter. The patient is sedated just as if a cystotomy is going to be performed. However, first try voiding urohydropropulsion. If you have difficulty catheterizing the urethra, feel uncomfortable maximally distending the urinary bladder with fluid or are unsuccessful at removing all uroliths, the patient is already prepared for surgery. In fact, even if you rupture the urinary bladder, which is not likely, you are prepared to surgically repair the tear.

**Table 1. PERFORMING VOIDING UROHYDROPROPULSION**

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
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<tbody>
<tr>
<td>1</td>
<td>Anesthetize the patient.</td>
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<tr>
<td>2</td>
<td>Distend the bladder with a sterile physiologic solution injected through a transurethral catheter.</td>
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<tr>
<td>3</td>
<td>Remove the catheter. If fluid is expelled prematurely, the vulva and/or urethra can be gently pinched closed using your thumb and first finger.</td>
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<tr>
<td>4</td>
<td>Position the patient so that the vertebral column is approximately vertical.</td>
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<tr>
<td>5</td>
<td>Gently agitate the urinary bladder by palpation to promote gravitational movement of all urocystoliths into the neck of the bladder.</td>
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<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.</td>
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</table>
CATHETER RETRIEVAL OF UROLITHS

Catheter retrieval of uroliths was previously described to remove a few uroliths for quantitative analysis. This technique can also be used to remove all uroliths if their size permits passage through urethral catheters. Catheter retrieval of uroliths is suitable for patients at high risk for anesthesia related morbidity and mortality because it is easily performed in conscious animals. Following urolith retrieval, double contrast cystography should be performed to assess urolith status. To minimize catheter induced bacterial urinary tract infection, antimicrobial therapy should be considered immediately before and for an appropriate duration after catheter urolith retrieval.

| Step 1 | Select the largest catheter that can be easily inserted into the urethra. We commonly use sterile, 8fr diameter or larger catheters. Often the distal tip is smoothly cut off so that the catheter is open ended. |
| Step 2 | With the patient in lateral recumbency, a well lubricated, sterile catheter is advanced through the urethra into the bladder lumen. |
| Step 3 | If the urinary bladder is not distended with urine, it should be moderately distended with physiologic saline (insert A). |
| Step 4 | While aspirating urine (or saline) vigorously and repeatedly move the animals abdomen (i.e. urinary bladder) up and down. This maneuver will disperse uroliths throughout fluid in the bladder lumen. Small uroliths in the vicinity of the catheter tip are usually sucked into the catheter along with the urine-saline mixture (inserts B & C). |
| Step 5 | It may be necessary to repeat this sequence of steps several times before a sufficient quantity of uroliths are retrieved. Difficulty in aspirating the urine-saline solution may be caused by poor catheter position (position catheter tip in trigone of bladder) or occlusion of the catheter lumen with uroliths (forcing fluid back through the catheter should clear catheter lumen). |

HOW CAN MICROWAVES BE USED TO STERILIZE URINARY CATHETERS?

Douglas et al published a technique entitled, "Microwave: Practical Cost-Effective Method for Sterilizing Urinary Catheters In The Home" (Urology 35: 219. 1990). Basically, the technique involved placing flexible urinary catheters in reusable Ziploc freezer bags and placing them in a microwave oven. Along with the catheter, a beaker with water must be placed in the oven to absorb excessive heat. The microwave oven was set at 12 minutes (high power). The authors emphasized the need to avoid "cold areas" in the microwave oven.

We recommend that this procedure be validated with each hospital's microwave before using it to sterilize urinary catheters. This may be accomplished by culturing contaminated urinary catheters for bacteria before and after microwaving them.

FORCEPS BIOPSY OF THE LOWER URINARY TRACT

Differentiation of potentially reversible disease from progressive irreversible disease is the single most important factor in the management of persistent or recurrent
lower urinary tract signs. Biopsy of the urinary bladder and urethra is helpful to make this distinction in the living patient. Many options are available to obtain tissue for microscopic evaluation. If structures to be biopsied can be palpated, they are accessible for aspiration with a needle and syringe. If larger, architecturally intact samples are desired, they can be obtained by catheter biopsy (Osborne 1995), cystoscopy and pinch biopsy (Senior 1995), or celiotomy and core resection. A practical alternative to these procedures is use of flexible endoscopy forceps to retrieve tissue samples from the lower urinary tract.

