Ruptured Bladder in Dogs and Cats

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Trauma to the urinary bladder is very common in veterinary patients. It often results in uroperitoneum, which is associated with severe metabolic and multisystemic disturbances that can be fatal if not treated appropriately. Blunt abdominal trauma and direct injury from pelvic fractures are the most common causes of bladder rupture in dogs. In cats, blunt abdominal trauma, injury during catheterization, and rupture during bladder palpation are the most common causes. Other reasons include urethral obstruction, erosive neoplastic lesions, and penetrating abdominal wounds. The bladder is the most common site of urinary tract trauma. The apex is most often the site of rupture, although any part of the bladder can be affected, especially when pelvic fracture is the culprit.

Patients with a ruptured bladder often do not show clinical signs immediately after injury. However, they become dehydrated and develop severe metabolic and electrolyte disturbances over the subsequent 24 to 48 hours. As urine accumulates in the peritoneal space, chemical peritonitis ensues; if the peritonitis is sterile, it is not immediately life-threatening but will cause abdominal pain and ileus.

Urine is hyperosmolar compared with extracellular fluid. This results in a net flux of fluid down concentration gradients that are established across the peritoneal membrane. Third-spacing of fluid in the peritoneal cavity in conjunction with decreased fluid intake and often increased losses through vomiting lead to severe dehydration. Hyperkalemia and azotemia develop as (1) potassium and urea from the peritoneal cavity equilibrate rapidly with extracellular fluid and (2) the reduced glomerular filtration rate decreases excretion of these small solutes through the kidneys. Metabolic acidosis often develops as a result of decreased excretion of hydrogen ions in urine and progressively worsening hypovolemic shock.

Rapid diagnosis of urinary tract injury is vital. Aggressive emergency management of associated metabolic abnormalities to stabilize the patient should be followed by definitive surgical repair in most cases. In cases where a preexisting urinary tract infection results in septic peritonitis, surgical intervention should occur without delay.

DIAGNOSTIC CRITERIA

Historical Information

Gender Predisposition

• Male dogs are predisposed to traumatic bladder rupture because the longer, less-distensible male urethra is better able to withstand elevated intravesicular pressure.
• There is no sex predisposition in cats.

KEY TO COSTS

$ indicates relative costs of any diagnostic and treatment regimens listed.
Age Predisposition
None. Cats and dogs of any age can be affected.

Breed Predisposition
There are no known breed predispositions.

Owner Observations
• Occurrence of a known traumatic event is often reported, although such incidents are not always observed by owners.
• Vomiting, anorexia, hematuria or stranguria, lethargy, and depression may be seen.
• As time passes, some owners may notice progressive abdominal distention.

Physical Examination Findings
• Lethargy.
• Anorexia.
• Dehydration.
• Abdominal pain.
• Ascites.
• Hypothermia.
• Other signs of traumatic injury.

Laboratory Findings
• Azotemia: Elevated blood urea nitrogen (normal range: 5–30 mg/dl [dogs]; 15–32 mg/dl [cats]) and creatinine (normal range: 0.7–1.8 mg/dl [dogs]; 1.0–2.0 mg/dl [cats]).
• Hyperkalemia: Potassium >4.9 mmol/L (normal range: 3.9–4.9 mmol/L [dogs]; 3.5–4.9 mmol/L [cats]).
• Metabolic acidosis: Decreased bicarbonate (normal range: 18.8–25.6 mmol/L [dogs]; 14.4–21.6 mmol/L [cats]).
• Hyperalbuminemia: Elevated albumin (normal range: 2.5–3.7 g/dl [dogs]; 2.4–3.8 g/dl [cats]).
• Increased hematocrit: >60.3% in dogs (normal range: 40.3% to 60.3%) or >48% in cats (normal range: 31.7% to 48%).
• Elevated neutrophil count: >14.4 × 10³/µl in dogs (normal range: 3.1–14.4 × 10³/µl) or >14 × 10³/µl in cats (normal range: 2.3–14 × 10³/µl).

