

Evaluation of hematology and some biochemical serum factors following experimental unilateral ureteral anastomosis in dogs

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Abstract

Ureteral obstruction is a clinically important condition in dogs that often requires surgical intervention. Such procedures can lead to significant physiological changes, particularly in hematological and biochemical parameters. This study aimed to evaluate hematological alterations and selected serum biochemical factors following experimental ureteral anastomosis in dogs. Five healthy mixed-breed dogs (15–30 kg, aged 1.5–4.5 years) underwent left ureteral transection and end-to-end anastomosis using a simple interrupted suture pattern. Anesthesia was induced with thiopental sodium and maintained with halothane after premedication with acepromazine (Schwartz, 2022; Hardie & Kyles, 2004). Urine and venous blood samples were collected pre-operatively and on days 1, 3, 7, 14, 21, 28, 35, 42, and 90 post-surgery for urinalysis, complete blood count, hematocrit, and measurement of blood urea nitrogen (BUN), creatinine, uric acid, calcium, phosphorus, chloride, sodium, and potassium. Data were analyzed using repeated measures ANOVA and Tukey's post hoc test. Significant increases in BUN, creatinine, and neutrophil counts were observed at all post-operative time points. BUN and creatinine exceeded normal ranges on days 1 and 3. Phosphorus levels were significantly elevated on days 1, 3, 7, 14, 21, 28, and 35, while potassium levels increased significantly on days 1, 3, 7, and 14. Uric acid, calcium, chloride, and sodium changes were not statistically significant. Despite compensatory mechanisms by the kidney and contralateral ureter, certain biochemical changes are inevitable following unilateral ureteral surgery, highlighting the need for careful postoperative monitoring to prevent complications.

Key words: Anastomosis, Biochemical changes, Dog, ureter, Urinalysis

Introduction

Ureteral obstruction in dogs and cats, primarily caused by ureteral calculi, manifests through symptoms such as abnormal urination, persistent urinary tract infections, abdominal pain, vomiting, anorexia, weight loss, and lethargy (Schwartz, 2022; Hardie and Kyles, 2004).

It is important to distinguish ureteral obstruction, which involves blockage of the ureter between the kidney and bladder, from urethral obstruction, which occurs at the distal urinary tract. This study focuses exclusively on ureteral obstruction in small animals.

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Medical management of ureteral obstruction aims to restore urine flow, relieve discomfort, and preserve renal function until definitive resolution of the obstruction is achieved. As described in the previous studies (Schwartz, 2022; Hardie and Kyles, 2004), the initial therapy often includes aggressive fluid diuresis to promote stone passage, administration of smooth muscle relaxants to reduce ureteral spasm, analgesics for pain control, antibiotic therapy when urinary tract infection is present, and close monitoring of renal biochemical parameters such as blood urea nitrogen (BUN), creatinine, and electrolytes.

In cases of complete obstruction, failure of medical therapy, or presence of large calculi, surgical intervention becomes necessary. Surgical options include ureterotomy, ureteroneocystostomy, and, in specialized centers, minimally invasive techniques such as ureteral stenting or subcutaneous ureteral bypass (SUB). Prompt alleviation of complete ureteral obstruction is crucial for preserving renal function and preventing irreversible loss of glomerular filtration rate (Schwartz, 2022; Hardie and Kyles, 2004).

Ureteral surgeries, especially those involving ureteral re-anastomosis, are critical procedures necessitated by conditions like ectopic ureter and direct trauma to the ureter. These surgeries pose significant challenges in small animals due to the delicate nature of the structures involved. Potential complications from these procedures include hydronephrosis, hydroureter, stricture, or obstruction at the anastomosis site, which can significantly alter serum biochemical factors and impact the animal's overall health (Mayhew and Berent, 2023; Siddighi et al, 2017; Wormser et al, 2015; Hardie and Kyles, 2004).

Despite advancements in surgical techniques and tools (Pavia et al, 2018), ureteral anastomosis remains susceptible to complications. Functional or structural obstructions can still occur at the

anastomosis site, interfering with ureteral peristaltic movements and reducing urine flow. This reduction can subsequently decrease the glomerular filtration rate in the associated kidney, leading to changes in serum biochemical factors (Hooi et al, 2021).

