

USE OF PERICARDIAL FLUID pH IN THE DIFFERENTIATION OF NEOPLASTIC AND NONNEOPLASTIC PERICARDIAL EFFUSION

UTILIZAREA pH-ULUI FLUIDULUI PERICARDIC ÎN DIFERENȚIEREA EFUZIUNII PERICARDICE NEOPLAZICE ȘI NON-NEOPLAZICE

Nicoleta Andreea MINCĂ^{1),*}, D. ȚOGOE^{1),*},
Daniela Elena BRĂSLAȘU¹⁾, Carmen IONIȚĂ¹⁾,
L. IONIȚĂ¹⁾

ABSTRACT | REZUMAT

Pericardial effusion secondary to neoplastic cardiac damage is increasingly frequently diagnosed in veterinary cardiology, and diagnostic methods are constantly developing. The study includes 34 canids of different breeds, aged between 6 and 18 years, who were diagnosed with pericardial effusion, the fluid extracted by pericardiocentesis being subjected to pH determination by two distinct methods. According to current theories, the pH value of the fluid extracted from the pericardial level can indicate its origin (neoplastic or non-neoplastic). pH values were analysed in relation to echocardiographic and cytopathological examination to assess whether they can serve as an effective indicator in differentiating idiopathic from neoplastic causes of pericardial effusion. The samples used were subjected to both centrifugation and testing as such using pH indicator strips and a mobile pH meter for liquids. The parameters obtained support international results in certain types of neoplasms and add additional information to the working technique. This diagnostic method is not certain at this time, but it can be useful in guiding it through its simplicity of application and low costs.

Keywords: pericardial fluids, pericardiocentesis, cardiac tamponade, dog

Efuzia pericardică secundară afectării cardiace neoplazice este din ce în ce mai frecvent diagnosticată în cardiologia veterinară, metodele de diagnostic fiind în continuă dezvoltare. Studiul cuprinde 34 de canide, din rase diferite, cu vârste cuprinse între 6-18 ani, care au fost diagnosticate cu efuzie pericardică, lichidul extras prin pericardiocenteză fiind supus determinării de pH prin două metode distincte. Conform teoriilor actuale, valoarea pH-ului lichidului extras de la nivel pericardic poate indica originea acestuia (neoplazic sau non-neoplazic). Valorile pH-ului au fost analizate în raport cu examenul ecocardiografic și citopatologic pentru a evalua dacă acestea pot servi ca un indicator eficient în diferențierea cauzelor idiopatice de cele neoplazice ale efuziunii pericardice. Probele utilizate au fost supuse atât centrifugării, cât și testate ca atare cu ajutorul unor benzi indicatoare pentru pH și cu ajutorul unui pH-metru mobil pentru lichide. Parametrii obținuți susțin rezultatele internaționale în anumite tipuri de neoplazii și adaugă informații suplimentare în tehnica de lucru. Această metodă de diagnostic nu este de certitudine la acest moment, dar poate să fie utilă în orientarea acesteia prin simplitatea de aplicare și costurile reduse.

Cuvinte cheie: fluide pericardice, pericardiocenteză, tamponadă cardiacă, câine

Pericardial effusion is an abnormal accumulation of fluid in the pericardial space of multiple origins, most commonly neoplastic (secondary to hemangiosarcoma or chemodectoma) or idiopathic. Non-neoplastic causes are generally represented by right heart failure; ruptures of cardiac structures secondary to chronic pathologies (degenerative mitral valve disease); bacterial diseases; and trauma or consequences of metabolic disorders (uremia or hypoalbuminemia).

Pericardial effusion secondary to neoplasms is associated with a poor prognosis, while idiopathic or non-neoplastic effusion may have a favourable prognosis. Identifying the root cause is essential for establishing an appropriate treatment plan and providing an accurate prognosis, as therapeutic pericardiocentesis is often a short-term method (4-7).

Another essential aspect is the determination of the volume and pressure at the pericardial level; in general, small volumes are not life-threatening, most of the time not being associated with clinical symptoms. The increase in volume and pressure in the pericardial space leads to the production of cardiac tamponade, an aspect characterised by an increase in pressure and a decrease in cardiac diastolic filling (7, 8).

