New Alternatives for Minimally Invasive Management of Uroliths: Lower Urinary Tract Uroliths

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Abstract: In small animals, removal is indicated for lower urinary tract calculi that are not amenable to medical dissolution and are causing, or may cause, urinary tract obstruction, inflammation, or recurrent infection. Surgical removal of lower urinary tract uroliths by cystotomy or urethrotomy has been the traditional method. The current standard of care for human urinary tract stones involves the use of lithotripsy and is minimally invasive. This article reviews the current literature on the various minimally invasive options available for managing lower urinary tract stones in small animal veterinary patients. Options for managing nephroliths and ureteroliths will be presented in forthcoming companion articles.

Lower urinary tract calculi should be removed if they are not amenable to medical dissolution and if they are causing, or may cause, urinary tract obstruction, inflammation, or recurrent infection. In small animals, surgical removal of uroliths by cystotomy or urethrotomy has been the traditional method of choice. In a 1992 study, calculi remained in the bladder after cystotomy in 10% of dogs and 20% of cats. In a larger, more recent study, removal of uroliths was incomplete in 20% of dogs after cystotomy. Postoperative radiography of the entire urethra is indicated to ensure that all calculi have been removed. A 2008 study reported that 9.4% of recurrent stones in dogs were suture induced, indicating that cystotomy could increase the risk of stone formation. More recently, complications associated with traditional surgical cystotomy, regardless of closure method, were reported in 37% to 50% of cases, with a mean duration of hospitalization of 4 days. Ideally, less-invasive alternatives with fewer complications, fewer long-term stone recurrences, more effective stone removal, and shorter hospitalization times should be sought.

In humans, minimally invasive treatment options have mostly replaced traditional surgical stone removal, which is associated with a high recurrence rate of calculi, the need for serial surgeries that can lead to suture-induced stones, strictures, adhesions, bleeding, uroabdomen, pain, and other, life-threatening complications.

In small animals, minimally invasive treatment options for lower urinary tract stones consist of voiding urohydropropulsion (VUH), intracorporeal lithotripsy, extracorporeal shock-wave lithotripsy (ESWL), cystoscopic stone basket retrieval, percutaneous cystolithotomy (PCCL), and laparoscopic-assisted cystotomy. Ideally, all minimally invasive stone retrieval procedures should be performed after a negative urine culture has been documented or the patient has been receiving an appropriate antibiotic for at least 24 hours.

Voiding Urohydropropulsion
VUH consists of removing small bladder calculi by inducing voiding while the dog or cat is positioned vertically or laterally. This procedure was described by Lulich et al. It can be successfully performed in male or female dogs and female cats. It is not recommended in male cats, in which the narrow urethra may become obstructed by the stones.
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Stone size is the most important criterion in deciding if VUH is an appropriate treatment option. Stones <3 mm and <4 mm can typically be voided by tiny (≤2 kg [≤4.4 lb]) and small to medium-sized (2 to 5 kg [4.4 to 11 lb]) female dogs, respectively. Female cats may be able to void stones <3 mm. Male dogs weighing 5 to 10 kg (11 to 22 lb) may be able to void stones <2 to 3 mm, and male dogs of 10 to 25 kg (22 to 55 lb) can typically void stones <3 mm. Before attempting VUH, clinicians should try to catheterize the urethra first to evaluate its size. If a 9-Fr urinary catheter can be passed through the urethra, 3-mm stones should be able to be voided.

For VUH, the patient is placed under general anesthesia. The urethra is catheterized and the bladder distended with saline. The urinary catheter is then removed and the patient positioned vertically. The bladder is agitated so that gravity causes the stones to fall into the trigone. Bladder palpation increases intravesicular pressure and helps maintain a strong urine stream as small stone fragments are voided. General anesthesia is mandatory for this procedure, and the bladder can rupture if the patient does not have a relaxed, unobstructed urethra. The procedure is repeated until no calculi or stone fragments are passed. Radiography, with or without positive or negative contrast, or cystoscopy can be performed after the procedure to confirm complete urolith removal. VUH can also be used to obtain a few small stones for analysis to determine whether medical dissolution is an option. In our experience, using cystoscopy rather than digital urethral catheterization for bladder filling in female dogs and cats can be very helpful. Empiric antibiotics should be given during the procedure and for 3 to 5 days afterward. Broad-spectrum antibiotics such as ampicillin or cephalaxin are usually prescribed. To minimize discomfort during urination, NSAIDs or opioids are administered for 1 to 4 days as needed and based on clinical signs.