Although compensatory mechanisms in the healthy kidney may eventually restore electrolyte balance, these mechanisms are often not fully activated in the immediate postoperative period, resulting in temporary changes in blood electrolyte levels. Understanding these changes and the underlying mechanisms is crucial for improving postoperative outcomes and managing potential complications (Johnson et al, 2024; Wilson, 1977).

The previous studies have documented significant changes in blood biochemical factors following ureteral surgeries. Elevated levels of BUN and creatinine, for instance, are common indicators of impaired renal clearance and urine leakage into the abdominal cavity (Saygin et al, 2021). These biochemical markers are essential for assessing the kidney function and detecting postoperative complications.

This study aims to investigate the changes in serum biochemical factors, particularly BUN and creatinine, following ureteral re-anastomosis in dogs. By understanding these changes and their causes, we can develop better strategies for managing postoperative complications and improving the overall health and recovery of affected animals.

Materials and Methods

Selection of Animals: Five healthy adult mixed-breed dogs (three males and two females), weighing 15–30 kg and aged 1.5–4.5 years, were included. Age was determined by a board-certified small animal internal medicine specialist through dental examination (tooth eruption patterns, wear, and tartar accumulation) in accordance with standard veterinary guidelines. All dogs underwent clinical

examination to confirm normal appetite, urination, and defecation, and were dewormed using conventional antiparasitic drugs. The study protocol was reviewed and approved by the Ethics Committee of the Faculty of Veterinary Medicine, Shahid Chamran University of Ahvaz, Iran. Although no specific approval code was issued, the study was conducted under the committee's supervision in accordance with institutional animal care and use guidelines.

This study aimed to monitor hematological and biochemical changes following unilateral ureteral anastomosis and to provide a detailed 90-day temporal profile of these parameters. While some changes in renal function markers were anticipated due to surgery, the innovative aspect lies in the longitudinal evaluation of multiple hematological and biochemical variables at frequent intervals, offering a clearer understanding of contralateral kidney compensatory mechanisms.

Sampling Protocol

Blood and urine samples were collected preoperatively and on postoperative days 1, 3, 7, 14, 21, 28, 35, 42, and 90. For blood collection, 5 mL was drawn from the cephalic vein into heparinized tubes. A complete blood count, including hematocrit and differential leukocyte count, was performed. Samples were centrifuged at 2500 rpm for 5 minutes, and plasma was stored at -20°C until biochemical analysis. Urine samples were obtained via urinary catheter, and physical characteristics (color, clarity, specific gravity) were recorded before centrifugation and microscopic sediment examination.

Preoperative Preparation

Dogs were fasted for approximately 12 hours before the surgery, with free access to water. Sedation was achieved with intramuscular acepromazine (0.03 mg/kg). Anesthesia was induced intravenously with 2.5% thiopental sodium (6–10 mg/kg) and maintained with oxygen and halothane (1–

1.5%) in a closed inhalation system, following standard veterinary anesthesia protocols (Hall, Clarke, & Trim, 2001). Animals were positioned in dorsal recumbency, and the area from the umbilicus to the pubis was shaved and aseptically prepared.

Surgical Procedure

A 10 cm midline incision was made from the umbilicus to the cranial pubis. After entering the abdominal cavity, the bladder and left ureter were exposed. The ureter was transected obliquely approximately 5 cm from its insertion into the bladder to increase the luminal cross-section. End-to-end anastomosis was performed with simple interrupted 6-0 polydioxanone sutures. The anastomosis site was checked for leakage before returning the ureter to the abdominal cavity. The laparotomy was closed routinely. Cefazolin (20 mg/kg IV) and tramadol (3 mg/kg IV) were administered intraoperatively.

Postoperative Care

Cefazolin (20 mg/kg IV, twice daily) was continued for 5 days after post-surgery. Tramadol was administered for up to 3 days, depending on pain sensitivity at the surgical site. Skin sutures were removed 14 days postoperatively.

Biochemical Assays

Plasma urea was measured by the urease method, creatinine by the Jaffe method, uric acid by the PAP method, calcium and phosphorus by direct colorimetry, chloride by the thiocyanate colorimetric method, and sodium and potassium by flame photometry.

Statistical Analysis

Data were analyzed using SPSS software. Changes over time were assessed by repeated measures ANOVA, with $P < 0.05$ considered statistically significant. Tukey's post hoc test was used for pairwise comparisons.