Other Diagnostic Findings
Fluid Analysis $–$$
Samples of abdominal fluid can be obtained by abdominocentesis or diagnostic peritoneal lavage (see box at right).
• Physical analysis: The fluid recovered can be a transudate, modified transudate, or exudate, depending on the chronicity and whether concurrent sepsis is present.
• Biochemical analysis: Comparisons of creatinine and potassium concentrations in peritoneal fluid and serum are the most reliable tests for confirming uroabdomen in dogs and cats. Because of the large molecular size of creatinine, it diffuses only slowly across the peritoneum into the extracellular fluid. A significant gradient is established between abdominal fluid and serum, and detection of this gradient is a sensitive and specific test for uroabdomen. A similar gradient exists with potassium. When creatinine and potassium levels are slightly to markedly higher in abdominal fluid than in serum, the patient is very likely to have uroabdomen.

COLLECTION OF A PERITONEAL FLUID SAMPLE

Single-Site Abdominocentesis
• Animal is positioned in lateral recumbency.
• A 10 × 10–cm area is clipped and aseptically scrubbed along the ventral midline.
• A 20- or 22-gauge 1.5-inch needle on a 5- to 10-ml syringe is inserted at the level of the umbilicus. (Procedure can also be performed using a 1.5- to 2-inch 18- or 20-gauge over-the-needle catheter.)
• Using gentle aspiration, samples are collected for fluid analysis, cytology, and microbial culture and sensitivity testing.

Four-Quadrant Tap
• A four-quadrant tap is attempted if the single-site abdominocentesis process is unsuccessful.
• Procedure is repeated as described above, but four sites located in the right and left cranial and caudal quadrants of the abdomen are used.
• If one site yields a fluid sample, the other taps are abandoned.
• Samples are collected as described above.

Diagnostic Peritoneal Lavage
• This technique is performed if the above two methods fail to yield a sample and suspicion remains high.
• Most patients will require either sedation or local anesthetic before the catheter is inserted.
• Preparation for catheter placement is the same as for the other two techniques. An 18- to 20-gauge over-the-needle catheter with additional side holes cut into it is used.
• Using aseptic technique, the catheter is inserted into the peritoneal space just caudal to umbilicus in the dependent part of the ventral abdominal wall.
• The stylet is withdrawn once the catheter is inserted; if fluid flows, samples are collected.
• If no fluid is recovered, a sterile IV set should be attached and 10–20 ml/kg of warm saline solution infused.
• Once the fluid has been infused, the catheter is removed and the patient is rolled from side to side while the abdomen is gently massaged.
• Fluid samples should then be collected using the single-site or four-quadrant abdominocentesis procedure.
• Recovery of only a small portion of the fluid infused is to be expected.
concentrations in cases of uroabdomen are 5:1 in dogs and 2:1 in cats; reported mean ratios of abdominal fluid:serum potassium concentrations are 2.5:1 in dogs and 1.9:1 in cats.

Plain Abdominal Radiography

The bladder may or may not be visible in patients with bladder rupture because small leaks still allow some degree of bladder distention. Loss of abdominal detail caused by fluid accumulation will worsen over time. Evidence of an underlying cause (e.g., pelvic fractures, cystic or urethral calculi) may be obvious.

Contrast Radiography $–$$

Care should be taken administering contrast agents to dehydrated or azotemic patients because of the potential for renal insult. Patients should be fully stabilized before undergoing these studies. Positive-contrast retrograde urethrocystography is the contrast study of choice in patients with bladder rupture and should be the first radiographic study conducted. It is easy to conduct and, in most cases, allows confirmation of the diagnosis and location of the site of leakage in the lower urinary tract. Fluoroscopic visualization during contrast injection is helpful as it aids in early detection of the leakage site. If fluoroscopy is not available, plain radiography can confirm leakage, but dispersal of contrast material may somewhat obscure the origin of the leakage. If sufficient intravesicular pressure is not achieved during contrast injection, false-negative results may be seen, especially with small tears and in unusual cases in which the lesion has self-sealed. Because urine leakage from the upper urinary tract cannot be detected with retrograde urethrocystography, excretory urography should be performed, especially if no lesions were found during the first study. A description of radiographic techniques is provided in the box at left.