The notions of physiology and pathophysiology mention that normally, the fluid at the pericardial level represents between 1 and 15 ml depending on the physiological constants (waist, race). The pericardium normally has a minimal degree of elasticity due to its fibrous nature, yet it has the ability to expand when the intrapericardial volume of fluid increases (7, 8). Various experimental studies have been carried out that claim that it can support a capacity of up to 2 L of liquid in large canids. Another example of increased pericardial elasticity is demonstrated in cases of congenital malformations, such as peritoneopericardial

1) University of Agronomic Sciences and Veterinary Medicine, Faculty of Veterinary Medicine, Bucharest, Romania

*) Corresponding author: dtogoe@yahoo.com

hernia (PPDH), in which the capacity of the pericardium is forced by the migration of other organs into the pericardial cavity (1, 7, 8).

Because cardiac biopsy is a method that is still difficult to access in animals, various paraclinical diagnostic methods have been developed, such as cytological examination or determination of the pH of the extracted fluid. Several standard studies published in recent years have made different important classifications according to pH or fluid appearance.

MATERIALS AND METHODS

The study includes a number of 34 canids, aged between 6 and 18 years, who presented for cardiologic examination at the "Prof. Univ. Dr. Alin Bîrțoiu" University Emergency Hospital between 2023 and 2024. Of the total of 34 canids with pericardial effusion, 26 subjects underwent pericardiocentesis, 8 individuals responding to diuretic therapy. Patients presented to the clinic most frequently following increasingly frequent episodes of dyspnoea and cyanosis. To make the diagnosis of pericardial effusion or cardiac tamponade, we used cardiac echocardiography performed with the MyLab™ X7 ultrasound. In the echocardiographic evaluation, the two-dimensional mode (2D-Eco), the motion mode (M) and the colour Doppler method were used. Pericardiocentesis was performed by forming a closed circuit consisting of a catheter with a calibre between 14-22G, a 3-way valve, an extension tube and a 5-50 ml syringe. For 20 canids, anaesthesia consisted of performing a local blockade with 2% Lidocaine, the remaining 6 canids being subjected to general anaesthesia (induced with butorphanol, diazepam and propofol), this aspect being influenced by the adrenergic status and the present aggressiveness fence.

The performance of pericardiocentesis is constantly following a classic procedure under sedation or local blockage that includes aseptic assembly of a syringe with tubing and a 3-way valve, positioning the patient in sternal or lateral decubitus (in the case of those with general anaesthesia), determining the optimal place for performing the labour (usually in the 4th and 6th intercostal spaces), aseptic preparation of the site, penetration and evacuation of pericardial fluid. This work is performed under electrocardiogram monitoring with an electrocardiograph or emergency monitor (1, 2). The determination of the pH of the extracted fluid was carried out with the pH indicator strips and with the help of a mobile pH meter for liquids. There were also highly cellular fluids that required centrifugation using the Centrifuge XC-2000. In cases where the origin of the fluid could not be established, complementary blood investigations (biochemistry and blood count) were performed.

RESULTS AND DISCUSSIONS

The study was conducted on a sample of 34 canids from various breeds, aged between 6 and 18 years, all

diagnosed with pericardial effusion or cardiac tamponade. Our study started from the research of Fine et al. (2003), which provides us with a benchmark for comparison for the values obtained by determining the pH of the fluid. According to the literature, the pH value of the pericardial fluid can provide important information regarding the origin of the effusion, indicating the possibility that it is neoplastic or non-neoplastic in nature (3). The pericardial fluid was collected by the pericardiocentesis procedure and was subjected to a set of analyses to determine the pH, using two distinct measurement methods. In the study, the pH values obtained were correlated with the results of echocardiographic and cytopathological examinations in order to evaluate whether the pH of the pericardial fluid can represent a useful and reliable indicator in differentiating the idiopathic from the neoplastic causes of pericardial effusion (Fig. 1).

