

**Regression of Struvite Urolithiasis and Resolution of Hemorrhagic Cystitis in Persian Cats:
Clinical and Ultrasonographic Evaluation Following Dietary and Medical Therapy**

Running Title: Feline Struvite Regression and Resolution of Cystitis

Waode Santa Monica^{1,4*}, Muhammad Furqan Hidayat¹, Andi Rifqatul Ummah², Muhammad Zulfadillah Sinusi^{2,4},
Andi Tri Julyana Eka Astuty¹, Dian Fatmawati^{1,4}, Musdalifah^{1,4}, Sarmin³

¹ Department of Veterinary Internal Medicine, Study Program Of Veterinary Medicine, Faculty of Medicine,
Hasanuddin University, Makassar, Indonesia

² Department of Surgery and Radiology, Study Program Of Veterinary Medicine, Faculty of Medicine, Hasanuddin
University, Makassar, Indonesia

³ Department of Physiology Faculty of Veterinary Medicine, Universitas Gadjah Mada, Yogyakarta, Indonesia

⁴ Veterinary Hospital, Hasanuddin University, Makassar, Indonesia

*Corresponding author: santawaode@med.unhas.ac.id

ORCID:

Waode Santa Monica^{1*} : <https://orcid.org/0000-0001-7955-533X>

Muhammad Furqan Hidayat : <https://orcid.org/0009-0005-0458-5127>

Andi Rifqatul Ummah : <https://orcid.org/0009-0009-6683-4087>

Muhammad Zulfadillah Sinusi : <https://orcid.org/0000-0002-7738-0879>

Andi Tri Julyana Eka Astuty : <https://orcid.org/0009-0009-2814-2813>

Dian Fatmawati : <https://orcid.org/0009-0009-6815-8553>

Musdalifah Musdalifah : <https://orcid.org/0009-0001-3933-3705>

Sarmin Sarmin : <https://orcid.org/0000-0002-9116-4734>

Abstract

This case report describes the management and outcome of dissolution therapy in a 2 year old female Persian cat diagnosed with Struvite Urolithiasis complicated by acute Hemorrhagic Cystitis. Clinical symptoms were characterized by severe stranguria and pollakiuria. Ultrasonography revealed thickening of the bladder wall and an initial urolith measuring 1.16 x 0.47 cm. Laboratory examination confirmed the diagnosis: slightly acidic urine pH (6.0), inflammatory leukogram, and the presence of *Escherichia coli* in urine culture, confirming the infection. Urine sediment microscopy revealed numerous erythrocytes and leukocytes, but few struvite crystals were found (low crystalluria). Treatment involved a multidimensional protocol: stabilization with intravenous fluids, the antibiotic ciprofloxacin (after initiation of amoxicillin) to eliminate *E. coli*, anti-inflammatory therapy with tolfenamic acid, and urolith intervention using a therapeutic urinary dissolution diet S/O wet food for 14 days and the diuretic herbal medicine Batugin. This intervention resulted in remarkably rapid clinical resolution. By day 14, the urolith had drastically regressed >50% from its initial stone size to 0.70 x 0.27 cm. Microscopic examination of the urine sediment demonstrated resolution of pyuria and hemorrhagic cystitis, characterized by the disappearance of red blood cells, white blood cells, and struvite crystals. The success of this case confirms that comprehensive medical dissolution therapy, combined with aggressive elimination of infection, should be the first choice for struvite urolithiasis with associated symptoms.

Keywords: Dissolution Therapy; *Escherichia coli*; Hemorrhagic Cystitis; Persian Cat; Struvite Urolithiasis

1. Introduction

Urolithiasis is a common and significant pathological condition in small animal practice, particularly in domestic cats, characterized by the formation of crystals and stones (uroliths) in the urinary tract [1]. Among the various types of uroliths found, struvite (magnesium ammonium phosphate, $\text{MgNH}_4\text{PO}_4 \cdot 6\text{H}_2\text{O}$) is the second most frequently diagnosed crystal type in the feline population, although its prevalence has decreased substantially since consumer feed formulations began to be adjusted to control urinary pH [2]. Struvite urolithiasis is often closely associated with Feline Lower Urinary Tract Disease (FLUTD), and untreated cases can lead to serious complications, including hemorrhagic cystitis characterized by hematuria and severe dysuria, and potentially life-threatening urethral obstruction [1]. Persian cats, as a long-haired breed, may have a genetic predisposition or specific environmental management that may influence the risk of urolith development [3]. Therefore, a thorough understanding of the pathogenesis and therapeutic response in this specific breed remains crucial.