Abdominal Ultrasonography $–$$

Ultrasonographic examination should detect fluid accumulation in the peritoneal space and can be used to guide abdominocentesis. It may also help to identify underlying bladder pathology, calculi, and other possible causes of uroabdomen, such as renal, ureteral, and urethral lesions.

Exploratory Laparotomy

Surgical exploration of the abdominal cavity may play an important role in diagnosing uroabdomen, especially in situations in which fluid analysis has confirmed urine leakage but imaging studies could not verify the site of leakage. Preoperative knowledge of the site of leakage is invaluable information, however, and may avoid urinary tract discontinuity from being missed at surgery, especially when multiple injuries are present.

Summary of Diagnostic Criteria

- Evidence of contrast leakage from the urinary tract during positive-contrast retrograde urethrocystography.
- Laboratory evidence of azotemia, hyperkalemia, and metabolic acidosis in a patient with a known underlying predisposition, such as trauma, bladder pathology, or possible iatrogenic damage from a urinary tract intervention.
- Rapidly progressing clinical signs that may include vomiting, dehydration, abdominal distention, hematuria, and stranguria.
Diagnostic Differentials
- Leakage of urine from a location other than the bladder can usually be ruled out with contrast studies (e.g., retrograde urethrocystography, excretory urography) of the upper and lower urinary tract.
- Other causes of acute abdomen, such as ruptured vescus, pancreatitis, splenic neoplasia, torsion, and peritonitis, can usually be ruled out by abdominocentesis, radiography, and/or ultrasonography.
- Caution: Urinary tract injuries detected via radiographic contrast studies or ultrasonography may not be the only sites of injury. The entire urinary tract and other abdominal organs should be imaged and/or examined at surgery.

TREATMENT RECOMMENDATIONS
- The goal of initial treatment is to stabilize the patient for surgery. Principal areas of concern are azotemia, electrolyte and acid–base disorders, and cardiac arrhythmias caused by severe hyperkalemia.
- Drainage of urine from the abdomen is the second most important step. This can be achieved through placement of a peritoneal lavage catheter or at exploratory surgery if the patient is rapidly stabilized. Use of an indwelling urethral catheter or tube cystostomy is helpful in decreasing the amount of urine entering the peritoneal space from the bladder.
- Surgical management is ultimately required in most cases. However, uroabdomen is a medical—not surgical—emergency, and patients undergoing surgery before they have been adequately stabilized are likely to experience perioperative complications.

Initial Treatment
Initial Patient Stabilization
Intravenous Fluid Therapy $^
Fluids should be administered as soon as the patient is admitted for treatment. An isotonic saline solution (0.9% NaCl) is the fluid of choice. Volume of fluid given varies based on the degree of hypovolemia, ongoing losses, and the patient’s maintenance needs.

Treatment of Hyperkalemia $^
Fluid diuresis alone often resolves mild hyperkalemia. More severe hyperkalemia (potassium >7mEq/L) may be associated with cardiotoxicity, and specific treatment should be considered. Options for treatment include:
- Diuresis with 0.9% NaCl.
- Administration of calcium gluconate (0.5–1.0 ml/kg of a 10% solution given slowly over 5 to 10 minutes) while monitoring the electrocardiogram (ECG). This drug provides transient cardiac protection and is indicated in animals with ECG abnormalities associated with hyperkalemia; it does not actually remove excessive potassium ions from the extracellular space.
- Administration of regular insulin (0.5–1 IU/kg IV) followed by 50% dextrose solution (1–2 g/unit of insulin). The dextrose should be diluted to a 10% solution. Thereafter, IV isotonic saline solution enriched with 2.5% dextrose solution should be used.
- Sodium bicarbonate (1–2 mEq/kg IV slowly). This dose can be repeated if continued assessment of acid–base status is performed.

Cardiac Monitoring $^
Continuous ECG monitoring is recommended. Most cardiac abnormalities are related to hyperkalemia and will resolve once normokalemia is reestablished. Typical changes include absent or flattened P waves, prolongation of the P–R interval, widened QRS complexes, spiked T waves, and bradycardic arrhythmias. ECG abnormalities are not consistent, however, and it should not be assumed that hyperkalemia is absent if the ECG is normal or vice versa.