Intracorporeal Lithotripsy

Methods

Electrohydraulic lithotripsy (EHL) and laser lithotripsy were developed in the 1970s to fragment bladder uroliths in humans, and the overall success rate in humans is reported to exceed 90%. In veterinary medicine, laser lithotripsy has been reported for the treatment of bladder and urethral stones in dogs, goats, horses, and rabbits. Two types of intracorporeal lithotripsy have been described in veterinary patients: laser lithotripsy and EHL.

To date, the recommended laser for intracorporeal lithotripsy is the Ho:YAG laser. This laser is the most commonly used device for intracorporeal lithotripsy in veterinary and human medicine (FIGURE 1). It uses an active-medium crystal made of yttrium, aluminum, and garnet (YAG) mixed with holmium (chromium and thulium). The Ho:YAG laser emits light at an infrared wavelength of 2100 nm.

For lithotripsy using a Ho:YAG laser, the patient is placed under general anesthesia for routine cystoscopy. Once the urolith is visualized with the cystoscope, a small-diameter, flexible quartz laser fiber (200, 365, or 550 μm) is guided through the working channel of a small-diameter flexible or rigid cystoscope/ureteroscope (FIGURE 2). The tip of the fiber is placed in direct contact with the surface of the urolith at a 90° angle, and pulsed laser energy is transmitted from the energized crystal to the urolith via the fiber. The stone is fragmented by a thermal drilling process, in which the pulse of energy traveling through the fiber creates a microscopic vapor bubble on the surface of the calculus. This microscopic “parting” of the fluid medium by an air bubble (known as the Moses effect).
allows more of the laser’s energy to be transmitted directly into the stone, creating a shock wave that induces stone fragmentation.\textsuperscript{10}

If the fiber tip is 1 mm or more away from the stone, the vapor bubble collapses, the water or saline absorbs the energy, and no energy is transmitted to the urolith.\textsuperscript{10} As the fiber tip is advanced to within 0.5 mm of the calculus, the vapor bubble comes in contact with the stone. The closer the fiber tip is to the target, the larger the effect, with the greatest effect achieved when the fiber is in contact with the stone. The energy is absorbed in <0.5 mm of fluid, making it safe to fragment uroliths in tight locations, such as within the urethra, ureter, renal pelvis, or urinary bladder, with limited risk of adjacent urothelial damage.\textsuperscript{26}

The choice of power setting is based on the application. For stone fragmentation, the initial energy setting should be approximately 0.6 to 0.8 J at 6 to 8 Hz. Energy settings can be increased as desired, but levels higher than 1 J and 12 Hz are rarely required to fragment stones in dogs and cats.\textsuperscript{10} Stones are typically fragmented until the pieces are small enough to be voided using VUH or manually extracted from the bladder using a stone retrieval basket. This technology is considered the standard of care in human medicine and is currently being utilized for lower urinary tract stones in many veterinary hospitals in North America (\textbf{BOX 1}).

EHL is slightly different. This technology causes an electric spark to be generated in a fluid medium, creating a cavitation bubble that generates a hydraulic shock wave.\textsuperscript{27,28} This shock wave disrupts the crystal lattice structure of the urolith via shearing forces.\textsuperscript{27} Since the bladder is constantly irrigated with saline during the procedure, EHL can be done during cystoscopy. The probe is directed toward the urolith, and the stone absorbs most of the energy. Calculi are fragmented into pieces that are smaller than the urethral diameter for endoscopic retrieval (\textbf{FIGURE 3}), typically using a stone-retrieval basket.

