

ANIMAL PATHOLOGY, MORPHOLOGY, PHYSIOLOGY, PHARMACOLOGY AND TOXICOLOGY

ПАТОЛОГИЯ ЖИВОТНЫХ, МОРФОЛОГИЯ, ФИЗИОЛОГИЯ, ФАРМАКОЛОГИЯ И ТОКСИКОЛОГИЯ



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Clinical, Echocardiographic and Cytological Characteristics of Pericardial Pathologies Accompanied by Pericardial Effusion in Dogs

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Abstract

Introduction. The majority of pericardial diseases are accompanied by pathological accumulation of fluid in the pericardial cavity (effusion), as well as cardiac tamponade. Physical examination methods combined with transthoracic echocardiography are widely used to diagnose these conditions. An important task for veterinary specialists is to determine characteristic symptoms and specific echocardiographic signs of cardiac tamponade, which is considered to be a life-threatening condition. Cytological examination of pericardial fluid is an integral part in diagnosing the cause of the effusion. A comprehensive approach to diagnosis underpins the efficiency of treatment strategies. The existing studies poorly reveal the relationships between the clinical symptoms and echocardiographic signs, which could enable the diagnosis of disease severity and its prognosis, neither do they fully elucidate the cytological characteristics of effusions that could indicate the causes of effusion occurrence. The aim of the study is to establish the clinical, echocardiographic, and cytological relationships in dogs with pericardial pathologies accompanied by pericardial effusion.

Materials and Methods. The study was conducted at the Department of Veterinary Surgery of Moscow State Academy of Veterinary Medicine and Biotechnology – MVA named after K. I. Skryabin and at the Veterinary Research Center “Biocontrol” in the period from 2018 to 2023. The objects under study were dogs of various breeds, ages, and sexes (n=200). The examination methodology included: collection of patient’s medical history, clinical examination, echocardiography, electrocardiography, chest radiography, ultrasonographic visualization of free fluid in the thoracic and abdominal cavities, pericardiocentesis, cytological examination of effusion, and histological examination of pathological material obtained during surgery.

Results. During the echocardiography, a ring-shaped anechoic space of varying diameter was revealed around the heart in all the studied dogs with pericardial effusion. Of 200 patients, cardiac tamponade was registered in 64 animals (32.0%), to whom pericardiocentesis was performed. For further determination of the causes of pericardial effusion, cytological examination of the obtained fluid was performed in 61 patients. According to cytomorphological characteristics, the following types of effusion were identified: transudate (1.6%), modified transudate (4.9%), septic exudate (1.6%), hemorrhagic effusion (which, in turn, was divided into effusion corresponding to: acute hemorrhage (4.9%), chronic hemorrhage (77.0%), hemorrhagic effusion with cytological signs of a tumor (9.8%)).

Discussion and Conclusion. In the presence of pericardial effusion, detection of the cardiac tamponade syndrome is of great clinical importance. We have established the most common echocardiographic signs of tamponade: caudal vena cava dilation and reduction of its collapsibility amplitude to less than 50%, as well as right atrial collapse. A relationship between the clinical symptoms (abdomen volume increase due to accumulation of ascitic fluid, progressing weakness, and exercise tolerance decrease) and echocardiographic signs of cardiac tamponade was revealed. Based on cytological examination results, the hemorrhagic type of pericardial effusion was identified as the most common one, concomitant to cardiac and pericardial tumors in older dogs of medium and large breeds.

