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Research article

Urolithiasis and the effectiveness of treatments in dogs and cats in Ho Chi Minh City, Viet Nam

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Abstract

This study aimed to investigate the prevalence of urolithiasis, analyze the chemical composition and anatomical location of the stone, and evaluate the effectiveness of treatments in dogs and cats. The investigation lasted one year in 7 Veterinary Clinics in the urban area of Ho Chi Minh City. Results show that urolithiasis accounted for 37.1% of total cases of dogs and cats, and that cats are more sensitive to urolithiasis than dogs (44.93% vs 27.90% of total population). Some risk factors such as sex, type of food and levels of drinking water affect urolithiasis rate, in which male animals and low levels of drinking water are more sensitive to urolithiasis than females and adequate levels. Lower urinary stones are common in dogs (74.05% of cases) and in cats (88.00% of cases). Struvite stones in dogs (62.00% of cases) and calcium oxalate in cats (56.00% of cases) are the most common type of urinary stones. Medical treatment is the most effective method to treat urolithiasis in cats and dogs.

Keywords: Cat, Chemical composition, Dog, Urban Area, Uroliths, Urinary tract

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INTRODUCTION

Urolithiasis can be defined as the formation of sediment anywhere within the urinary tract which consists of one or more poorly soluble urine crystalloids (Ulrich et al., 1996). Urolithiasis is considered a multi-factorial disease and understanding the composition of uroliths to define the cause of their formation is essential, especially considering treatment and prevention measures (Gomes et al., 2022). Urolithiasis is an important disease in cats and dogs, particularly because of its occurrence within both the lower and upper urinary tract, which can result in clinically important morbidity and mortality. In the World, the prevalence of urolithiasis in dogs was reported to be 0.25 - 3% in Sweden, Norway, North America, Ukraine and Germany.

An urolith may be defined as the aggregation of crystalline and matrix materials that form in one or more locations within the urinary tract when urine becomes oversaturated with crystallogenic substances, and may be composed of one or more mineral types. Uroliths that form in cats and dogs can be grouped into four main mineral types, namely urate (including ammonium urate, sodium urate and uric acid), cysteine, magnesium ammonium phosphate and calcium (Ulrich et al., 1996). Nutrition is the major factor responsible for formation of uroliths in dogs and cats.

Haematuria, pollakiuria, stranguria, and dysuria are common clinical signs of lower urinary tract disease and are not specific for cystic calculi. Uroliths of both the upper and lower urinary tracts may cause secondary infection. Several methods to treat urolithiasis have been applied. Osborne et al. (1990) found that dissolution therapy is effective in management of sterile feline struvite calculi. Abreu and Gill (2005) reported that open surgery for renal tract stones has become almost obsolete, with laparoscopic surgery increasingly used in situations for which open surgery would previously have been used, including complex stone burden, failed previous ESWL and/or endourological procedures, anatomical abnormalities and morbid obesity. However, regarding a range of factors, including stone location, size, chemical composition, and the condition of kidney fluid retention, the appropriate treatment is selected from medical treatment, surgical treatment, or a combination of both methods (Pearle et al., 2014).

To our knowledge, few studies are available concerning the urolithiasis in cats and dogs in Viet Nam. Tran et al. (2014) indicated that 122 of 1,652 examined dogs (7.38%) in Can Tho City have pathological changes in urinary system, in which, 31.97% of urinary disease cases happen in the kidney and 39.34% in bladder and urethra. Incidence of urinary tract disease in dogs increases with age, most elderly dogs (over 5 years old with 19.93%). However, Le et al. (2024) reported that 472 of 3,700 examined dogs (12.67%) in Ho Chi Minh City showed urinary pathology, in which 22.67% of total urolithiasis cases happen in the kidney and 77.33% in bladder. Urologic diseases occur in dogs of all ages, increasing with the age of dogs, and depending on breed and sex. In addition, Nguyen et al. (2022) found that in 164 cases with pathological symptoms on the bladder, male 81.71% were in cat males, 63.41% in domestic breeds, 64.02% in neutered cats, 61.59% in industrial food diet and 54.88% in free-range.

This study, therefore, aimed at investigating prevalence of urolithiasis, stone chemical composition, and effectiveness of treatments in dogs and cats in urban areas in Ho Chi Minh City.

MATERIALS AND METHODS

Location and animal ethics

The survey was conducted at 7 Veterinary Clinics in Ho Chi Minh City from November 2023 – November 2024 and the research protocol was approved by the

Scientific Committee of the Faculty of Veterinary Medicine and Animal Sciences, Ho Chi Minh City University of Technology (HUTECH).

