

Original research

The development of ultrasonographic diagnosis criteria for cholecystitis differentiation in dogs

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Received: 19 February 2024
Revised: 25 March 2024
Accepted: 20 May 2024

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Abstract. The paper presents the results of research of diagnosis and stage determination peculiarities of cholecystitis in dogs. In general, the clinical, differential diagnostic and ultrasonographic stages of the course of cholecystitis were studied. An important clinical and diagnostic tool for the diagnosis of cholecystitis in dogs is the application of the ultrasonographic examination. The study included 64 dogs, which were examined to diagnose cholecystitis. Three groups of dogs were identified: 17 dogs (27% of cases) were affected with initial stage of cholecystitis, 26 dogs (40% of cases) were affected with intermediate and 21 dogs (33%) were affected with late stage. The main clinical symptoms of the first stage of the gallbladder inflammation consisted of anorexia, vomiting, abdominal wall pain. The ultrasonographic picture was characterized by the presence of a hyperechoic wall of the gallbladder, an increase in the thickness of its wall, and a thickening of the mucous layer. Following mentioned symptoms including anorexia, weight loss, the presence of vomiting, decreased skin turgor, icterus of the mucous membranes, and abdominal wall pain were chosen as the main clinical symptoms of the 2nd stage of the gallbladder inflammation. Morphological signs that were selected for the diagnosis of cholecystitis were investigated by ultrasonography, including the presence of the wall hyperechoicity, thickening of the gallbladder wall, thickening of the mucous membrane layer, the presence of a suspension (mucocele) in the gallbladder and hyperechoic calculi. Presence of anorexia, a decrease in body weight, the presence of vomiting, a decrease in skin turgor, icterus of the mucous membranes, tenderness of the abdominal wall during palpation were chosen as the main clinical symptoms of the 3rd stage of gallbladder inflammation. During the 3rd stage of cholecystitis in dogs, the following signs were determined by ultrasonography: hyperechogenicity and heteroechogenicity of the gallbladder wall, thickening of the mucous membrane of the gallbladder; the presence of erosions on the mucous membrane, the presence of mucocele and hyperechoic calculi up to 5-7 mm in the gallbladder.

Keywords: gall bladder; cholecystitis; dogs

Розробка критеріїв ультрасонографічної діагностики холециститу у собак

Анотація. В роботі представлені особливості діагностики та визначення стадії холециститу у собак. В цілому досліджено клінічні, диференціально-діагностичні та ультрасонографічні стадій перебігу холециститу. Важливим клініко-діагностичним заходом, щодо постановки діагнозу на холецистит, у собак є проведення ультрасонографічного дослідження. У проведені дослідження були включені 64 собаки, обстеження котрих проводили з метою діагностики холециститу. Виявлено 17 собак (27% випадків) із початковою стадією холециститу, 26 собак (40% випадків) із середньою та 21 собака (33%) з пізньою стадією. Основними клінічними симптомами I стадії запалення жовчного міхура були обрані: анорексія, блювання, болочість черевної стінки, ультрасонографічна характеристика виявлялася наявністю гіперехогенної стінки, збільшенням товщини стінки жовчного міхура, потовщенням слизового шару. Основними клінічними симптомами II стадії запалення жовчного міхура були обрані: анорексія, зниження маси тіла, наявність блювання, зниження тургору шкіри, іктеричність слизових оболонок, болочість черевної стінки. Морфологічні ознаки, які були обрані для діагностики холециститу, досліджені за допомогою ультрасонографії включаючи наявність гіперехогенності стінки, потовщення стінки жовчного міхура, потовщення шару слизової оболонки, наявність зависі (мукоцеле) у жовчному міхурі та гіперехогенних конкрементів. Основними клінічними симптомами III стадії запалення жовчного міхура були обрані: наявність анорексії, зниження маси тіла, наявність блювання, зниження тургору шкіри, іктеричність слизових оболонок, болочість черевної стінки при пальпації. Морфологічні ознаки, які досліджені за допомогою ультрасонографії включаючи. Ультрасонографічними симптомами III стадії холециститу були: наявність у ряді випадків гіперехогенної стінки, а також гетерохогенної стінки, потовщення стінки жовчного міхура, потовщення шару слизової оболонки, наявність ерозійного слизового шару, наявність зависі (мукоцеле) у жовчному міхурі, наявність гіперехогенних конкрементів до 5-7 мм.

