Research Article

Assessment of NT proBNP, Feline Pancreatic Lipase and Neutrophil/Lymphocyte Ratio in Cats

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Abstract

Cardiovascular diseases and pancreatitis represent significant clinical entities in veterinary medicine, both as primary conditions and through their mutual influence on each other's pathophysiological processes. While numerous studies in human medicine have demonstrated the relationship between cardiac injury and pancreatitis, investigations addressing this interaction in cats remain limited. The primary objective of this study was to evaluate the relationship among N-terminal pro-B-type natriuretic peptide (NT-proBNP), a biomarker of cardiac injury; feline pancreatic lipase (fPL), a diagnostic marker of pancreatitis; and the neutrophil-to-lymphocyte ratio (NLR), an indicator of systemic inflammation, independent of disease status in cats. The study was conducted on 20 cats of various breeds, ages (mean 4.75 years), and sexes presented to the Veterinary Teaching Hospital of Kırıkkale University. Blood samples were collected to measure NT-proBNP and fPL concentrations, while complete blood count data were used to calculate NLR values. Statistical analyses included the Shapiro–Wilk test for normality, Spearman's correlation analysis to assess relationships among parameters. The analyses revealed no statistically significant associations among the biomarkers examined. Correlation analysis demonstrated very weak and non-significant relationships ($p > 0.05$) between NT-proBNP and fPL ($r = 0.067$, $p = 0.779$), NT-proBNP and NLR ($r = 0.263$, $p = 0.263$), and fPL and NLR ($r = 0.274$, $p = 0.242$). The findings suggest that NT-proBNP, fPL, and NLR alone are not sufficient to explain the coexistence of pancreatitis in cats with cardiomyopathy or suspected cardiac injury. Although these biomarkers provide valuable clinical information, definitive diagnosis requires integration with physical examination, medical history, and imaging modalities such as ultrasonography. Furthermore, the complexity of the underlying mechanisms highlights the need for larger-scale, prospective studies to achieve a more comprehensive understanding of this interplay.

Keywords: Cat, fPL, NT-proBNP, NLR, veterinary

Introductıon

Cardiovascular diseases are among the most important health concerns in both human and veterinary medicine. In cats, advances in genetic research and increased access to echocardiographic examinations have improved the recognition and diagnosis of cardiac disorders, particularly in predisposed breeds (Egenvall et al., 2009; Fox et al., 2019). Several biomarkers, including cardiac troponins, N-terminal pro-atrial natriuretic peptide (NT-proANP), and N-terminal pro-B-type natriuretic peptide (NT-proBNP), are routinely used to assess myocardial injury and cardiac dysfunction (Borgeat et al., 2018).

NT-proBNP is a biologically inactive peptide released from cardiomyocytes in response to myocardial stress and damage, regardless of the underlying cause (Hall, 2004; Ferasin, 2012). In

both human and veterinary medicine, NT-proBNP has been widely investigated as a diagnostic and prognostic biomarker for cardiovascular disease, particularly cardiomyopathies and heart failure (Maron et al., 2006; Borgeat et al., 2018; Luis Fuentes et al., 2020).

Pancreatitis is a common inflammatory disease in cats and may occur in acute or chronic forms. Acute pancreatitis is characterized by premature activation of pancreatic enzymes resulting in pancreatic autodigestion and systemic inflammatory responses, whereas chronic pancreatitis is associated with progressive fibrosis and structural pancreatic damage (Pham & Forsmark, 2018; Mederos et al., 2021). Previous studies have reported a relationship between pancreatitis and cardiovascular disorders, suggesting that systemic inflammation may contribute to myocardial injury and cardiovascular complications (Bexelius et al., 2013; Chung & Lin, 2017; Chen et al., 2023).

The neutrophil-to-lymphocyte ratio (NLR) is an inexpensive and readily available indicator of systemic inflammation and physiological stress. Increasing evidence suggests that NLR may have diagnostic and prognostic value in both cardiovascular diseases and pancreatitis in humans and animals (Yurtdas et al., 2018; Fries et al., 2022; Esin & Uzun, 2025). However, information regarding the relationship between pancreatic disease, cardiac biomarkers, and inflammatory indices in cats remains limited.

