ISSN: 1220-3173; E-ISSN: 2457-7618

STUDY ON ELECTROCARDIOGRAPHIC, ECHOCARDIOGRAPHIC AND BIOCHEMICAL BLOOD PARAMETERS IN HYPERTROPHIC CARDIOMYOPATHY IN DOGS

STUDIU PRIVIND PARAMETRII ELECTROCARDIOGRAFICI, ECOCARDIOGRAFICI ŞI BIOCHIMICI SANGUINI ÎN CARDIOMIOPATIE HIPERTROFICĂ LA CÂINI

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ABSTRACT | REZUMAT

In this study, 164 dogs were investigated for the early diagnosis of cardiovascular disease, particularly those with cardiac hypertrophy. They were electrocardiographically and echocardiographically examined and blood biochemistry has been tested for aspartate aminotransferase enzymes (ASAT), lactate dehydrogenase (LDH), creatine phosphokinase (CPK) and the B-type natriuretic peptide marker (BNP). Electrocardiographies were performed with the Contec electrocardiograph, Model 300 GA, with 12 derivatives, thermal printer and 80 mm ECG paper, using bipolar (DI, DII, DIII) and unipolar (aVR, aVL, aVF) derivatives. The working parameters were: the electrocardiographic paper velocity of 2.5 mm / sec, the minivolt amplitude of 10 mm. Electrocardiography revealed phenomena of concentric type interventricular septal hypertrophy with negative consequences on the minute volume and ST segment depression, meaning an aspect of subendocardial ischemia, which predisposes the heart to degenerative phenomena, falling into a heart failure syndrome NYHA II. Echocardiographic aspects of hypertrophic cardiomyopathy (HCM) have been reported, with repercussions on beat volume, heart rate, and blood flow dynamics. For the determination of the B-type natriuretic peptide marker, the method used is immunochemical, with electrochemiluminescence detection (ECLIA). The kit used contains 2 polyclonal antibodies that recognize epitopes located in the N-terminal (1-76) portion of the BNP. The value of the natriuretic peptide superior to the physiological limits proves that there are also interventricular cavitary pressure changes secondary to interventricular septal hypertrophy. The association of increased myocardial specific enzymes (CPK, LDH, ASAT) with elevated levels of the natriuretic peptide (BNP) suggests an aspect of hypertrophic cardiomyopathy with haemodynamic repercussions.

Key words: cardiomyopathy, electrocardiogram, echocardiography, natriuretic peptide

În acest studiu au fost investigați 164 câini în vederea depistării precoce a afecțiunilor cardiovasculare, în special la cei cu hipertrofie cardiacă.

Au fost examinați din punct de vedere electrocardiografic, ecocardiografic și biochimic sanguin, cu determinarea enzimelor aspartat-aminotransferaza (ASAT), lactat dehidrogenaza (LDH), creatinfosfokinaza (CPK) și markerul cardiac peptid natriuretic de tip B (BNP). Electrocardiografiile au fost realizate cu electrocardiograful digital tip Contec, model 300 GA, prevăzut cu 12 derivații, imprimantă termică și hârtie ECG de 80 mm, utilizându-se derivațiile bipolare (DI, DII, DIII) și unipolare (aVR, aVL, aVF).

Parametrii de lucru au fost: viteza de derulare a hârtiei electrocardiografice de 2,5 mm/sec., amplitudinea minivoltului de 10 mm. Electrocardiografic s-au evidențiat fenomene de hipertrofie sepală interventriculară de tip concentric, cu consecințe negative asupra minut-volumului și subdenivelarea segmentului ST, semnificând un aspect de ischemie subendocardică, ceea ce predispune cordul la fenomene degenerative, încadrându-se într-un sindrom de insuficiență cardiacă NYHA II.

Ecocardiografic s-au înregistrat aspecte de cardiomiopatie hipertrofică (CMH), cu repercusiuni asupra volumului bătăii, frecvenței cardiace și a dinamicii fluxului sanguin. Pentru determinarea markerului cardiac peptid natriuretic de tip B, metoda utilizată este imunochimică, cu detecție prin electrochemiluminiscență (ECLIA). Kit-ul utilizat conține 2 anticorpi policlonali care recunosc epitopi localizați în porțiunea N-terminală (1-76) a BNP.

