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Abstract

Uroabdomen commonly results from blunt abdominal or vehicular trauma in veterinary patients. Diagnosis can be difficult in acute trauma cases due to nonspecific physical examination findings and metabolic derangements that lag behind the trauma. Stabilization for uroabdomen includes intravenous crystalloid therapy and temporary urinary diversion. Without recognition and initial medical stabilization, severe hyperkalemia, pH imbalances, azotemia, and arrhythmias can occur. Imaging aids in localizing the defect in the urinary tract before surgical intervention. Surgery is not considered an emergency if the patient can be medically stabilized. Prognosis is good following initial medical management and surgical correction.

EMERGENCY MEDICINE/CRITICAL CARE

Uroabdomen: Approach and Management

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Uroabdomen results from rupture of the urinary system and leakage of urine into the peritoneal cavity, the retroperitoneal cavity, or both. If the retroperitoneal cavity remains intact, damage to the kidney or upper- to midureter results in accumulation of urine within the retroperitoneal space. If the retroperitoneum is compromised, this will also lead to a uroperitoneum, or what is commonly referred to as a uroabdomen. Rupture of the distal ureters, bladder, and proximal urethra directly results in a uroabdomen. Uroabdomen is an emergent condition that causes marked metabolic and electrolyte disturbances that can lead to life-threatening systemic sequelae. Early identification of uroabdomen and medical management are essential to the successful outcome of these cases.

COMMON CAUSES OF UROABDOMEN

Although multiple causes of uroabdomen have been reported in cats and dogs, blunt and vehicular trauma remain the most common cause in both species.[1,2] A rapid rise in intraabdominal pressure from blunt trauma coupled with a distended bladder can lead to rupture of a thin bladder wall. Male dogs are at increased risk of

Take-Home Points

- Vehicular and blunt trauma are the most common causes of uroabdomen in cats and dogs.
- Common bloodwork abnormalities include azotemia, mild hyponatremia, hyperphosphatemia, hyperkalemia, and metabolic acidosis.
- A peritoneal fluid creatinine to peripheral blood creatinine ratio of >2:1 is diagnostic for uroabdomen.
- Acute management consists of intravenous fluid therapy, urinary diversion, and peritoneal drainage.
- Guidewire-inserted chest tubes can be used as abdominal drains as they are simple to place and require minimal, if any, sedation.
- Imaging can be considered before surgery to identify the source of the uroabdomen.
- Surgical management is indicated in many cases but should be delayed until electrolyte derangements and azotemia have been corrected.
- Patients with urosepsis may require more urgent surgical intervention for stabilization.
- Medical management alone may be considered in a select group of uroabdomen cases.

Male dogs are at increased risk of uroabdomen due to their long, narrow urethra that cannot adapt to a rapid rise in bladder pressure.[3]

uroabdomen due to their long, narrow urethra that cannot adapt to a rapid rise in bladder pressure.[3] Intraabdominal injuries such as urinary bladder or urethral tearing are common in animals with traumatic pelvic fractures.[4,5] Kidney and ureteral injury secondary to blunt or penetrating trauma have been reported but are less common than urinary bladder rupture.[6]

Other causes of uroabdomen include mechanical obstruction, neoplastic invasion, or iatrogenic trauma. A recent study looking at 53 cats with uroabdomen found that urethral obstruction resulted in uroabdomen in 21% of cats, while 23% of cats had uroabdomen due to iatrogenic trauma from cystocentesis, catheterization, and bladder expression.[2] Similarly, a study in dogs found that obstruction resulted in uroabdomen in 21% of cases, and 16% of cases had uroabdomen due to iatrogenic causes.[1] Distal traumatic urethral catheterization more often results in perineal urine extravasation and may not always result in uroabdomen (**FIGURE 1**). Other uncommon causes of uroabdomen include urinary trauma during abdominal cryptorchidectomy surgery or failed urinary surgeries.[6,7]