Methods

Historical information collection

Retrieve detailed information on animal disease by obtaining information from the owner, including age, gender, breed, diet, water consumption, living conditions, fecal characteristics, urination patterns, movement, etc. prior to getting medical history, any unusual symptoms observed at home, graft disease, and the duration between emergence of symptoms.

Sub-clinical diagnosis

A total of 185 dogs and 350 cats in 1442 cases were observed and recorded daily clinical symptoms, including aspects namely urine color, presence of blood or pus in urine, urination position (straining), urination frequency, urine volume, and timing of urination.

A total of 50 dogs and 50 cats were examined by ultrasound and X-ray followed by Langston et al. (2008) to investigate urolith location and mineral composition.

Treatment methods

Medical treatment. A total of 130 dogs and 227 cats were used in medical treatment. The selection of medications depends on the chemical composition of the stones, aiming to modulate urine pH for stone dissolution, size reduction, or growth inhibition. Some medicines utilized for the treatment and prevention of urinary stones are listed below:

- Acetohydroxamic acid (AHA) for treatment of struvite stones in dogs, dosage of 25 mg/kg of body weight twice daily.

- Allopurinol is mainly used to treat or prevent the recurrence of uric acid stones in small animals. In dogs, a dose of 7-10 mg/kg body weight twice daily; in cats, 9 mg/kg of body weight daily.

- Diuretics not only increase the excretion rate of sodium but also change the excretion of other ions such as K^+, H^+, Ca^{2+}, Mg^{2+}, and HCO_3^-.

Surgical treatment. A total of 48 dogs and 112 cats were operated on to remove a proactive stone with short treatment time.

Besides, 7 dogs and 11 cats were treated by both medical and surgical treatment.

Statistical analysis

Data were descriptively analyzed on Microsoft Excel 2010, and using the Chi-square test on Minitab version 17 software to compare the means.

RESULTS

Urolithiasis and risk factors

A 535 of 1,442 dogs and cats (37.1%) with symptoms of urinary tract disease, were diagnosed with urinary stones, and dogs infected less than cats (27.9% vs 44.93%) (Table 1). Sex affects significantly urolithiasis in dogs and cats. In general, males affect rather than females ($P<0.05$). However, the breed didn't affect urolithiasis in both dogs and cats ($P>0.05$). In addition, the type of feed and levels of drinking water affect significantly urolithiasis. Dogs and cats eat commercial food and mixed diets have higher urolithiasis infection than cooked rice

and meat diets. Moreover, low levels of drinking water affect strongly urolithiasis in both animals.

Table 1 Incidence of urinary stones in dogs and cats according to sex, breed, feed type and drinking water

Criteria	Dog				Cat			
	No. of surveyed cases	No. of urinary stone cases	Rate (%)	*P*	No. of surveyed cases	No. of urinary stone cases	Rate (%)	*P*
Total	**663**	**185**	**27.90**		**779**	**350**	**44.93**	**0.001**
Sex								
Male	304	106	45.40	0.023	401	243	60.60	<.001
Female	174	79	34.87		378	107	28.30	
Breeds								
Local	286	88	30.77	0.153	259	109	42.10	0.295
Exotic	377	97	25.73		520	241	46.34	
Types of feed								
Commercial feed	382	127	32.98		513	243	47.40	
Rice and meat	94	21	25.40	0.001	53	13	24.50	0.005
Mixed diet	187	37	30.50		213	94	44.13	
Levels of water intake*								
Low	38	26	68.42		492	226	89.25	
High	336	83	24.70	<.001	194	41	21.13	<.001
Ad lib	289	76	26.30		93	83	25.93	

**Low: 50% of request; High: > 100% of request; Ad lib: drinking as the demand*

Urolith location

Table 2 provides information on the numbers of stones detected in different internal organs in the surveyed cats and dogs' bodies. It can be seen that stones are more likely to form in lower urinary tract than in upper once in both dogs and cats. Approximate 74% urolith cases were in lower urinary tract in dogs, and 88% in cats.

Table 2 Urolith location in different urinary systems of dogs and cats

Anatomical location	Animals			
	Dog (n=185)	Rate (%)	Cat (n=350)	Rate (%)
Upper urinary tract				
Kidney	46	24.87	12	3.43
Bladder and kidney	2	1.08	30	8.57
Sub-total	*48*	*25.95*	*42*	*12.00*
Lower urinary tract				
Bladder	117	63.24	163	46.57
Urethra	6	3.24	45	12.86
Bladder and urethra	14	7.57	100	28.57
Sub-total	*137*	*74.05*	*308*	*88.00*

Clinical signs of urolithiasis

Table 3 shows that the typical clinical symptoms related to both dogs and cats with urolithiasis occur at different rates. The most common symptom among infected dogs is frequent urination, accounting for 32.97%, while cats exhibit the highest percentage of urine retention which is 36.28%.