Valoarea peptidului natriuretic superioară limitelor fiziologice, dovedește faptul că există și modificări presionale cavitare interventriculare, secundare hipertrofiei de sept interventricular. Asocierea valorilor crescute ale enzimelor cu specificitate relativă pentru miocard (CPK, LDH, ASAT) cu valori crescute ale peptidului natriuretic (BNP), sugerează un aspect de cardiomiopatie hipertrofică cu repercusiuni hemodinamice.

Cuvinte cheie: cardiomiopatii, electrocardiogramă, ecocardiografie, peptidul natriuretic

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In recent years, veterinary cardiology has been on the increase, on the one hand, given that cardiovascular disease is more and more common in both pet animals and those of economic interest, and, on the other, due to diversification and the improvement of the complementary diagnostic equipment (e.g., electrocardiograph, echocardiograph, electronic tensiometers, and radiographic devices) (2, 3, 6, 10).

The structural, energetic and functional features of the heart make it possible to maintain the homeostasis necessary to carry all the biological processes in the body up to a certain level (11). Thus, the energy required for contraction is provided by fatty acids (67%), lactate and pyruvate (17%), and glucose, ketone bodies and amino acids (16%) (12).

If until now, cardiomyopathy could be diagnosed only after the clinical signs have been established and, implicitly, after the occurrence of secondary complications and secondary lesions, with the determination of specific enzymes [creatine phosphokinase (CPK), lactate dehydrogenase (LDH), aspartate aminotransferase (ASAT)] and B-type natriuretic peptide (BNP), we now have the possibility of early diagnosis of heart disease, when prognosis is still favourable and treatment is less complicated and less expensive.

If CPK, the enzyme involved in energetic metabolism of the myocardial cell, determination is useful in assessing myocardial integrity, in case of subendocardial and/or myocardial ischemia, LDH determination is very useful in assessing the age of the myocardial disorder. ASAT enzyme determination is effective for subendocardial or myocardial syndrome in combination with CPK and LDH, and the evaluation of BNP is useful in the early assessment of ventricular filling pressure in dogs that do not exhibit visible cardiac symptoms. According to Verman (2008), the natriuretic peptides belong to a genetically distinct protein family with similar structure [e.g. atrial natriuretic peptide (ANP), BNP, C-type natriuretic peptide (CNP)], and play a role in diagnosing heart failure and assessing its severity, asymptomatic ventricular dysfunction and diastolic dysfunction in order to estimate prognosis, including prediction of sudden death, and evaluating efficient therapy (13).

Physiologically, BNP acts as a natural antagonist of the renin-angiotensin system, lowers blood volume and vascular resistance through vasodilator, natriuretic and diuretic properties. The BNP factor acts like a "biomarker", each of the levels of BNP that circulates through the body, highlights aspects of the severity of the cardiac disease (1, 4, 8, 9). The N-terminal fragment of the BNP (NT-pro BNP) is released in proportion to BNP in response to increased cardiac filling pressure or myocardial dysfunction and its accuracy as a diagnostic biomarker is high because it has a high stability and a longer half-time (4, 5, 7, 9).

MATERIAL AND METHODS

Research was conducted on 164 adult dogs of different breeds, with different weights and ages. The dogs were brought for medical examination at the University Veterinary Clinics of the Veterinary Medicine Faculty in Timişoara. Electrocardiography were performed with the digital Contec electrocardiograph, Model 300 GA, with 12 derivatives, thermal printer and 80 mm ECG paper, using bipolar (DI, DII, DIII) and unipolar (aVR, aVL, aVF) derivatives. The working parameters were: the electrocardiographic paper velocity of 2.5 mm/sec, the minivolt amplitude of 10 mm.

Echocardiographic investigations were performed with a stationary ultrasound machine, *MyLab ™70 Vet* model XVG (Esaote Pie medical) with a cardiac probe with a frequency of 3-8 MHz.

In order to perform the blood biochemical investigations, blood samples, drawn from the cephalic antebrachial vein, were taken in a vacuum blood collecting container with gel activator.