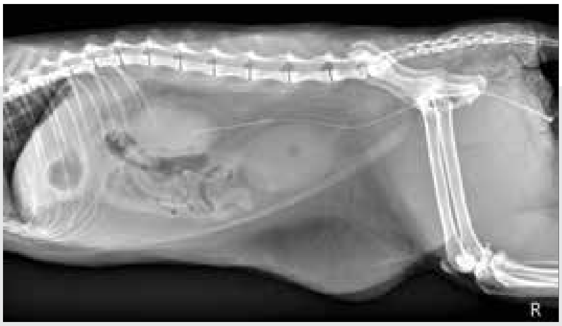


FIGURE 1. Urethral catheterization of an obstructed male cat that resulted in perforation of the distal urethra without uroabdomen.

DIAGNOSIS OF UROABDOMEN

Diagnosis of uroabdomen is based on history, physical examination findings, imaging, and biochemical analysis of both the peripheral blood and peritoneal effusion. Physical examination may reveal lethargy; signs of systemic shock; vomiting; tachycardia, bradycardia, or other arrhythmias; abdominal pain; a palpable fluid wave within the abdomen; and bruising of the abdominal and/or inguinal regions.[1,2] These examination findings are common in trauma cases and are not unique to uroabdomen patients; therefore, diagnosis of uroabdomen can be delayed. Depending on the extent of trauma sustained and the duration of uroabdomen, patients may not initially have significant clinical signs. Therefore, serial monitoring is essential. Active urination or palpation of the urinary bladder on

FIGURE 2. Cystourethrography with fluoroscopy revealed a leak in the bladder apex **(A)**. During surgery, a large necrotic area in the bladder apex was discovered **(B)**.

TABLE 1 The Effects of Serum Potassium Concentration on Electrocardiogram[6,12,13]

SERUM POTASSIUM CONCENTRATION, MMOL/L	ELECTROCARDIOGRAM ABNORMALITY
≥5.5–6.5	Increased T-wave amplitude
≥6.6–7	Decreased R-wave amplitude, prolonged QRS and QPR intervals, ST segment depression
≥7.1–8.5*	Decreased P-wave amplitude, increased P-wave duration, prolongation of QT interval
≥8.6–10	Lack of P waves (atrial standstill), sinoventricular rhythm
≥10.1	Widened and biphasic QRS complex, ventricular flutter, fibrillation, or asystole

**Consider additional therapy for serum potassium ≥7.5 mmol/L.*
Modified from Stafford JR, Bartges JW. A clinical review of pathophysiology, diagnosis, and treatment of uroabdomen in the dog and cat. J Vet Emerg Crit Care (San Antonio). *2013;23(2):217-229. doi:10.1111/vec.12033*

physical examination does not rule out uroabdomen. Voided urine can even appear grossly normal.

Trauma cases and those cases suspected of uroabdomen should have initial blood work performed, including a complete blood count, electrolytes, serum biochemical profile, and acid–base parameters. Animals with uroabdomen will develop azotemia and electrolyte derangements. The severity of these derangements will depend on the duration of the uroabdomen. Initially, azotemia, mild hyponatremia, and hyperphosphatemia are present with a metabolic acidosis. Hyperkalemia develops over 24 to 48 hours.[6]

Imaging of the urinary system should be considered when trying to rule out uroabdomen. In a trauma scenario, this is most commonly performed with an abdominal-focused assessment with sonography for trauma (aFAST) to identify the urinary bladder and any free peritoneal effusion. Abdominocentesis should be performed and analysis of the fluid should include cytology, cell count with differential, and biochemical analysis. Urine is a chemical irritant and will incite inflammation within the abdominal cavity. As a result, fluid can be a transudate, modified transudate, or exudate, depending on the amount of inflammation and hemorrhage present within the fluid. Often, cell counts are >5000 nucleated cells/μL, specific gravity is >1.025, and total solids are >3 g/dL.[8] Paired creatinine and potassium are used as diagnostic tools for uroabdomen, with 1 study showing a potassium fluid to blood ratio of >1.4:1 being 100% sensitive and specific and a creatinine fluid to blood ratio of >2:1 being 100% specific and 86% sensitive for uroabdomen.[9] In this same study, all dogs with a uroabdomen had an abdominal creatinine that was ≥4 times peripheral blood levels.[9]