Keywords: dogs, pericardial effusion, cardiac tamponade, pericardial cavity, echocardiography, cytological examination of fluid

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Оригинальное эмпирическое исследование

Клинико-эхокардиографические и цитологические характеристики патологий перикарда собак, сопровождающихся перикардальным выпотом

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Аннотация

Введение. Большинство болезней перикарда сопровождаются патологическим скоплением жидкости в перикардальной полости (выпот), а также тампонадой сердца. Для диагностики подобных состояний широко используют методы физикального обследования в сочетании с трансторакальной эхокардиографией. Важной задачей ветеринарных специалистов является определение характерных симптомов, а также специфических эхокардиографических признаков тампонады сердца как состояния, угрожающего жизни. Цитологическое исследование перикардальной жидкости является неотъемлемой частью диагностического поиска причин выпота. Комплексный подход к диагностике определяет эффективную тактику лечения пациента. В существующих исследованиях остаются мало раскрытыми клинико-эхокардиографические взаимосвязи, позволяющие диагностировать тяжесть течения и прогноз заболевания, а также недостаточно освещены цитологические характеристики выпотов, определяющие их причины. Цель исследования — установить клинико-эхокардиографические и цитологические взаимосвязи у собак с патологиями перикарда, сопровождающимися перикардальным выпотом.

Материалы и методы. Исследование проведено на кафедре ветеринарной хирургии ФГБОУ ВО «Московская государственная академия ветеринарной медицины и биотехнологии – МВА имени К.И. Скрябина», а также на базе ветеринарного научного центра «Биоконтроль» в период с 2018 по 2023 г. Объектом исследования послужили собаки различных пород, возраста и пола (n=200). Методика обследования включала: сбор анамнеза, клинический осмотр, эхокардиографию, электрокардиографию, рентгенографию грудной клетки, ультрасонографическую визуализацию свободной жидкости в грудной и брюшной полостях, перикардицентез, цитологическое исследование выпота, гистологическое исследование патологического материала, полученного в ходе хирургического вмешательства.

Результаты исследования. У всех исследуемых собак с перикардальным выпотом на эхокардиографии выявлено кольцевидное анэхогенное пространство (ободок) разного диаметра вокруг сердца. Из 200 пациентов у 64 животных (32,0 %) зарегистрирована тампонада сердца и выполнен перикардицентез. Цитологическое исследование полученной жидкости для дальнейшей диагностики причины перикардального выпота выполнено у 61 пациента. По цитоморфологическому характеру выявлены следующие виды выпота: трансудат (1,6 %), модифицированный трансудат (4,9 %), септический экссудат (1,6 %), геморрагический (который, в свою очередь, разделялся на выпот, соответствующий: острому кровотечению (4,9 %), хроническому кровотечению (77,0 %), геморрагический выпот с цитологическими признаками опухоли (9,8 %)).

Обсуждение и заключение. При наличии перикардального выпота важное клиническое значение имеет распознавание синдрома тампонады сердца. Нами установлены самые распространённые эхокардиографические признаки тампонады: расширение и снижение амплитуды спадения каудальной полой вены менее 50 % и коллапс стенки правого предсердия. Выявлена взаимосвязь между клиническими симптомами (увеличение объема живота в результате накопления асцитной жидкости, прогрессирующая слабость и снижение переносимости нагрузок) и эхокардиографическими признаками тампонады сердца. По результатам цитологического исследования самым распространенным видом перикардального выпота явился геморрагический, сопровождавший опухоли сердца и перикарда у собак старшей возрастной группы средних и крупных пород.

Ключевые слова: собаки, перикардальный выпот, тампонада сердца, перикардальная полость, эхокардиография, цитологическое исследование жидкости

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Introduction. Enhancement of cardiac disease diagnostics in animals is particularly important due to the increasing incidence of pericardial pathologies in dogs of various breeds and sizes. In recent years, significant progress has been made in diagnostics of cardiac diseases in animals, including diagnostics of diseases accompanied by pericardial effusion inducing compression of the heart chambers and hemodynamic disorders. This condition causes reduction of cardiac filling and emptying, provokes venous congestion, and can lead to cardiogenic shock and death of a patient [1–3].

