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Investigation of the Relationship Between Ultrasonographic Findings and Analyses of Bladder Contents in Cats

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Abstract:

BACKGROUND: Echoes are frequently observed in cat bladder contents through ultrasonography and often mentioned as incidental findings. No comprehensive study has been conducted so far on the precise echoes nature in the bladder contents ultrasonography in cats.

OBJECTIVES: The purpose of this study is to provide an accurate description of the cat bladder contents echoes and to specify the relationship between ultrasonographic findings and urinalyses.

METHODS: 30 adult DSH cats were investigated. Bladder ultrasonography was performed. The numbers of echoes in the bladder were qualitatively divided into four classes. At least 5 ml of urine was collected with cystocentesis. Urinalysis was performed on the urine sediment. The statistical analyses were done.

RESULTS: Echoes were observed in 19 cases. The echoes were suspended in 17 of the cases, in those cases they were observed and clumped in 2 cases. Of the 19 cases where echoes had been observed in the bladder contents, 9 included oil droplets, 2 included struvite crystals and 4 included hematuria as reported in urinalysis. For 6 of the cats with echoes in the bladder contents, oil droplets, RBCs, and crystals were not reported in urinalysis. The number of echoes observed in the bladder in presence of RBCs, oil droplets, crystals, and leucocytes was not statistically significant ($P>0.05$).

CONCLUSIONS: Based on this study, most of the echoes observed in the ultrasonography of cats' bladder contents can be associated with the presence of oil droplets in the urine, which is in accordance with previous studies.

Keywords:

Cat, Echoes, Ultrasound, Urinalysis, Urinary bladder

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Introduction

Ultrasonography has turned today into a common assessment of the urinary system in medicine and veterinary medicine (Cooper 2015). A bladder containing urine can be assessed easily through ultrasonography (Thrall 2018 and 2013). Ultrasonography is often regarded as the first method of diagnosis in patients with hematuria or pollakiuria. This method has higher sensitivity and specificity than double-contrast cystography in diagnosis of bladder problems. In fact, it is possible using ultrasonography to assess the entire urinary system except the distal part of the urethra (Widmer 2004, O'Brien 2009). Echoes are frequently observed in cat bladder contents through urinary system or abdominal ultrasonography with or without clinical symptoms associated with urinary system diseases (Sisalk 2014). Their observations are often mentioned as incidental findings in urinary system or abdominal ultrasonographic reports (Sisalk 2014, Vila 2018), and are not necessarily symptoms of urinary system diseases. Therefore, urinalysis is very helpful in specification of the importance of these echoes (Penninck 2015, Brabson 2015). No precise definition, from the aspect of ultrasonography, and classification of these particles and information on their association with clinical symptoms has been provided in references. These echoes may be accompanied by some of the ultrasonographic artifacts, such as the twinkle artifact, the reverberation artifact, and an acoustic shadow (Voros 1997). As mentioned in different references, they can include dead cells (resulting from hematuria or pyuria), blood clots, lipid particles, gas bubbles, foreign bodies (catheters or surgical sutures left in the bladder or spinose structures), and crystals in the urine (Baumann 2014, Bell 2015). Lipiduria is a complication usually mentioned as present in a nephrotic syndrome (Cherbinsky 2010). Presence of blood clots in the bladder of a patient with trauma history, bleeding disorders, Infections, or neoplasms is probable, and presence of gas bubbles has been reported in emphysematous cystitis, which can result from diabetes in dogs in most cases (Lobetti 1998). Aranovich et al., stated in a 2008 study on echoes in the bladder contents of patients with trauma history that presence of hyperechoic particles in the bladder contents should be considered as presence of blood in the bladder (Aranovich 2008).

Sislak et al., stated in a 2014 study on the ultrasonographic characteristics of lipiduria in cats clinically evaluated as healthy that echoes are usually observed in ultrasonography for the bladders of healthy cats. Echoes suspended in the bladder without an acoustic shadow, the reverberation artifact, or the twinkle artifact can be associated with presence of lipids in the urine (Sislak 2014).