Ключові слова: жовчний міхур; холецистит; собаки

Cite this article: Shkvaria, M. M., Semionov, O. V., Suslova, N. I., & Khomutenko, V. L. (2024). The development of ultrasonographic diagnosis criteria for cholecystitis differentiation in dogs. *Theoretical and Applied Veterinary Medicine*, 12(2), 10–16. doi: 10.32819/2024.12007

Introduction

Gallbladder inflammation may be a more common disease than most veterinarians realize. This pathology is accompanied by various clinical symptoms. One of the important clinical and diagnostic measures for the diagnosis of cholecystitis in dogs is an ultrasonographic analysis (Spaulding, 1993; Woodworth et al., 2021; Murakami et al., 2023).

Gallbladder is one of the well-studied objects of the ultrasound diagnostics (USD). Thanks to the study of the gallbladder, ultrasound proved its superiority over radiocontrast methods as early as the 1970s (Spaulding, 1993). Despite the long-term local use of ultrasound examination of the biliary system, in animal care there are often incidents when clinicians cannot fully assess the possibilities of ultrasound and interpret and even formally correctly perform the ultrasound description of the biliary system. The same echographic symptom as, for example, thickening of the gallbladder wall, requires different diagnostic and treatment tactics depending on additional data and the specific situation (Bargellini, 2016; Sonet et al., 2018; Haworth et al., 2019; De Jonge et al., 2020; Liscandro et al., 2021).

Therefore, the purpose of our research was to study of the clinical, differential diagnostic and ultrasonographic characteristics of cholecystitis in relation to the stages of the disease.

Materials and methods

The study was conducted at the facilities of the Department of Clinical Diagnostics and Internal Diseases of Animals of the Dnipro State Agrarian and Economic University and at the Veterinary Medicine Clinic "Doctor Vet" in Dnipro. Sick animals diagnosed with cholecystitis were studied in the experiment. Set of methods was used for diagnostic studies, including a general examination of the animal and examination of the pathological process zone. The general study of dogs was carried out according to the generally accepted methodology. The Esaote MyLab ultrasound machine equipped with sensors with a frequency of 7.5-15.0 MHz was used to study the areas of the pathological process. The condition of the gallbladder walls and their compaction, thickening of the mucous layer, mucocele and hyperechoic calculi were studied.

A clinical study of 64 dogs with suspected cholecystitis was conducted. Three groups of dogs were identified: 17 dogs (27% of cases) with initial stage, 26 dogs (40% of cases) with intermediate stage and 21 dogs (33%) with late stage of cholecystitis.

Results

Clinical and ultrasonographic patterns revealed in the study indicate the presence of three main clinical stages of cholecystitis: beginning, middle and late pathology complications.

Clinical signs of the first stage of the disease: anorexia, vomiting, soreness of the cervical wall, presence of the gall bladder wall thickening in ultrasound examination (Table 1).

Clinical signs of stage II include: anorexia, decreased body weight, vomiting, decreased skin turgor, icteric mucous membranes, abdominal wall soreness, thickening of the gall bladder wall in echographic examination.

Clinical signs of stage III include: anorexia, decreased body weight, vomiting, decreased skin turgor, icteric mucous membranes, abdominal wall soreness, thickening of the gall bladder wall in echographic examination

Thus, the main diagnostic clinical signs of the 1st stage were anorexia in 3 dogs (14% of cases). Vomiting was present in 13 dogs (74% of cases). The presence of the abdominal wall diseases was noted in 12 dogs (68% of cases). Gallbladder wall thickening during ultrasound examination was noted in 17 dogs (100% of cases) (Table 2).

In animals with diagnostic indicators of the II (middle) stage of cholecystitis, the presence of anorexia was noted in 18 dogs (72% of cases). A decrease in body weight was found in 21 dogs (82% of cases). The presence of vomiting was noted in 22 dogs (86% of cases). A decrease in skin turgor was found in 24 dogs (94% of cases). The jaundice of mucous membranes was observed in 13 dogs (51% of cases). Abdominal wall soreness was detected in 26 dogs (100% of cases). Gallbladder wall thickening during ultrasound examination was noted in 26 dogs (100% of cases).

In animals with diagnostic indicators of the III (late) stage of cholecystitis, the presence of anorexia was noted in 21 dogs (100% of cases). A decrease in body weight was found in 20 dogs (95% of cases). The presence of vomiting was recorded in 18 dogs (92% of cases). A decrease in skin turgor was found in 20 dogs (95% of cases). The jaundice of mucous membranes was noted in 21 dogs (100% of cases). Abdominal wall soreness was detected in 21 dogs (100% of cases). Gallbladder wall thickening during ultrasound examination was noted in 21 dogs (100% of cases).