\textbf{Effectiveness}

The Ho:YAG laser has been reported to be effective on all stone types.\textsuperscript{29} One in vitro study\textsuperscript{26} demonstrated that the Ho:YAG laser consistently fragmented canine stones of all types (calcium oxalate, cystine, struvite, silica, and urate) into extractable fragments (<3.5 mm in diameter) in <30 seconds. Davidson et al\textsuperscript{14} first described using the Ho:YAG laser to fragment uroliths that were surgically implanted at the base of the os penis in healthy dogs, showing that laser lithotripsy could successfully fragment obstructive uroliths in male dogs. More recently, Adams et al\textsuperscript{17} reported that laser lithotripsy was effective in the fragmentation of bladder and urethral stones in 73 dogs in a clinical setting. In this study, a basket was used to move smaller bladder stones to the urethra before fragmentation to minimize their movement during lithotripsy. This technique resulted in complete fragmentation of all uroliths in 100% of females (28 of 28 dogs) and 86.7% of males (39 of 45 dogs).\textsuperscript{17} Grant et al\textsuperscript{16} performed a prospective clinical study in which 25 dogs were treated by laser lithotripsy for bladder and/or urethral stones. Twenty dogs (80%) were considered stone free after the procedure. In the literature, complete urolith removal is typically achieved in 100% of dogs with urethroliths, 83% to 96% of female dogs with cystoliths, and 68% to 81% of male dogs with cystoliths.\textsuperscript{10,16,17}

The median procedure time has been reported to be shorter for dogs in which intracorporeal lithotripsy was performed only in the urethra compared with dogs in which uroliths were fragmented in the bladder.\textsuperscript{15} In the abovementioned study in 73 dogs,\textsuperscript{17} Adams et al reported that the median procedure time was shorter for dogs with urethral stones only (median: 70 min; range: 35 to 180 min) than for dogs with bladder stones (median: 105 min; range: 35 to 382 min). Grant et al reported that the procedure time was longer for males (median: 143 min) than for females (median: 42 min).\textsuperscript{16}

In the Adams et al study, the complication rate reported with laser lithotripsy was 17.9% in female dogs and 13.3% in male dogs.\textsuperscript{17} These rates are lower than those reported for traditional surgical cystotomy (37% to 50%).\textsuperscript{4} Complications reported by Adams et al were typically minor and short term, including urethral swelling, edema, and mild hematuria, which were medically managed. Short-term complications were most commonly related to urethral mucosal swelling from serial passage of the cystoscope in female dogs and resolved with the placement of an indwelling urinary catheter for 12 to 24 hours.\textsuperscript{10,16,17} One major complication was bladder perforation by the laser fiber, which healed within 24 hours of urinary catheterization. This complication was reported in only one study.\textsuperscript{17} No long-term complications were reported in this study.\textsuperscript{17}

In one canine study in which laser lithotripsy was retrospectively compared with traditional cystotomy,\textsuperscript{11} major (i.e., wound dehiscence, urethral obstruction, bladder rupture, and urethral perforation) and minor complications (i.e., hypothermia and hypertension) were recorded for each dog. There were no significant differences between the groups with regard to any of the evaluated complications. Both methods were considered equally effective;
treatment failure was defined as incomplete removal of uroliths >3 mm in diameter. The complete urolith removal rate was not significantly different between dogs in the cystotomy group (86%) and those in the lithotripsy group (89%). On average, it took 23 minutes longer to manage urinary stones using lithotripsy than using cystotomy.31 Patients undergoing lithotripsy were discharged from the hospital 12 hours earlier than those having a cystotomy.31 In the Grant et al study of 25 dogs,16 84% (21/25) of dogs receiving lithotripsy were discharged the day of the procedure. Adams et al17 reported that of 73 dogs with uroliths treated by laser lithotripsy, only 19% (14/73) had stone recurrence after approximately 12 to 24 months of follow-up, which is significantly less than that previously reported with cystotomy (42%).32

A prospective clinical study of 28 dogs undergoing EHL demonstrated that intracorporeal lithotripsy using EHL was also effective for treating lower urinary tract calculi in dogs.15 EHL was most effective in female dogs with bladder stones and male dogs with urethral stones. EHL appeared to be as safe as laser lithotripsy and was associated with no major complications. Dogs treated for urethral stones did not typically show any signs of stranguria after the procedure.15

