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Sensitivity of urolithiasis detection using urinary, radiography and ultrasound parameters

Sensibilidade da detecção da urolitíase utilizando parâmetros urinários radiográficos e ultrassonográficos

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Abstract

Although many information has been published regarding canine urolithiasis, sensitivity of radiography, ultrasound and urinary parameters have been poorly correlated with number, size, and composition of the stones. One hundred and thirteen clinical files of dogs with diagnosis of urolithiasis were retrospectively selected. Information regarding number, appearance, location, size, and composition of the stones were noted after surgical removed. Urolithiasis data was compared with radiographs and ultrasound images and urinalysis parameters. Pure struvite was found in 42.4% and calcium oxalate in 35.6%. Survey radiographs enabled the detection of radiopaque stones and when an ultrasound examination was also performed, the sensitivity was increased. Double contrast radiography enabled identification in 100% of radiolucent stones, and allowed for size measurement and number counts in 76.9% of radiolucent stones. Crystalluria had low sensitivity (31.5%) and specificity (58.8%). Hematuria (96.3%) and leukocyturia (61.1%) were the most common parameters found. We concluded that double contrast radiography can be considered the method of choice for detection of radiolucent stones. Crystalluria is not a good parameter to detect or predict type of stone. Hematuria and leukocyturia, although non-specific findings, can be used as triage for investigation of urolithiasis.
Key words: Canine. Crystalluria. Stones. Urine.

Resumo

Embora várias informações já tenham sido publicadas sobre a urolitíase canina, a sensibilidade dos exames radiográficos, ultrassonográficos e urinários é pouco correlacionada com a composição, número e tamanho dos urólitos. Dessa forma, objetivou-se com esse estudo, analisar retrospectivamente cento e treze prontuários de cães com diagnóstico de urolitíase. Após a remoção cirúrgica dos cálculos, informações sobre o número, aspecto, localização, tamanho e composição foram comparados com os

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exames de imagens (raio-x e ultrassom) e achados da urinálise. Cálculos de estruvita foram encontrados em 42,4% dos pacientes e de oxalato de cálcio em 35,6%. Exames radiográficos foram capazes de detectar cálculos radiopacos e quando associado ao ultrassom tiveram melhores resultados. A radiografia de duplo contraste permitiu a identificação de 100% dos urólitos radiolucentes e foi capaz de estimar o tamanho e o número em 76,9% desses. Na urinálise a cristalúria apresentou baixa sensibilidade (31,5%) e especificidade (58,8%) na detecção de urólitos, já a hematúria (96,3%) e leucocitúria (61,1%) foram os parâmetros mais observados. Conclui-se que a radiografia de duplo contraste é o método de escolha para a detecção de urólitos radiolucentes e que a cristalúria não pode ser considerada um bom parâmetro para detectar ou prever o tipo de urólitos. Embora a hematúria e leucocitúria não sejam achados específicos, podem ser utilizados como triagem para a investigação da urolitíase.
Palavras-chave: Canino. Cálculos. Cristalúria. Urina.

Introduction

During the last three decades, a range of new information has been published regarding etiology, detection, treatment, and prevention of canine urolithiasis. Despite these advances, a higher morbidity has been observed in the last few years (HOUSTON; MOORE, 2009; LULICH et al., 2011; BARTGES; CALLENS, 2015).

Although a plausible explanation of increase in morbidity is that canine urinary system has the ability to concentrate urine, which in certain conditions predisposes precipitation and formation of crystals (LULICH et al., 2011; BARTGES; CALLENS, 2015) and/or effects of inhibitors of crystalliazation and incite the formation of stones (BARTGES; CALLENS, 2015), others factors could be contributing as malpractice, indiscriminate use of therapeutic food or even use of treatments based in urinary crystals, x-ray and others which can all cause inadequate dissolution or even growth of the stone.

Even though the consensus found in the medical literature is that individuals with risk of urinary stone formation exhibit a more severe crystalluria than others (DAUDON et al., 2004; PAK et al., 2008). Although many use crystal identification as the primary method of predicting composition, crystalluria is not a consistent feature of urinalysis in dogs and cats (LULICH et al., 2011) due to it is a frequent finding in veterinary routine urinary sediment examination of normal animals (FOGAZZI, 1996), and in uroliths cases have been reported sporadic (less than 60%) (OSBORNE et al., 1990).

Survey radiographs and abdominal ultrasound (US) are appropriate diagnostic approaches for nephrolithiasis in humans, which often yield similar results as those obtained by more sophisticated exams such as helical computed tomography scan (FREITAS et al., 2004). In veterinary practice usually simple or contrasted x-ray (especially double contrast cystogram) and US are used to evaluate cystolithiasis (BARTGES; CALLENS, 2015). Although the primary objective is to verify urolith presence, location, number, size, density and shape (LULICH et al., 2011), sensitivity of the imaging exams for the detection of urolithiasis are unknown.