Diagnostic tests for pericardial pathologies accompanied by pericardial effusion include echocardiography, electrocardiography, radiography, computed tomography, cytomorphological examination of effusion, histological examination of the pericardium and neoplasms of the heart and pericardium. Each method has its advantages and limitations, but echocardiography (EchoCG) is the preferred first-line diagnostic test [2]. This visual diagnostic method is highly informative, as it allows one to determine the size of the heart and evaluate its function, the presence and volume of pericardial effusion, the presence of intracardiac thrombi and cardiac and pericardial tumors [3, 5, 6]. EchoCG is the leading method for dynamic monitoring of pericardial effusion during conservative therapy [7]. An important advantage of EchoCG is its non-invasiveness and the absence of the need for animal sedation.

A cytological analysis of pericardial effusion is a necessary diagnostic method for determining the etiology of the pathological process and patient's treatment strategy. In some cases, this test is crucial and reduces the amount of diagnostic procedures required for the patient.

A number of ultrasound criteria for diagnosing canine pericardial diseases accompanied by effusions have been identified in the available national and international literature. However, the relationship between the clinical symptoms and echocardiographic signs that enables diagnosing disease severity and prognosticating its course remains poorly studied, the same as the correlation of pathological changes with the body weight and age of the patients. Furthermore, the cytological characteristics of effusions, which determine effusion causes, are insufficiently described. The aim of the study is to establish clinical, echocardiographic, and cytological relationships in dogs with pericardial pathologies accompanied by pericardial effusions.

Materials and Methods. The study was conducted at the Department of Veterinary Surgery of Moscow State Academy of Veterinary Medicine and Biotechnology – MVA named after K. I. Skryabin and at the Veterinary Research Center “Biocontrol” in the period from 2018 to 2023. The objects of the study were sexually mature dogs of various breeds, ages, and sexes (n=200). The following

dog breeds were included in the study: mixed breeds (n=38), French Bulldogs (n=19), Labrador Retrievers (n=12), Chihuahuas (n=11), Yorkshire Terriers (n=10), Golden Retrievers (n=8), Smooth-haired Dachshunds (n=6), American Staffordshire Terriers (n=5), Jack Russell Terriers (n=5), Cane Corso (n=5), German Shepherd Dogs (n=4), Bullmastiffs (n=4), Dogue de Bordeaux (n=4), Siberian Huskies (n=4), German Spitz (n=3), Staffordshire Bull Terriers (n=3), Shiba Inu (n=2), Central Asian Shepherd Dogs (n=2), Russian Spaniels (n=2), Pomeranian Spitz (n=2), German Boxers (n=2), Chinese Crested (n=2), Ca de Bou (n=2), Caucasian Shepherd Dogs (n=2), Dobermans (n=2), East European Shepherd Dogs (n=2), Weimaraners (n=2), Boerboels (n=2), Bernese Mountain Dogs (n=2), American Pit Bull Terriers (n=2), English Bulldogs (n=2), Biewer Yorkshire Terriers (n=2). The following breeds included in the study were represented by a single animal: English Cocker Spaniel, Alaskan Malamute, Dogo Argentino, Beauceron, West Highland White Terrier, Dalmatian, Irish Setter, Keeshond, Maremma Sheepdog, Miniature Poodle, Moscow Toy Terrier, Pug, Neapolitan Mastiff, Pointer, Petit Brabancon, Rhodesian Ridgeback, Russian Hound, Russian Toy Terrier, Samoyed, Skye Terrier, Scottish Terrier, Olde English Bulldogge, Whippet, Fox Terrier, Miniature Pinscher, Shar Pei, Shih Tzu, Entlebucher Mountain Dog, Japanese Chin (Fig. 1).

The distribution of animals by age groups was as follows: Group 1 — from 1 to 5 years (n = 14), Group 2 — from 6 to 9 years (n = 71), Group 3 — from 10 to 15 years (n = 107), Group 4 — from 16 to 17 years (n = 8). Distribution of animals by sex — 134 males and 66 females (Table 1).