Table 3 Clinical signs of urolithiasis in dogs and cats

Signs	Animals			
	Dog	Rate (%)	Cat	Rate (%)
Retention Urine	47	25.41	127	36.28
Frequent urination	61	32.97	24	6.85
Difficult urination	33	17.84	89	25.43
Hematuria	14	7.57	84	24.00
Abdominal pain	7	3.78	3	0.86
Fever	3	1.62	0	0.00
No eating	5	2.70	1	0.30
Purulent urine	1	0.54	3	0.86
2 symptoms and/or more	14	7.57	19	5.42
Total	185	100	350	100

Mineral composition of uroliths

Both species of dogs and cats develop different types of urinary stones, the two most common of which recorded during diagnostic procedures are listed in Table 4. A total of 62% of dog cases with stones in the urinary tract are composed of struvite stones whereas 56% of infected cats develop calcium oxalate stones.

Table 4 Mineral composition of uroliths in dogs and cats

Minerals	Animals			
	Dog	Rate (%)	Cat	Rate (%)
Magnesium ammonium phosphate (Struvite)	31	62.00	22	44.00
Calcium oxalate	19	38.00	28	56.00
Total	50	100	50	100

Effectiveness of treatments

Results of effectiveness of treatment methods in dogs and cats present Table 5. In Table 5, we can show that the most commonly used method of treating urolithiasis in dogs and cats is internal medicine, accounting for 70.27% in dogs and 64.86% in cats.

DISCUSIONS

Urolithiasis and risk factors

Our findings the rate of dogs and cats with urinary stones is higher in cats than dogs. Le et al. (2003), who conducted a survey on 279 dogs with unusual symptoms related to the urinary system with ultrasound and X-ray, found 47 cases of dogs with bladder stones, accounting for 16.84% of the whole population. In addition, Lee et al. (2012) reported that the number of cats with urinary stones accounts for 56.52% of the total number of cats with urinary tract diseases.

Table 5 Treatment methods, effectiveness and treatment time for urolithiasis in dogs and cats

Variables	Animals			
	Dog (n=185)	Rate (%)	Cat (n=350)	Rate (%)
Treatments				
Medical	130	70.27	227	64.86
Surgery	48	25.95	112	32.00
Combine (Medical + Surgery)	7	3.78	11	3.14
Treatment efficacy				
Cured	126	68.1	266	76.00
Remission	57	30.81	75	21.43
Relapse	2	1.08	9	2.57
Treatment time (days)				
<7	67	36.22	180	51.43
7-14	71	38.37	107	30.57
>14	47	25.41	63	18.00

Regarding gender, both dogs and cats show a higher infection rate in males than in females (Schaible, 2020). Typically, male dogs are more susceptible to urinary diseases than females because of their narrower and more complex urinary tract structure. Similarly, the disease is more prevalent in male cats than the opposite sex because their urinary tracts, despite the similarity between both sexes in length and size, have a curve that forms a cavernous space, the process of urinary stone formation. The result in recent study is similar to the study of Ergin et al. (2018) on lower urinary system diseases in cats, which found that among 134 cats with clinical symptoms of urinary system diseases examined by ultrasound, all 6 cases diagnosed with the urinary stone disease were male.

In our findings, dogs and cats in commercial food and mixed diets are more sensitive with urolithiasis. This finding could be justified by the popularity of dried food on the pet food market among owners because of their high content of nutrients. However, this low-moisture product should be combined with higher and more regular water consumption. Because cats and dogs are regularly fed dry food, they have limited opportunities to consume water content in food and show a higher tendency towards urine retention. Therefore, they are more susceptible to developing urinary diseases (Syme, 2012). In addition to dehydrated food, the cat's habit of drinking little water also worsens their state of dehydration. From the aforementioned statistical analysis, it can be concluded that a good nutritional regimen would contribute to reducing and preventing urinary diseases in domestic pets.

Urolith location

It is evident that the formation of stones is more common in the lower urinary tract than in the upper tract in both dogs and cats. This might be because the bladder is the place where urine is stored before being discharged. Additionally, kidney stones tend to move through the ureters and eventually accumulate in the bladder, causing a higher concentration there. Another explanation for this tendency is that, in pets with genital tract diseases, bacteria from the genital tract can also cause bladder infections, increasing the risk of bladder stones. On the other hand, according to Fogle (2007), the anatomical structure of female cats and dogs, which are typically shorter with a larger opening, increases the risk of bladder and other infections, thus accelerating stone formation.