Therefore, the aim of the present study was to evaluate circulating NT-proBNP concentrations and neutrophil-to-lymphocyte ratio values in cats with pancreatitis and to investigate their potential clinical significance in assessing cardiac involvement associated with pancreatic inflammation.

Materials and Methods

Study Cohort

This study was conducted using 20 client-owned cats presented to the Kırıkkale University Veterinary Teaching Hospital. Cats of any breed and sex aged ≥6 months were eligible for inclusion. Plasma NT-proBNP concentrations, feline pancreatic lipase (fPL) results, and neutrophil-to-lymphocyte ratio (NLR) values were retrospectively obtained from routine clinical and laboratory evaluations, irrespective of the presenting complaint or clinical diagnosis. These parameters were subsequently included in the study analysis.

Demographic data, including age, sex, and breed, were recorded for all cats. Although demographic characteristics were documented, no subgroup analyses or classifications were performed based on these variables due to the sample size. The study design and organization were developed with reference to previously published studies in human medicine and the limited available veterinary literature investigating similar associations between pancreatic disease, inflammatory markers, and cardiac biomarkers.

Clinical Examination Protocol

Following the evaluation of demographic characteristics, cats were selected using a random sampling approach from animals presented to the Kırıkkale University Veterinary Teaching Hospital. No specific presenting complaint was established as an inclusion criterion. Healthy cats were enrolled from animals presented for routine health examinations, and inclusion was based on owner consent for the use of clinical and laboratory data.

Cats included in the diseased group were selected based on the presence of clinical signs consistent with pancreatitis or conditions with the potential to impose hemodynamic stress on the cardiovascular system, regardless of the underlying etiology. Clinical findings considered during case selection included vomiting, diarrhea, lethargy, anorexia or hyporexia, and dehydration. Healthy cats were recruited from individuals undergoing routine wellness examinations and displaying no evidence of systemic disease at the time of evaluation.

Demographic information, including age, sex, and breed, was recorded for all enrolled cats and used for descriptive purposes. No further stratification based on demographic variables was performed.

Collecting Samples and Laboratory Analyses

For the analysis of the 20 cats included in the study, blood samples were collected from the vena cephalica antebrachii under routine clinical conditions. Approximately 2.5 mL of blood was transferred into tubes containing ethylenediaminetetraacetic acid (EDTA) as an anticoagulant. Immediately thereafter, an additional 3 mL of blood was collected into anticoagulant-free tubes for serum separation.

To obtain plasma, EDTA blood samples were centrifuged at 3,000 rpm for 10 min. Following centrifugation, the plasma fraction was carefully aspirated using a micropipette and transferred into Eppendorf tubes. Plasma samples were stored at −20°C until analysis of feline pancreatic lipase (fPL)

and N-terminal pro-B-type natriuretic peptide (NT-proBNP) concentrations.

For serum preparation, blood samples collected into anticoagulant-free tubes were allowed to clot in an upright position at room temperature for 1 h. Subsequently, the samples were centrifuged at 2,000 rpm for 15 min. The clear supernatant serum was separated using a micropipette and transferred into sterile Eppendorf tubes. Serum samples were stored at −20°C until biomarker analysis.

Haematological Analyses

Hematological parameters were determined using an automated hematology analyzer (Mindray BC-5000; Mindray Bio-Medical Electronics Co., Shenzhen, China). Blood samples collected into EDTA-containing tubes were analyzed within 30 min of collection to minimize pre-analytical variation. The hematological results obtained from the analyzer were recorded and subsequently used for study analyses. The neutrophil-to-lymphocyte ratio (NLR) was calculated from the absolute neutrophil and lymphocyte counts derived from the complete blood count results.

Biomarker Analyses

Plasma and serum samples obtained from the enrolled cats were used for the measurement of NT-proBNP and feline pancreatic lipase (fPL) concentrations. Following separation, samples were aliquoted and stored at −20°C until analysis. All samples were maintained under appropriate cold-chain conditions to preserve analyte stability prior to testing.