In addition to identifying peritoneal effusion, imaging aids in localizing the defect in the urinary system. Imaging should be delayed until the patient is systemically stable. Imaging modalities include abdominal radiographs, cystourethrography, excretory urography, computed tomography (CT), and abdominal ultrasound:

- **Abdominal radiographs** are of limited diagnostic value due to loss of serosal detail in the abdomen but can be used to identify radiopaque stones in cases of obstruction and to assess pelvic fractures.
- **Cystourethrography** is the imaging modality that provides the most practical information about the site of leakage in the bladder and/or urethra.[10] A large Foley urinary catheter is aseptically placed, and a 10% to 20% solution of water-soluble, organic, iodinated contrast medium (e.g., iohexol) is infused into the bladder (~10 mL/kg) until resistance is met. Postcontrast radiographs are taken, or the procedure can be performed with fluoroscopy (**FIGURE 2**). If a leak is not identified within the bladder, the catheter can be withdrawn while injecting contrast to highlight the urethra (10 to 15 mL for dogs, 5 to 10 mL for cats). A lateral radiograph is performed toward the end of the infusion to assess for leakage. Additional views can be performed as needed.
- **Excretory urography** can be used if leakage is not seen on cystourethrogram and urine leakage is suspected to be cranial to the bladder, or if urinary catheterization of the urethra is not possible.
- **CT excretory urography** can also be performed and has the benefit of eliminating the superimposition that comes with 2-dimensional imaging.
- **Abdominal ultrasounds** can be useful for visualizing both the upper and lower urinary system and identifying abdominal effusion; however, it is not as valuable as other imaging modalities in localizing the defect.

ACUTE MANAGEMENT OPTIONS FOR UROABDOMEN

Many patients with uroabdomen will have sustained some form of trauma, and initial management is aimed at treating shock and reestablishing tissue perfusion and oxygen delivery with intravenous crystalloid therapy. Despite electrolyte derangements that occur with uroabdomen, a balanced electrolyte solution can be used.[6] Fluid resuscitation is typically provided in one-quarter shock dose increments (shock fluids: dog, 60 to 90 mL/kg; cat, 40 to 60 mL/kg), and perfusion parameters (mentation, capillary refill, heart rate, and blood pressure) are reassessed.

Patients with uroabdomen accumulate potassium-containing urine in the abdomen, which is then resorbed into the systemic circulation, resulting in hyperkalemia. Hyperkalemia induces cardiac electrical disturbances due to increases in cell membrane excitability. If hyperkalemia is not addressed, it can lead to bradycardia and subsequently ventricular fibrillation and asystole. Mild hyperkalemia can be addressed with intravenous fluid therapy because potassium is excreted as glomerular filtration rate improves.[11] However, as hyperkalemia progresses, particularly in the face of other electrolyte derangements and metabolic acidosis, the risk for arrhythmias is greater (**TABLE 1**) and additional treatments should be considered (**TABLE 2**).

Other important methods to decrease serum hyperkalemia are urinary diversion and prevention of further urine accumulation within the peritoneal cavity. The simplest method is to place a urinary catheter to decompress the bladder and prevent urine from extravasating into the peritoneal cavity (**FIGURE 3**). Urethral obstruction may not allow for urinary