In spite of the importance of these data, little has been discussed in veterinary medicine. Thus, this study has the aim to perform a retrospective evaluation of urine analysis, ultrasound images, survey and contrast radiographs of dogs with urolithiasis, and to qualitatively correlate the results with the type of urinary stone found. This work is relevant to investigate the sensitivity of laboratorial and image exams for the detection of canine urolithiasis.

Material and Methods

One hundred and thirteen clinical files of dogs with diagnosis of urolithiasis were retrospectively selected out of the patients seen at the Veterinary

Hospital at UNESP, Jaboticabal and Veterinary Hospital at UNIFRAN, Franca. The study was approved by the Ethics Committee on Animal Use (CEUA), Protocol n ° 53/15. Data pertaining to signalment, urinalysis, and imaging exams were obtained, as well as the composition and physical characteristics of the stones. Dogs with kidney stones and patients that received medications which could cause urinary alterations were excluded from the study.

Seventy-two dogs presents stones from the bladder, 25 from bladder and urethra, and 7 from the urethra alone were surgically removed, 9 dogs did not have urolith local recorded. Information regarding number, appearance, size, and composition of the stones were obtained. The stones were analyzed qualitatively (Kit Bioclin – Quibasa Química Básica Ltda, Belo Horizonte-MG, Brazil), and whenever possible, providing data about composition of the nidus, inner, and peripheral layers (outer layer "shell" and surface crystals).

Radiographs and ultrasound images were blind-analyzed by a specialized veterinary radiologist. On radiographs, the urinary stones were classified as radiopaque (from + to +++) or radiolucent. The number, location and size were also noted. Images with poor quality, inadequate focus or contrast were excluded.

Data regarding urinary density, pH and presence of bacteria and crystals were obtained from urinalysis. Hematuria and leukocyturia were considered significant when more than three cells were visualized per field.

The sensitivity of the imaging exams for the detection of urolithiasis was evaluated by comparing the number of stones detected with the number of stones surgically removed. Errors of up to 15% were considered acceptable.

The sensitivity of crystalluria in detecting urolithiasis as well as the specificity of the test in determining composition was performed comparing crystal classification to the type of stone found.

Statistical analyses were performed using descriptive statistics and applying formulas for sensitivity and specificity when relevant.

Results and Discussion

The 113 dogs (74 from males and 39 from females) had stone classified according to the amount of mineral deposited. There was a predominance of simple stones (with only one type of mineral) (52.2%, n=59). From these, 42.4% (n=25) were composed of struvite and 35.6% (n=21) of calcium oxalate. With lesser frequency, urate and calcium phosphate represented 15.2% (n=9) and 6.8% (n=4), respectively. The majority of the stones with two or more minerals contained struvite and/or calcium carbonate (36,3%, n=41). Struvite was the most frequent mineral in the nucleus and inner layer, and calcium carbonate in the outer layer (shell) and surface crystals.

Simple calcium oxalate stones were observed in 21 dogs (ages ranging between 3 and 15 years; average 8.2 years) with a higher occurrence in male (n=15) than in female (n=6). Regarding breed, Poodle (n=5) was the most affected breed followed by Yorkshire (n=3), Schnauzer (n=2), Maltese (n=2), Pinscher (n=1), Lhasa Apso (n=1), Collie (n=1), Pug (n=1), Bichon Frisé (n=1) and three mixed breed dogs. Simple struvite stones were identified in 25 dogs (ages between 2 and 11 years; average 6.2 years) and was found in both males (n=18) and females (n=7). Mixed breed dogs were the most affected (n=6), followed by Poodle (n=4), Rottweiler (n=2), Basset hound (n=2), Yorkshire (n=2), German shepherd (n=2) and other breeds with only one case. Simple urate stones (n=9) occurred only in male Dalmatians (n=6), Bulldog (n=1), Pit Bull (n=1) and Shih Tzu (n=1).

Both radiography and ultrasound were used to evaluate and count stones in 10.6% (n=12) of the animals, survey radiographs alone in 37.1% (n=42), and ultrasound alone in 5.3% (n=6). Fifty three dogs did not have a diagnostic field complete

recorded. The bladder was the most affected site, which represents 92.6% (n=50) of all radiographic cases identified. From these, 82.0% (n=42) were radiopaque and 14.8% (n=8) were radiolucent. As for sensitivity of radiographs for the identification of the location of radiopaque stones, survey radiographs revealed 85.2% (n=46) sensitivity. When analyzing radiolucent stones, positive contrast and double contrast yielded 50% (n=4) and 87.5% (n=7) sensitivity for finding the location of the stone, respectively.

Survey radiographs allowed for quantification and measurement in 47.6% (n=20) of the cases of radiopaque stones while ultrasound alone yielded the same data in 33.3% of the cases (n=2) independently of type of stone.