For a reliable assessment of the heart structures, the animals were divided into groups depending on body weight: Group 1 — up to 10 kg (n=54), Group 2 — 10–25 kg (n=58), Group 3 — 26–45 kg (n=62), Group 4 — over 45 kg (n=26) (Table 2).

General clinical examination of the dogs was performed according to a standard methodology, including collection of patient's medical history, and physical examination. Echocardiography was performed using Philips Epiq 5 and Philips HD15 ultrasound systems (“Philips”, USA) with phased array transducers operating at frequencies of 1–5 MHz, 2–9 MHz, and 4–12 MHz. The animals were positioned in the right and left lateral positions. To ensure direct contact between the transducer and the skin, the dogs' coats were shaved, and 30% isopropyl alcohol and ultrasound gel were applied. During the examination, the structural and functional characteristics of the heart were assessed, including the presence of thrombi in the cardiac chambers, tumors in the heart, pericardium and thoracic cavity, pericardial thickening, and the presence of free fluid in the pericardial cavity.

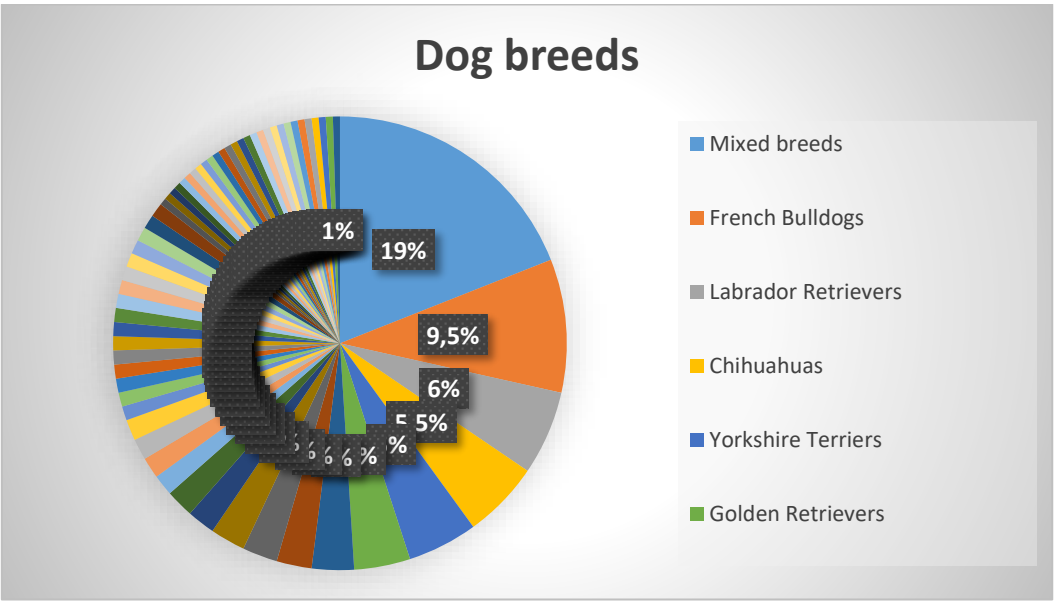


Fig. 1. Distribution of dogs with pericardial effusion by breed

Table 1

Distribution of dogs with pericardial effusion by age and sex

Group/age, years	Absolute number, n	Relative quantity, %	Sex			
			Males		Females	
Group 1 (1–5)	14	7.0				
Group 2 (6–9)	71	35.5	n	%	n	%
			134	67	66	33
Group 3 (10–15)	107	53.5				
Group 4 (16–17)	8	4.0				
Total	200	100	200	100	200	100

Table 2

Distribution of dogs with pericardial effusion by body weight

Group/body weight, kg	Absolute number, n	Relative quantity, %
Group 1 (up to 10)	54	27.0
Group 2 (10–25)	58	29.0
Group 3 (26–45)	62	31.0
Group 4 (over 45)	26	13.0
Total	200	100

To obtain the material for cytological examination, ultrasound-guided pericardiocentesis was performed through the 3rd–5th intercostal spaces on the right. The patient was given general anesthesia (by intravenous injection of Propofol at a dose of 4–8 mg/kg) and positioned in the left lateral decubitus position. To prepare the surgical site, the coat was shaved, and the skin around the needle insertion site was cleaned with 70% ethyl alcohol.