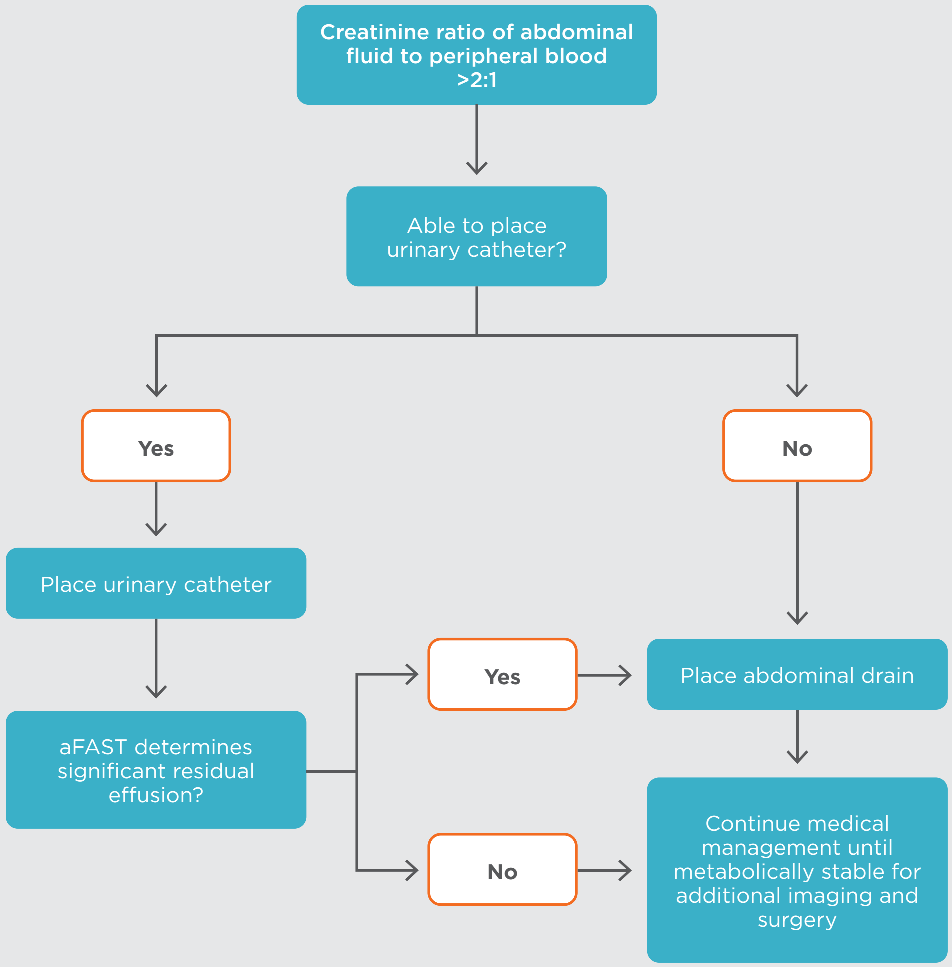


FIGURE 3. Acute management algorithm for animals with uroabdomen.
aFAST = abdominal-focused assessment with sonography for trauma

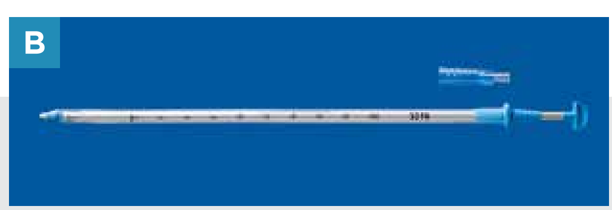
TABLE 2 Treatment of Severe Hyperkalemia[6]

DRUG	DOSE[1]	NOTES
Insulin and 50% dextrose	▪ 0.5 units/kg regular insulin IV ▪ 2 g (4 mL) of 50% dextrose (diluted) for every unit of insulin administered	
50% dextrose alone	▪ 0.7–1 g/kg (1.4–2 mL/kg) IV diluted slowly q3-5min	Not recommended in humans[14]
10% calcium gluconate	▪ 0.5–1.5 mL/kg IV slowly q5–10min; monitor with electrocardiogram for bradycardia or exacerbation of arrhythmias	Does not lower serum potassium concentration; antagonizes the effect of hyperkalemia on the myocardium
Sodium bicarbonate	▪ 1-2 mEq/kg IV slowly over 15 minutes	May be more effective if given with other treatments for hyperkalemia