For the determination of the BNP, the method used is immunochemical, with electrochemiluminescence detection (ECLIA). The kit used contains 2 polyclonal antibodies that recognize epitopes located in the N-terminal (1-76) portion of the BNP.

Data processing was performed with the IBM 22 SPSS software.

RESULTS AND DISCUSSIONS

The analysis of the electrocardiographic parameters shows the average heart rate (FC) in the dogs under study was 132.5 bpm, being superior to the reference one, with a minimum limit of 100 bpm and a maximum of 160 bpm, with an increase of 62% relative to the species maxima, representing an aspect of sinusal tachycardia (Table 1).

At the level of the atrial complex, it was found that the duration of the P wave had a minimum value of 0.04 s and a peak value of 0.05 s and the average was of 0.04 s. The amplitude of the P wave has reached a maximum of 0.8mV and a minimum of 0.1mV, with an average of 0.2mV, which suggests the existence of atrial cardiomyopathies.

Table 1

Average values and dispersion indices of electrocardiographic parameters in dogs with cardiac hypertrophy

Item	FC	P wave		PQ	QRS		QT	ST Segment
		s	ms		s	ms		
Mean	132.50	0.0425	0.244	0.109	0.037	1.375	0.195	0.019
Std. Error of Mean	8.183	0.0016	0.082	0.010	0.005	0.134	0.006	0.061
Std. Deviation	23.145	0.0046	0.232	0.029	0.016	0.380	0.017	0.175
Variance	535.71	0.000	0.054	0.001	0.000	0.145	0.000	0.031
Minimum	100	0.04	0.10	0.08	0.00	0.80	0.16	−0.25
Maximum	160	0.05	0.80	0.16	0.06	2.00	0.22	0.25

The PR interval ranged between 0.08-0.16 s with an average of 0.1s. The existence of a double value, a 100% increase of PR_{int}, signifies that there were individuals with a first-degree atrioventricular block (AVB I).

The QRS ventricular complex and QT interval (QT_{int}) had an average value of 0.03 s/1.3 mV and a maximum of 0.06 s/2.0 mV, respectively 0.16-0.22 s, with an average of 0.19 s, values that fall within the physiological limits of the species.

The ST segment (ST_{segm}) recorded a maximum value of +0.25mV and a minimum value of −0.25mV, aspect suggestive of subendocardial ischemic phenomena (Table 1).

Figure 1 shows graphical aspects of average values and standard deviation in dogs with cardiac hypertrophy, observing the distribution of the registered electrocardiographic parameters in the group of dogs under study.

Serum creatine phosphokinase (CPK) had an average of 245.75 U/L with a minimum of 125U/L and a maximum of 432 U/L, more than 360% above the maximum physiological values. This signifies myocardial lesions, but the isoenzymes not being differentiated, we cannot claim to have a myocardial or skeletal muscle provenance.

As for LDH, it recorded a maximum of 608 U/L, 176% above the maximum reference level, and a minimum of 173 U/L, with an average level 345.87 U/L, be-