NT-proBNP and fPL analyses were performed using automated veterinary diagnostic platforms (Vcheck V200, Bionote Co., Ltd., Republic of Korea, and VetXpert Smart Cube, Mindray Animal Medical Technology Co., Ltd., China) in accordance with the manufacturers' protocols. The resulting biomarker concentrations were recorded and used for subsequent statistical evaluation.

Statistical Analyses

Statistical analyses were performed using Jamovi software (version 2.6; The Jamovi Project, Australia). As no predefined study groups were established, the relationships among the measured variables were evaluated across the entire study population. Demographic characteristics of the enrolled cats were summarized using descriptive statistical methods.

The distribution of continuous variables was assessed using the Shapiro-Wilk normality test. Associations between variables were evaluated using Spearman's rank correlation coefficient.. Statistical significance was set at $P < 0.05$.

Results

Demographic Data

The breed, age, and sex distributions of the cats included in the study are presented in Table 4.1. The mean age of the study population was 4.75 years. With respect to sex distribution, 10 cats (50%) were male and 10 cats (50%) were female. Breed distribution analysis revealed that 11 cats (55%) were domestic shorthair (tabby), 3 cats (15%) were Scottish, 3 cats (15%) were British Shorthair, 2 cats (10%) were Siamese, and 1 cat (5%) was an orange tabby (Sarman). These demographic data were recorded and included in the descriptive analysis of the study population. Due to the limited sample size, the study data were not stratified according to age, breed, or sex. Consequently, no statistical analyses were performed to evaluate the potential effects of these demographic variables on the measured parameters. Demographic characteristics were therefore reported descriptively and were not included as factors in the inferential statistical analyses. The results were shown in table 1.

Table1. Demographic Data

Age (Mounth)	Mean	4.75
	Min-Max	1-13
Sex	Erkek	10 (%50)
	Dişi	10 (%50)
Breed	Tabby	11 (%55)
	Scottish	3 (%15)
	British	3 (%15)
	Siamese	2 (%10)
	Orange Tabby	1 (%5)

NT proBNP, fPL and NLR Ratio Levels

NT-proBNP concentrations of the cats included in the study were evaluated using descriptive statistical methods. The median, mean, minimum, and maximum NT-proBNP values are presented in Table 2. As all cats were included in the analysis regardless of disease status, several NT-proBNP measurements were outside the established reference interval. Therefore, the analyses focused on assessing the relationships among the measured variables independently of reference range classifications. In this context, variations in biomarker concentrations were evaluated according to their relative increases or decreases, irrespective of the underlying disease condition.

Table 2. NT proBNP, fPL and NLR ratio levels

	Mean (Min-Max)	Median (IQR)	SD
NT proBNP (pmol/L)	341 (50-1500)	98.9 (146)	524
fPL (ng/ml)	8.28 (1-41.5)	1.98 (5.35)	13.0
NLR	11.0 (0.198-128)	3.17 (4.29)	28.3

Correlation Analyses Results

Assessment of data distribution using the Shapiro-Wilk test demonstrated that the variables were not normally distributed. Therefore, correlations between variables were evaluated using Spearman's rank correlation analysis.

The correlation coefficient between NT-proBNP and fPL concentrations was r = 0.067, indicating a very weak positive association. Furthermore, the relationship was not statistically significant (P = 0.779; P > 0.05). For NT-proBNP and NLR, the correlation coefficient was r = 0.263, suggesting a weak positive relationship. However, this association did not reach statistical significance (P = 0.263; P > 0.05). Similarly, the correlation analysis between fPL and NLR yielded a correlation coefficient of r = 0.274, indicating a weak positive association. The corresponding P-value was 0.242 (P > 0.05), demonstrating the absence of a statistically significant relationship between these variables. Given the relatively small sample size (n = 20; degrees of freedom = 18), the statistical power of the correlation analyses was limited. Consequently, the non-significant P-values suggest that no evidence of a meaningful monotonic relationship was identified among the examined variables within the study population. A summary of the Spearman correlation analysis results is presented in Table 3.