**MATERIALS NEEDED FOR BIOPSY**

Flexible endoscope forceps (not the endoscope) is inserted into the urethra to obtain tissue samples. Several types of grasping units on the end of the forceps are available. We have had the best results using forceps with a fenestrated oval cup and central needle. The fenestrated cup minimizes tissue crushing and the central needle helps anchor the grasping unit to the mucosa that is to be sampled.

No other special equipment is required. However, additional routine supplies would include those needed to assist catheterization in the female dog (e.g. otoscope) and the desired fixative for histologic processing of the sample (e.g. 10% buffered formalin).

**PERFORMING FORCEPS BIOPSY**

Obtaining tissue samples using the endoscopy forceps is similar to methods used to obtain gastrointestinal mucosal with an endoscope. Since the endoscope is not inserted into the urethra, other methods, such as palpation or radiography, are needed to localize the lesion and direct the biopsy forceps.

1. Allow the patient to void urine prior to biopsy. If micturition is difficult due to partial or complete obstruction, urine can be removed by transurethral catheterization or decompressive cystocentesis. An empty bladder will facilitate patient comfort and cooperation.

2. Sedate or anesthetize the patient. For many dogs general anesthesia is not needed. However, mild tranquilization may facilitate urethral catheterization, palpation of the urethra and bladder, and will minimize patient discomfort and anxiety. In lieu of generalized sedation, local anesthesia can be achieved by applying water soluble lubricants containing lidocaine to the vaginal mucosa and/or urethra. To anesthetize urethral mucosa, the same lubricant can be applied to the biopsy forceps prior to urethral insertion or it can be diluted and injected into the urethral lumen through a catheter. It has been our experience that most cats usually require general sedation to manipulate and catheterize their urethra.

3. Identify the site for biopsy by palpation, catheterization and/or radiography.

4. With the grasping unit at the end of the forceps closed, insert the flexible endoscopy forceps (not the endoscope) into the urethra.

5. Advance the forceps until the grasping unit is near the area to be biopsied. The tip of the grasping unit can be positioned by abdominal palpation, rectal palpation, radiography or ultrasonography. For most urethral lesions, the biopsy site is easily determined during insertion and advancement of the forceps through the urethral lumen; increased friction and force is often required to advance the
forceps at the biopsy site. The biopsy site can also be located by using previous radiograms to determine how far the forceps must be inserted into the urethral lumen to reach the lesion. For diffuse urothelial lesions the apex of the bladder can be sampled by advancing the forceps to the most cranial portion of the bladder. Positioning the forceps fluoroscopically, immediately following contrast urethrocystography is also an effective method of positioning the biopsy instrument adjacent to the lesion.

6. After the biopsy forceps is properly positioned, open the grasping unit and slightly advance the forceps against the lesion.

7. Close the grasping unit. With the grasping unit closed, the forceps and tissue sample are retracted from the urinary tract.

8. The biopsy sample can be removed from the forceps by lifting the sample from the cup of the grasping unit with a 22 or 25 gauge needle. The sample should then be transferred to formalin for histologic processing.

9. Impression smears for immediate cytologic evaluation can be made prior to placing the sample in formalin. Tissue samples are first lightly blotted on filter paper or dry gauze pads to remove surface blood. Then impressions are be made on glass slides and stained prior to microscopic evaluation.

10. Several samples should be retrieved to insure complete representation of the area in question.

**PATIENT CARE FOLLOWING BIOPSY**

Following bladder biopsy, hematuria and dysuria may be more pronounced. In most cases, bleeding quickly stabilizes (hours to a day) without treatment. Administration of antibiotics is indicated because the integrity of the mucosal surface of the lower urinary tract is damaged by this procedure, further altering normal host defenses. Infections diagnosed during initial evaluation should be eradicated prior to biopsy. Eliminating infection prior to biopsy will minimize hematuria and dysuria associated with sampling of inflamed tissues and also the potential of extending the infection into the biopsy site and adjacent tissues. In the absence of prior infection, we routinely administer antibiotics orally for the next 3 to 5 days.

