Use of selected biochemical indices in blood/peritoneal effusion in diagnostics of gastrointestinal tract damage in dogs

Lucie Urbanová[1], Ondrej Mišo[1], Andrea Nečasová[1], Zita Filipejová[2], Kristína Řeháková[3], Alois Nečas[1]

University of Veterinary Sciences Brno, Faculty of Veterinary Medicine, Small Animal Clinic,
[1]Department of Surgery and Orthopaedics, [2]Department of Internal Medicine,
[3]Small Animal Clinical Laboratory, Brno, Czech Republic

Received December 3, 2020
Accepted February 1, 2022

Abstract

This study evaluated selected biochemical indices in blood/peritoneal fluid in dogs with and without gastrointestinal tract damage. Blood and peritoneal fluid samples of 29 dogs presented to the Small Animal Clinic at the University of Veterinary and Pharmaceutical Sciences Brno were obtained as a part of the diagnostic approach and were subsequently biochemically analysed. The biochemical indices analysed were potassium, total protein, glucose, lactate and creatinine. Effusion-to-blood concentration ratios of selected indices were obtained for higher data validity and this ratio was then compared between two groups: patients with gastrointestinal tract damage and patients without gastrointestinal tract damage. There were 11 dogs in the study group of patients with gastrointestinal tract damage and 18 dogs in the study group of patients without gastrointestinal tract damage. Subsequent statistical data analysis did not show any significant difference between these two groups in any of the selected indices. According to our study results, selected biochemical indices cannot be considered as decisive for diagnosing gastrointestinal tract damage.

Potassium, total protein, glucose, lactate, creatinine

Peritoneal effusion is a pathological accumulation of fluid inside the abdominal cavity. When deciding on the therapeutic approach, it is essential to determine in a majority of patients the main cause of peritoneal effusion formation. Due to its clinical impact, the aim of our study was to evaluate the importance of blood and effusion biochemical analysis as a minimally invasive diagnostic technique in patients with peritoneal effusion. A study by Oz et al. (2016) described increased potassium concentration in peritoneal effusion in a dog with gastrointestinal tract (GIT) perforation. In our study, besides the potassium concentration, we extended the indices analysed to include total protein, glucose, lactate and creatinine. The aim of our study was to evaluate the role of the selected variables for the diagnostics of GIT damage in dogs.

Materials and Methods

Subjects enrolled in the study were patients with peritoneal effusion of different aetiologies, that were presented to the Small Animal Clinic, Faculty of Veterinary Medicine, University of Veterinary Sciences Brno. As part of the standard diagnostic procedure, samples of peripheral blood and peritoneal fluid were obtained from these patients and analysed. Blood samples were obtained by venepuncture of v. cephalica antebrachii, v. saphena lateralis or v. jugularis. Peritoneal fluid samples were obtained by ultrasound-guided abdominocentesis. Samples were analysed in the Small Animal Clinical Laboratory at the University of Veterinary Sciences Brno (SACL) either immediately after obtaining or they were centrifuged (2,945 × *g* for 10 minutes) and stored at 4 °C for a maximum of 48 h before being analysed in SACL. The biochemical properties analysed from the blood and peritoneal fluid samples included potassium, total protein, glucose, lactate and creatinine. These indices were analysed on the Abbott Architect c4000 analyser (Abbott Laboratories, Lake Bluff, IL, USA). The reagent sets used were Total Protein, Creatinine, Glucose, Lactate Dehydrogenase, ICT module (Abbott Laboratories, Lake Bluff, IL, USA) and Lac (Randox Laboratories Ltd, Crumlin, County Antrim, UK). Potassium concentrations were measured potentiometrically, other selected indices were measured photometrically.