The diagnosis of struvite urolithiasis requires a multidisciplinary approach, encompassing clinical assessment, urinalysis (including crystalluria examination), and diagnostic imaging such as radiography or ultrasonography, which are essential to confirm the location, size, and number of uroliths [4]. The difference in chemical composition (struvite vs. calcium oxalate) is crucial for the treatment strategy chosen [4]. Struvite urolithiasis has the advantage of being dissolvable [2]. Medical dissolution therapy involves a combination of a therapeutic diet designed to produce acidic and dilute urine, and additional medical therapy, such as antibiotics if a urinary tract infection (UTI) is identified as a triggering factor [5]. This strategy aims to reduce the ion concentration in the urine and increase mineral solubility, thus allowing regression (size reduction) or complete dissolution of uroliths without the need for invasive surgical intervention. The success

of dissolution therapy should be closely monitored through serial ultrasonographic evaluation and resolution of clinical symptoms.

Although struvite dissolution therapy protocols are well documented, a single case report detailing measurable regression of uroliths and complete resolution of severe complications such as hemorrhagic cystitis in a specific breed such as the Persian cat is still needed to enrich the clinical literature [6]. This case provides objective data regarding the This report presents a unique case of a Persian cat diagnosed with struvite urolithiasis and hemorrhagic cystitis, demonstrating how the application of structured dietary and medical therapy resulted in a marked reduction in urolith size. The diagnosis and validation of the case were achieved through imaging, as well as improvement in clinical symptoms [7]. This case provides objective data regarding the timeline of urolith regression and the efficacy of a non-invasive protocol. The purpose of this case report is to comprehensively describe the clinical course, diagnostics, and successful management of dissolution therapy in struvite urolithiasis with hemorrhagic cystitis in a Persian cat, reaffirming the role of conservative therapy as an effective first-line approach.

2. Case Presentation

A 2-year-old, intact female Persian cat weighing 2.6 kg was referred to the Hasanuddin University Veterinary Teaching Hospital with the primary complaint of stranguria and macroscopic hematuria that had persisted for 7 days. The owner reported increased frequency of urination with very small volumes (pollakiuria) and straining during urination (stranguria). The cat's daily diet consisted primarily of commercial dry food. On initial examination, the patient's general condition was considered somewhat alert and lethargic.

Physical examination at presentation revealed a fever of 40.2°C, a respiratory rate of 28 breaths/minute, and a heart rate of 124 beats/minute. Abdominal palpation revealed a full, tense, and painful bladder. There were no signs of complete urethral obstruction. The patient exhibited a clear pain response to palpation of the bladder area (cringing response). The mucous membranes appeared pale with a capillary refill time (CRT) of 4 seconds, indicating dehydration. The patient's Body Condition Score (BCS) was 3/9, indicating suboptimal nutritional status.

Routine hematology analysis was performed using an automated hematology analyzer (Licare CC-3200 Vet), the results (Table 1) showed a total white blood cell (WBC) count within normal limits ($11.0 \times 10^9/L$), but the differential count indicated a significant inflammatory and stress response. The cat displayed relative neutrophilia, indicated by an increase in the granulocyte percentage to 87.8 (reference value: 35.0 - 85.0%). This pattern was accompanied by relative lymphopenia, with the lymphocyte percentage decreasing to 9.0% (reference value: 12.0 - 45.0%). This stress/inflammatory leukogram confirmed a severe acute inflammatory process, highly consistent with a diagnosis of Hemorrhagic Cystitis caused by irritation of struvite uroliths. Although the patient had hematuria, the red blood cell count (RBC, $8.03 \times 10^{12}/L$) and hematocrit (40.3%) were within normal limits, ruling out systemic anemia. All platelet parameters were also normal, indicating that the bleeding was primarily local and directly related to lower urinary tract inflammation.