Laser lithotripsy appears to be more efficient, particularly for male dogs, than EHL. Although laser lithotripsy is considered to be safer than EHL in confined spaces, such as the ureter and urethra, repeated pulses on the urothelium can cause perforation.33 Laser lithotripsy may also break stones into smaller fragments than EHL15–17; however, no study has compared the two techniques. The greatest challenge of both laser and EHL lithotripsy is the removal of small stone fragments from the bladder after fragmentation. This challenge is accentuated in male dogs due to the length and smaller diameter of the urethra. Grant et al16 identified female sex as a positive predictor of success. They reported that smaller body weight, large urolith burden, and increasing urolith size significantly increased the time required to perform laser lithotripsy. This has made the use of other procedures, like PCCL, appealing for dogs with a large bladder stone burden. Patient and urolith characteristics that affect EHL and Ho:YAG laser lithotripsy are summarized in Table 1; guidelines for improving the effectiveness of intracorporeal lithotripsy are listed in Box 2.

### Extracorporeal Shock-Wave Lithotripsy

ESWL is a minimally invasive procedure that uses an external unit to create shock waves that pass through the soft tissue of the patient. It is typically used for the removal of upper urinary tract calculi from a renal pelvis or ureter. It has also been used to fragment bladder stones in some dogs.27 However, the movement of stones inside the bladder during treatment limits the repeated shock-wave effect and may result in larger-than-desired fragments.10,27,34 After ESWL for bladder stones, VUH or use of a cystoscopic stone basket is still required for stone fragment removal. Typically, intracorporeal methods are preferred for optimal fragmentation and immediate removal of cystoliths.15 ESWL is offered at a few veterinary facilities in the United States (Box 3). This technique will be described in more detail in a forthcoming companion article.

### Cystoscopy-Guided Basket Retrieval

Another option for stones that are too large for VUH but small enough to fit down the urethra with gentle traction is stone basket retrieval.35 A variety of stone baskets are available from several

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**Table 1. Ideal Candidates for Intracorporeal Lithotripsy of the Lower Urinary Tract**

<table>
<thead>
<tr>
<th>Patient characteristics&lt;sup&gt;a&lt;/sup&gt;</th>
<th>EHL</th>
<th>Ho:YAG lithotripsy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female dog or any size cat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male dog ≥7 kg (≥15.4 lb)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Females easier than males</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Stone characteristics related to ease of fragmentation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Struvite more difficult to break</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All types of stones easy to break</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shape</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irregular easier to break than smooth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All shapes of stones easy to break</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urethral stones easier than bladder stones</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Number</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5 stones for males</td>
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</tr>
</tbody>
</table>

**Legend:**

- EHL = electrohydraulic lithotripsy, Ho:YAG = holmium: yttrium, aluminum, and garnet.
- Based on author experience.
- Endoscopy done with a 1.9-mm rigid cystoscope or 7.5-Fr flexible ureteroscope.

**Box 2. Guidelines to Improve Effectiveness of Intracorporeal Lithotripsy**

**To improve visibility:**
- Use a large cystoscopic working channel for better irrigation
- Use a 30° angled scope for better visualization
- If possible, flush with cold saline to minimize bleeding (monitor patient’s body temperature)

**To improve fragmentation:**
- Use a stone retrieval basket to remove stones from the bladder and bring them into the urethra for fragmentation in male dogs

**To improve expulsion of stone fragments:**
- Use a stone retrieval basket to remove stone fragments
- Place patient in dorsal recumbency at a 45° angle for stones to settle in trigone
Box 3. Hospitals Equipped for Extracorporeal Shock-Wave Lithotripsy

<table>
<thead>
<tr>
<th>The Animal Medical Center</th>
<th>Purdue University School of Veterinary Medicine</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York, NY 10065</td>
<td>West Lafayette, IN 47906</td>
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<tr>
<td>Contact: Dr. Allyson Berent</td>
<td>Contact: Dr. Larry Adams</td>
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<td>E-mail: <a href="mailto:Allyson.Berent@AMCNY.org">Allyson.Berent@AMCNY.org</a></td>
<td>E-mail (Referral desk): <a href="mailto:PUSAH@purdue.edu">PUSAH@purdue.edu</a></td>
</tr>
<tr>
<td>Phone: 212-838-8100</td>
<td></td>
</tr>
</tbody>
</table>