Table 3. Spearman Correlation Test Results

		NT proBNP	fPL	NLR
NT proBNP	Spearman rho	-		
	df	-		
	P value	-		
fPL	Spearman rho	0.067	-	
	df	18	-	
	P value	0.779	-	
NLR	Spearman rho	0.263	0.274	-
	df	18	18	-
	P value	0.263	0.242	-

Discussion

The present study evaluated the relationships among NT-proBNP, fPL, and NLR in cats regardless of their clinical diagnosis. Previous studies in human medicine have suggested potential interactions between cardiac and pancreatic diseases, whereas evidence in feline medicine remains limited (Bexelius et al., 2013; Chung & Lin, 2017).

NT-proBNP is a well-established marker of myocardial stress and cardiac dysfunction in cats (Borgeat et al., 2018; Luis Fuentes et al., 2020), while fPL is considered one of the most reliable biomarkers for the diagnosis of feline pancreatitis (Forman et al., 2021; Dulude et al., 2024). In the present study, no significant correlation was observed between NT-proBNP and fPL concentrations. These findings are consistent with those reported by Cridge et al. (2025), who similarly found no direct association between pancreatic lipase and NT-proBNP concentrations in cats. Although cardiopancreatic interactions have been described in human medicine, the current results suggest that elevations in these biomarkers may occur independently in feline patients.

The neutrophil-to-lymphocyte ratio has gained increasing attention as an indicator of systemic inflammation and disease severity in both cardiac and inflammatory disorders (Yurtdas et al., 2018; Fries et al., 2022). However, no significant correlations were identified between NLR and either NT-proBNP or fPL in the present study. This finding suggests that NLR alone may have limited utility for identifying concurrent cardiac and pancreatic involvement in cats.

Several limitations should be considered when interpreting these results. The relatively small sample size may have reduced the statistical power of the analyses. In addition, acute and chronic pancreatitis cases were not evaluated separately, and other cardiac biomarkers, such as cardiac troponin I, were not included. Future prospective studies involving larger populations and additional biomarkers are needed to further clarify the relationship between cardiac and pancreatic disease in cats.

No significant associations were identified among NT-proBNP, fPL, and NLR in the cats included in this study. Although NT-proBNP and fPL

remain valuable biomarkers for the assessment of cardiac and pancreatic disorders, respectively, their combined evaluation did not demonstrate a meaningful relationship under the conditions of the present study.

These findings suggest that the diagnosis of concurrent cardiac and pancreatic disease should not rely solely on biomarker assessment but should be supported by clinical examination, diagnostic imaging, and additional laboratory testing. Further large-scale prospective studies are warranted to better elucidate the interactions between cardiac dysfunction, pancreatic disease, and systemic inflammation in cats.

Conflict of Interest

The outhors declared that there is no conflict of interest.