Cytological examination of pericardial effusion was performed in 61 dogs. Pericardial fluid obtained by pericardiocentesis was transferred to the EDTA tube. For cell count in the Goryaev chamber, 20 µl of fluid was removed from the tube and mixed with 380 µl of a 3–5% acetic acid solution stained with methylene blue. The EDTA tube was then centrifuged for 5 min at 2000 rpm. Direct brush smears were prepared from the sediment. The smears were stained for 20–30 min according to Romanowsky staining technique. The resulting smears were examined at 100×, 200×, and

1000× magnification using an Olympus CX43 microscope (“Olympus”, Japan).

A histological examination was performed in 23 patients. The dogs had recurrent cardiac tamponade with pericardial effusion accumulated two or more times. Patients underwent pericardiectomy to collect the pericardial and cardiac tumor specimens for histological examination, or euthanasia followed by pathological autopsy with histological examination. A sample for the study (a 3–5 mm thick section) was excised from the obtained biopsy specimen that had been fixed in 10% buffered formalin (BF). The resulting samples were dehydrated and impregnated with paraffin using a Histo-Tek VP1 histoprocessor (“Sakura Seiki Co.” LLC, Japan). Paraffin blocks were then prepared, from which series of sections (2–4 µm thick) were sliced using a HistoCore Bicut rotary microtome (“Leica Biosystems”, Germany).

The resulting preparations were then stained with hematoxylin and eosin to visualize tissue components. But prior to this, the preparations were deparaffinized (sequentially through a paraffin solvent (xylene) and alcohols of descending concentration). After staining, the prepared samples were cleared in xylene and mounted under coverslips using a mounting medium. The prepared histological slides were examined using an Olympus CX43 microscope at 100×, 200×, 400×, and 1000× magnification.

Research Results. Based on the anamnesis and clinical examination of 200 patients with pericardial effusion, cardiac tamponade was diagnosed in 64 animals (32.0%). In this group of animals, one or more of the leading clinical symptoms were identified: increase in volume of the abdomen due

to the accumulation of ascitic fluid (50.0%), sudden weakness/syncope (37.5%), progressing weakness/decreased activity (62.5%), and dyspnea caused by hydrothorax (32.8%). The remaining patients had nonspecific symptoms (Table 3).

Physical examination of dogs with cardiac tamponade revealed a number of characteristic clinical symptoms: pallor of the mucous membranes (15.6%), muffled heart sounds (75.0%), weak pulse waveform (35.9%), arrhythmic pulse (21.8%), and paradoxical pulse (7.8%) (Table 4). One or more components of Beck’s triad (edema of the neck, dewlap, and peripheral edemas) were recorded in 3 dogs (1.5%). Jugular venous distention was not detected, possibly because of the difficulty to identify the characteristic signs due to the thick coats of the patients. In 27 of 64 patients with cardiac tamponade, the tonometry data had been obtained before pericardiocentesis. Hypotension with mean systolic blood pressure of 80 mmHg and lower was detected in 12 dogs (42.0%).

In all dogs (n=200) with pericardial effusion, echocardiography revealed a ring-shaped anechoic space (rim) of varying diameter around the heart. Echocardiographic signs of cardiac tamponade were: right atrial collapse in 42 dogs (65.6%), right ventricular diastolic collapse in 20 dogs (31.2%), reduced cardiac chambers due to insufficient filling with blood in 5 dogs (7.8%), paradoxical septal motion during respiration in 8 dogs (12.5%), dilation of caudal vena cava and reduction of its collapsibility amplitude to less than 50% during inhalation in 34 animals (53.1%) (Table 5).