Table 1. Hematology examination results

No	Type of Examination	Results	Unit	Reference Value	Description
1	WBC	11.0	$10^9/L$	5.5 – 19.5	Normal
2	Lymph#	1.0	$10^9/L$	0.8 – 7.0	Normal
3	Mid#	0.4	$10^9/L$	0.0 – 1.9	Normal

4	Gran#	9.6	$10^9/L$	2.1 – 15.0	Normal
5	Lymph%	9.0	%	12.0 – 45.0	decrease
6	Mid%	3.2	%	2.0 – 9.0	Normal
7	Gran%	87.8	%	35.0 – 85.0	Increase
8	RBC	8.03	$10^{12}/L$	4.60 – 10.00	Normal
9	HGB	12.5	g/dL	9.3 – 15.3	Normal
10	HCT	40.3	%	28.0 – 49.0	Normal
11	MCV	50.2	fL	39.0 – 52.0	Normal
12	MCH	15.5	pg	13.0 – 21.0	Normal
13	MCHC	310	g/L	300 – 380	Normal
14	PLT	247	$10^9/L$	100 – 514	Normal
15	PCT	0.237	%	0.100 – 0.500	Normal

Note: WBC=white blood cells, Lymph=lymphocyte, Mid=agranulocyte, Gran=granulocyte, RBC=red blood cells, HGB=hemoglobin, HCT=hematocrit, MCV=mean corpuscular volume, MCH=mean corpuscular hemoglobin, MCHC=mean corpuscular hemoglobin concentration, PLT=platelet, PCT=plateletcrit.

Macroscopic hematuria confirmed severe active bleeding, consistent with Hemorrhagic Cystitis. Hematologically (Table 1), there was relative neutrophilia and relative lymphopenia, indicating a strong acute inflammatory/stress response. The erythrocyte count was normal, ruling out systemic anemia. Urinalysis results (Table 2) revealed proteinuria (+2) due to mucosal damage. Interestingly, the recorded urine pH was 6.0 (acidic), which should favor dissolution, but the presence of an inflammatory leukogram and proteinuria confirmed chronic mechanical irritation of the urolith as the primary etiology.

Table 2. Urine dipstick examination results of the patient upon presentation

Parameter	Result	Reference Value	Interpretation
Protein	100(1.0) ++	Negative (-)	Abnormal
pH	6.0	5.0	Acidic
Glucose	Negative (-)	Negative (-)	Normal

Microscopic examination of the urine sediment confirmed the etiologic diagnosis with the identification of struvite crystals (green arrows). However, a key contrasting finding was that struvite crystals were present in small numbers per field (low crystalluria), despite the patient having formed large uroliths. This phenomenon suggests that the urolithiasis was likely a chronic process and that the urine conditions at the time of sampling (pH 6.0) were no longer conducive to active crystal precipitation. Despite low crystalluria, the presence of uroliths (Figure 1) confirms that urinary supersaturation favoring stone formation has occurred in the past. This finding is supported by the abundance of erythrocytes (red arrows) and leukocytes (blue arrows), indicating that the current clinical symptoms are dominated by inflammation and severe mechanical irritation caused by the already formed uroliths, rather than by active crystal precipitation.