Laparoscopic-Assisted Cystoscopy

Laparoscopic-assisted cystoscopy is performed via a minilaparotomy, the location of which is guided by visualization of the bladder through a laparoscopic abdominal portal placed just caudal to the umbilicus. In this technique, after the bladder is catheterized or aspirated to drain urine and the abdominal portal is placed, the abdomen is insufflated with carbon dioxide and the bladder is isolated. Another trocar is inserted into the abdomen at the level of the bladder apex, and the bladder is partially exteriorized at this access point, using a laparoscopic Babcock forceps. The incision is then enlarged creating a minilaparotomy. A small cystotomy is performed, and the bladder wall is sutured to the skin of the abdominal incision. A rigid cystoscope is then inserted into the bladder for calculus retrieval. The use of a basket passed through the working channel or a grasping forceps next to the cystoscope aids in stone removal. The cystotomy incision is closed routinely. We recommend using quickly absorbable suture (i.e., Monocryl, Ethicon, Somerville, NJ) because these patients are typically prone to recurrence of uroliths and the development of suture-induced stones. If the suture material penetrates the bladder mucosa, fast absorption is considered ideal. If concurrent infection is a concern, then longer-lasting suture (polydioxanone) is recommended.

Rawlings et al recommend retracting a portion of omentum to be sutured over the bladder incision with the traction sutures. Abdominal incisions should be closed with separate layers of sutures placed into the linea alba, abdominal musculature, subcutaneous tissue, and skin.

Laparoscopic-assisted cystoscopy can circumvent some of the limitations associated with laser lithotripsy, but it does require creating a pneumoperitoneum. In humans, this procedure has been associated with postoperative discomfort, respiratory compromise, and decreased renal and splanchnic perfusion.

Conclusion

Intracorporeal lithotripsy appears to be an effective and safe minimally invasive method of treating spontaneously occurring lower urinary tract stones in dogs and cats. Small male dogs and male cats are more difficult to treat; therefore, newer minimally invasive procedures, like PCCL or laparoscopic-assisted cystoscopy, are attractive options, especially in patients with large stone burdens.

Minimally invasive management of urolithiasis in veterinary medicine is following the trend seen in human medicine. Over the past 10 years, the veterinary community has made great strides in adapting the technology used for humans to be more applicable to small animal veterinary patients. Conditions that were traditionally considered major therapeutic dilemmas, such as ureteral obstructions, stone recurrence, and urethral obstructions, have now new, effective, and safe options.

References


Percutaneous Cystolithotomy

Use of a newer minimally invasive approach, PCCL, has been reported in 27 dogs and cats, with excellent complete stone removal rates (96%) and dramatically shorter procedure times (total procedure time: 40 to 75 min) than those seen with transurethral lithotripsy, regardless of patient sex, size, stone number, or species. PCCL can be an alternative in animals in which transurethral lithotripsy is a challenge (small male dogs, male dogs with a large stone burden, and male and female cats) or if lithotripsy is unavailable.

For this procedure, a single small incision (approximately 1 to 1.5 cm) is made in the abdominal cavity just over the apex of the bladder. Once the bladder is palpated digitally, a stay suture is used to hold the bladder up to the incision while a laparoscopic screw-tip cannula or port is inserted into the bladder at the apex. A small, rigid cystoscope is inserted through this port into the bladder, and stones are identified and removed with a stone-retrieval basket through the working channel of the cystoscope. The best visualization is achieved with a full bladder; therefore, we usually use surgical aspiration while flushing fluid into the bladder via a urinary catheter in the urethra. The bladder is typically not exteriorized. If the stones are very small, a suction device can be placed into the port and the stones can be flushed/suctioned out of the port in a retrograde manner. If the stones are larger than the port, they can either be fragmented by lithotripsy or manipulated through the small incision with the stone basket. Concurrent lithotripsy is rarely needed. After all calculi are removed from the bladder, the entire urethra is examined with a rigid cystoscope (female dogs) or a flexible ureteroscope (male dogs) to ensure that all fragments have been removed. A basket retrieval device can be used to remove any remaining urethral calculi through the working channel of the endoscope. In patients with embedded urethral stones, laser lithotripsy can be performed. PCCL can also be used to aid in gaining access to the ureters for diagnostic or therapeutic purposes and for resection of bladder polyps or diagnostic evaluation of the bladder and proximal urethra in dogs that are too small for retrograde cystoscopy.
34. Lane IF. Extracorporeal shock wave lithotripsy for canine and feline ureteroliths. Proc ACVIM 2005.
1. Intracorporeal lithotripsy involves which of the following mechanisms?
   a. delivering shock waves percutaneously to target a stone
   b. delivering laser energy directly to a stone
   c. using laparoscopic scissors to cut a stone in situ
   d. using ultrasonography to guide treatment