Address for correspondence:
Lucie Urbanová
Department of Surgery and Orthopaedics
Small Animal Clinic, Faculty of Veterinary Medicine
University of Veterinary Sciences Brno, Czech Republic

Phone: 606 638 088
E-mail: lucieurbanova@email.cz
http://actavet.vfu.cz/

According to the GIT condition, patients were divided into two groups – patients with GIT damage and patients without GIT damage. Effusion-to-blood concentration ratios of selected indices were obtained and this ratio was then compared between the two study groups. Data were statistically analysed using the Real Statistics Resource Pack software (Release 6.3) in Microsoft Excel (version 16.26; Microsoft Corporation, Redmond, WA). Shapiro-Wilk test was used for evaluation of normal data distribution. Differences between the two study groups (patients with GIT damage versus patients without GIT damage) were statistically analysed with two-sample *t*-test. The level of significance was set at 5% ($P \leq 0.05$).

Results

Twenty-nine dogs with peritoneal effusion were enrolled in the study. There were more females (57%) in the study than males. The patients' mean age was 7 ± 3.8 years (range of 6 months to 12 years). The 29 patients were of 23 different breeds. The most often represented breeds were the Yorkshire terrier and Pug; two dogs were crossbreeds.

There were 11 dogs in the group of patients with GIT damage and 18 dogs in the group of patients without GIT damage. Dogs in the study group of patients with GIT damage were diagnosed e.g. with GIT neoplasia, gastric dilation and volvulus (GDV), GIT foreign body, small intestine invagination, colon perforation or enterotomy wound dehiscence. Dogs in the study group of patients without GIT damage were diagnosed e.g. with a portosystemic shunt, peritonitis, pyometra, neoplastic disease outside the GIT, heart failure or diaphragmatic hernia.

Concentrations measured in blood/fluid of patients with and without GIT damage are shown in Tables 1–5. Comparison between the two groups is illustrated in Figs 1–5. No significant difference in potassium, total protein, glucose, lactate and creatinine concentration was found between the two groups.

Table 1. Potassium concentration (mmol/l) in blood/effusion of patients with and without gastrointestinal tract damage.

	Patients with GIT damage n = 11			Patients without GIT damage n = 18		
	Potassium mmol/l					
	Blood	Effusion	C_e:C_b	Blood	Effusion	C_e:C_b
Max	4.00	5.80	1.71	5.20	5.80	1.71
Min	3.00	2.10	0.53	3.40	1.90	0.54
Median	3.70	4.80	1.26	3.85	4.05	1.01
Mean	3.56	4.42	1.25	4.01	4.14	1.04
SD	-	-	0.32	-	-	0.27

GIT - gastrointestinal tract; C_e:C_b - effusion-to-blood potassium concentration

Table 2. Total protein concentration (g/l) in blood/effusion in patients with and without gastrointestinal tract damage.

	Patients with GIT damage n = 11			Patients without GIT damage n = 18		
	Total protein g/l					
	Blood	Effusion	C_e:C_b	Blood	Effusion	C_e:C_b
Max	76.50	49.10	0.78	87.70	67.80	0.89
Min	34.20	4.20	0.12	33.10	10.20	0.29
Median	49.50	30.80	0.63	56.10	32.80	0.54
Mean	50.01	29.08	0.56	57.60	32.65	0.55
SD	-	-	0.21	-	-	0.17

GIT - gastrointestinal tract; C_e:C_b - effusion-to-blood potassium concentration

Table 3. Glucose concentration (mmol/l) in blood/effusion in patients with and without gastrointestinal tract damage.

	Patients with GIT damage n = 11			Patients without GIT damage n = 18		
	Glucose mmol/l					
	Blood	Effusion	$C_e:C_b$	Blood	Effusion	$C_e:C_b$
Max	8.20	14.30	1.86	7.20	14.80	2.91
Min	2.10	0.20	0.04	3.30	0.20	0.04
Median	5.80	5.90	0.87	5.65	5.60	1.04
Mean	5.84	5.13	0.82	5.49	5.50	1.01
SD	-	-	0.60	-	-	0.67

GIT - gastrointestinal tract; $C_e:C_b$ - effusion-to-blood potassium concentration

Table 4. Lactate concentration (mmol/l) in blood/effusion in patients with and without gastrointestinal tract damage.