Pure struvite, oxalate and urate stones were identified by simple radiographs in 100% (n=17), 100% (n=13), and 11.1% (n=1) of the cases, respectively.

Positive contrast radiography and double contrast radiography were used in 5.3% (n=6) and 11.5% (n=13) of the cases, respectively. Positive contrast radiographs enabled identification in 100% of radiolucent stones; however, they could not (0%) evaluation of size and number of stones. On the other hand, double contrast radiography enabled identification in 100% of radiolucent stones, and allowed for size measurement and number counts in 76.9% (n=10) of radiolucent stones.

Urinalysis was evaluated in 54 dogs (47.8%). From these, 17 exhibited crystalluria (31.5% sensitivity); and from these, 10 (58.8%) yielded similar result when compared to the stone analyzed (specificity). Urinary density varied from 1.008 to 1.043 (average 1.024). Hematuria was observed in 96.3% (n=52) and microscopic hematuria was the most common type 80.7% (n=42). Other parameters observed were pH of 6.9±1.1, leukocyturia 61.1% (n=33) and bacteriuria 35.2% (n=19).

Although retrospective studies have limitations, this study provides data to support future investigations, both for diagnostic imaging and for veterinary nephrology and urology.

Fewer simple stones (52.2%) were found in this study when compared to what is described in the literature (80%) (HOUSTON; MOORE, 2009; OYAFUSO et al., 2010). This finding might be due to the methodology employed in this study, which considers simple stone to be those with only one type of mineral, as opposed to the quantitative methodology, which takes into account the predominance of a mineral (greater or equal to 70%).

Although struvite stones have been described to be more prevalent in females (HOUSTON et al., 2004, HOUSTON; MOORE, 2009), a larger number of males were affected by simple struvite stones. Males were also the majority when the overall number of animals affected was considered, as found in another study conducted in Brazil (OYAFUSO et al., 2010). This finding might be explained because males are usually seen due to obstructive episodes, whereas females might remain longer periods without signs which are evident to the owners.

In humans, about 90% of the stones can be seen in abdomen survey radiographs (FREITAS et al., 2004). In this study, all struvite and calcium oxalate stones were seen in simple radiographs, but just one urate case was able to this identification, which highlights the importance of associating other methodologies, especially ultrasound imaging since it is fast, less invasive and enables the detection of radiolucent stones (BARTGES; CALLENS, 2015).

In the global evaluation, it was possible to precisely identify the region of stone location in 85.2%, and size and number of stones in 47.6% of the cases. The decreased sensitivity of survey radiographs can be caused by presence of gastrointestinal contents, bone shadows, incorrect positioning of the patient, and geometric magnification (FREITAS et al., 2004). These findings are consistent with the veterinary routine, in which adequate procedure

preparation and positioning are difficult but very important for image interpretation.

Measurement and quantification of stones in survey radiographs were most difficult when stones were smaller than 0.5 cm and/or in a higher number than 20. In these cases, ultrasound examination may increased sensitivity of detection, as described by other authors (FREITAS et al., 2004).

Measurement and quantification of radiolucent stones were more sensitive when using double contrast radiography (76.9%) as compared to positive contrast radiography (0%). Also ultrasound (33.3%) was not sensible to quantify and measure stones. These data show that the choice of less sensitive procedures can result in failure to detect and measure uroliths, especially the smaller ones. Despite this observation, it is important to stress that those are precision criteria and since this is a retrospective study, ultrasound was evaluated based on static images and reports, which may have affected the evaluation of its real sensitivity. This results may also be reinforced by another prospective study that identified more often uroliths and bladder wall thickening using ultrasound than in a positive contrast and simple x-ray evaluation (GALLATTI; IWASAKI, 2004).

Even though most veterinarians use crystal evaluation to determine the type of stone, this study found low sensitivity for this methodology (31.5%); in other words, most cases did not exhibit urolithiasis with concurrent crystalluria as related in recent article (BARTGES; CALLENS, 2015). Furthermore, 41.2% of the crystals were not correlated with the existing stone. Based on the values found for specificity (58.8%) and sensitivity (31.5%), it is contraindicated to base therapeutic management of urolithiasis on crystalluria assessment alone.

Hematuria was the most common urinalysis finding (96.3%). This data is consistent with bladder lesion, since nephrolithiasis cases were not included. This finding, either alone or associated to leukocyturia, although non-specific, can serve as a triage method for asymptomatic patients.

Conclusion

Survey radiographs enabled the detection of radiopaque stones and when an ultrasound examination was also performed, the sensitivity was increased. Double contrast radiography can be considered to be the method of choice for detection of radiolucent stones. Crystalluria is not a good parameter to detect or predict type of stone. Hematuria and leukocyturia, although non-specific findings, can be used as triage for investigation of urolithiasis.

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