Analgesia $^
Pain relief should be instituted early because chemical peritonitis is very painful. Opioid analgesics, such as morphine (0.5–1 mg/kg IM or SC q4h), hydromorphone (0.05–0.1 mg/kg IM or IV q4h), or buprenorphine (5–15 µg/kg IV or IM q6h), are most commonly used.

Antibiotics $^
Antibiotics should be instituted if there is cytologic evidence of sepsis in the abdominal effusion and in any patient perioperatively. Samples for culture and sensitivity testing should be obtained by abdominocentesis or diagnostic peritoneal lavage before initiating antibiotic therapy; a first-generation cephalosporin (e.g., cefazolin, 20 mg/kg IV q8h) is an appropriate empirical choice.

Drainage of Urine from the Abdomen
Drainage of the effusion aids in the management of azotemia and electrolyte and acid–base disturbances and should be considered before surgery for patients in which stabilization time is prolonged or intercurrent injuries are likely to delay surgical treatment.

Peritoneal Dialysis Catheter $–$$^
Peritoneal dialysis catheters are commercially available, or fenestrated chest tubes can be used. The catheter is placed similarly as for diagnostic peritoneal lavage. A closed, sterile collection system is used to allow continuous drainage of the peritoneal cavity. The peritoneal membrane can be used as a dialyzing membrane in animals with severe azotemia or electrolyte disturbances. Fluid is instilled into the peritoneal cavity, left in place while equilibration of nitrogenous waste products and electrolytes occurs, and is then removed. A full description of peritoneal dialysis, which is used only rarely in the management of uroabdomen in small animals, is beyond the scope of this article.

Indwelling Urethral Catheter $^
Passage of an indwelling catheter will not allow recovery of urine from the peritoneal cavity but will recover most newly
produced urine from the bladder. Some authors have recommended placement of an indwelling catheter as the sole treatment for small bladder ruptures. The bladder will remain decompressed and may heal if the catheter can be maintained for several days. We generally elect to perform an exploratory laparotomy to examine all abdominal organs and perform a primary repair of the urinary tract injury whenever possible.

**Cystostomy Tube $–$$**

If placement of a urethral catheter is not possible, passage of a percutaneous cystostomy tube may aid drainage of urine from the bladder as well. This can be achieved using either a Malecot or locking-loop catheter placed with ultrasonographic or fluoroscopic guidance.

**Surgical Management $$$–$$$$**

An exploratory laparotomy should be performed. Any rents in the bladder are identified, and the area is debrided of necrotic or damaged tissue. The bladder is sutured with one or two layers of a monofilament absorbable suture material (such as 3-0 or 4-0 polydioxanone) in an appositional pattern. At the discretion of the surgeon, omental “wrapping” can be performed for extra security or a “serosal patch” can be created for greater reinforcement. Before closure, samples of effusion and/or bladder mucosa are collected for microbial culture and sensitivity testing, especially if a septic effusion is suspected. Copious lavage of the peritoneal cavity is performed, followed by routine abdominal closure. Lavage fluid should always be thoroughly suctioned from the abdomen before closure. If bladder wall integrity is of concern after surgery, an indwelling urethral catheter can be left in place for 24 to 48 hours to allow decompression but is not mandatory.

**Supportive Treatment**

**IV Fluid Therapy $**

After surgery, fluid therapy with an isotonic saline solution should be administered at 2 to 6 ml/kg/hr IV depending on the patient’s hydration status. This should be maintained until the patient can drink on its own.

**Antibiotic Therapy $–$$**

If the abdominal effusion was sterile, it is not necessary to continue antibiotic therapy beyond the intraoperative period. If septic effusion was detected, antibiotic therapy based on the results of culture and sensitivity testing should be continued for 7 to 10 days. Urine should be recultured 10 to 14 days after antibiotic treatment has ended to confirm that the infection has been cleared. If the infection remains, a 4-week course of antibiotic therapy should be instigated based on the results of new culture and sensitivity testing.