The results of the echographic examination of the 1st stage of cholecystitis presented in the echograms (Fig. 1, Fig. 2). The obtained results showed that hyperechogenicity of the wall was present in 100% of cases of examined animals. Gallbladder wall thickening from 2 to 3 mm was noted in 5 dogs (25% of cases), in the range of 3-4 mm – in 12 dogs (75% of cases), the mucous layer thickened to 0.5 mm in 5 dogs (25% of cases), up to 1 mm – in 12 dogs (75% of cases).

The echographic characteristics of the II stage of cholecystitis are presented (Fig. 3, Fig. 4), which demonstrate that hyperechogenic wall during ultrasound examination was detected in 26 dogs (100% of cases), thickening of the gallbladder wall to 4-5 mm in 12 animals (45% of cases), thickening up to 5-6 mm – in 6 animals (24% of cases), thickening up to 6-7 mm in 8 animals (31% of cases). Thickening of the mucous layer during ultrasound examination up

Table 1 – Features of the clinical picture of cholecystitis in dogs (n = 64)

Indicator	Cob stage (I stage)		Mid stage (II stage)		Late stage (III stage)	
	Number of animals (n)	Number of animals (%)	Number of animals (n)	Number of animals (%)	Number of animals (n)	Number of animals (%)
Anorexia	3	14	18	72	21	100
Decrease in body weight			21	82	20	95
Vomiting	13	74	22	86	18	92
Decreased skin turgor			24	94	20	95
Ictericity of mucous membranes			13	51	21	100
Abdominal wall soreness	12	68	26	100	21	100

Table 2 – Echographic characteristics of dogs with cholecystitis, by stage (n = 64)

Indicator	Cob stage (I stage)		Mid stage (II stage)		Late stage (III stage)	
	Number of animals (ea)	Number of animals (%)	Number of animals (ea)	Number of animals (ea)	Number of animals (%)	Number of animals (ea)
1. Gallbladder wall echogenicity:						
aneogenic	-	-	-	-	-	-
hypoechoic	-	-	26	100	-	-
hyperechoic	17	100	-	-	15	71
heteroechoic	-	-	-	-	6	29
2. Gallbladder wall thickening:						
2-3 mm	5	275	-	-	-	-
3-4 mm	12	-	-	-	-	-
4-5 mm	-	-	12	45	-	-
5-6 mm	-	-	6	24	-	-
6-7 mm	-	-	8	31	-	-
7-8 mm	-	-	-	-	21	100
3. Mucous layer thickening:						
not thickened	-	-	-	-	-	-
< 0.5 mm	5	25	18	71	-	-
< 1.0 mm	12	75	7	29	-	-
< 1.5 mm	-	-	-	-	18	83
erosion	-	-	-	-	3	17
4. Suspension (mucocele) presence in a gallbladder:						
present	-	-	6	24	21	100
absent	-	-	20	76	-	-
5. Presence of the hyperechoic calculi						
not registered	-	-	21	82	-	-
1-2 mm	-	-	3	12	3	12
2-3 mm	-	-	2	6	4	19
3-5 mm	-	-	-	-	9	45
5-7 mm	-	-	-	-	5	24
Animals total:	17		26		21	

to 0.5 mm was detected in 18 animals (71% of cases), thickening up to 1 mm – in 7 animals (29% of cases), the presence of a suspension (mucocele) in the gallbladder – in 6 dogs (24% cases). Echographic examination revealed the presence of hyperechoic concretions with a size of 1-2 mm in 3 dogs (12% of cases), with a size of 2-3 mm in 2 dogs (6% of cases).

The results of the studies present an echographic picture of the III stage of cholecystitis (Fig. 5, 6), from which it follows that 15 (71% of cases) of sick dogs with hyperechoic wall were detected during ultrasound examination, and a heteroechoic wall was identified in 6 dogs (29% of cases), thickening of the gallbladder wall up to 7-8 mm was found in 21 dogs (100% of cases). Thickening of the mucous layer up to 1.5 mm was detected in 18 dogs (83% of cases), the presence of an erosive mucous layer was detected in 3 dogs (17% of cases). Mucocele in the gallbladder was found in 21 dogs (100% of cases). The presence of hyperechoic calculi with a size of 1-2 mm was detected in 3 dogs (12% of cases), with a size of 2-3 mm – in 4 dogs (19% of cases), with a size of 3-5 mm – in 9 dogs (45% of cases), with a size of 5-7 mm – in 5 dogs (24% of cases).

Taking into the account aforementioned results, the differences

in the observed data can serve as the prerequisite for differential diagnostics of cholecystitis stages.