	Patients with GIT damage n = 11			Patients without GIT damage n = 18		
	Lactate mmol/l					
	Blood	Effusion	$C_e:C_b$	Blood	Effusion	$C_e:C_b$
Max	10.30	18.43	10.42	5.38	19.36	10.08
Min	0.620	0.63	0.28	0.87	0.77	0.25
Median	2.72	2.32	1.40	1.75	1.92	1.31
Mean	3.60	6.60	2.59	2.04	4.56	2.85
SD	-	-	3.10	-	-	2.91

GIT - gastrointestinal tract; $C_e:C_b$ - effusion-to-blood potassium concentration

Table 5. Creatinine concentration (μmol/l) in blood/effusion in patients with and without gastrointestinal tract damage.

	Patients with GIT damage n = 11			Patients without GIT damage n = 18		
	Creatinine μmol/l					
	Blood	Effusion	$C_e:C_b$	Blood	Effusion	$C_e:C_b$
Max	145.30	113.60	1.69	152.30	123.20	1.57
Min	20.00	27.30	0.77	28.50	21.00	0.74
Median	59.30	61.40	0.87	66.15	57.85	0.84
Mean	67.33	62.53	0.99	69.59	61.21	0.90
SD	-	-	0.27	-	-	0.1

GIT - gastrointestinal tract; $C_e:C_b$ - effusion-to-blood potassium concentration

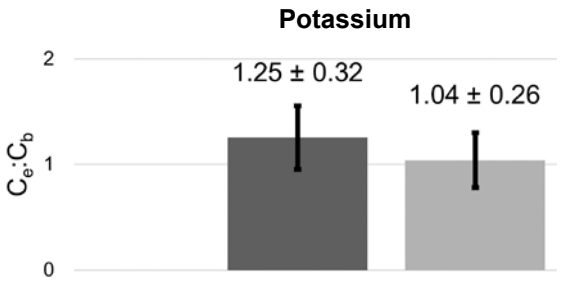

Fig. 1. A boxplot representing the mean value and standard deviation of effusion-to-blood potassium concentration in two selected groups of patients (patients with and without gastrointestinal tract damage). Left boxplot represents patients with gastrointestinal tract damage and right boxplot represents patients without gastrointestinal tract damage.
$C_e:C_b$ - effusion-to-blood potassium concentration

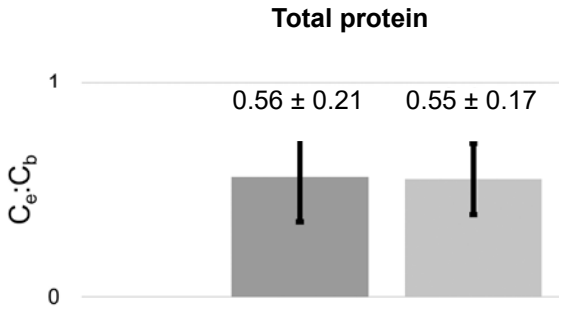

Fig. 2. A boxplot representing mean value and standard deviation of effusion-to-blood total protein concentration in two selected groups of patients (patients with and without gastrointestinal tract damage). Left boxplot represents patients with gastrointestinal tract damage and right boxplot represents patients without gastrointestinal tract damage.
C_e:C_b - effusion-to-blood potassium concentration

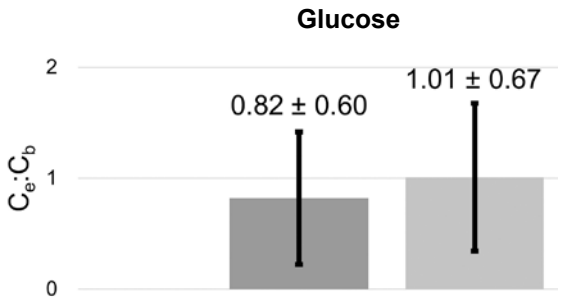

Fig. 3. A boxplot representing mean value and standard deviation of effusion-to-blood glucose concentration in two selected groups of patients (patients with and without gastrointestinal tract damage). Left boxplot represents patients with gastrointestinal tract damage and right boxplot represents patients without gastrointestinal tract damage.
C_e:C_b - effusion-to-blood potassium concentration