**Analgesia $**

Appropriate opioid analgesia (as discussed previously) should be continued for at least 48 hours after surgery. For analgesia beyond this period, NSAIDs should be used with caution in dogs with possible uremic gastritis and renal compromise. Alternatives are the use of transdermal fentanyl patches (see box below for dosing guidelines) or oral butorphanol (0.2 mg/kg PO bid–tid for 5–7 days).

**Gastric Protectants $**

Uremic gastritis may cause vomiting and ulceration. An H$_2$ receptor antagonist such as ranitidine (2 mg/kg IV tid), cimetidine (5–10 mg/kg IV tid), or famotidine (0.5 mg/kg PO sid) can be administered for 7 to 10 days. Sucralfate forms a barrier at the site of ulcerated areas and prevents further damage by pepsin, bile, or acid. It can be administered at a dose of 0.5 to 1 g PO tid for 7 to 10 days.

**Patient Monitoring**

- Repeat serum biochemical analysis should be performed after surgery to demonstrate resolution of azotemia, electrolyte imbalances, and acid–base abnormalities.
- Postsurgical urinary leakage is a potential complication and should be diagnosed promptly if it occurs. Failure to recover from surgery uneventfully, persistence of azotemia or hyperkalemia, and recurrence of abdominal distention should alert the clinician to a possible problem.
- Continuous ECG monitoring should be performed until complete resolution of all cardiac abnormalities.

**Home Management**

- Strict rest with short leash walks only should be enforced for the first 2 weeks to allow the laparotomy site to heal. Cats

**Fentanyl Patch Doses**

- Small dogs (<5 kg) and cats: 25–µg/hr patch should be half covered with tape (do not cut patch in half)
- For dogs weighing 5–10 kg: 25-µg patch
- For dogs weighing 10–20 kg: 50-µg patch
- For dogs weighing 20–30 kg: 75-µg patch
- For dogs weighing >30 kg: 100-µg patch
should be restricted to a small area of the home for 2 weeks to avoid excessive exercise, running, and jumping.

- Continued observation of urination is required to ensure resolution of hematuria and/or stranguria.
- Sutures should be removed after 7 to 10 days if the wound has healed uneventfully.
- Other home care instructions may be instituted based on management requirements of intercurrent injuries.

**Milestones/Recovery Time Frames**

- Azotemia and electrolyte abnormalities should begin to return to the reference range within 24 hours of surgery.
- Hematuria and/or stranguria should resolve within a few days after surgery.
- Patients should be eating and drinking on their own within 24 to 48 hours after surgery.

**Treatment Contraindications**

- When anesthesia and surgery are performed before patients are adequately stabilized, perioperative morbidity and/or mortality is likely to be increased.
- Nephrotoxic drugs (e.g., aminoglycosides, NSAIDs) are contraindicated in patients with hypovolemic shock and decreased renal perfusion.
- Corticosteroids are contraindicated in patients with septic peritonitis.
- Although self-sealing of rents in the bladder has been reported, it is unlikely to occur in most cases. Such a conservative approach in patients with demonstrated urinary leakage is not advised except for patients unable to tolerate anesthesia and surgery.

**PROGNOSIS**

In general, prognosis after bladder rupture is excellent if diagnosis and treatment are prompt.

**Favorable Criteria**

- Simple rents in the apex of the bladder are easy to close.
- Patients that are systemically stable before surgery and that can be promptly taken to surgery are likely to make an excellent recovery.

**Unfavorable Criteria**

- The prognosis is less favorable for patients in which bladder wall damage is extensive or in cases of rupture secondary to avascular necrosis of the bladder wall.
- Severe metabolic abnormalities prolong recovery and result in a less-favorable prognosis.
- Presence of septic peritoneal effusion adversely affects outcome.
- Significant delay in time to diagnosis and treatment adversely affects outcome.
- Severe intercurrent traumatic injury adversely affects outcome.
- The vasculature of the bladder is based on two paired vessel groups, the right and left caudal vesicular arteries and veins. Other collaterals are nonexistent. If these vessels are injured at the time of rupture or by iatrogenic intervention, bladder ischemia or necrosis will ensue.

**RECOMMENDED READING**