Investigating bacteriuria in cats with diseases of the distal parts of the urine system, Eggersdottir et al., stated in a 2007 study on 134 cats that bacteriuria may not be diagnosed in Norwegian cats by ultrasonography, and the importance of the diagnosis and results of the culture are clear in the research. The cystocentesis method of urine collection has been mentioned in this study, and no ultrasonographic investigation has been conducted on the features of the bladder contents of the patient with bacteriuria (Eggersdottir 2007).

In a case report on a cat with hematuria resulting from bladder inversion, Adin

et al., (2011) stated that inversion of the bladder in a patient with clinical symptoms such as hematuria, pollakiuria, and a mass abnormally observed during ultrasonography in the cranial part of the bladder can be subject to differential diagnosis. The ultrasonographic characteristics of the urine in the bladder have not been mentioned in this study either (Adin 2011).

Use of diagnostic ultrasonography by veterinarians has developed today more than before. The urinary system is one of the most important systems in the body, which can be assessed easily using diagnostic ultrasonography. No comprehensive study has been conducted so far on the precise nature of the echoes in the bladder in terms of ultrasonographic findings in cats and dogs, and differentiation of the echoes in the bladder contents from each other and their importance with regard to the clinical findings relevant to urinary system diseases in cats have remained unknown up to now (Nevins 2015). It seems necessary to examine these echoes and specify their types and relationships with ultrasonographic characteristic.

The purpose of this study is to precisely describe the ultrasonography of the echoes in cats' bladder contents and to specify the relationship between ultrasonographic findings and urinalysis.

Materials and Methods

Sample: For conducting this research, 30 cats of the DSH breed, including 13 females and 17 males, with a median age of three years and weight of 4 kg were examined.

Ultrasonography: The patients underwent full ultrasonography of the urinary system using a GE Voluson 730 Pro ultrasound machine and a linear multi-frequency 6-12 transducer. Bladder ultrasonography was performed in transverse and sagittal planes, and the images were stored. The numbers of echoes in the bladder were subjectively divided into four classes: none, a few, moderate, and many. If the bladder contents were absolutely anechoic, they would be classed as none, and if there were fewer than ten echoes in them, they would be classed as a few. If 25-50 percent of the bladder contents were echoes, they would be classed as moderate, and if more than 50 percent of them were echoes, they would be classed as many (Fig. 1).

Presence of any ultrasonographic artifact relevant to the echoes was also recorded. Patients with bladder stones or large clots in their bladders were excluded from the research Assessment of the kidneys in terms of size and echogenicity (as compared to that in liver and renal parenchyma) and differentiation between the cortex and the medulla were also performed.

At the end of ultrasonography, a sufficient amount of urine (at least 5 ml) was collected with the ultrasound-guided cystocentesis method after shaking the bladder for creating homogenous content. The bladder was almost equally middle-distended in all the samplings. Analysis was made of the bladder images recorded by the authors objectively with no information on the urinalysis results.

Urinalysis: Urinalysis was made on the sediment obtained from 5 ml of urine by within 20 minutes after sampling at the latest. This included measurement of the specific volume and pH of the urine and examination of presence of urinary casts, different types of crystal, lipid particles, white and red blood cells, different types of bacterium, epithelial cells, urobilinogen,

bilirubin, proteins, nitrite, ketones, ascorbic acid, and glucose.

Statistical analysis: The statistical analyses were done using the SPSS package Version 19.0. The data were analyzed using Chi-square and Fisher's exact test. Parameters for which p-value≤0.05 were considered statistically significant.

Results

Ultrasonographic study: Of the totally 30 cats undergoing urinary system ultrasonography in this study, 11 exhibited absolutely anechoic bladders (none: 11). Echoes were observed in the bladders of 19 of the patients (a few: 7, moderate: 3, many: 9). Floating and clumped echogenic particles were observed in 17 and 2 cases, respectively. (Fig. 2).

No acoustic shadow or the reverberation or twinkle artifact was observed in any of the patients with echoes suspended in the bladder. The bladder wall was evaluated as normal in terms of thickness and layering in all the patients. The kidney was evaluated as normal ultrasonographically in all the patients, except in one patient the kidney cortex was markedly hyperechoic as compared to the adjacent spleen, and a hyperechoic rim sign was present in the medulla. It should be mentioned that a large number of echoes were observed in this patient's bladder (Fig. 3).