Modified from Stafford JR, Bartges JW. A clinical review of pathophysiology, diagnosis, and treatment of uroabdomen in the dog and cat. J Vet Emerg Crit Care (San Antonio). *2013;23(2):217-229. doi:10.1111/vec.12033*

catheterization, and cystocentesis may be necessary for bladder decompression. Continued cystocenteses can increase the risk of bladder rupture, and cystostomy tube placement could be considered for those animals with uroabdomen and urethral obstruction.[13,15] In some patients, urinary catheters alone do not fully drain the peritoneal cavity, and azotemia and electrolyte abnormalities do not normalize. In these patients, the addition of abdominal drainage to urinary catheterization can help further remove urine from the peritoneal cavity (**FIGURE 4A**). While abdominocentesis can be performed, an indwelling drain allows for continuous drainage and often expedites stabilization of the patient. Any type of long catheter or tubing can be used as an abdominal drain; however, omentum can easily obstruct many types of drains. Effective options for abdominal drains include a commercially available abdominal drain with blunt insertion trocar (**FIGURE 4B**) along with peritoneal dialysis catheters, active suction Jackson-Pratt drains, and guidewire-inserted thoracostomy tubes (**FIGURE 4C**). The latter is the preference of the author because it is effective, is simple to place, and can be placed with local anesthetic and minimal systemic sedation.

If abdominal fluid cytology reveals urosepsis, antimicrobial therapy should be instituted. In humans, there is a 20% to 40% risk of mortality with urosepsis.[16] No studies have yet evaluated prognosis for veterinary patients with urosepsis, but the condition is assumed to be high risk for mortality. In cases of urosepsis, patients should be medically stabilized, but



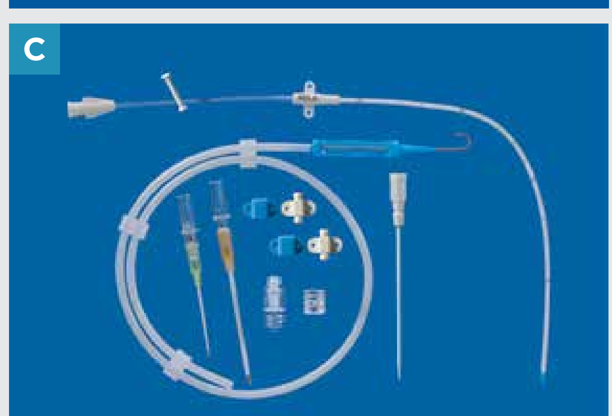


FIGURE 4. A dog with a traumatic uroabdomen has both a urinary catheter and an abdominal drain in place to aid in stabilization before surgical intervention **(A)**. Effective options for abdominal drains include a true abdominal drain with a blunt trocar **(B)** and a guidewire-inserted chest tube **(C)**.

Figure 4 (B and C): courtesy MILA international

In a recent study, 25% of cats with uroabdomen were medically managed,[2] and in another study, 14% of dogs were treated with medical management alone.[1]

definitive correction of the uroabdomen should not be delayed. Whether antimicrobial therapy should be started prophylactically when there is no evidence of urosepsis is controversial. The use of antimicrobial therapy will depend on concurrent trauma and risk factors for infection.

Uroabdomen is a form of chemical peritonitis, inciting pain and inflammation, and analgesia should not be overlooked. Specific pain management protocols will depend on the stability of the patient and the severity of concurrent injuries. Reversible pure μ-agonist opioids are a good analgesic option because other analgesics may have a higher risk of potential complications or side effects. Nonsteroidal anti-inflammatory drugs are not recommended because patients with uroabdomen often have azotemia and hypovolemia. Caution should be used with dexmedetomidine in patients with severe electrolyte derangements, azotemia, and arrhythmias. Similarly, ketamine should be avoided because it is excreted in the urine and can lead to prolonged sedation from resorption of residual urine within the abdomen.