Results

Blood Urea Nitrogen (BUN): Mean BUN values showed a highly significant difference over time ($P \leq 0.001$). According to Tukey's test, preoperative BUN levels differed significantly from all postoperative time points. Given the wide normal range (10–28 mg/dl), the most notable increases occurred on days 1 and 3, when values exceeded the upper limit. The minimum preoperative BUN was 16.8 mg/dl, peaking at 31 mg/dl on day 1, then gradually declining but remaining above baseline (21.2 mg/dl) on day 90.

Creatinine: Mean serum creatinine increased immediately after surgery, reaching a maximum of 1.85 mg/dl on day 3, then gradually decreased toward normal. Differences between preoperative and all postoperative values were highly significant ($P \leq 0.001$). The most pronounced elevations were on days 1 and 3, exceeding the normal range (0.5–1.5 mg/dl). The minimum preoperative value was 0.97 mg/dl, and by day 90, creatinine stabilized at 1.27 mg/dl, still slightly above baseline.

Uric Acid: Changes in mean uric acid levels were not statistically significant ($P > 0.05$). Values showed a mild upward trend post-surgery, from 4.34 mg/dl preoperatively to a maximum of 4.52 mg/dl on days 21 and 90.

Calcium: Although mean calcium levels decreased after surgery and returned to normal (9.64 mg/dl) by day 28, these

changes were not statistically significant ($P > 0.05$).

Phosphorus: Mean phosphorus levels increased after surgery, peaking at 4.68 mg/dl on day 3, then gradually declined toward baseline. Differences between preoperative values and those on days 1, 3, 7, 14, 21, 28, and 35 were highly significant ($P \leq 0.001$).

Chloride: Mean chloride levels rose after surgery, reaching 116 mg/dl on day 7, then declined. These changes were not statistically significant ($P > 0.05$).

Sodium: No statistically significant changes in mean sodium levels were observed over time ($P > 0.05$).

Potassium: Preoperative potassium levels differed significantly from those on days 1, 3, 7, and 14 ($P \leq 0.001$). Values increased from 4.50 mEq/dl preoperatively to a maximum of 4.96 mEq/dl on day 3, then decreased thereafter.

Table 1 presents the mean \pm standard error for all biochemical parameters before and after surgery, with statistical significance indicated.

Hematology: Mean neutrophil counts before surgery differed significantly from all postoperative values ($P \leq 0.01$). The most marked increase occurred on day 1. Although subsequent values remained significantly different from baseline, they stayed within the normal range. Table 2 shows the mean \pm standard error for hematological parameters, with significant changes indicated.

Table1: The mean and standard error of biochemical serum parameters following ureteral anastomosis surgery in five dogs

Potassium (mEq/l)	Sodium (mEq/l)	Chlorine (mg/dl)	Phosphorus (mg/dl)	Calcium (mg/dl)	Uric acid (mg/dl)	Creatinine mg/dl	Blood urea nitrogen (BUN) mg/dl	Serum Parameters
4.52±0.280	146.4±1.82	114.4±1.82	4.24±0.330	9.44±0.240	4.34±0.220	0.97±0.130	16.8±0.84	Before surgery
4.72±0.180*	146.8±1.48	114.8±2.28	4.44±0.370*	9.06±0.330	4.38±0.230	1.68±0.250*	30.4±2.07*	1 day post surgery
4.96±0.250*	147.6±1.52	115.8±2.17	4.68±0.270*	9.06±0.560	4.40±0.200	1.85±0.210*	29.8±1.64*	3 days post surgery
4.78±0.300*	147.2±1.48	116±1.22	4.56±0.380*	9.42±0.620	4.30±0.160	1.58±0.280*	26.2±1.64*	7 days post surgery
4.78±0.250*	146.2±1.79	114.6±1.35	4.58±0.300*	9.26±0.350	4.42±0.280	1.42±0.200*	26±1.87*	14 days post surgery
4.70±0.200	146.8±1.83	115±2.12	4.46±0.290*	9.20±0.400	4.52±0.130	1.35±0.150*	23.4±2.30*	21 days post surgery
4.70±0.140	145.6±2.70	115±2.34	4.38±0.240*	9.46±0.190	4.42±0.290	1.32±0.100*	23.2±2.04*	28 days post surgery
4.56±0.280	144.6±2.07	113.4±1.14	4.42±0.290*	9.40±0.190	4.36±0.210	1.29±0.110*	22.6±1.52*	35 days post surgery
4.60±0.160	144.6±2.50	113.8±0.83	4.28±0.200	9.38±0.270	4.40±0.280	1.28±0.130*	21.4±0.55*	42 days post surgery
14.58±0.130	145.6±1.14	114.2±1.48	4.28±0.230	9.48±0.050	4.52±0.180	1.27±0.050*	21.2±1.92*	90 days post surgery