Urinalysis: The urinalysis results of the 30 cats under study are shown in the results. In 16 of the urine specimens obtained from the cats, no oil droplet was observed; in the 14 cases which oil droplets were reported, the parameter value had been many in 11 cases and a few in 3. Of the 30 urine specimens obtained, 4 exhibited hematuria, and struvite crystals were reported in 2 of the cases. It should be mentioned that one of the cases of hematuria was accompanied by glycosuria. One case of urine concentration capacity reduction and one case of cystitis along with proteinuria and bilirubinuria were observed.

Correspondence between the urinalysis and ultrasonography results: Of the 19 cases where echoes had been observed in the bladder contents, 9 included oil droplets, 2 included struvite crystals, and 4 included hematuria as reported in urinalysis. In 2 of the 4 cases of hematuria, abnormal presence of RBCs in the urine had made them TNTC (too numerous to count). In the two cases with fewer RBCs, large numbers of oil droplets were reported. Echoes had been observed in the ultrasonographic studies of all the 4 cases in the urinalysis of which hematuria were reported. Two of the hematuria cases, in the urinalysis of which the number of RBCs were reported as TNTC while no oil droplets were observed, had been classified as moderate in terms of presence of echoes in ultrasonography. In the other two cases, where the numbers of RBCs were lower while large numbers of oil droplets accompanied them, presence of echoes had been classified as many.

For 6 of the cats, whose bladder contents had contained echoes, oil droplets, RBCs, and crystals were not reported in urinalysis. Of these 6 cats, 5 had been classified as containing a few echoes and one as containing a moderate number of them; a large number of leucocytes were reported in the urinalysis of this case.

Of the 11 cases the ultrasonographic studies of which had exhibited no echo in the bladder contents, 5 included oil droplets as reported in their urinalyses (many oil droplets: 4, a few oil droplets: 1). No oil droplet,