Upper urinary tract stones are uncommonly reported in cats and dogs and the vast majority of uroliths (>95%) submitted for analysis are removed from the lower urinary tract (Koehler et al., 2009). It seems more likely that there is a real species difference. It has been hypothesized that this may, at least in part, relate to the positioning of the kidney and bladder relative to gravity in quadrupeds and bipeds (Markwell et al., 2000). Anatomical differences in the structure of the kidney

and in particular the absence of renal pyramids and calyces in the dog and cat kidney, may also contribute to observed anatomical differences in the occurrence of urolithiasis. Urolithiasis accounts for 15% to 23% of cases of feline lower urinary tract disease; up to 11% of cases are due to anatomic defects; and 1% to 8% are urinary tract infections (Gerber et al., 2005)

Clinical signs of urolithiasis

The difference in rates of these symptoms may be due to the fact that cats have easier-to-monitor toilets than dogs (toilets in sand), so monitoring may be more accurate. In addition to the above common symptoms, there are also some less common symptoms that are not representative of this disease such as fever, abdominal pain, and loss of appetite. It is worth noting that these atypical symptoms might have affected the statistical accuracy of our study.

Larger stones in the lower urinary tract can block urination or irritate the lining of the bladder or urethra. These problems could consequently cause slow and painful urination with bloody urine. In general, kidney stones display little or no signs unless the kidney becomes inflamed or the stone passes into the ureter. A blocked utterer caused by stones could cause vomiting, fatigue, and pain in the area around the kidney. This sign is especially common when the ureter becomes suddenly and completely blocked, and the fluid causes the kidneys to enlarge. Pain may be a sign of a ureteral stone on one side. However, the pain can be difficult to develop in dogs. If a blocked ureter is not diagnosed immediately, kidney damage will occur (Defarges et al., 2020).

Mineral composition of uroliths

The different types of urinary stones in both dogs and cats might be linked to the biological characteristics difference among them. There are many different types of urinary gravel, each of which has a different and complex composition of minerals. Stones are classified according to their composition, such as struvite, calcium oxalate, urate, calcium phosphate, xanthine, cystine, and silica. The most common types are made with struvite, calcium oxalate and urate. These components can be found in the various urolith layers, i.e., nucleus, stone, and wall. Determining the exact composition of each urolith layer is only possible when using quantitative techniques (Koehler et al., 2009).

In dogs, struvite stones are associated with urinary tract infections, which are more common in female dogs than in male dogs. Urinary stones only form when the stone components are available in sufficient quantities and when the crystals remain in the urine for a specific length of time. Some other types of gravel can only form in certain favorable conditions or environments such as the right level of acidity. These conditions can be influenced by urinary tract infections, diet, digestion, the amount of urine the animal produces, frequency of urination, medications, and genetic makeup (Defarges et al., 2020).

In cats, calcium oxalate stones, the most common type of urinary stones, can form in excessively acidic urine (Schaible, 2020). They may be seen in cats with elevated blood calcium levels which are the secondary symptoms of a condition called idiopathic hypercalcemia or in cats with chronic kidney disease. Struvite stones occur not only in cats with highly alkaline urine but also in those with excessive intake of magnesium, phosphorus, calcium, chlorine, and fibre. According to Mendoza-Lospez et al. (2019), female cats are more susceptible to struvite stone formation than the opposite sex while males are more subject to calcium oxalate gravel.

Effectiveness of treatments

Urinary tract diseases are not too difficult to detect and treat. Several methods to treat urolithiasis have been applied such as dissolution therapy (Osborne et al., 1990); and open surgery (Abreu and Gill, 2005). Medical method is widely adopted to limit interventions in the animal's body, minimize expense and support good animal health (Le et al., 2024). If the stone is too large and the medicine does not yield satisfactory results, surgery to remove the stone will be prescribed (Nguyen et al., 2022). Therefore, Pearle et al. (2014) indicated that the appropriate treatment regarded a range of factors, including stone location, size, chemical composition, and the condition of kidney fluid retention, etc.

CONCLUSIONS

In conclusion, urolithiasis accounted for 37.10% of total cases in dogs and cats, with a higher prevalence in cats than in dogs. Several risk factors, such as sex, diet, and water intake, influence the incidence of urolithiasis, with male animals and those consuming lower levels of drinking water being more susceptible compared to females and those with adequate water intake. Lower urinary tract stones are commonly observed in both species, with struvite stones being the most prevalent in dogs, and calcium oxalate stones in cats. Medical treatment remains the most effective approach for managing urolithiasis in both cats and dogs.

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AUTHOR CONTRIBUTIONS

Nguyen Vu Thuy Hong Loan and Dang Hoang Dao conceived, designed the experiments; Dang Hoang Dao performed the experiment; Nguyen Vu Thuy Hong Loan and Dang Hoang Dao analysed the data; Nguyen Vu Thuy Hong Loan wrote the paper; all authors reviewed and approved the final manuscript.

CONFLICT OF INTEREST

Authors declare no conflict of interest.

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