Table 3

Leading clinical symptoms accompanying cardiac tamponade

Symptoms	Absolute number, n	Relative quantity, %
Dyspnea caused by hydrothorax	21	32.8
Sudden weakness/ syncope/forced posture	24	37.5
Increasing apathy/weakness/decreased activity	40	62.5
Increase in volume of the abdomen (ascitic fluid)	32	50.0

Table 4

Leading symptoms of cardiac tamponade identified during physical examination (n=64)

Symptoms	Absolute number, n	Relative quantity, %
Pallor of the mucous membranes	10	15.6
Muffled heart sounds	48	75.0
Weak pulse waveform	23	35.9
Paradoxical pulse	5	7.8
Arrhythmic pulse	14	21.8

Table 5

Echocardiographic signs of cardiac tamponade in the dogs studied (n=64)

Echocardiographic signs	Absolute number, n	Relative quantity, %
Right atrial collapse	42	65.6
Right ventricular diastolic collapse	20	31.2
Paradoxical septal motion	8	12.5
Reduction of left cardiac chambers (visual assessment)	5	7.8

Dilation and poor collapsibility of caudal vena cava (less than 50%)	34	53.1
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Data analysis enabled establishing a relationship between clinical symptoms and structural and functional parameters of the heart: of 34 dogs with signs of dilation of caudal vena cava and reduction of its collapsibility amplitude to less than 50% during inhalation (diagnosed by echocardiography), 29 patients had ascites, 15 dogs — progressing weakness, and 13 dogs — dyspnea. Of 42 patients with right atrial collapse, 22 dogs had ascites, 23 had progressing weakness, and 19 dogs had dyspnea (Table 6).

Pericardiocentesis was performed in 64 dogs with cardiac tamponade, whereas the cytological examination of the obtained fluid for further diagnostics was performed in

61 patients. By the cytomorphological nature of effusion, the following types were identified: transudate (1.6%), modified transudate (4.9%), septic exudate (1.6%), hemorrhagic effusion, which in turn was divided into effusion corresponding to: acute hemorrhage (4.9%), chronic hemorrhage (77%) and hemorrhagic effusion with cytological signs of a tumor (9.8%) (Table 7).

Histological examination of the pericardium was performed in 23 patients with recurrent cardiac tamponade. In 16 dogs, cardiac or pericardial neoplasms were diagnosed by echocardiography, and 2 patients were suspected of having pericardial neoplasia (Table 8).

Table 6

Correlation of clinical symptoms with echocardiography data (n=64)

Symptoms	EchoCG sign				
	Dilation/poor collapsibility of caudal vena cava	Right atrial collapse	Right ventricular diastolic collapse	Reduced left cardiac chambers	Paradoxical septal motion
Ascites/Асцит	29	22	10	-	4
Гидроторакс	10	7	1	1	2
Sudden weakness/ syncope	9	14	8	2	5
Hypotension	2	5	5	5	9
Increasing apathy/weakness/decreased activity	15	23	10	—	4
Peripheral edemas	2	1	1	—	
Dyspnea	13	19	10	—	4

Table 7

Correlation between the causes and cytological characteristics of pericardial effusion (n=61)

Causes of effusion	Absolute number, n	Relative quantity, %	Type of effusion by nature					
			Transudate	Modified transudate	Septic exudate	Chronic hemorrhagic effusion	Acute hemorrhagic effusion	Hemorrhagic effusion with cytological signs of a tumor
Cardiac/pericardial neoplasms	34	55.7		1		26	1	4 (lymphoma)
								1 (carcinoma)
								1 (mesothelioma)
Idiopathic/unknown cause	18	29.5		1		16	1	
Congestive heart failure	2	3.3		1		1		
Pericarditis	5	8.2			1	4		
Left atrial rupture	1	1.6					1	