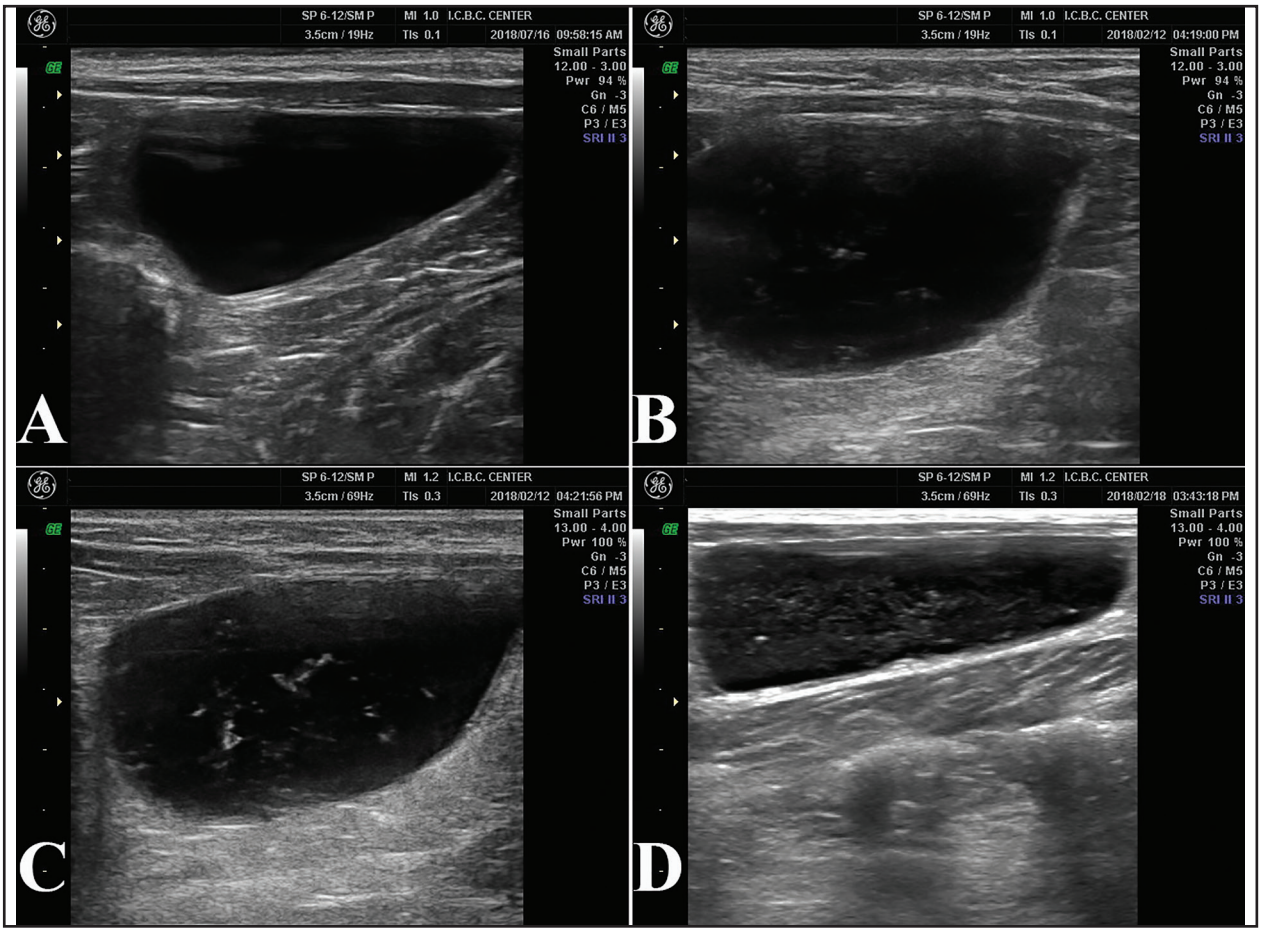

Figure 1. Sample sonograms for classification of echoes present in the cat bladder. A) None; B) A few; C) Moderate; D) Many.

RBC, or crystal was reported in the urinalyses of the remaining 6 cases.

Of the 9 cases where many echoes had been observed in the ultrasonographic examinations of the bladder contents, 2 included struvite crystals as reported in their urinalyses, and large numbers of oil droplets were reported in the remaining 7 cases, 2 of which included hematuria at the same time.

Of the 3 cases where moderate numbers of echoes had been observed in the ultrasonographic examinations of the bladder contents, 2 (TNTC) included hematuria, and 1 included no oil droplet, RBC, or crystal as reported.

Of the 7 cases where a few echoes had been observed in the ultrasonographic examinations of the bladder contents, 5 included no oil droplet, RBC, or crystal, and 2 included a few oil droplets as reported in urinalysis.

Both cases where clumped echoes had been observed in the ultrasonographic examinations of the bladder contents included large numbers of oil droplets and hematuria in urinalysis.

In the one case where the kidney cortex had been markedly hyperechoic, and a large number of echoes had been observed in the bladder contents, a large number of oil droplets were also reported in urinalysis.

Statistical analyses: There was no significant difference between the number of oil droplets identified in urinalysis and that of echoes in ultrasound ($P>0.05$). Additionally, the differences between the number of