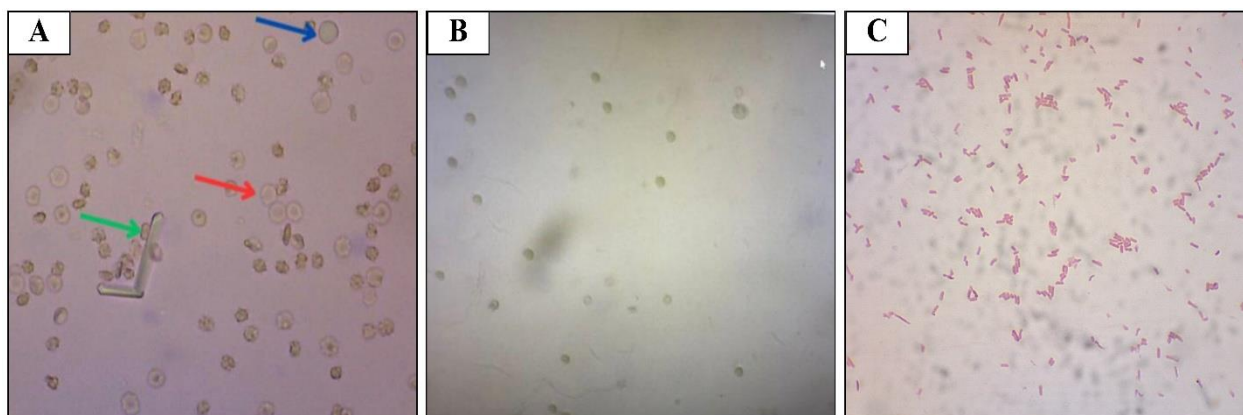


Figure 1. Urine Sediment Examination Results A: day 1, red arrow (erythrocytes), blue arrow (leukocytes), green arrow (struvite), B: Day 14 after no findings, C: E. coli bacterial culture of urine sample day 1.

Ultrasonography (USG) examination revealed qualitative thickening of the bladder wall (specific thickness was not measured), indicating acute transmural edema and inflammation, highly consistent with Hemorrhagic Cystitis. These USG findings were further confirmed by a positive urine culture identifying *Escherichia coli*, confirming the infection-induced nature of this case of struvite urolithiasis (urease-producing bacteria), making specific antibiotic treatment crucial for resolution. However, the patient's response to the dissolution therapy and antibiotic regimen was remarkable: in just 14 days, the urolith had shown significant regression from its initial dimensions of 1.16 x 0.47 cm to 0.70 x 0.27 cm (Figure 2.). This rapid dissolution rate (approximately 40-50% volume reduction) demonstrated the high efficacy of the combination of dietary therapy that acidifies the urine and eliminates *E. coli*. This rapid response demonstrates that medical dissolution is the best option despite the presence of infection and inflammation.

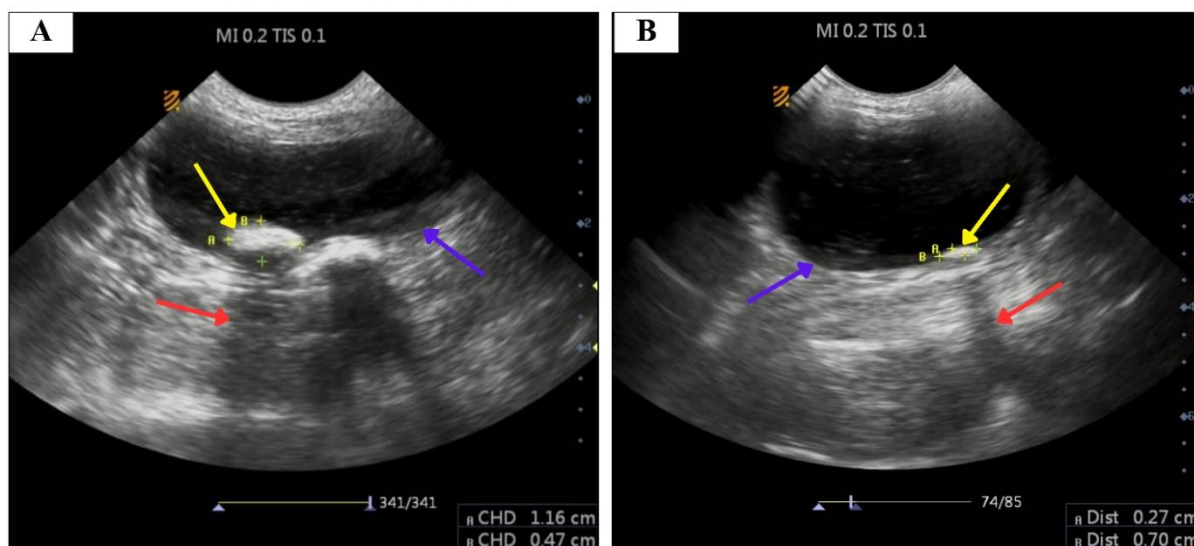


Figure 2. Results of V.U. USG Examination. A: Examination on day 1; B; Examination on day 14, hyperechoic mass, round shape, white color, presence of stones (yellow arrow), acoustic shadowing (red arrow), showing the wall (blue arrow).