*The difference from the preoperative value was significant ($P<0.001$).

Table 2: The mean and standard error of hematology parameters following ureteral anastomosis surgery in five dogs

Hematocrit (%)	Monocyte (cell/ μ l)	Eosinophil (cell/ μ l)	Lymphocyte (cell/ μ l)	Neutrophil (cell/ μ l)	Blood parameters
42±1.30	368.2±86.50	982.6±355.30	2506±478.00	7293.2±624.70	Before surgery
43.8±1.50	476±148.90	613.8±156.50	1008.6±256.20	17293.6±2563.80*	1 day post surgery
40.2±1.30	672.9±301.30	627±210.30	1890.5±681.30	10086.1±2095.80*	3 days post surgery
41.6±0.90	525.3±175.40	831.7±110.60	1914.2±662.00	9778.8±1389.50*	7 days post surgery
49.2±2.20	442±74.40	404.5±189.50	2064.5±475.80	9489±1504.40*	14 days post surgery
44.2±0.80	316±113.40	784.9±165.10	1981.7±610.10	8377.4±717.10*	21 days post surgery
44.6±2.10	380.5±157.80	781.5±234.50	2220.5±291.3	8021.5±463.50*	28 days post surgery
46.6±2.20	166±116.50	810±178.70	2232±532.2	8592±1751.30*	35 days post surgery
48.4±1.90	370.5±148.20	692.5±251.40	2308±298.8	8229±1520.90*	42 days post surgery
48±2.10	240±185.90	825±202.70	1885±274.4	7350±380.30*	90 days post surgery

*The difference from the preoperative value was significant ($P<0.01$)

Urinalysis: Preoperative urinalysis confirmed normal physical, chemical, and cellular indices: amber-yellow, clear urine with mean specific gravity of 1.040, pH 7, and normal counts of red and white blood cells, epithelial cells, and transitional cells. Occasional uric acid and triple phosphate crystals were observed, consistent with normal carnivore urine.

On days 3 and 7 post-surgery, urinalysis revealed increased red and white blood cell counts. By day 14, these values began returning toward normal, and by day 90, they had stabilized. Mild proteinuria persisted throughout the sampling period but was not clinically or statistically significant. Overall, urinalysis indicated that inflammatory and hemorrhagic changes in the urinary tract gradually resolved during recovery.

Discussion

In certain ureteral surgeries, particularly in cases of ectopic ureter or direct trauma, ureteral re-anastomosis may be required (Dekerle et al, 2022; Brown, 2013). Performing this procedure in small animals is technically challenging, and postoperative alterations in the urinary tract are common. Among the most significant complications are hydronephrosis, hydroureter, stricture, or obstruction at the anastomosis site, all of which can alter serum biochemical parameters and adversely affect the animal's health (Degner et al, 2022).

Even with optimal surgical techniques and advanced instrumentation, ureteral anastomosis cannot fully prevent the occurrence of functional or structural obstruction at the anastomosis site (Cooper & Scansen, 2020). In some cases, without any visible structural obstruction, disruption of ureteral peristalsis—particularly in the early postoperative period—can reduce urine flow through the anastomosis. This reduction in flow decreases the glomerular filtration rate (GFR) of the affected kidney, leading to

measurable changes in serum biochemical values (Mayhew and Berent, 2023; Barthez et al, 2004).

Although compensatory mechanisms in the contralateral kidney can eventually restore electrolyte balance, these mechanisms are not fully active in the immediate postoperative period. As a result, transient alterations in blood electrolyte levels are expected. In line with the previous literature, the present study also anticipated changes in serum biochemical parameters due to the potential for stricture or obstruction at the anastomosis site (Urie et al, 2007).