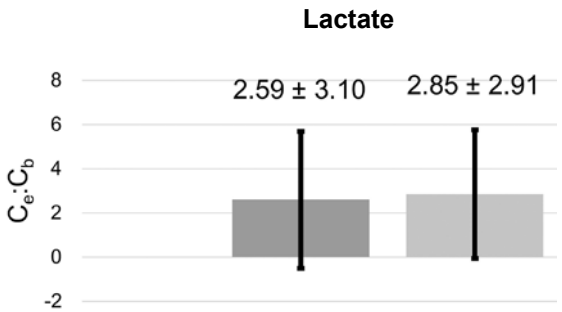

Fig. 4. A boxplot representing mean value and standard deviation of effusion-to-blood lactate concentration in two selected groups of patients (patients with and without gastrointestinal tract damage). Left boxplot represents patients with gastrointestinal tract damage and right boxplot represents patients without gastrointestinal tract damage.
C_e:C_b - effusion-to-blood potassium concentration

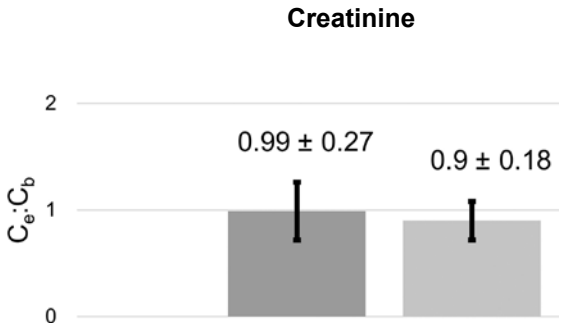

Fig. 5. A boxplot representing mean value and standard deviation of effusion-to-blood creatinine concentration in two selected groups of patients (patients with and without gastrointestinal tract damage). Left boxplot represents patients with gastrointestinal tract damage and right boxplot represents patients without gastrointestinal tract damage.
C_e:C_b - effusion-to-blood potassium concentration

Discussion

Obtaining peritoneal fluid samples and their analysis are technically undemanding procedures that are frequently used as a standard approach to diagnosis of various diseases. However, the use of peritoneal fluid biochemical analysis for diagnosing GIT damage is controversial. Based on a published case report by Oz et al. (2016), we decided to evaluate whether GIT damage is associated with increased potassium in peritoneal fluid in dogs. In the cited report, authors described a clinical case of a dog with increased concentrations of potassium in peritoneal fluid in association with gastric perforation (Oz et al. 2016). Pathophysiology of this finding can be explained by the fact that potassium is highly concentrated in the gastric content. In available literature, increased potassium concentration is associated mainly with uroperitoneum (Schmiedt et al. 2001; Tsompanidou et al. 2015), because potassium is secreted from the body mainly by the kidneys (Thier 1986). Our study results did not prove a significant increase of potassium in peritoneal fluid of patients with GIT damage. Unfortunately, published studies examining gastric perforation do not document potassium concentration in peritoneal fluid (Reed 2002; Enberg et al. 2006; Dayer et al. 2013).

Analysis of total protein, lactate, glucose and creatinine concentrations in peritoneal fluid or blood is easily available. Total protein is a basic indicator to analyse in peritoneal fluid and based on its concentration, we can categorize effusions as transudate, modified transudate and exudate (Rakich and Latimer 2011), or as a protein-poor transudate, protein-rich transudate and exudate (Stockham and Scott 2008). In our study, we did not distinguish between the above-mentioned types of effusions, however, the total protein concentrations did not differ very much between the study groups of patients, therefore, it cannot be considered as a suitable indicator for GIT damage diagnostics.