Discussion

Sonography of the gallbladder in dogs is the best method for diagnosing cholecystitis from a practical point of view (Gaschen, 2009). It is theoretically and strategically correctly to examine the gallbladder and biliary tract for obstruction or other pathology in dogs with jaundice (Smith et al., 1998). According to our practical studies, although jaundice is a mandatory symptom in dogs with gall bladder pathology, icterus of the mucous membranes and skin is not a mandatory symptom, especially in the first and second stages of cholecystitis.

There are two worldwide accepted objective criteria in the ultrasound diagnostics according to which the evaluation of the biliary tract is of a crucial importance. Criterion 1 is the thickness of the gallbladder wall and criterion 2 is the diameter of the bile duct (Martinez et al, 2023). The thickness of the gallbladder wall is most often considered to be an indicator of potential burning



Fig. 1. Cholecystitis in a dog at stage I: gall bladder with anechoic content, wall thickened to 2 mm, hyperechoic.



Fig. 2. Cholecystitis in a dog at stage I: gall bladder with anechoic content, wall thickened to 3 mm, hyperechoic. Exacerbation of chronic cholecystitis with manifestation of cholangitis.



Fig. 3. Gallbladder of a dog at the 2nd stage of cholecystitis: anechoic capacity, wall thickened to 4.5 mm, hyperechoic, visualized hyperechoic suspension (mucocele)



Fig. 4. Gallbladder of a dog at the 2nd stage of cholecystitis: anechoic capacity, the wall is thickened to 4.5 mm, hyperechoic, a hyperechoic suspension (mucocele) is visible.



Fig. 5. Gallbladder of a dog at the 3rd stage of cholecystitis: anechoic content, wall thickened to 6 mm, hyperechoic, a hyperechoic stone with a characteristic echoacoustic shadow is visible.

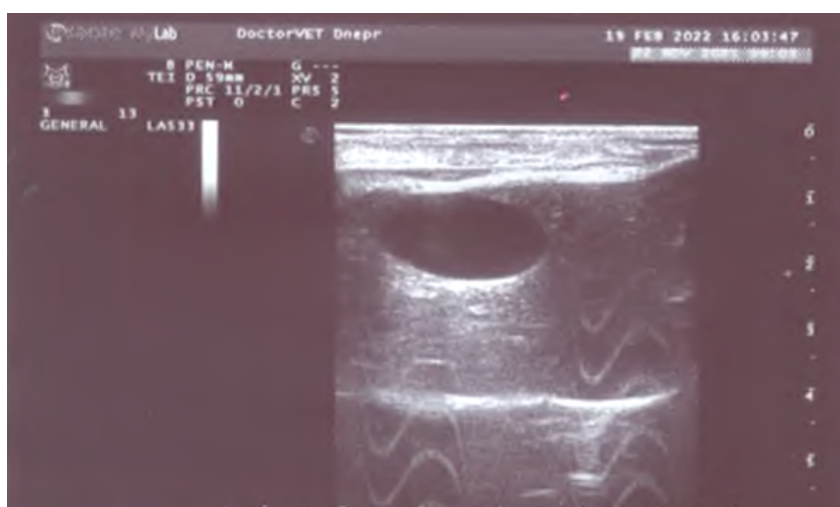


Fig. 6. Gallbladder of a dog at the 3rd stage of cholecystitis: anechoic content, wall thickened to 6 mm, hyperechoic, a hyperechoic calculus with a characteristic echoacoustic shadow is visible.

of the gallbladder (Neer et al., 1992). The upper boundary of the gallbladder wall thickness in 53 dogs (8 hours fasting) <40 kg was recorded as 1.30 mm (90% confidence interval, 1.19-1.41 mm) (Spaulding, 1993). The remaining publications indicate that the normal thickness of the gallbladder wall in dogs ranges from 1 to 2 mm, but without supporting data (Kealy, 2010; Nyland, 2015). Most publications that refer to gallbladder wall thickness in dogs use the default values provided. (Spaulding, 1993). However, there is a discrepancy between this historically accepted data and veterinary practice (Martinez et al., 2023).

A significant difference was established in the average thickness of the gallbladder wall in the presence of biliary sludge (sludge, a sediment that can accumulate in the gallbladder) 6 and 9 months after its appearance in dogs compared to the wall thickness at the beginning of the sludge appearance (0 months).