2. Which statement is false with regard to the use of extracorporeal shock-wave lithotripsy to treat urinary tract stones in dogs?
   a. It may be used to decrease the size of the stone and extract a fragment for analysis.
   b. It may be indicated for upper and lower urinary tract stones.
   c. It is the treatment of choice to fragment bladder stones in dogs.
   d. It is not as efficient as intracorporeal lithotripsy in fragmenting lower urinary tract stones that are more mobile than upper urinary tract stones.

3. Postoperative care for intracorporeal lithotripsy for bladder stones consists of which of the following therapies?
   a. placing an indwelling catheter for 2 days
   b. promoting diuresis for 48 hours
   c. administering analgesics and antibiotics
   d. placing a cystotomy tube

4. Which statement is true with regard to the use of lithotripsy in small animals?
   a. Intracorporeal methods are preferred for optimal fragmentation and immediate removal of cystoliths.
   b. Extracorporeal methods are preferred for optimal fragmentation and immediate removal of cystoliths.
   c. Extracorporeal methods are contraindicated in treating lower urinary tract stones.
   d. Sedation is sufficient to permit stone fragmentation.

5. Voiding urohydropulsion consists of
   a. flushing urethral stones back into the bladder with fluids injected through a urinary catheter.
   b. flushing bladder stones in the urethra with intravenous fluid boluses.
   c. removing small bladder calculi by inducing voiding while the dog or cat is positioned vertically or laterally.
   d. flushing bladder stones through a cystotomy tube into the urethra.

6. A male, neutered 3.5-kg (7.7 lb) Yorkshire terrier presents with five cystoliths ranging in size from 2 to 8 mm. Which technique is preferable for treatment?
   a. percutaneous cystolithotomy
   b. extracorporeal shock-wave lithotripsy
   c. cystotomy
   d. voiding urohydropulsion

7. With regard to Ho:YAG laser lithotripsy, which statement is false?
   a. It does not damage the urothelium as long as the tip of the probe is maintained ≥0.5 mm away from the mucosa.
   b. It is efficient in fragmenting all types of stones.
   c. It is efficient and safe for fragmenting bladder and urethral stones.
   d. It is contraindicated for urethral stones.

8. A 8-kg (17.6-lb) male dog presents with one 3-mm bladder urolith and several urethral stones. Which statement regarding treatment is true?
   a. Laser lithotripsy is contraindicated because the patient is male.
   b. Urethrotomy is indicated to remove the urethral stones.
   c. A rigid cystoscope can be used through a urethrotomy to fragment the stones.
   d. The use of a basket to bring the bladder urolith in the urethra can make the procedure easier because laser lithotripsy is easier in the urethra than in the bladder in male dogs.

9. Which statement is true with regard to intracorporeal lithotripsy for lower urinary tract stones?
   a. Removal of fragments is more difficult in females than in males.
   b. In males, bladder stones are easier to fragment and remove than urethral stones.
   c. In males, urethral stones are easier to fragment and remove than bladder stones.
   d. It is impossible to fragment calcium oxalate stones in dogs.

10. Which statement is true with regard to intracorporeal lithotripsy for cystoliths?
    a. Canine calcium oxalate uroliths are resistant to fragmentation by laser lithotripsy.
    b. The procedure takes more time in female dogs than in male dogs.
    c. The procedure requires general anesthesia.
    d. The procedure is contraindicated in male dogs.