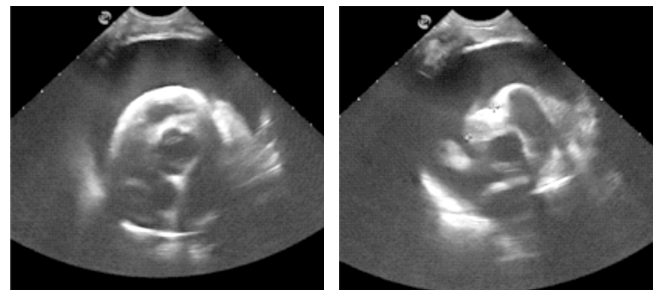


Fig. 1. Echocardiographic images showing the presence of pericardial effusion

Pericardiocentesis is a procedure necessary in cardiovascular stabilisation in patients with effusion in the pericardial space (Fig. 2). Pericardial effusion can have several origins; the most cited are idiopathic and neoplastic causes (hemangiosarcoma, chemodectoma, mesothelioma), right heart failure, coagulopathies (primary or secondary, especially in the case of rodenticide poisoning), atrial rupture secondary to chronic degenerative mitral valve disease, systemic diseases (uraemia or hypoalbuminemia), trauma or thyroid disease.

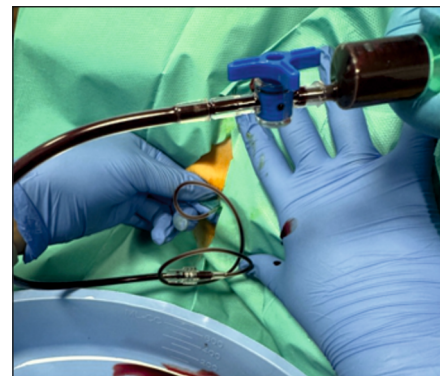


Fig. 2. Image of pericardiocentesis in a sternal position using a closed circuit

The pericardiocentesis procedure is a procedure with rare complications, but it is not without them, the

Table 1

The reference table comparing the pH values obtained in the study with the ranges established based on the research of Fine et al. (2003), to determine the origin of the fluid

Origin of the fluid	pH range		Observations
	Fine et al. (2003) study	Our study	
Nonneoplastic origin	6.4 - 7.85	6.40 - 7.85	It covers most nonneoplastic cases, including hypoalbuminemia, trauma, pericardial haemorrhages.
Possible neoplastic origin	7.40 - 8.00	7.48 - 9.08	Longer interval compared to nonneoplastic fluids, characteristically tumours (haemangiosarcomas, chemectomy, mesotheliomas).
Idiopathic origin (overlapping)	7.40 - 8.00	7.42 - 7.7	Overlap between pH ranges for fluids of idiopathic and possibly neoplastic origin.

Table 2

Statistics of pH values by type of disease

Type diseases	Number of cases	pH range	Observations
Nonneoplastic Disorders			
Hypoalbuminemia	2	6.6 - 7.2	Lower pH values, correlated with decreased plasma albumins.
Trauma	3	6.6 - 7.2	Physical trauma that produces an accumulation of pericardial fluid, mostly with a haemorrhagic appearance.
Pericardial haemorrhages following degenerative mitral valve disease	3	6.6 - 7.2	Pericardial haemorrhages have been observed in cases of stage D degenerative mitral valve disease, often following left atrial fissure or rupture.
Right heart failure caused by heartworm disease	1	6.6 - 7.2	In the secondary case, identified in the case of a canid with caval syndrome, it was not diagnosed in time.
Neoplastic Diseases			
Hemangiosarcoma	8	7.48 - 9.08	The pH range is higher, characteristic of neoplastic diseases.
Chemodectoma	5	7.48 - 9.08	Benign tumours that have a higher pH compared to nonneoplastic conditions.
Mesothelioma	2	7.48 - 9.08	Pericardial mesothelioma with extreme pH, being assigned a value of 9.08.
Idiopathic origin			
Pericardial effusion of idiopathic origin	2	7.42 - 7.7	They could not be classified as neoplastic or nonneoplastic, the cytopathological examination indicating a non-specific aspect of the fluid.

most common being the recurrence of pericardial effusion (4). Using as a benchmark in the study the values between 6.4 and 7.85 obtained by Fine et al. in 2003 (3), we compared and formed reference intervals for determining the origin of the fluid.