Blood Urea Nitrogen (BUN) and Creatinine (Cr): BUN and creatinine are key indicators of renal function. BUN reflects the concentration of nitrogen derived from urea, a protein metabolism byproduct, in the blood. Elevated BUN may indicate impaired renal clearance, dehydration, or high protein intake. Creatinine, a muscle metabolism byproduct, is excreted by the kidneys and serves as a reliable marker of GFR. Increases in creatinine typically indicate reduced renal function or obstruction (Hessels et al, 2018).

These two parameters are often measured together to provide a comprehensive assessment of kidney health. Both undergo significant changes in many urinary tract disorders, particularly in obstructive conditions. Creatinine is especially sensitive to reductions in renal clearance, making it a valuable marker for evaluating urinary tract obstruction, including postoperative cases (Inker and Titan, 2021).

Two main mechanisms may explain the marked increases in BUN and creatinine observed during the first three postoperative days. The first is either partial or complete obstruction at the anastomosis site, impairing clearance by the affected kidney (Aronson, 2020; Adin and Scansen, 2011). The second is temporary cessation of ureteral peristalsis, which reduces urine flow in the operated ureter (Geavlete,

2016). Both mechanisms are supported by the previous studies.

Clinical signs of ureteral obstruction in dogs include urinary incontinence, stranguria, dysuria, pollakiuria, polyuria, hematuria, persistent urinary tract infection, abdominal pain, vomiting, anorexia, lethargy, weight loss, fever or hypothermia, palpable abdominal mass, vaginal discharge, and prostatomegaly (Hardie and Kyles, 2004). In bilateral cases, clinical signs are often severe and acute. For example, in a 5-year-old Labrador Retriever with urethral obstruction secondary to bladder torsion, any impediment to urine outflow was associated with elevated BUN and creatinine (Pozzi et al, 2006).

Other reports describe similar findings. Nwadike et al, (2000) documented vomiting, lethargy, and anorexia in a 2-year-old Himalayan cat following ovariohysterectomy. Excretory urography revealed bilateral ureteral obstruction due to inadvertent ligation. Temporary nephrostomy tube placement normalized BUN and creatinine, and subsequent ureteral re-anastomosis resolved the obstruction. In a retrospective study, Kyles et al. (2005) identified elevated creatinine as a common laboratory abnormality in dogs with ureterolithiasis. Surgical removal of stones resulted in full recovery in many cases, though not all.

Interestingly, elevated BUN and creatinine can also occur without overt obstruction. For example, in ureterocolonic anastomosis, postoperative increases in these parameters during the first 2–3 days have been attributed to reabsorption of nitrogenous waste products from the colon (Saberi Afshar et al, 2007). Similarly, Sarin et al, (2006) and El-Leithy (2008) reported hydronephrosis and hydronephrosis without obstruction after ureteral surgeries, suggesting that reduced urine flow alone can elevate BUN and creatinine. Patil et al, (2008) also observed functional obstruction without physical blockage after psoas hitch ureteral reimplantation.

In the present study, necropsy confirmed the absence of complete obstruction, but stenosis at the anastomosis site was present in most cases. Therefore, the most plausible explanation for the early postoperative increases in BUN and creatinine is functional ureteral obstruction. The potential influence of the closed halothane anesthesia system cannot be entirely excluded. No severe postoperative complications such as wound infection, dehiscence, or persistent urinary abnormalities were observed. Only mild, transient signs—reduced appetite and mild discomfort at the surgical site were noted and resolved with supportive care.

Changes in Blood Electrolytes: Ureteral anastomosis can temporarily affect renal clearance and alter blood electrolyte levels. However, literature review reveals no consistent pattern for these changes. Obstructive uropathy, whether functional or physical, may cause various electrolyte disturbances before and after relief of obstruction, especially in high-grade chronic cases (Yaxley & Yaxley, 2023). Early post-renal obstruction often results in tubular solute wasting (sodium, potassium, bicarbonate, magnesium, calcium, phosphate), followed by retention of potassium, hydrogen, chloride, and ammonium as renal function declines.