However, most dogs had normal gallbladder wall thickness (<2 mm) at each examination. In dogs, the normal gallbladder wall is either poorly visualized or appears as a thin hyperechoic line, and the possibility of accurate measurement depends on the angle of the ultrasound beam and the degree of distension of the gallbladder. Accurate measurements in some dogs were difficult due to the very thin nature of the gallbladder wall which was assumed to be <1 mm thick. This occurred in approximately half of the dogs in this study at each examination period. Thus, the significant difference in GBW thickness between 6- and 9-month-old dogs may not be a sign of variation in GBW thickness, but rather a difference in the accuracy of GBW thickness measurement by ultrasound. Despite this, changes in gallbladder wall thickness were minimal and within normal limits. Wall thickness did not differ significantly during the study at 12 months of age, while changes observed at 6 and 9 months of age were generally not significant (DeMonaco et al., 2016).

The results of scientific studies that evaluated the safety of percutaneous ultrasound-guided cholecystocentesis (percutaneous ultrasound-guided cholecystocentesis) indicate an average thickness of the gallbladder wall at the level of 1.3 mm (Schiborra, 2017). In another study of 45 dogs with histologically confirmed gallbladder disease, only 23 had gallbladder wall thickening (>3 mm) (Crews et al, 2009). However, in another report, in 11 dogs undergoing cholecystectomy, none had increased gallbladder wall thickness on ultrasonography (>3 mm) preoperatively, despite histopathologically confirmed chronic cholecystitis in all 8 dogs selected for the study (Uno et al., 2009).

Diffuse thickening of the gallbladder wall has also been reported in dogs with cholecystitis (Bargellini et al., 2016), infectious hepatitis (De Jonge et al., 2020), shock, leptospirosis (Sonet et al., 2018), anaphylaxis (Haworth et al., 2019), right-sided heart failure (Lisciandro et al., 2021) and sedation (Seitz et al., 2021).

Possible causes of gallbladder wall thickening in dogs include mucosal cystic hyperplasia, hepatopathy, hepatobiliary neoplasia, pancreatitis, chronic bile duct obstruction, renal failure, hyperhydration, recent blood transfusion, immune-mediated disease, hypoalbuminemia, hypovolemic shock, syndrome systemic inflammatory response, sepsis and disseminated intravascular coagulation (Spaulding, 1993; Woodworth et al., 2021; Murakami et al., 2023).

Data on the relationship between gallbladder wall thickening and serum/plasma albumin levels in dogs have recently been published in the scientific literature. However, the publication did not discuss gallbladder wall edema and ultrasound imaging of gallbladder wall thickening (Sparago et al., 2021; Murakami et al., 2023).

Several sources provide ranges for normal gallbladder wall thickness in dogs, with values ranging from 2 mm (Kealy et al., 2011; Schiborra et al., 2017) to 3 mm (Spaulding, 1993). Using these references, it can be argued that the main criteria by which the condition of the biliary tract is assessed are the thickness of the gallbladder wall and the diameter of the bile duct.

Some of the canine gallbladder sonography studies presented were conducted several years ago using older ultrasound machines, sensors, and imaging software. Accordingly, literature data on the diagnostic criteria of the norm and pathology of the gallbladder in dogs can be partially considered morally outdated. Therefore, it remains unclear what the norm is for use in current practice. With regard to the presented results of our study, the diagnostic advantage of the selected indicators for identifying the appropriate stage of cholecystitis through the determination of the thickness of the gallbladder wall, its content and signs of inflammation of the bladder using ultrasonography is shown.

Conclusion

The results of the study showed the advantages of using a complex ultrasonographic analysis of cholecystitis in dogs to differentiate the stages of inflammation of the gallbladder. Suggested indicators of the ultrasound image of the 1st stage of cholecystitis in dogs: visualization of a hyperechoic gallbladder wall, general thickening of the gallbladder wall from 2 to 4 mm, thickening of the mucous layer.

Characteristic clinical symptoms of the 2nd stage of cholecystitis in dogs are anorexia, weight loss, vomiting, decreased skin turgor, icterus of the mucous membranes, abdominal wall pain. Suggested indicators of the ultrasound picture of the 2nd stage of cholecystitis in dogs: visualization of the hyperechoic wall of the gallbladder, general thickening of the wall of the gallbladder from 2 to 5 mm, thickening of the mucous layer, the presence of biliary sludge and hyperechoic calculi.

Characteristic clinical symptoms of the 3rd stage of the gallbladder inflammation in dogs: anorexia, weight loss, vomiting, decreased skin turgor, icterus of the mucous membranes, tenderness of the abdominal wall upon palpation. Proposed indicators of the ultrasound picture of the 3rd stage of cholecystitis in dogs: the presence in some cases of a hyperechoic wall, as well as a heteroechoic wall, thickening of the gallbladder wall from 2 to 5 mm, thickening of the mucous membrane layer, the presence of an erosive mucous layer, the presence of biliary sludge and mucocele, hyperechoic calculi up to 5-7 mm.

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