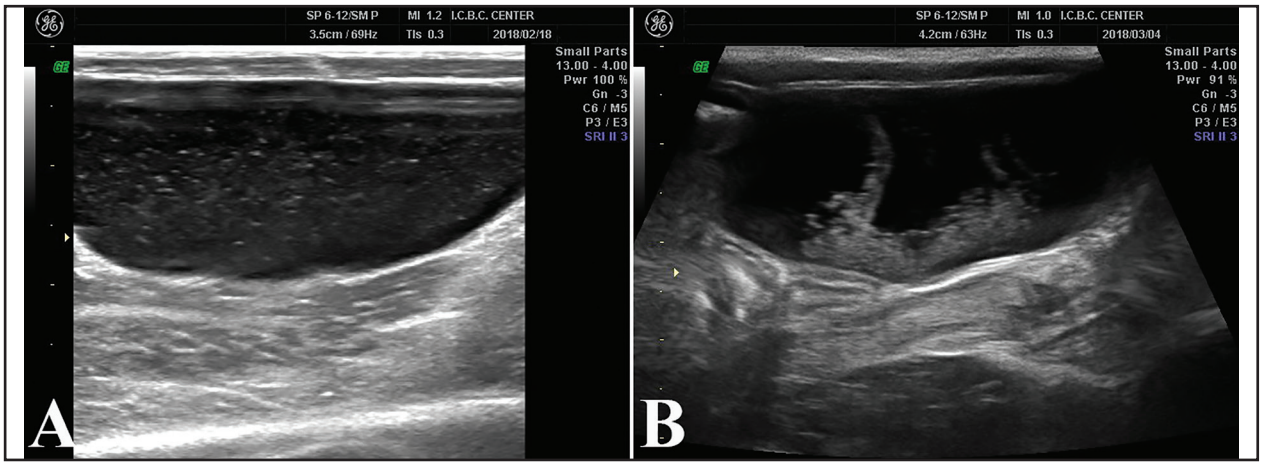

Figure 2. Sample sonograms for classification of the dispersion types of echoes present in the cat bladder. A) Suspended; B) Clumped.

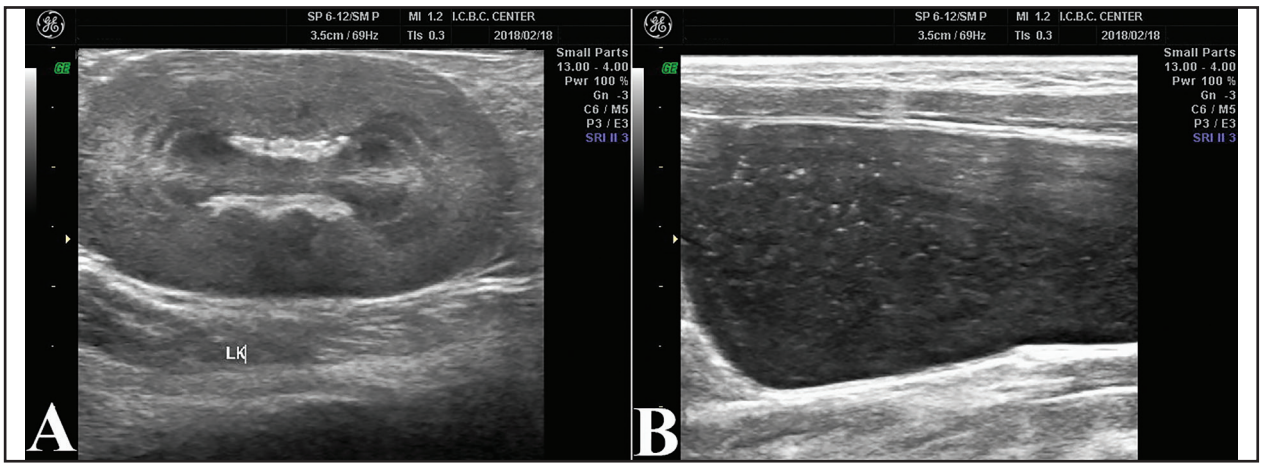

Figure 3. Ultrasonographic images concerning a cat whose renal cortex was markedly hyperechoic. A) Left kidney; B) Urinary bladder.

echoes in ultrasound and that of RBCs identified in urinalysis were not statistically significant (P>0.05). Furthermore, there was no significant relationship between presence of crystals and the number of echoes (P>0.05).

Discussion

In common abdominal ultrasonography in cats, echoes are frequently observed inside the bladder, dispersion of which can be dependent on gravity to a great extent. Barr et al., have mentioned in 2011 that urine sediment can contain RBCs, WBCs, organisms, epithelial cells, crystals, and casts. They have also mentioned that oil droplets constitute one of the most common particles in cat urine, usually observed as suspended in the urine. Furthermore, a small amount of sediment can be observed in the urine as an incidental finding, and urinalysis is made for further examination (Barr 2011).

Mattoon et al., have stated in 2015 that a thin, hyperechoic layer of crystal sediment in the bladder can generate a very strong acoustic shadow, and oil droplets also generate echoes suspended in the bladder usually (Mattoon 2015). In our study on cats, however, no significant relationship was observed between reports of oil droplets

present in urinalysis and echoes observed in bladder content ultrasonography.

Dennis et al., (2010) have regarded urine sediment as containing blood or cellular debris, crystals, or air bubbles, and have made no mention of oil droplets (Dennis 2010). Lobetti et al., have stated in a 1998 case study of bladder trigone diverticula and emphysematous cystitis that the reverberation artifact had been observed in the dorsal part of the bladder wall in abdominal ultrasonography, indicating emphysematous changes; they have also mentioned the presence of a large number of hyperechoic points in the urine, interpreted as crystalluria in later assessments (Lobetti 1998).