Sodium and potassium disorders are the most clinically significant. Hyponatremia, often due to plasma dilution and tubulopathy, may take weeks to normalize after decompression (Moore, 1958). Hypernatremia can occur with prolonged diuresis, while hypokalemia is common post-obstruction and usually self-limiting. Hyperkalemia may arise from severe renal impairment or distal tubular injury (Yaxley and Yaxley, 2023; Yang et al, 2021).

Experimental and clinical studies support these findings. Chevalier et al, (2002) showed that even after relief of unilateral ureteral obstruction in rats, GFR, urine flow, and sodium/potassium excretion decreased, leading to retention of these ions.

Saberi Afshar et al. (2007) reported increased phosphorus and chloride and decreased calcium, sodium, and potassium after ureteral reconstruction with a colon graft. Bigham Sadegh et al, (2009) found no major electrolyte changes after ureteral replacement with fetal urachus, though potassium increase approached significance ($P=0.06$). Abbas et al, (2008) and Pozzi et al, (2006) documented variable potassium changes in bladder outlet obstruction cases.

Hematology: Postoperative leukocytosis can occur due to surgical stress or urinary tract stimulation from urine retention, even without infection (Pozzi et al, 2006). In this study, neutrophil counts were significantly elevated at all postoperative time points compared to baseline, but exceeded the

normal range only during the first three days. Clinically, all animals remained healthy.

A limitation of this study is the absence of blood gas analysis, which could have provided additional insight into postoperative acid–base status. Future studies should incorporate such measurements.

Ureteral anastomosis, even when performed unilaterally with expected compensation from the contralateral kidney and ureter, can cause transient changes in parameters related to glomerular filtration rate, leading to alterations in serum biochemical values. These changes are generally temporary and most evident during the first few weeks of post-surgery.

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Conflict of Interest

The authors declare that they have no conflicts of interest related to this study.

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References

- Abbas, M. T., Khan, F. Y., Baidaa, A., Errayes, M., & Al Haleem, H. (2008). Respiratory failure secondary to obstructive uropathy. *Journal of Clinical Diagnosis and Research*, 2(4), 1107.
- Adin, C. A., & Scansen, B. A. (2011). Complications of upper urinary tract surgery in companion animals. *Veterinary Clinics of North America: Small Animal Practice*, 41(5), 869–888.
- Aronson, L. R. (2020). Upper urinary tract urolithiasis. *Veterinary Focus*. Retrieved from <https://vetfocus.royalcanin.com/en/scientific/upper-urinary-tract-urolithiasis>
- Barthez, P. Y., Smeak, D. D., Wisner, E. R., Dibartola, S. P., & Chew, D. J. (2000). Ureteral obstruction after ureteroneocystostomy in dogs assessed by technetium Tc 99m diethylenetriamine pentaacetic acid (DTPA) scintigraphy. *Veterinary Surgery*, 29(2), 178–185.
- Bigham Sadegh, A., Shadkhist, M., Sharifi, S., & Mohammadnia, A. R. (2009). Ureteral segment replacement using an ovine fetal urachus duct (new xenogenic graft) in dogs. *Comparative Clinical Pathology*, 18(2), 125–129.
- Chevalier, R. L., Thornhill, B. A., Chang, A. Y., Cachat, F., & Lackey, A. (2002). Recovery from release of ureteral obstruction in the rat: Relationship to nephrogenesis. *Kidney International*, 61(6), 2033–2043.
- Cooper, E., & Scansen, B. A. (2020). Obstructive uropathy. In D. S. Bruyette (Ed.), *Canine and feline endocrinology* (Chapter 122). Wiley.
- Degner, D., Clarke, D., & Wormser, C. (2022). Ureteral obstruction. In L. R. Aronson (Ed.), *Veterinary surgery: Small animal* (Chapter 26). Wiley.

