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A RETROSPECTIVE STUDY ON THE INCIDENCE OF CRYSTAL TYPES IN CATS

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Abstract

Cats exhibit a high susceptibility to the formation of urinary calculi, which can lead to severe urinary complications. This study was conducted on a batch of 46 cats from a private veterinary clinic in Bucharest, consisting of 15 females and 31 males. Among the females, 14 were spayed, while 27 of the males were neutered.
The most frequently identified type of urolith was magnesium ammonium phosphate (struvite), observed in 25 cases, followed by amorphous crystals in 13 cases, calcium oxalate in 3 cases, and mixed urolithiasis (magnesium ammonium phosphate and calcium oxalate) in 5 cases. Shorthairs showed the highest prevalence of struvite crystals. Middle-aged cats were the most affected, with a higher incidence in neutered males. These findings underscore the importance of early urinalysis and breed-specific preventive strategies to reduce the risk of surgical intervention.

Key words*: uroliths, cats, calcium oxalates, magnesium ammonium phosphates, urinalysis.*

INTRODUCTION

Urolithiasis is the second most common cause of clinical signs associated with feline urinary tract disease. The term "urolithiasis" refers to the presence of uroliths in any part of the urinary tract, although it is most frequently observed in the bladder and urethra. Uroliths are classified according to the mineral composition of their structure. As such, both quantitative and qualitative analyses of the uroliths are essential for determining an appropriate therapeutic approach (Gomes et al., 2018).
The formation of urine supersaturation with crystalloids is influenced by several factors, including the volume of crystals in the urine, renal crystal excretion, urine concentration, pH, and the presence or absence of urolith-promoting substances or inhibitors (Defarges et al., 2020; Kovaříková et al., 2021).
Urolithiasis is a prevalent condition in both dogs and cats, with struvite and calcium oxalate being the most commonly identified mineral types. However, other mineral compositions may also contribute to the formation of uroliths. Certain types of uroliths, such as struvite, purines, and cysteine, are amenable to medical dissolution, whereas others, including calcium oxalate and compound uroliths, are resistant to this form of treatment (Bartges, 2018; Jepson, 2023; Canello et al., 2017)

MATERIALS AND METHODS

To evaluate the incidence and distribution of various types of uroliths in felines, we conducted a retrospective study between 2022 and 2024 at a private veterinary clinic in Bucharest. The research encompassed a cohort of 47 domestic cats, comprising both males and females, presenting with varying clinical manifestations. While some exhibited overt lower urinary tract signs such as hematuria, dysuria, pollakiuria, or urinary obstruction, others were asymptomatic and diagnosed incidentally.
Comprehensive diagnostic assessments were performed, including abdominal ultrasonography and urinalysis, which facilitated the identification of urolithiasis localized to the urinary bladder. Urine samples were aseptically collected via ultrasound-guided cystocentesis to ensure sample integrity and minimize contamination risk. These specimens underwent thorough analysis in the clinic's in-house laboratory.

Following sample collection, the urine was analyzed immediately. The sample was centrifuged for 5 minutes at 2000 rpm. After centrifugation, the supernatant was discarded, leaving approximately 0.5 mL of fluid to retain the sediment. The sediment was then gently resuspended using a pipette. A single drop of the resuspended sediment was placed on a microscope slide, covered with a cover slip, and examined microscopically. Microscopic evaluation was performed using a 10× objective for initial scanning and a 40× objective for the identification of uroliths

RESULTS AND DISCUSSIONS

Of the total number of felines included in the study, 15 were females and 31 were males. Among the females, 14 were spayed, which represents 93% of the total number of females, while only one remained intact, 7% of the total number of females. Regarding the males, 27 were neutered, which represents 87%
of the total number of males and only four were unneutered, which accounts for 13%.

A key aspect of this study was the systematic classification of feline subjects based on breed in order to evaluate potential breed-specific predispositions to urolithiasis.