**LIMITATIONS OF FORCEPS BIOPSY**

Standard flexible biopsy forceps are no larger in diameter than an 8 french catheter. As a general rule, you should be able to insert the biopsy forceps into the urethral lumen of most male dogs greater than 4 kilograms, and into the urethral lumen of most, if not all, female cats and dogs. The lumen of the penile urethra of male cats is usually too small to accommodate insertion of standard flexible biopsy forceps. However, the urethra of male cats following perineal urethrostomies usually is large enough to accommodate insertion of standard biopsy forceps.

It is possible that a thin or weakened bladder wall could be perforated by this procedure. For this reason we do not recommend biopsy of the lower urinary tract at sites proximal to partial or complete obstruction because increases in intravesicular pressure may result in extravasation of urine into the abdominal cavity. If a tissue sample proximal to a urinary obstruction is desired, constant bladder evacuation by means of indwelling urethral catheterization or antepubic percutaneous catheterization
(Stone 1992) of the urinary bladder should be considered. Minimizing intravesicular pressure should allow small perforations of the bladder wall to spontaneously heal.

Although forceps biopsy is ideal for obtaining samples from the urethra, trigone, and apex of the urinary bladder, directing the flexible forceps to obtain samples from the lateral wall of the urinary bladder requires patience and skill. Use of biopsy forceps with a central needle may help secure samples from this location.

**Techniques to remove urethral plugs from male cats**

1. Perform appropriate diagnostics (medical imaging) to insure that other causes of urethral obstruction have been eliminated (e.g. uroliths, cancer, stricture).
2. Insure that patient is suitably prepared for anesthesia (e.g. normothermic, normotensive, normokalemic, etc.)
3. Administer appropriate and sufficient anesthesia to abolish urethral pain and facilitate urethra manipulation
4. Make every effort to protect the patient from iatrogenic complications associated with urethral catheterization (infection, trauma).

**Normograde evacuation of plug**

1. Exteriorize the penis and massage the urethral with the goal of disrupting the continuing of the urethral plug
2. Provide steady, but not excessive pressure on the urinary bladder to evacuate the plug. Excessive pressure should not be used because it may result in trauma to the bladder wall, reflux of potentially infected urine into the ureters, and/or rupture of the bladder wall.
3. Submit plug for quantitative mineral analysis and histopathologic evaluation.

**Normograde evacuation of plug following reverse flushing of fluid**

1. Exteriorize the penis and massage the urethral with the goal of disrupting the continuing of the urethral plug
2. Select and olive tip urethral catheter for initial urethral catheterization. Attach catheter to an intravenous collection set and syringe filled with normal saline. Evacuate air form the line by flushing the system with the saline from the syringe.
3. Before inserting the catheter, stretch the exteriorized penis caudally and dorsally (i.e. parallel with the spine).
4. Without using excessive force, advance the catheter to the site of obstruction.
5. Flush large quantities (40 to 60 mls) of physiologic saline into the urethral lumen allowing it to reflux out of the external urethral orifice. As the plug is disrupted, the catheter can be advanced toward the urinary bladder.
6. Apply steady, but gentle digital pressure to the bladder wall attempting to expel the urethral plug out of the external urethral orifice. Excessive pressure should not be used because it may result in trauma to the bladder wall, reflux of potentially infected urine into the ureters, and/or rupture of the bladder wall.
7. Submit plug for quantitative mineral analysis and histopathologic evaluation.

**Retrograde flushing of the urethral plug**
1. Attempting normograde evacuation of plug using reverse flushing techniques (see above) is likely to facilitate retrograde movement of urethral plugs into the urinary bladder.
2. If the bladder is even moderately over-distended perform decompressive cystocentesis using a 22gauge, 1.5 inch needle attached to an intravenous collection set, three-way stop cock and syringe.
3. Select a short olive-tip urethral catheter. Attach catheter to an intravenous collection set and syringe filled with normal saline. Evacuate air from the line by flushing the system with the saline from the syringe.
4. Before inserting the catheter, stretch the exteriorized penis caudally and dorsally (i.e. parallel with the spine).
5. With the catheter in place, occlude the urethra around the catheter shaft using your finger and thumb. Placing a moistened gauze pad between the urethra and your fingers may minimize trauma to the surface of the urethra. By preventing reflux of solutions out of the external urethral orifice, this maneuver tends to dilate the urethra and advance the plug into the urinary bladder.
6. Stretch the urethra caudally as physiologic saline is flushed (the volume should not exceed the capacity of the bladder, i.e. approximately 10 to 30mls).