- Dekerle, B., Maurice, E., Decambon, A., Viateau, V., Maurey, C., & Manassero, M. (2022). Outcomes of 25 female dogs treated for ectopic ureters by open surgery or cystoscopic-guided laser ablation. *Veterinary Surgery*, 51(5), 568–575.
- El-Leithy, T. R. (2008). Ureterosigmoidostomy: A gold standard in orthotopic bladder era. *Research Journal of Medicine and Medical Sciences*, 3(2), 105–110.
- Geavlete, P. A. (Ed.). (2016). Notions of histology, anatomy, and physiology of the upper urinary tract. In *Handbook of endourology* Springer.
- Hall, L. W., Clarke, K. W., & Trim, C. M. (2001). *Veterinary anaesthesia* (10th ed.). W.B. Saunders.
- Hardie, E. M., & Kyles, A. E. (2004). Management of ureteral obstruction. *Veterinary Clinics of North America: Small Animal Practice*, 34(4), 989–1010.
- Hessels, L., Koopmans, N., Gomes Neto, A. W., Volbeda, M., Koeze, J., Lansink-Hartgring, A. O., Bakker, S. J., Oudemans-van Straaten, H. M., & Nijsten, M. W. (2018). Urinary creatinine excretion is related to short-term and long-term mortality in critically ill patients. *Intensive Care Medicine*, 44(10), 1699–1708.
- Hooi, K. S., Vachon, C., Martel, D. V., & Dunn, M. (2021). Retrospective evaluation of cystoscopic-guided laser ablation of intramural ectopic ureters in female dogs. *Journal of Veterinary Internal Medicine*, 36(1), 156–163.
- Inker, L. A., & Titan, S. (2021). Measurement and estimation of GFR for use in clinical practice: Core curriculum 2021. *American Journal of Kidney Diseases*, 78(5), 736–749.
- Johnson, C., Piegols, H., Lapsley, J., & Selmic, L. E. (2024). Unilateral nephrectomy in dogs is associated with a high rate of intraoperative and postoperative complications. *Journal of the American Veterinary Medical Association*, 262(6), 1–7.
- Kyles, A. E., Hardie, E. M., Wooden, B. G., Adin, C. A., Stone, E. A., Gregory, C. R., Mathews, K. G., Cowgill, L. D., Vaden, S., Nyland, T. G., & Ling, G. V. (2005). Management and outcome of cats with ureteral calculi: 153 cases (1984–2002). *Journal of the American Veterinary Medical Association*, 226(6), 937–944.
- Mayhew, P. D., & Berent, A. (2023). Ureteral ectopia and urinary incontinence. In E. Monnet (Ed.), *Veterinary surgery: Small animal* (Chapter 45). Wiley.
- Nwadike, B. S., Wilson, L. P., & Stone, E. A. (2000). Use of bilateral temporary nephrostomy catheters for emergency treatment of bilateral ureter transection in a cat. *Journal of the American Veterinary Medical Association*, 217(12), 1862–1865.
- Patil, N. N., Mottrie, A., Sundaram, B., & Patel, V. R. (2008). Robotic-assisted laparoscopic ureteral reimplantation with psoas hitch: A multi-institutional, multinational evaluation. *Urology*, 72(1), 47–50.
- Pavia, P. R., Berent, A. C., Weisse, C. W., Neiman, D., Lamb, K., & Bagley, D. (2018). Outcome of ureteral stent placement for treatment of benign ureteral obstruction in dogs: 44 cases (2010–2013). *Journal of the American Veterinary Medical Association*, 252(6), 739–748.
- Pozzi, A., Smeak, D. D., & Aper, R. (2006). Colonic seromuscular augmentation cystoplasty following subtotal cystectomy for treatment of bladder necrosis caused by bladder torsion in a dog. *Journal of the American Veterinary Medical Association*, 229(2), 235–239.
- Saberi Afshar, F., Koushyar, S., & Razi Jalali, M. (2007). Some serum biochemical alterations after urinary diversion with colonic segment in dog. *Iranian Journal of Veterinary Surgery*, 2(5), 45–51.
- Saygin, H., Ergin, I. E., Kirac, E., & Korgali, E. (2021). One method that can be applied in the ectopic ureter is uretero-ureterostomy: Case report. *Journal of Surgical Techniques and Procedures*, 5(1), 1044.
- Schwartz, P. (2022). Current concepts in urinary surgery. *Veterinary Clinics of North America: Small Animal Practice*, 52(2), 387–417.
- Siddighi, S., Yune, J. J., Kwon, N. B., Hardesty, J. S., Kim, J. H., & Chan, P. J. (2017). Perioperative serum creatinine changes and ureteral injury. *Urology*, 49(11), 1915–1919.
- Urie, B. K., Tillson, D. M., Smith, C. M., Brawner, W. R., Almond, G. T., Beard, D. M., Lenz, S. D., & Lothrop, C. D. (2007). Evaluation of clinical status, renal function, and hematopoietic variables after unilateral nephrectomy in canine kidney donors. *Journal of the American Veterinary Medical Association*, 230(11), 1653–1656.
- Wilson, D. R. (1977). Renal function during and following obstruction. *Annual Review of Medicine*, 28, 329–339.