Lactate and glucose concentrations are indices that are most often associated with septic conditions. Bacterial peritonitis can arise from GIT perforation because of high levels of potentially pathogenic bacteria localized in GIT, however, no other association between these indices and GIT damage has been described yet. Our study did not show a significant relationship between glucose or lactate concentrations in peritoneal fluid and GIT damage, either. However, adequate analysis immediately after sampling and according to selected methodology is important for the assessment of these indices; otherwise, the glucose

concentration can be falsely low and the lactate concentration falsely high (Dempsey and Ewing 2011).

Creatinine concentration is one of the main indicators used for diagnosing kidney disease and urinary tract disease in general. Its increased levels are diagnostic in uroperitoneum (Alleman 2003; Dempsey and Ewing 2011; Tsompanidou et al. 2015; Athanasiou et al. 2019), however, there are no available sources describing its increased levels in patients with GIT damage. Although the mean creatinine concentration in our study population was higher in the group of patients without GIT damage, the difference between the two groups was not significant.

In conclusion, no significant difference in potassium, total protein, glucose, lactate and creatinine concentrations was found between the two study groups. According to our results, analysis of these indices does not seem to be valuable for the diagnostics of GIT damage. However, our study results could have been affected by the small number of our study population, which is why we would like to continue our observations and evaluate a larger study population in the future.

Acknowledgements

This work was supported by the grant agency IGA VFU Brno (FVL IGA 2019 – project 128/2019/FVL).

References

Alleman AR 2003: Abdominal, thoracic, and pericardial effusions. Vet Clin North Am Small Anim Pract **33**: 89-118

Athanasiou LV, Spyropoulou M, Meichner K 2019: The laboratory diagnostic approach to thoracic and abdominal effusions in the dog, cat, and horse. J Hellenic Vet Med Soc **70**: 1589-1602

Dayer T, Howard J, Spreng D 2013: Septic peritonitis from pyloric and non-pyloric gastrointestinal perforation: prognostic factors in 44 dogs and 11 cats. J Small Anim Pract **54**: 625-629

Dempsey SM, Ewing PJ 2011: A review of the pathophysiology, classification, and analysis of canine and feline cavitary effusions. J Am Anim Hosp Assoc **47**: 1-11

Enberg TB, Braun LD, Kuzma AB 2006: Gastrointestinal perforation in five dogs associated with the administration of meloxicam. J Vet Emerg Crit Care **16**: 34-43

Oz BJ, Aroch I, Segev G 2016: Increased ratio of peritoneal effusion-to-serum potassium concentration in a dog with gastric perforation. J Vet Emerg Crit Care **26**: 793-797

Rakich PM, Latimer KS 2011: Cytology. In Latimer KS (Ed.): Duncan and Prasse's Veterinary Laboratory Medicine: Clinical Pathology. Fifth edn. Chichester, Wiley-Blackwell, 528 p.

Reed S 2002: Nonsteroidal anti-inflammatory drug-induced duodenal ulceration and perforation in a mature rottweiler. Can Vet J **43**: 971-972

Schmiedt CH, Tobias KM, Motto C 2001: Evaluation of abdominal fluid: peripheral blood creatinine and potassium ratios for diagnosis of uroperitoneum in dogs. J Vet Emerg Crit Care **11**: 275-280

Stockham SL, Scott MA 2008: Cavitary effusions. In Stockham SL, Scott MA (Eds): Fundamentals of veterinary clinical pathology. Second edn. Ames, Iowa, Blackwell Pub., 928 p.

Thier SO 1986: Potassium physiology. Am J Med **80**: 3-7

Tsompanidou PT, Anagnostou T, Kazakos G, Papazoglou L, Flouraki E, Patsikas MN 2015: Urothorax associated with uroperitoneum in a dog without diaphragmatic disruption. J Am Anim Hosp Assoc **51**: 256-259