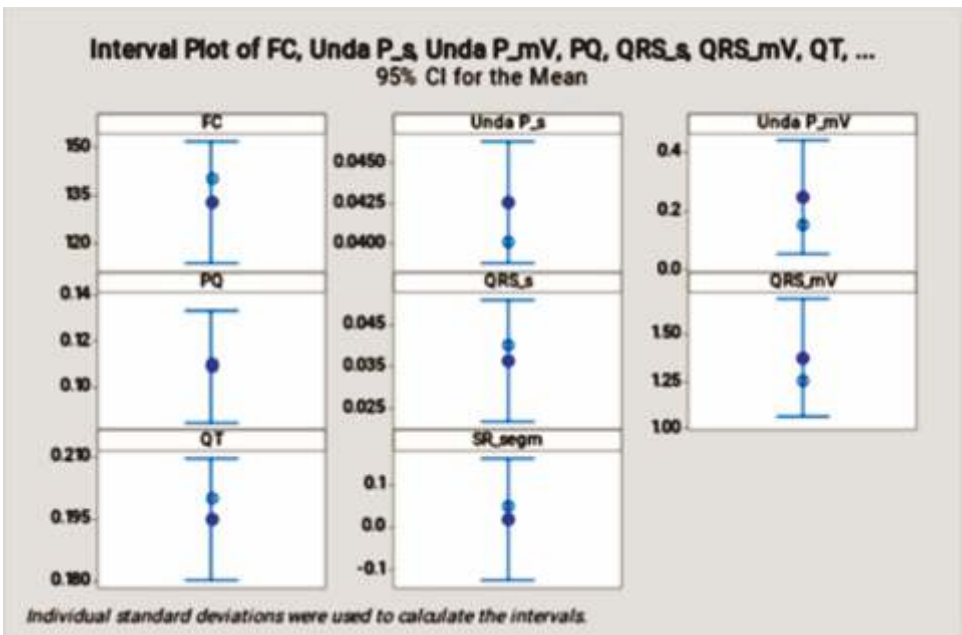

Fig. 1. Graphic representation of average values and dispersion indices of electrocardiographic parameters in dogs with cardiac hypertrophy

Table 2

Average values and standard deviation of blood biochemical parameters in dogs with cardiac hypertrophy

Item	CK/CPK (U/L)	LDH (U/L)	TGO/ASAT (U/L)	NTproBNP (mol/L)
Mean	245.75	345.87	49.62	263.54
Std. Error of Mean	33.035	60.741	8.421	113.319
Std. Deviation	93.437	171.803	23.820	320.515
Variance	8730.50	29516.41	567.411	102729.95
Minimum	125	173	25	0.59
Maximum	432	608	87	780

ing superior to the physiological peak. Knowing that this enzyme is showing slower growth than the CPK, it can be said that there were aspects of cardiac ischemia. In correlation with CPK and LDH, ASAT, which is part of the blood chemistry profile of ischemic syndromes, recorded a maximum of 87 U/L, higher than the maximum physiological limit.

An important marker of heart failure, even in the compensatory phases, is the BNP, which recorded a maximum value of 780 pmol/l and a minimum one of 0.59 pmol/l,with an average within the reference range. It can be concluded that in a number of individuals there have also been aspects of cardiac hypertrophy with negative repercussions on the cardiac function (Table 2).

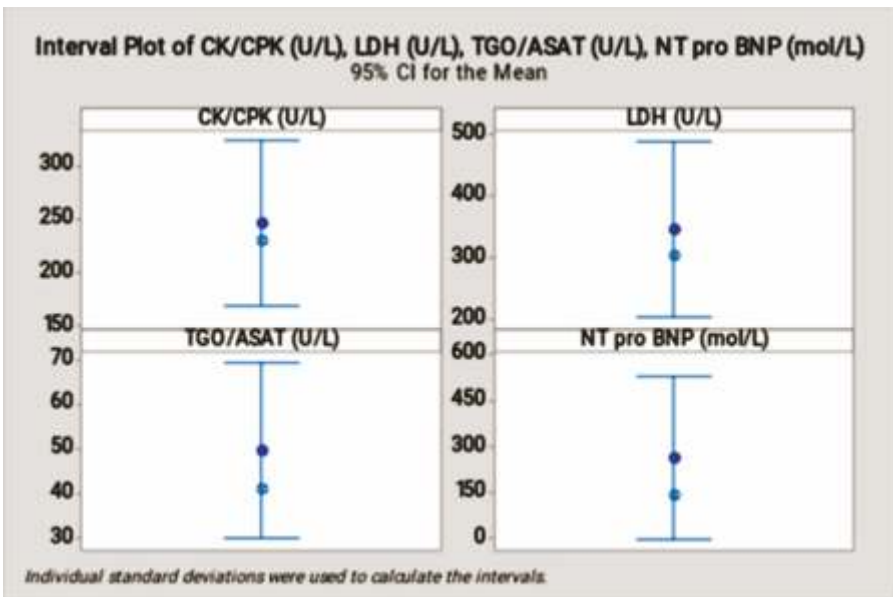

Fig. 2. Graphic representation of average values and standard deviation of blood biochemical parameters in dogs with cardiac hypertrophy

Fig. 3. Electrocardiography in a dog with cardiac hypertrophy

Cardiac hypertrophy is accompanied by intraventricular morphostructural and presional changes which will result in reduced oxygenation of subendocardial and myocardial areas, exemplified by increasing serum concentrations of CPK, LDH, ASAT, on the one hand, and, on the other hand, by the secretion of an increased amount of B-type natriuretic peptide (BNP), aspects outlined in Fig. 2.