According to our investigations, not much research has been performed on correspondence and comparison between ultrasonographic findings on bladder contents and urinalysis. In the present study, presence of echoes was observed in the bladder contents in 63.3% of the cats under study, and they were anechoic in the remaining 36.7%.

The highest percentage of presence of echoes in the bladder contents concerned the many class (47.4%), and the lowest pertained to the moderate class (15.8%). In urinalysis, presence of lipid particles was reported in 46.7% (n=14) of the patients, while very large numbers of oil droplets were observed in 36.7% (n=11) of them. Presence of leucocytes was reported in all the urinalyses, but it was only in one case that the number of leukocytes was more than the normal value, which can be due to cystitis.

In 50% (n=15) of the cases, presence of RBCs in the urine sediment was reported, which can be due to hematuria only in 4 cases, and it may have occurred in the other 11 cases as a result of the method of obtaining urine specimens (cystocentesis), although all the specimens were obtained as guided by ultrasound, and other abnormal cases such as pyuria were not reported either at the same time in urinalysis. Proteinuria can occur secondarily due to presence of blood in the urine, which was reported among these cases. One of the cases of hematuria was accompanied by glycosuria, which can be due to stress, tubular reabsorption problems, or diabetes. It should be mentioned that Sislak et al., have mentioned such cases in their 2014 studies (Sislak 2014). One case of urine concentration capacity reduction and one case of cystitis along with proteinuria and bilirubinuria, reported in urinalysis, can be due to simultaneous presence of a biliary obstruction problem. Presence of crystals was also reported in 13.3% (n=2) of the cases. The crystals may indicate the comet tail artifact. Ultrasonography is valuable in assessment of cell debris in the bladder contents and specification of whether a surgery solution is required (Widmer 2004). It should be mentioned that this artifact was not observed in the two cases where crystals were observed in the present study, but there was more echogenicity.

In a 2014 study performed on the ultrasonographic characteristic of lipiduria in cats evaluated as clinically healthy, Sislak et al., stated that more echoes were observed in the urine of cats with more echogenic kidney cortexes, which can be associated with increase in lipid disposal via the kidney (Yeager 1989, Sislak 2014). One case of increase in kidney cortex echogenicity was also observed in the present study, where a large number of echoes were observed in the bladder through ultrasonography, as expected; a large number of oil droplets were also reported in urinalysis. There was no

relationship in Sislak et al.'s study between the value of echogenicity observed in the bladder and that of lipid in the urine sediment analysis. No significant relationship was observed either in the present study.

Widmer et al., stated in a 2004 study on urinary system ultrasonography in small animals that cell debris and crystal matrices are observed as echogenic points in the bladder contents (Widmer 2004) in conditions where there is feline idiopathic cystitis. One case of cystitis was also reported in the present study given the large number of leukocytes in urinalysis, where the bladder wall had been observed as normal in ultrasonography, but the average number of echoes in the bladder contents had been recorded. Observation of these echoes can be associated with presence of leucocytes in the urine contents given that no oil droplet or RBC was reported in urinalysis.

Widmer et al., stated in 2004 on the features of blood in the urine that blood clots are usually suspended in the urine, and have high echogenicity and no acoustic shadow (Widmer 2004). In all the cases in the present study where abnormal presence of RBCs in urinalysis was reported, echoes were observed in urine content ultrasonography. In the cases where presence of large numbers of oil droplets was reported along with presence of RBCs, echo dispersion in the bladder contents was classified as many.

Sislak et al., stated in 2014 that echoes in the urine appear as clumped in cases where the values of DAG (Diacylglycerol) are high in the lipids in the urine, which is associated with the structure of DAG (Sislak 2014). It was the case also in the present study that in the cases where the echoes in the bladder contents were observed as clumped, they were accompanied by a large number of oil droplets in urinalysis. In Sislak et al.'s study, the larger the amounts of cholesteryl esters, triglycerides, free fatty acids, and DAG in the urine, the higher the number of oil droplets reported in urinalysis. Since there are different types of lipid, the number of echoes observed in the urine may not be significantly related to the amount of lipid reported in urinalysis. If there are a very large number of cholesteryl esters in the urine, for instance, a large number of oil droplets will also be reported in urinalysis, while not many echoes may be observed in ultrasonography (Sislak 2014). There were cases also in the present study where no or very few (in one case) echoes were observed in ultrasonography although a large number of oil droplets were reported in urinalysis.