The management of Struvite Urolithiasis and Hemorrhagic Cystitis cases involves a multifaceted intervention protocol. Initial stabilization of hydration with Ringer's Lactate (IV) is performed to facilitate diuresis. Infection induced etiologies are specifically addressed, starting with IM amoxicillin as an initial empirical parenteral therapy during emergency stabilization, which was subsequently transitioned to oral ciprofloxacin for 7 days to achieve broader antimicrobial spectrum coverage and superior tissue penetration within the urinary tract, particularly against Gram-negative uropathogens such as *E. coli* and potential urease producing bacteria [1]. The core dissolution intervention is a therapeutic diet (Royal Canin Urinary S/O) in wet form for 14 days, which creates a highly acidic and dilute urine, directly reducing struvite supersaturation. Anti-inflammatory support is provided through tolfenamic acid to alleviate bladder edema and stranguria. Although the herbal medicine Batugin® (a complementary herbal therapy) is used adjunctively and empirically at a dose of 1 mL PO once daily (0.38 mL/kg/day, equivalent to 38.46 mg/kg/day *Sonchus arvensis* extract and 3.85 mg/kg/day *Strobilanthes crispus*

extract for a 2.6 kg body weight), its diuretic effect theoretically accelerates dissolution. This combination of targeted interventions results in measurable urolith regression and rapid resolution of the pathology. The use of Batugin® in veterinary cases, particularly struvite urolithiasis, is still rarely reported in the scientific literature.

3. Discussion

This case presents the successful management of struvite urolithiasis complicated by infection-induced hemorrhagic cystitis in a young Persian cat. Struvite urolithiasis, although decreasing in prevalence, remains a clinical challenge, particularly when accompanied by acute inflammatory *E. coli* infection and a predominantly dry food diet. Successful management relies on a rigorous combination of dietary dissolution and urease-induced bacterial elimination. This report aims to evaluate the efficacy of our multifaceted therapy protocol, which resulted in remarkably rapid regression of uroliths.

Struvite urolithiasis is the second most common type of urolith in cats, with an increased incidence in young to middle-aged cats, averaging between 2 and 7 years [2]. Purebred cats such as Persians and Himalayans exhibit a higher breed susceptibility, often attributed to genetic predisposition or breeding practices [3]. The primary etiology of struvite in cats is urinary tract infection caused by urease-producing bacteria, such as *E. coli* or *Staphylococcus* spp., although cases of sterile struvite have also been reported [8]. Consumption of dry food high in magnesium and low in moisture has historically been believed to trigger cases, but modern diets have shifted the focus to urine saturation and pH [2].

A definitive diagnosis of urolithiasis requires a combination of imaging and urinalysis. The presence of calculi shows hyperechoic structures associated with strong and distinct distal acoustic

shadowing in ultrasound examination [9]. A similar case of urolithiasis has also been reported with hyperechoic echogenicity of hard, round structures [10]. This case of struvite urolithiasis in a Persian cat highlights the strong correlation between clinical, laboratory, and imaging findings. The manifestation of severe stranguria and pollakiuria, accompanied by Hemorrhagic Cystitis, is consistent with mechanical irritation of the 1.16 x 0.47 cm urolith and acute inflammation due to *E. coli* infection, which can trigger active urolith formation. Bacterial infection is the cause of increased ammonium concentration and struvite formation. Infection with urease-producing bacteria also contributes to the formation of struvite crystals in the urine [11].

The findings of an acidic urine pH (6.0) and low crystalluria despite the presence of large stones indicate that the active stone formation process has subsided. Similar reports suggest that the presence of crystals does not always confirm the presence of urolithiasis. Some patients may exhibit active urolithiasis without dominant crystalluria [12]. In these cases, clinical complications such as mechanical irritation and secondary infection also occur. The presence of whole blood in the urine indicates hematuria due to mechanical pressure and mucosal abrasion of uroliths on the bladder wall, where direct physical trauma from the calculi causes micro-erosion of the urothelium and rupture of mucosal capillaries, leading to the extravasation of erythrocytes into the lumen [2, 8]. Kidney stone fragments or calculi in the urethra also cause inflammation, causing blood vessels in the urinary tract wall to rupture and trigger the release of blood carried in the urine [11]. A similar study in a case of urolithiasis in a male domestic cat, where proteinuria with a value of +3 occurred, was suspected to be due to blood originating from the inflamed bladder wall mixing with the urine [13]. The presence of leukocytes in the urinary tract indicates a urinary tract infection [14]. The patient's leukogram, with relative neutrophilia and lymphopenia, confirmed a systemic

inflammatory/stress response consistent with cystitis. A similar case report of urolithiasis showed leukocytosis and neutrophilia [10].