Of the total number of cats included in the study, 32 were European Shorthair, representing 70% of the total population, followed by 8 British Shorthair cats, accounting for 18%. Additionally, there were 2 individuals from each of the Persian, Birman, and Russian Blue breeds, each constituting 4% of the total (Table 1). Identifying breed-related susceptibility is essential for understanding genetic or physiological factors that may contribute to the pathogenesis of urinary stone formation. By categorizing felines according to their breed, this study aimed to assess whether particular breeds exhibit a higher incidence of urolithiasis, which could have implications for targeted preventative measures, breed-specific dietary recommendations, and early diagnostic strategies.

To compare with our study, a study conducted on a larger sample of animals has been cited in the specialized literature, highlighting similar trends or notable differences regarding the incidence of urolithiasis in different cat breeds, this study was conducted over eight years, analyzing a cohort of 143 feline cases, identified a predominant incidence of urolithiasis among specific feline breeds. The vast majority of affected individuals were domestic shorthair cats, accounting for 99.69% of cases, followed by domestic longhair cats at 21.15% and domestic medium hair cats at 6%. These findings suggest a potential breed predisposition, with domestic shorthair cats being disproportionately affected. Furthermore, the mean age of cats diagnosed with urolithiasis was determined to be approximately seven years, indicating that middle-aged felines may be at an increased risk for urinary stone formation (Dear et al., 2011).

Table 1. The classification of cats based on their breed

Breed	Total number
Persian Cat	2
European shorthair	32
British Shorthair	8
Birman	2
Russian Blue	2

Age was a fundamental demographic variable evaluated in this study to investigate its potential contribution as a predisposing factor in the pathogenesis of urolithiasis in felines. The correlation between age and the incidence of urolithiasis is of important clinical significance, as physiological, metabolic, and dietary changes associated with aging may influence urinary tract health and the propensity for urolith formation.

Among the 46 feline subjects included in the study, 20 individuals (44%) were classified within the 0-5-year age group, indicating that a significant proportion of cases occurred in younger cats. The second-largest group comprised felines aged 6-10 years, accounting for 18 cases (39%), suggesting that middle-aged cats may also be at considerable risk for urolithiasis. Furthermore, 8 cats (17%) fell within the 11-16-year age category, representing the geriatric population in this study (Figure 1). These findings provide valuable insights into the age-related distribution of urolithiasis and may support the need for age-specific management strategies, including dietary modifications and routine urinalysis screening in at-risk populations.

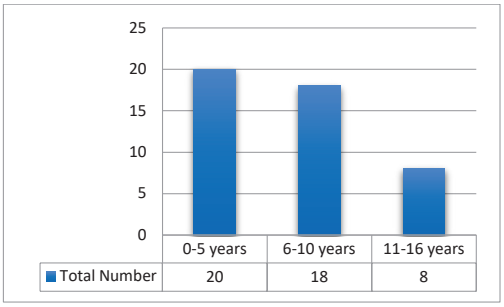

Figure 1. The classification of felines based on age

A total of 46 urine samples were analysed to determine the prevalence and distribution of different types of urinary crystals associated with urolithiasis in felines. The most frequently identified crystalline composition was ammonium-magnesium phosphate, commonly known as struvite, which was present in 25 samples, accounting for 54% of the total cases.

In 13 samples (28%), amorphous crystals were detected. These crystals, which may consist of a mixture of various mineral components, are often considered a nonspecific finding. However, their presence can indicate urinary supersaturation and a predisposition to urolith formation, particularly in felines with underlying metabolic imbalances or dietary influences that affect urine composition.

A mixed composition of both ammonium-magnesium phosphate and calcium oxalate crystals was identified in 5 samples, representing 11% of the total cases. The coexistence of these two types of urolithogenic minerals suggests fluctuating urinary pH conditions, potentially influenced by dietary intake, hydration status, or concurrent metabolic alterations. Such cases may be of particular clinical concern, as they indicate a complex pathophysiological process requiring individualized therapeutic and dietary management strategies.