DEFINITIVE TREATMENT OF UROABDOMEN

Animals with uroabdomen caused by small defects can potentially be medically managed with intravenous fluid therapy and urinary diversion (with a urinary catheter and/or abdominal drain). In a recent study, 25% of cats with uroabdomen were medically managed,[2] and in another study, 14% of dogs were treated with medical management alone.[1] Otherwise, uroabdomen is generally considered a surgical condition once the patient has been stabilized.

Occasionally, uroabdomen can be caused by renal and ureteral injuries. These injuries can be complex, and surgery should be performed by an experienced surgeon. These advanced procedures are beyond the scope of this article. Ureteronephrectomy can be considered a salvage procedure for injuries to the kidney or ureter.

The most common cause of uroabdomen requiring surgical intervention is rupture of the urinary bladder

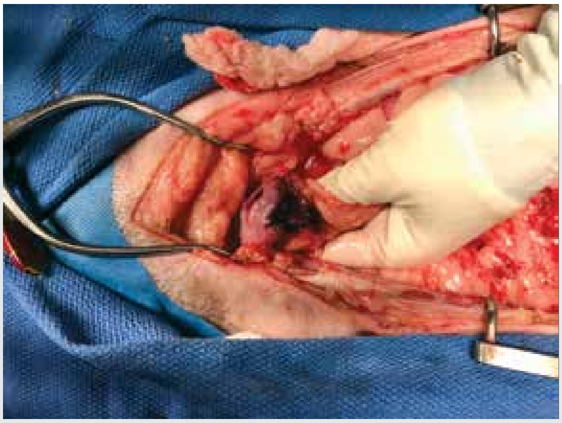


FIGURE 5. Traumatic bladder rupture in a dog. There is a large blood clot over the apex of the bladder where the rupture occurred.

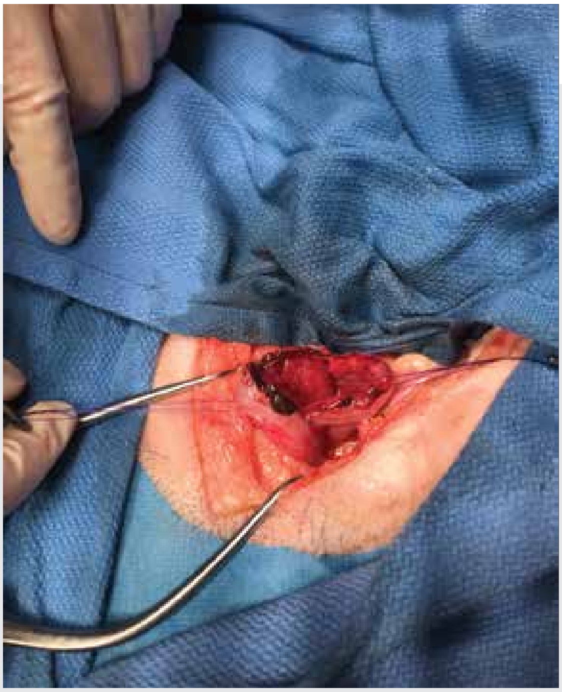


FIGURE 6. Stay sutures with 4-0 monofilament suture are placed in the healthy bladder tissue to help facilitate atraumatic handling of the bladder wall during debridement.

(**FIGURE 5**). A caudal midline laparotomy should be performed and the bladder assessed for viability. Stay sutures should be placed along the margin of the healthy bladder wall to allow for atraumatic manipulation of the bladder during debridement (**FIGURE 6**). The unhealthy bladder tissue should then be debrided. When trauma occurs near the bladder neck, the ureteral openings should be identified, patency confirmed, and the trigone protected during debridement and closure. Up to 75% of the bladder can be removed and still result in normal bladder function.[17] Closure of the defect can be performed in a simple continuous pattern in a single or double layer (**FIGURE 7**). Prior to closure, samples for aerobic culture and histopathology should be considered. Thorough abdominal lavage will help remove residual urine from the peritoneal cavity; however, continued abdominal drainage is not typically necessary postoperatively.