As an adjuvant therapy, Batugin, containing extracts of *Strobilanthes crispus* folia and *Sonchus arvensis* folia, is used to help dissolve crystals in the urine and urinary tract stones (urolithiasis) [15]. Empirically in Indonesia, this extract is believed to have diuretic properties. Although international documentation of the use of Batugin in feline urolithiasis is very limited in global the veterinary literature, the use of native Indonesian phytotherapeutic agents for urolithiasis and nephrolithiasis management is well documented in domestic studies, demonstrating significant diuretic and calculus dissolving effects in preclinical models [16]. The use of herbal medicine in this case showed clinical improvement validated by ultrasound and microscopy examination. Reports of the use of this herbal medicine in a case of Cystitis et struvite also showed clinical improvement [15]. The contribution of herbal medicine to the rate of measurable urolith regression and the patient's overall clinical recovery is noteworthy, as its active components (*Sonchus arvensis* and *Strobilanthes crispus*) exert a synergistic effect through high potassium content and flavonoids. Mechanistically, this promotes diuresis to facilitate the flushing of micro-calculi, prevents crystal nucleation and aggregation, and aids in calculus dissolution via ion displacement, thereby accelerating stone size reduction [16]. The success of this case demonstrates the synergy of local therapeutic support with a standard dissolution protocol within 14 days of infection-induced struvite and a specific commercial feed diet. When strictly managed using a specific diet, antibiotics, and herbal medicine, the prognosis is very good.

A complicating factor was the client's request for a plant-based diet. The client's lack of adherence to the veterinarian's therapeutic dietary recommendations resulted in relapse. This case

report proposes nutritional counseling and the development of a nutritional support plan tailored to the patient's nutritional needs and the pet owner's lifestyle, habits, and beliefs.

By implementing this comprehensive approach, this report demonstrates the successful non-invasive management of infection-induced struvite urolithiasis with hemorrhagic cystitis in Persian cats. A multifaceted therapy protocol involving a dissolution diet, specific antibiotics, and the herbal remedy Batugin (an adjuvant diuretic) resulted in significant urolith regression within 14 days, verified by ultrasound and clinical improvement. The rapid disappearance of leukocytes, erythrocytes, and struvite crystals in the urine sediment demonstrated its efficacy. This case confirms that medical dissolution therapy is an effective and comprehensive option, even in complex cases.

Acknowledgments

The authors thank the Veterinary Teaching Hospital (RSHP) of Hasanuddin University for providing the essential clinical and laboratory facilities for this case. We also extend special thanks to the cat's owner for granting permission to publish this article.

Authors' Contribution

Study concept and design: MFH;WSM

Acquisition of data: ARU; ATJEA

Analysis and interpretation of data: MZS; DF

Drafting of the manuscript: WSM; M; S

Critical revision of the manuscript for important intellectual content: S; WSM; DF

Ethics

Animal ethics approval was not required for standard clinical care. The owner has agreed to this publication and a written informed consent form.

Conflict of Interest

The author declares no conflict of interest with any parties involved in this study.

Funding/Support

This study was conducted without financial support from any funding agencies.