Electrocardiographical examination in dogs with cardiac hypertrophy revealed hypervoltage of the QRS ventricular complexes (3.2 mV) and depression of the ST segment (ST_{segm}) representing subdenocardial ischemia (Fig. 3).

M-mode echocardiography in a dog with cardiac hypertrophy revealed changes in both the interventricular septum (IVS) thickness, the left ventricle's free

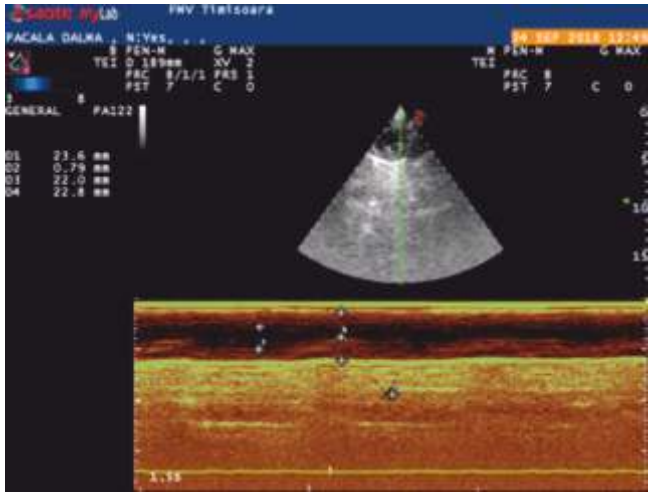

Fig. 4. M-mode echocardiography in a dog with cardiac hypertrophy

Fig. 5. Color Doppler echocardiography in a dog with cardiac hypertrophy

wall and the papillary muscles (Fig. 4).

Color Doppler echocardiography revealed a slightly mixed aspect of the transmitral flow, representing a low degree of regurgitation (I/VI), as a consequence of morphostructural myocardial changes (Fig. 5).

CONCLUSIONS

Electrocardiography revealed phenomena of concentric interventricular septal hypertrophy with negative consequences on volume minute and ventricular dilated cardiomyopathy, intra-ventricular pressure disorders, enclosed in a NYHA II cardiac failure syndrome, ST segment depression, meaning an aspect of subendocardial ischemia.

The M-mode echocardiography revealed changes in both the interventricular septum (IVS) thickness, the left ventricle's free wall and the papillary muscles. Determination of the CPK, LDH, and ASAT enzymes and the B-type natriuretic peptide gives the possibility of early diagnosis of heart disease when prognosis is still favourable and treatment is less complicated and less expensive. Determination of the ASAT is effective in subendocardial or myocardial ischemic syndrome in combination with CPK and LDH. In the case of subendocardial and/or myocardial ischemia, LDH determination is very useful in assessing the age of the myocardial affection. The evaluation of the B-type natriuretic peptide (BNP) is useful in the early appreciation of ventricular filling pressure in dogs without visible cardiac symptoms. The value of the natriuretic peptide superior to the physiological limits proves that there are also interventricular cavitary pressure changes secondary to interventricular septal hypertrophy.

The association of increased myocardial enzymes (CPK, LDH, and ASAT) with elevated levels of the B-type natriuretic peptide suggests hypertrophic cardiomyopathy. Color Doppler echocardiography revealed a slightly mixed aspect of the transmitral flow, representing a low degree of regurgitation (I/VI), and the consequence of morphostructural myocardial changes.

ACKNOWLEDGEMENTS

This study was carried out with the support of the project "*Dezvoltarea infrastructurii de cercetare, educație și sevicii în domeniile medicinei veterinare și tehnologiilor innovative",* RO05, code SMIS-CSNR 2669.

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