Thus, the reference range for fluids with non-neoplastic origin was between 6.40 and 7.85, and for those with possible neo-plastic origin, the values were framed between 7.40 and 8, with an overlap range between 7.40 and 7.85 allocated to idiopathic groups (Table 1).

The values obtained after determining the pH and performing the cytopathological examination were included in Table 2, after which we concluded the following aspects: the pH values in the case of non-neo-

plastic diseases (identifying 2 cases of hypalbuminaemias, 3 traumas, 3 pericardial haemorrhages following degenerative mitral valve disease and 1 secondary case of right heart failure generated by heartworm disease) were between 6.6 and 7.2. The values associated with the neoplastic origin (8 haemangiosarcomas, 5 chemectomas and 2 mesotheliomas were identified) were between 7.48 and 9.08, a value of 9.08 being attributed to a case of pericardial mesothelioma. There were identified 2 forms of pericardial effusion with idiopathic origin that presented values between 7.42 and 7.7; they could not be attributed to a classification, the cytopathological examination suggesting a non-specific aspect of the evacuated fluid (Table 2, Fig. 3.).

Table 3

Assessing the appearance of the extracted fluid

Aspect Fluid	Associated diseases	Description
Haemorrhagic (red, with a tendency to clot)	Neoplasms, Trauma	Fluids with neoplastic or traumatic origins are usually haemorrhagic, with blood that coagulates quickly after extraction.
Whitish (opalescent)	Inflammatory conditions, changes in the white line (e.g., lymphoma)	The whitish appearance indicates inflammation, often associated with the presence of leukocytes or white blood cells in the fluid.
Transparent (water-like)	Hypalbuminaemia (e.g., nephrotic syndrome, chronic liver failure)	Clear, transparent fluids are characteristic of hypoalbuminemia, where proteins in the blood are low, which makes the fluid clear.
Yellowish (slightly yellow)	Chronic diseases, infectious pathologies (e.g., tuberculosis, abscess)	The yellowish appearance may indicate chronic processes or infections, especially when there is an increased content of bile or degraded protein.
Inhomogeneous, smelly, with suspended particles	Pericarditis, pyogranulomas, chronic pyothorax, post-pericardiocentesis myocarditis	The appearance of the fluid is inhomogeneous, with an unpleasant smell and particles like coconut flakes in suspension.



Fig. 3. Images during pH determinations with moving pH meter and determination strips of the pericardial extracted fluid



Fig. 4. The appearance of the pericardial extracted fluid. (a) Yellowish appearance; (b) Haemorrhagic appearance; (c) Whitish appearance; (d) transparent appearance

Other diagnostic guidance elements identified or used comparatively consist of assessing the appearance of the extracted fluid (Table 3, Fig. 4). Common elements such as the colour and density of the fluid were found; thus, it was found as a common characteristic in the case of fluids of neoplastic or traumatic origin, the haemorrhagic appearance with the tendency to coagulate shortly after extraction, and the whitish appearance in the case of inflammatory diseases associated with changes in the white line and the transparent appearance (similar to water) in the case of hypoalbuminemia. The slightly yellowish appearance has been associated with chronic conditions or associated with infectious pathologies; the inhomogeneous appearance with a stinky odour has been associated with chronic pericarditis, post-pericardiocentesis myocarditis or other chronic bacterial infections.

CONCLUSIONS

Determining the pH of pericardial fluid as a diagnostic method does not currently provide certainty; it can be useful in guiding the diagnosis due to its ease of use and low cost. The pH values that may suggest the presence of a neoplasm of cardiac origin were between 7.48 and 9.08, with a range that can be allocated to idiopathic cases (pH = 7.42-7.7). The pH values that may indicate a nonneoplastic involvement were between 6.6 and 7.2.

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