Data Availability

All of the data has been included in the manuscript

Reference

1. Taylor S, Boysen S, Buffington T, Chalhoub S, Defauw P, Delgado MM, et al. 2025 iCatCare Consensus guidelines on the diagnosis and management of lower urinary tract diseases in cats. J Feline Med Surg. 2025 Feb;27(2). <https://doi.org/10.1177/1098612X241309176>
2. Lulich JP, Berent AC, Adams LG, Westropp JL, Bartges JW, Osborne CA. ACVIM Small Animal consensus recommendations on the treatment and prevention of uroliths in dogs and cats. J Vet Intern Med. 2016 Sep;30(5):1564–74. <https://doi.org/10.1111/jvim.14559>
3. Gomes VDR, Ariza PC, Borges NC, Schulz FJ, Fioravanti MCS. Risk factors associated with feline urolithiasis. Vet Res Commun. 2018 Mar;42(1):87–94. <https://doi.org/10.1007/s11259-018-9710-8>

4. Tefft KM, Byron JK, Hostnik ET, Daristotle L, Carmella V, Frantz NZ. Effect of a struvite dissolution diet in cats with naturally occurring struvite urolithiasis. *J Feline Med Surg*. 2021 Apr;23(4):269–77. <https://doi.org/10.1177/1098612X20942382>
5. Queau Y. Nutritional management of urolithiasis. *Vet Clin North Am Small Anim Pract*. 2019 Mar;49(2):175–86. <https://doi.org/10.1016/j.cvsm.2018.10.004>
6. Monnet E. Urolithiasis of the lower urinary tract. in: Monnet E, editor. *Small Animal Soft Tissue Surgery*. 1st ed. Wiley; 2023 [cited 2025 Dec 7]. p. 523–32. Available from: <https://onlinelibrary.wiley.com/doi/10.1002/9781119693741.ch44>
7. Osborne CA, Lulich JP, Kruger JM, Polzin DJ, Johnston GR, Kroll RA. Medical dissolution of feline struvite urocystoliths. *J Am Vet Med Assoc*. 1990 Apr 1;196(7): 1053–63. Available from: <https://avmajournals.avma.org/view/journals/javma/196/7/javma.1990.196.07.1053.xml>
8. Bartges JW, Callens AJ. Urolithiasis. *Vet Clin North Am Small Anim Pract*. 2015 Jul;45(4):747–68. <https://doi.org/10.1016/j.cvsm.2015.03.001>
9. Griffin S. Feline abdominal ultrasonography: What’s normal? What’s abnormal? Renal pelvis, ureters and urinary bladder. *J Feline Med Surg*. 2020 Sep;22(9):847–65. <https://doi.org/10.1177/1098612X20941786>
10. Elkewahy A, El-Maghrapy H, Badway A, Farghaly S. Ultrasonography of the urinary tract in dogs and cats: clinical investigations & prevalence. *Benha Vet Med J*. 2023 Oct 1;45(1):54–9. <https://doi.org/10.21608/bvmj.2023.227644.1698>
11. Rahmiati DU, Balasubramaniam G, Sovinar M, Tampubolon DSB, Priyatna ES, Yusrinabilla Y, et al. Feline lower urinary tract disease diagnosis in an obese sterile male

Persian mixed-breed cat. ARSHI Vet Lett. 2024 Jan 28;8(1):7–8.

<https://doi.org/10.29244/avl.8.1.7-8>

12. Bartges JW. Feline calcium oxalate urolithiasis: risk factors and rational treatment approaches. J Feline Med Surg. 2016 Sep;18(9):712–22.

<https://doi.org/10.1177/1098612X16660442>

13. Ximenes Z, Widyastuti SK, Suartha IN. Urolithiasis in domestic male cats. Vet Sci Med J. 2023 Nov 21;5(11):381–91. <https://doi.org/10.24843/vsmj.2023.v5.i11.p07>

14. Yadav SN, Ahmed N, Nath AJ, Mahanta D, Kalita MK. Urinalysis in dog and cat: A review. Vet World. 2020;13(10):2133–41. <https://doi.org/10.14202/vetworld.2020.2133-2141>

15. Samsuri DA, Soma IG, Antara MS. Case report: cystitis without an obvious cause in a domestic cat. Indones Med Veterinus. 2022 July 31;11(4):622–34.

<https://doi.org/10.19087/imv.2022.11.4.622>

16. Situmorang N, Simanjuntak P, Rosidah. Aktivitas antinefrolitiasis ekstrak etanol daun sambung nyawa (*Gynura procumbens* Lour. Merr) pada tikus putih jantan (*Rattus norvegicus*). 2024. Available from: <https://www.researchgate.net/publication/379080012>