One of the limitations of this study was that the subfractions of lipid in the urine were not separated and classified. If this classification had been made, it would have been possible to interpret the relationship between the ultrasonographic appearance of the urine and the particles present in it more properly.

In future studies, more numbers of patients in different classes including healthy cats and ones with cystitis or renal or metabolic diseases can undergo urinary system ultrasonographic assessment and urinalysis, and the results can be compared to each other.

Given the observations made in the present study, it can be stated that the echoes most frequently observed in cat bladder content ultrasonography can be concerned with presence of oil droplets in the urine. However, there may not be a statistical correspondence between observation of echoes in the bladder contents and reports concerning presence of oil droplet in urinaly-

sis, which can be associated with the type of lipid particle present in the urine. Lipid particles, RBCs, leukocytes, and crystals are much smaller by themselves than the resolution scale of ultrasonography probes; therefore, the particles should join each other to become large enough to be able to cause reflection in the ultrasound beam and be identified by the transducer.

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Conflicts of interest

The author declared no conflict of interest.

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مجله طب دامی ایران، ۱۳۹۷، دوره ۱۲، شماره ۴، ۳۰۳-۲۹۳

مطالعه ارتباط بین شاخص‌های اولتراسونوگرافی با آنالیز محتویات مثانه در گربه

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چکیده

زمینه مطالعه: ذرات اکوژنیک مکررا در اولتراسونوگرافی محتویات مثانه گربه‌ها دیده می‌شوند، که غالباً به عنوان یافته‌های تصادفی ذکر می‌گردند. تاکنون مطالعه کاملی روی ماهیت ذرات اکوژن مثانه گربه‌ها در اولتراسونوگرافی انجام نگرفته است.

هدف: هدف از این مطالعه توصیف دقیق اولتراسونوگرافی ذرات اکوژن محتویات مثانه گربه‌ها و مشخص کردن رابطه بین یافته‌های اولتراسونوگرافی با آنالیز ادرار است.

روش کار: تعداد ۳۰ گربه نژاد DSH بالغ، بررسی شدند. اولتراسونوگرافی مثانه انجام شد. میزان اکوهای موجود در مثانه به صورت کیفی به چهار دسته تقسیم شدند. حداقل ۵ mL ادرار، به روش سیستوسنتز جمع آوری شد. آنالیز ادرار بر روی سدیمان ادرار انجام گرفت. آنالیز آماری داده‌ها انجام شد.

نتایج: در ۱۹ مورد ذرات اکوژن مشاهده شد. در۱۷ مورد از نمونه‌هایی که در آنها ذرات اکوژن مشاهده شد، این ذرات به صورت شناور و در ۲ مورد به صورت غیرشناور بود. در آنالیز ادرار، از ۱۹ موردی که ذره اکوژن در محتویات مثانه آن‌ها مشاهده شده بود، ۹ مورد ذرات چربی، ۲ مورد کریستال‌استورویت و ۴ مورد هماچوری گزارش گردید. در ۶ مورد از گربه‌ها که دارای ذرات اکوژن در محتویات مثانه بودند گلبول قرمز، ذرات چربی وکریستال در آنالیز ادرار گزارش نشده بود. میزان ذرات اکوژن مشاهده شده در مثانه با حضور گلبول قرمز، کریستال، ذرات چربی و لوکوسیت از نظر آماری معنی دار نبود ($P>0/05$).

نتیجه گیری نهایی: بر اساس این مطالعه بیشترین ذرات اکوژنی که در اولتراسونوگرافی محتویات مثانه گربه‌ها دیده شد می‌تواند مربوط به حضور ذرات چربی در ادرار باشد که منطبق با مطالعات پیشین است.

واژه‌های کلیدی:
گربه، ذرات اکوژن، فراصوت، آنالیز ادرار، مثانه

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