Calcium oxalate crystals were identified as the sole mineral component in only 3 urine samples, comprising 7% of the total cases.

These findings provide valuable insight into the distribution of urinary crystals in felines diagnosed with urolithiasis, highlighting the predominance of struvite crystalluria while also acknowledging the occurrence of mixed and calcium oxalate compositions. The data emphasize the importance of urine analysis in the early detection of crystal formation, allowing for timely intervention through dietary modifications, increased water intake, and urinary pH regulation to mitigate the progression to clinical urolithiasis (Figure 2).

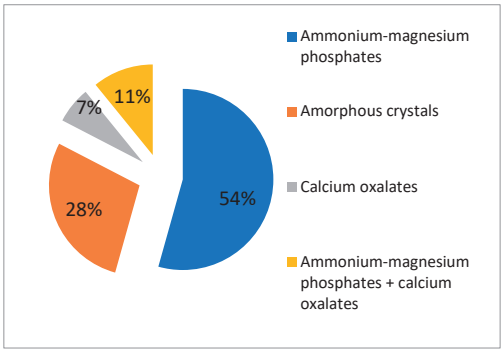

Figure 2. Classification based on the percentage of uroliths identified in the analysed samples

A comprehensive study conducted at the Minnesota Urolith Centre provided valuable epidemiological data regarding the incidence and demographic distribution of urolithiasis in felines. The findings indicated that struvite urolithiasis was most frequently diagnosed in cats between the ages of 2 and 7 years, suggesting that younger to middle-aged felines may be at an increased risk for the development of struvite-based urinary calculi. This pattern may be associated with dietary factors, urine pH, and differences in metabolic activity that influence urinary supersaturation with magnesium, ammonium, and phosphate ions, the primary constituents of struvite crystals.

Furthermore, the study highlighted a notable sex predisposition, with a higher prevalence of struvite urolithiasis observed in female cats compared to their male counterparts.

Breed predisposition was also examined, revealing that Siamese cats exhibited an increased susceptibility to struvite urolith formation compared to other feline breeds. This suggests a possible genetic or breed-related metabolic factor influencing urinary mineral composition, warranting further investigation into breed-specific risk factors and preventative measures.

In contrast, the incidence of calcium oxalate urolithiasis followed a distinct pattern. The mean age of affected felines ranged between 8 and 12 years, indicating that this type of urinary

stone is more commonly diagnosed in older cats. This trend may be linked to age-related physiological changes, including alterations in calcium homeostasis, renal function, and urine acidification, all of which are known to contribute to calcium oxalate crystallization.

Moreover, calcium oxalate urolithiasis demonstrated a pronounced male predisposition, with a significantly higher incidence reported in male cats compared to females. This finding aligns with existing research that suggests male cats may have an increased risk due to factors such as lower urinary tract anatomy, hormonal influences on calcium metabolism, and potential differences in dietary intake or water consumption patterns.

These results underscore the importance of demographic factors, including age, sex, and breed, in the epidemiology of feline urolithiasis. Understanding these predispositions is crucial for developing targeted prevention strategies, including age-specific dietary recommendations, sex-based risk assessments, and breed-focused urinary health monitoring. Further research is warranted to elucidate the underlying pathophysiological mechanisms driving these observed trends and to refine management approaches for reducing the incidence of urolithiasis in high-risk feline populations (Grauer, 2015).