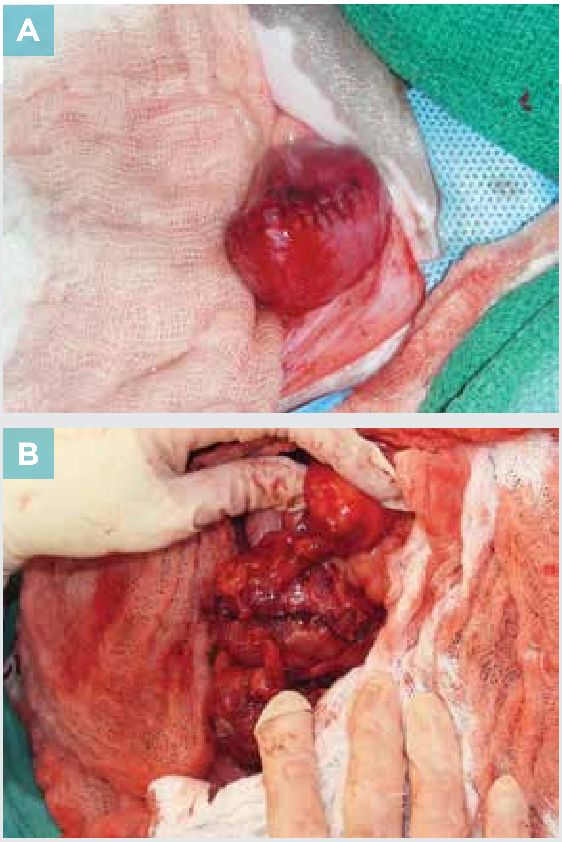


FIGURE 7. (A) A single-layer, full-thickness, simple continuous pattern is used to close a defect in a bladder from a traumatic bladder rupture. **(B)** A 2-layer closure is performed in a bladder defect in a dog with urosepsis.

Figure 7B courtesy Dr. Diane Scavelli

Proximal urethral lacerations or trauma may require repair, including resection and anastomosis or urinary diversion. Urethral lacerations that are not circumferential may epithelialize over a urinary catheter within 7 days.[18] In rare instances, it is possible that distal urethral lacerations resulting in uroabdomen can be treated with a urethrostomy.

Following surgery, patients should be supported with intravenous fluid therapy to allow for frequent urinary voiding to flush out any blood clots from the trauma/surgery, and electrolytes and renal values should be monitored. Urinary catheters are not typically recommended after surgical correction. Routine postoperative analgesics should be administered.

Prognosis following uroabdomen is good. A recent study in dogs with uroabdomen did not find any preoperative risk factors that influenced outcome, and 79% of dogs survived to discharge.[1] In cats, preoperative elevations in creatinine at the time of presentation were found to be prognostic for survival, but overall, 74% of cats with a uroabdomen survived to discharge.[2]

SUMMARY

Uroabdomen requires prompt diagnosis and emergency treatment. The most common cause of uroabdomen is blunt trauma; therefore, every patient with abdominal trauma should be assessed for uroabdomen. A >2:1 abdominal fluid to peripheral blood creatinine ratio is diagnostic for uroabdomen. Patients require initial medical stabilization in the form of intravenous fluid therapy, urinary diversion, and abdominal drainage to correct electrolyte abnormalities, arrhythmias, and hypovolemia. Many patients will ultimately require surgery for definitive treatment of the uroabdomen once medically stabilized. Prior to surgery, imaging can be performed to localize the source of uroabdomen for surgical planning. Prognosis with surgery is generally good. TVP