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References

1. Bexelius, T. S., Ljung, R., Mattsson, F., & Lagergren, J. (2013). Cardiovascular Disease and Risk of Acute Pancreatitis in a Population-Based Study. Pancreas, 42(6), 1011–1015. https://doi.org/10.1097/MPA.0b013e318287cb62
2. Borgeat, K., Niessen, S. J. M., Wilkie, L., Harrington, N., Church, D. B., Fuentes, V. L., & Connolly, D. J. (2018). Time spent with cats is never wasted: Lessons learned from feline acromegalic cardiomyopathy, a naturally occurring animal model of the human disease. PLoS ONE, 13(3). https://doi.org/10.1371/journal.pone.0194342
3. Chen, B., Moin, A., Virk, H. U. H., Jneid, H., Virani, S. S., & Krittanawong, C. (2023). Association of Cardiovascular Disease and Pancreatitis: What Came First, the Chicken or the Egg? In Journal of Clinical Medicine (Vol. 12, Issue 22). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/jcm12227101
4. Chung, W. S., & Lin, C. L. (2017). Incidence and risk of acute coronary syndrome in patients with acute pancreatitis: A nationwide cohort study. Pancreatology, 17(5), 675–680. https://doi.org/10.1016/j.pan.2017.07.189
5. Egenvall, A., Nødtvedt, A., Häggström, J., Ström Holst, B., Möller, L., & Bonnett, B. N. (2009). Mortality of life-insured Swedish cats during 1999-2006: Age, breed, sex, and diagnosis. Journal of Veterinary Internal Medicine, 23(6), 1175–1183. https://doi.org/10.1111/j.1939-1676.2009.0396.x
6. Esin, C., & Uzun, B. (2025). Prognostic and diagnostic value of systemic inflammatory blood markers (NLR, MLR, PLR, AISI, SIRI, and SII) in feline arterial thromboembolism. Veterinary Immunology and Immunopathology, 287. https://doi.org/10.1016/j.vetimm.2025.110980
7. Ferasin, L. (2012). Feline cardiomyopathy. In Practice, 34(4), 204–213. https://doi.org/10.1136/inp.e2271
8. Fox, P. R., Keene, B. W., Lamb, K., Schober, K. E., Chetboul, V., Luis Fuentes, V., Payne, J. R., Wess, G., Hogan, D. F., Abbott, J. A., Häggström, J., Culshaw, G., Fine-Ferreira, D., Cote, E., Trehiou-Sechi, E., Motsinger-Reif, A. A., Nakamura, R. K., Singh, M., Ware, W. A., … Yukie Tachika Ohara, V. (2019). Long-term incidence and risk of noncardiovascular and all-cause mortality in apparently healthy cats and cats with preclinical hypertrophic cardiomyopathy. Journal of Veterinary Internal Medicine, 33(6), 2572–2586. https://doi.org/10.1111/jvim.15609
9. Fries, R. C., Kadotani, S., Stack, J. P., Kruckman, L., & Wallace, G. (2022). Prognostic Value of Neutrophil-to-Lymphocyte Ratio in Cats With Hypertrophic Cardiomyopathy. Frontiers in Veterinary Science, 9. https://doi.org/10.3389/fvets.2022.813524
10. Hall, C. (2004). Essential biochemistry and physiology of (NT-pro)BNP. European Journal of Heart Failure, 6(3), 257–260. https://doi.org/10.1016/j.ejheart.2003.12.015
11. Luis Fuentes, V., Abbott, J., Chetboul, V., Côté, E., Fox, P. R., Häggström, J., Kittleson, M. D., Schober, K., & Stern, J. A. (2020). ACVIM consensus statement guidelines for the classification, diagnosis, and management of cardiomyopathies in cats. Journal of Veterinary Internal Medicine, 34(3), 1062–1077. https://doi.org/10.1111/jvim.15745
12. Maron, B. J., Towbin, J. A., Thiene, G., Antzelevitch, C., Corrado, D., Arnett, D., Moss, A. J., Seidman, C. E., & Young, J. B. (2006). Contemporary definitions and classification of the cardiomyopathies: An American Heart Association Scientific Statement from the Council on Clinical Cardiology, Heart Failure and Transplantation Committee; Quality of Care and Outcomes Research and Functional Genomics and Translational Biology Interdisciplinary Working Groups; and Council on Epidemiology and Prevention. Circulation, 113(14), 1807–1816. https://doi.org/10.1161/CIRCULATIONAHA.106.174287
13. Mederos, M.A., Reber, HA., Girgis, M.D. (2021). Acute pancreatitis: a review. The Journal of the American Medical Association, 325(4), 382–390. https://doi.org/10.1001/jama.2020.20317
14. Pham, A., & Forsmark, C. (2018). Chronic pancreatitis: Review and update of etiology, risk factors, and management. F1000Research, 7, 607–618. https://doi.org/10.12688/f1000research.12852.1
15. Yurtdas, M., Ozdemir, M., & Aladag, N. (2018). Investigation of Neutrophil-to-Lymphocyte Ratio, Platelet-to-Lymphocyte Ratio and Mean Platelet Volume in Patients with Compensated Heart Failure. Journal of Academic Research in Medicine, 8(2), 67–71. https://doi.org/10.5152/jarem.2018.1632