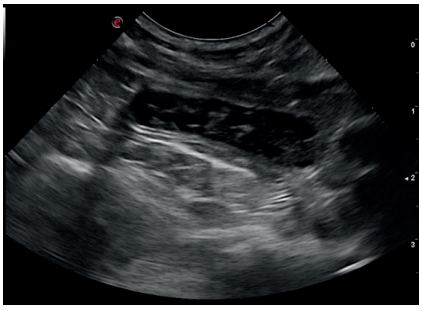

Figure 3. Ultrasound image of bladder urolithiasis in a cat involved in the study

Abdominal ultrasonography assisted in the diagnosis of urinary stone disease in the feline subjects included in this study. This imaging technique is widely recognized for its high sensitivity in detecting urinary tract abnormalities, including the presence of uroliths, bladder sand (crystalline sediment), and associated structural changes within the urinary bladder. Ultrasonography offers several advantages, such as being non-invasive, readily accessible in clinical practice, and capable of visualizing radiolucent uroliths that may not be detectable on conventional radiographs (Figures 3).

Despite these benefits, ultrasonography alone has limitations in determining the precise composition of uroliths. While certain sonographic characteristics, such as echogenicity and acoustic shadowing, may provide indirect clues regarding the mineral composition of urinary stones, definitive identification cannot be established through imaging alone. The accurate classification of urolith type is essential for guiding appropriate therapeutic interventions, including dietary modifications, pharmacologic management, or surgical removal when indicated.

To overcome these diagnostic limitations, urine samples were obtained via ultrasound-guided cystocentesis for further laboratory analysis. This technique, which involves the percutaneous aspiration of urine directly from the urinary bladder under ultrasonographic guidance, ensures a sterile sample collection method, minimizing the risk of contamination from the lower urinary tract. The collected urine was subsequently subjected to detailed laboratory evaluations, including urinalysis, urine sediment examination, and crystallographic analysis, to determine the specific mineral composition of the uroliths present (Figures 4, 5).

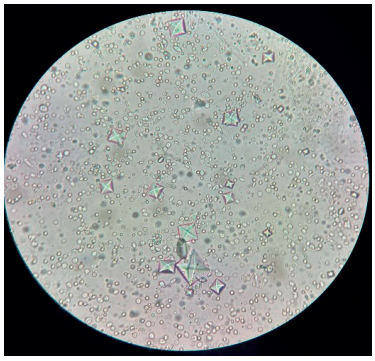

Figure 4. Microscopic image of calcium oxalates

By integrating ultrasonographic assessment with laboratory-based urine analysis, this study aimed to achieve a comprehensive diagnostic approach for feline urolithiasis. This multimodal strategy not only facilitated the detection of

urinary calculi but also allowed for the precise characterization of their composition, which is critical for selecting the most effective management and prevention strategies tailored to each individual case.

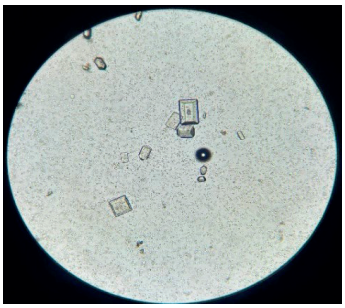

Figure 5. Microscopic image of magnesium ammonium phosphate

We also focused on assessing potential breed-related predispositions to urolithiasis. The most frequently detected crystalline composition was ammonium-magnesium phosphate, commonly referred to as struvite. Struvite crystals were identified in 18 European Shorthair cats, 6 British Shorthair cats, and 1 Russian Blue cat. These findings suggest a higher prevalence of struvite crystalluria in European Shorthairs, potentially indicating an underlying breed-specific susceptibility. This predisposition may be influenced by genetic factors, metabolic differences, or dietary habits that contribute to urinary supersaturation with struvite-forming minerals. The relatively high incidence of struvite crystalluria in British Shorthair and Russian Blue cats, though lower than in European Shorthairs, further underscores the need for targeted urinary health management in these breeds.

In addition to struvite, amorphous crystals were identified in multiple feline subjects, with the highest occurrence observed in European Shorthairs (9 cases). Other breeds in which amorphous crystals were detected included the Persian (1 case), British Shorthair (1 case), Birman (1 case), and Russian Blue (1 case).