References

1. Grimes JA, Fletcher JM, Schmiedt CW. Outcomes in dogs with uroabdomen: 43 cases (2006–2015). *JAVMA*. 2018;252(1):92-97. doi:10.2460/javma.252.1.92
2. Hornsey SJ, Halfacree Z, Kulendra E, Parker S, Kulendra N. Factors affecting survival to discharge in 53 cats diagnosed with uroabdomen: a single-centre retrospective analysis. *J Feline Med Surg*. 2021;23(2):115-120. doi:10.1177/1098612X20932267
3. Thornhill JA, Cechner PE. Traumatic injuries to the kidney, ureter, bladder, and urethra. *Vet Clin North Am Small Anim Pract*. 1981;11(1):157-169. doi:10.1016/s0195-5616(81)50011-8

4. Selcer BA. Urinary tract trauma associated with pelvic trauma. *JAAHA*. 1982;18:785-793.
5. Hoffberg JE, Koenigshof AM, Guiot LP. Retrospective evaluation of concurrent intra-abdominal injuries in dogs with traumatic pelvic fractures: 83 cases (2008-2013). *J Vet Emerg Crit Care (San Antonio)*. 2016;26(2):288-294. doi:10.1111/vec.12430
6. Stafford JR, Bartges JW. A clinical review of pathophysiology, diagnosis, and treatment of uroabdomen in the dog and cat. *J Vet Emerg Crit Care (San Antonio)*. 2013;23(2):216-229. doi:10.1111/vec.12033
7. Schulz KS, Waldron DR, Smith MM, Henderson RA, Howe LM. Inadvertent prostatectomy as a complication of cryptorchidectomy in four dogs. *JAAHA*. 1996;32(3):211-214. doi:10.5326/15473317-32-3-211
8. Chambers G. Abdominal distension, ascites, and peritonitis. In: Ettinger SJ, Feldman EC, eds. *Textbook of Veterinary Internal Medicine*. 7th ed. Saunders Elsevier; 2010:144-148.
9. Schmiedt C, Tobias KM, Otto CM. Evaluation of abdominal fluid: peripheral blood creatinine and potassium ratios for diagnosis of uroperitoneum in dogs. *J Vet Emerg Crit Care*. 2001;11(4):275-280. doi:10.1111/j.1476-4431.2001.tb00066.x
10. Klein L, Thorton G. Radiographic diagnosis of urinary tract trauma. *JAAHA*. 1971;7:318-327.
11. Lee JA, Drobatz KJ. Characterization of the clinical characteristics, electrolytes, acid-base, and renal parameters in male cats with urethral obstruction. *J Vet Emerg Crit Care*. 2003;13(4):227-233. doi:10.1111/j.1534-6935.2003.00100.x
12. Tag TL, Day TK. Electrocardiographic assessment of hyperkalemia in dogs and cats. *J Vet Emerg Crit Care*. 2008;18(1):61-67. doi:10.1111/j.1476-4431.2007.00268.x
13. McLoughlin MA. Surgical emergencies of the urinary tract. *Vet Clin North Am Small Anim Pract*. 2000;30(3):581-601, vi-vii. doi:10.1016/s0195-5616(00)50040-0
14. Ettinger PO, Regan TJ, Oldewurtel HA. Hyperkalemia, cardiac conduction, and the electrocardiogram: a review. *Am Heart J*. 1974;88(3):360-371. doi:10.1016/0002-8703(74)90473-6
15. Bray JP, Doyle RS, Burton CA. Minimally invasive inguinal approach for tube cystostomy. *Vet Surg*. 2009;38(3):411-416. doi:10.1111/j.1532-950X.2009.00510.x
16. Wagenlehner FME, Lichtenstern C, Rolfes C, et al. Diagnosis and management for urosepsis. *Int J Urol*. 2013;20(10):963-970. doi:10.1111/iju.12200
17. Cornell KK. Cystotomy, partial cystectomy, and tube cystostomy. *Clin Tech Small Anim Pract*. 2000;15(1):11-16. doi:10.1053/svms.2000.7300
18. Bellah JR. Wound healing in the urinary tract. *Semin Vet Med Surg Small Anim*. 1989;4(4):294-303.

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