Wormser, C., Clarke, D. L., & Aronson, L. R. (2015). End-to-end ureteral anastomosis and double-pigtail ureteral stent placement for treatment of iatrogenic ureteral trauma in two dogs. *Journal of the American Veterinary Medical Association*, 247(1), 67–72.

Yaxley, J., & Yaxley, W. (2023). Obstructive uropathy – Acute and chronic medical management. *World Journal of Nephrology*, 12(1), 1–9.

Yang, J., Sun, B. G., Min, H. J., Son, Y. B., Kim, T. B., Lee, J., Oh, S. W., Kim, M. G., Cho, W. Y., Ahn, S. Y., Ko, G. J., Kwon, Y. J., Cha, J. J., Kang, Y. S., Cha, D. R., & Jo, S. K. (2021). Impact of acute kidney injury on long-term adverse outcomes in obstructive uropathy. *Scientific Reports*, 11, 23639.

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ارزیابی هماتولوژی و برخی عوامل بیوشیمیایی سرم پس از آناستومونوتجربی یکطرفه حالب در سگ‌ها

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چکیده

انسداد حالب یکی از مشکلات مهم بالینی در سگ‌ها است که اغلب نیاز به مداخله جراحی دارد. چنین اقداماتی می‌تواند منجر به تغییرات فیزیولوژیک قابل توجهی در شاخص‌های هماتولوژیک و بیوشیمیایی شود. این مطالعه با هدف ارزیابی تغییرات هماتولوژیک و برخی از عوامل بیوشیمیایی سرم پس از جراحی تجربی آناستومون حالب در سگ‌ها انجام شد. پنج سگ سالم نژاد مخلوط (با وزن ۱۵ تا ۳۰ کیلوگرم و سن ۵/۱ تا ۵/۴ سال) تحت قطع حالب چپ و آناستومون انتها به انتها با الگوی بخیه ساده تکی قرار گرفتند. بیهوشی پس از پیش‌بیهوشی با آسپرومازین، با تیئوپنتال سدیم القا و با هالوتان در سیستم بسته حفظ شد. نمونه‌های ادرار و خون وریدی قبل از عمل و در روزهای ۱، ۳، ۷، ۱۴، ۲۱، ۲۸، ۳۵، ۴۲ و ۹۰ پس از جراحی برای آنالیز ادرار، شمارش کامل خون، هماتوکریت و اندازه‌گیری نیتروژن اوره خون (BUN)، کراتینین، اسید اوریک، کلسیم، فسفر، کلرید، سدیم و پتاسیم جمع‌آوری شد. داده‌ها با استفاده از آزمون واریانس مکرر (ANOVA) و آزمون پس‌هنگام توکی تحلیل شدند. افزایش معنی‌داری در نیتروژن اوره خون، کراتینین و شمارش نوتروفیل‌ها در تمامی زمان‌های پس از جراحی مشاهده شد. سطوح نیتروژن اوره خون و کراتینین در روزهای ۱ و ۳ بالاتر از محدوده طبیعی بود. سطوح فسفر در روزهای ۱، ۳، ۷، ۱۴، ۲۱، ۲۸ و ۳۵ به طور معنی‌داری افزایش یافت، در حالی که سطوح پتاسیم در روزهای ۱، ۳، ۷ و ۱۴ افزایش معنی‌داری نشان داد. تغییرات اسید اوریک، کلسیم، کلرید و سدیم از نظر آماری معنی‌دار نبودند. با وجود مکانیزم‌های جبرانی کلیه و حالب سالم، بروز برخی تغییرات بیوشیمیایی پس از جراحی یکطرفه حالب اجتناب‌ناپذیر است و این امر بر ضرورت پایش دقیق پس از عمل برای پیشگیری از عوارض تأکید دارد.

کلمات کلیدی: آناستومون، تغییرات بیوشیمیایی، سگ، حالب، آنالیز ادرار

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