Furthermore, a mixed composition of ammonium-magnesium phosphate (struvite) and calcium oxalate crystals was detected in 5 European Shorthair cats. This coexistence of differing crystalline types within the same urine sample suggests a dynamic urinary environment in which pH levels and mineral concentrations fluctuate over time, leading to the formation of mixed uroliths. Such cases may present a unique clinical challenge, as the management strategies for struvite and calcium oxalate stones differ significantly.

About calcium oxalate crystalluria, this type of urinary crystal was identified in the urine samples of 1 Persian cat, 1 British Shorthair cat, and 1 Birman cat. Compared to struvite, the overall prevalence of calcium oxalate crystals was lower in this study population. This discrepancy may reflect variations in urinary pH, as calcium oxalate tends to form in more acidic urine, whereas struvite formation is favoured in alkaline conditions (Ericksen, 2021).

These findings provide crucial insights into the breed-specific distribution of urinary crystals in felines diagnosed with urolithiasis. The predominance of struvite crystalluria, particularly in European Shorthair cats, highlights the necessity for breed-oriented preventative strategies, including regular urinalysis screening, appropriate dietary formulations, and hydration optimization. Furthermore, the detection of mixed and calcium oxalate crystals underscores the complexity of feline urolithiasis and the importance of individualized treatment approaches. Future research should focus on elucidating the genetic and environmental factors influencing urolith formation in different feline breeds to enhance preventive and therapeutic measures for this common urinary disorder (Table 2).

A large-scale study conducted over a six-year period, encompassing a total of 7,866 feline and canine subjects, identified 36 distinct cat breeds affected by urolithiasis. Among these, European Shorthair cats exhibited the highest prevalence of urinary stone formation, indicating a potential breed-specific predisposition. The most frequently identified urolith composition in this breed was ammonium-magnesium phosphate, commonly known as struvite. This finding aligns with previous research suggesting that European Shorthairs may have a metabolic or dietary susceptibility to struvite crystallization, necessitating targeted preventive measures such as urinary pH modulation and dietary adjustments.

In contrast, calcium oxalate uroliths were more frequently diagnosed in British Shorthair,

British Longhair, Birman, and Persian cats. These breeds exhibited a markedly higher incidence of calcium oxalate stones compared to struvite, suggesting differing pathophysiological mechanisms contributing to urolith formation.

These findings reinforce the importance of breed-specific risk assessments in the management of feline urolithiasis. Understanding the prevalence of different urolith types across various breeds can inform tailored preventive and therapeutic approaches, ultimately reducing the recurrence and clinical complications associated with urinary stone disease in felines (Burggraaf et al., 2020).

Table 2. Prevalence of urolith type within breed

Urolith type	Breed				
	Persian Cat	European shorthair	British Shorthair	Birman	Russian Blue
Ammonium-magnesium phosphates	0	18	6	0	1
Amorphous crystals	1	9	1	1	1
Ammonium-magnesium phosphates + Calcium oxalates	0	5	0	0	0
Calcium oxalates	1	0	1	1	0

CONCLUSIONS

This retrospective study highlights the predominance of struvite urolithiasis in cats, particularly among European Shorthair breeds, suggesting a potential breed-specific predisposition influenced by metabolic or dietary factors. In contrast, calcium oxalate crystals were more frequent in British Shorthair, Birman, and Persian cats, indicating distinct etiopathogenic mechanisms.

Age and sex were also relevant factors, with middle-aged cats being more commonly affected and a notable sex distribution observed across different crystal types. The identification of mixed urolith compositions further emphasizes the multifactorial nature of feline urolithiasis and the need for individualized diagnostic and therapeutic strategies.

These findings support the clinical utility of routine urinalysis and ultrasonography in early detection, particularly in predisposed breeds. Preventive approaches - focused on hydration, dietary management, and regular screening - are essential to minimize recurrence and reduce the need for surgical intervention.

Future research should explore genetic and environmental contributors to breed-associated risks and refine targeted, evidence-based management protocols to improve outcomes in feline urinary tract health.

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