Protein-losing enteropathy	1	1,6	1					
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Table 8

Histological examination of the causes of pericardial effusion (n=23)

Causes of effusion	Absolute number, n	Relative quantity, %
Lymphoplasmacytic pericarditis	1	4.3
Neutrophilic pericarditis	2	8.7
Mixed pericarditis (lymphoplasmacytic and neutrophilic)	6	26
Chemodectoma	6	26
Hemangiosarcoma	5	22
Mesothelioma	1	4.3
Carcinoma	1	4.3
No pathological changes	1	4.3

Discussion and Conclusion. Transthoracic echocardiography is a reliable method for detecting pericardial pathologies and the presence of free fluid in the pericardial cavity. Free fluid in the pericardial cavity is visualized on ultrasonogram as an anechoic rim around the heart. Upon accumulation of a large volume of fluid, a characteristic “floating” or “swinging” heart pattern is observed due to its pendulum-like movements [8].

In the presence of pericardial effusion, recognition of cardiac tamponade syndrome is of major clinical importance; it is diagnosed by comparing the characteristic clinical picture and echocardiographic signs [9]. Of 200 patients participating in the study, cardiac tamponade was diagnosed in 64 animals (32.0%). The diagnostic criteria for diagnosing cardiac tamponade obtained by the authors adhere to the data published in other studies [10]. The most common echocardiographic signs of cardiac tamponade were: right atrial collapse — detected in 65.6% (n=42), dilation of caudal vena cava and reduction of its collapsibility amplitude (to less than 50% during inhalation) — detected in 53.1% (n=34), right ventricular diastolic collapse— detected in 31.2% (n=20).

A comparison of physical examination data and echocardiographic signs revealed that symptoms such as the increase in the volume of the abdomen due to ascitic fluid accumulation, progressing weakness, and exercise tolerance decrease are diagnosed in patients with echocardiographic signs of dilation of caudal vena cava and reduction of its collapsibility amplitude to less than 50% and right atrial collapse. This is explained by impaired venous return in systemic circulation against the background of right ventricular end-diastolic pressure increase resulting from the pericardial fluid pressure. In the presence of all the above listed echocardiographic signs of cardiac tamponade (Table 5), including the paradoxical septal motion and reduction of cardiac chambers due to decrease in venous blood flow, the persistent arterial hypotension (with mean systolic blood pressure of 80 mmHg or lower) was observed in animals. The primary diagnostics of cardiac tamponade

is based on a constellation of patient’s clinical symptoms and physical examination results. Echocardiography is a confirmatory and expert method that allows visualization of pericardial effusion, assessment of its volume, identification of the signs of cardiac compression and, in some cases, differentiation of the causes of effusion.

When assessing the effusion, the hemorrhagic nature of the fluid was most often diagnosed (91.8%), which is consistent with the literature data [11, 12], whereas signs of acute hemorrhagic effusion were detected only in 4.9% of patients. The most common cause of hemorrhagic effusion in dogs was cardiac neoplasia — 55.7% of cases, of which cardiac hemangiosarcoma was histologically diagnosed in 22%, which, in turn, is considered one of the common neoplastic causes of pericardial effusions [13, 14]. In 26% of cases, histological confirmation of a basal cardiac tumor — chemodectoma was obtained. According to echocardiography, out of 200 patients, cardiac tumors were detected in 86 dogs, of which 32.5% were right heart tumors without histological confirmation, and in 53.5% of cases, basal cardiac tumors were determined. Unknown cause of effusion was the second most common cause and may also include patients with idiopathic pericardial effusion, which is consistent with the previous studies [11, 15]. Modified transudate was recorded in 4.9% of cases, including in cases of congestive heart failure. Transudate caused by protein-losing enteropathy and septic exudate caused by myopericarditis were the rarest types of pericardial effusions. Cytological examination of pericardial fluid is deemed to be less informative and depends on the tumor type and effusion hematocrit [16, 17]. Hemorrhagic effusion with cytological signs of a tumor was observed in 9.8% of cases, with large cell lymphoma being the most commonly diagnosed tumor, which is consistent with the foreign literature data [18, 19]. In this study, in 64 dogs with cardiac tamponade, cardiac neoplasms were diagnosed in 55.7% by echocardiography. The development of cardiac tamponade in such patients may be explained not only by mechanical com-

pression of the vessels by the tumor, but also by their bleeding, which can cause a surge in intrapericardial pressure, acute dilation of pericardial cavity and, as a consequence, cardiac tamponade.

Histological examination of cardiac and pericardial tumors excised during surgery is the “gold standard” for verifying the presence of cancer. According to the results of our study, of 16 dogs with cardiac and pericardial tumors identified by echocardiography, cardiac neoplasia was histologically confirmed in 12 animals: chemodectoma in 26% of cases and hemangiosarcoma in 22%. These types of cardiac tumors are the most common, as described above. In one patient suspected of having pericardial neoplasia, pericardial mesothelioma was diagnosed. In three dogs, histological examination of the cardiac or pericardial tumor turned to be inconclusive, and in one dog, a tumor biopsy was not performed. Pericarditis as a histological diagnosis was found in 39% of cases.

Most dogs with pericardial effusion were male, of medium to large breeds, weighing between 26 and 45 kg: mixed breeds (19%), Labrador Retrievers (6%), Golden Retrievers (4%), Cane Corso (2.5%), American Staffordshire Terriers (2.5%), German Shepherd Dogs (2%) — these breeds have been previously mentioned in other studies too [11, 15, 20]. Small dog breeds were represented by: French Bulldogs (9.5%), Chihuahuas (5.5%) and Yorkshire Terriers (5%). In this study, cardiac tamponade was most commonly diagnosed in mixed breeds (15.6%), French Bulldogs (14%), Golden Retrievers (7.8%), Yorkshire Terriers (6.25%), Siberian Huskies (4.6%), and Jack Russell Terriers (4.6%). It's worth noting that in all French Bulldogs with cardiac tamponade, basal cardiac tumors were detected by echocardiography. In Golden Retrievers,

Siberian Huskies, and Yorkshire Terriers, a common cause of cardiac tamponade was right heart tumor. Cases of right heart hemangiosarcoma diagnosed in Golden Retrievers are frequently described in scientific studies [21–23]. The unknown cause, was most common in Labrador Retrievers and Jack Russell Terriers.

Thus, as a result of the data analysis, the following most common clinical, physical and echocardiographic signs of cardiac tamponade were established: an increase in volume of the abdomen (50%), sudden weakness/syncope (37.5%), progressing weakness/decreased activity (62.5%), dyspnea (32.8%), pallor of the mucous membranes (15.6%), muffled heart sounds (75%), weak pulse waveform (35.9%), arrhythmic pulse (21.8%), paradoxical pulse (7.8%), right atrial collapse (65.6%), right ventricular diastolic collapse (31.2%), dilation of caudal vena cava and reduction of its collapsibility amplitude to less than 50% during inhalation (53.1%). A relationship was found between the clinical symptoms such as the increase in the volume of the abdomen due to the accumulation of ascitic fluid, progressing weakness and exercise tolerance decrease, and the echocardiographic signs of cardiac tamponade such as dilation of caudal vena cava and reduction of its collapsibility amplitude to less than 50% and right atrial collapse. The serious condition of a patient with developed arterial hypotension and cardiogenic shock will be accompanied by all EchoCG signs of cardiac tamponade, including paradoxical septal motion and weak filling of the left cardiac chambers. Based on the results of cytological examination, the hemorrhagic type of pericardial effusion was identified to be the most common one, accompanying cardiac and pericardial tumors in dogs of the older age group of medium and large breeds.

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