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Long-term Prognostic Significance of Pentraxin-3 in Patients with Non-ST Elevation Myocardial Infarction and Coronary Stenting

Koroner Stent Uygulanan ST Elevasyonsuz Miyokard İnfarktüsünde Pentraksin-3'ün Uzun Vadeli Prognostik Önemi

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ABSTRACT

Aim: We aimed to investigate the relationship of serially measured pentraxin-3 (PTX3) levels with Gensini risk score and cardiovascular mortality in long-term follow-up in patients who underwent percutaneous coronary intervention (PCI) with the diagnosis of non-ST elevation myocardial infarction (NSTEMI) and stable angina pectoris (SAP).

Materials and Methods: Our study was planned retrospectively, and the long-term cardiovascular mortality results of patients with NSTEMI and SAP, who underwent PCI, were evaluated. Our study consisted of two groups, including the study and the control groups. Eighteen patients with NSTEMI who underwent PCI were included in the study group, and 37 patients with a diagnosis of SAP were included in the control group. Blood samples were taken from all patients for PTX3 measurements at the time of admission, at the 8th and 24th hours. Gensini scores were calculated before PCI.

Results: PTX3 levels measured at the eighth hour were found to be numerically and statistically significant in NSTEMI patients compared to SAP patients [13.37 (5.47-27.75) and 5 (3.83-12.42), p=0.006]. PTX3 values measured at the time of admission were found to be associated with Gensini score (r=0.299, p=0.026). PTX3 values measured at the eighth hour were found to be independent predictors of long-term cardiovascular mortality (Hazard ratio: 1.294, 95% confidence interval: 1024-1.653, p=0.039).

Conclusion: PTX3 may be helpful in identifying individuals at high risk for cardiovascular mortality in the long term in NSTEMI patients.

Keywords: Acute coronary syndrome, Gensini risk score, pentraxin-3, long-term prognosis

ÖZ

Amaç: ST elevasyonu olmayan miyokard infarktüsü (NSTEMI) ve stabil anjina pektoris (SAP) tanısıyla perkütan koroner girişim (PKG) yapılmış hastalarda ardışık ölçülen pentraksin-3 (PTX3) düzeylerinin Gensini risk skoru ve uzun dönem takiplerde kardiyovasküler mortalite ile ilişkisini araştırmayı amaçladık.

Gereç ve Yöntem: Çalışmamız retrospektif olarak planlanmış olup PKG yapılan NSTEMI ve SAP tanılı hastaların uzun dönem kardiyovasküler mortalite sonuçları değerlendirildi. Çalışmamız, çalışma ve kontrol grubu olmak üzere iki gruptan oluşmaktadır. PKG yapılan NSTEMI tanılı 18 hasta çalışma grubuna, SAP tanılı 37 hasta ise kontrol gurubuna dahil edildi. Tüm hastalardan başvuru anı, 8. ve 24. saatte PTX3 ölçümleri için kan örnekleri alındı. Gensini skorları PKG öncesi hesaplandı.

Bulgular: Sekizinci saatte bakılan PTX3 düzeyleri NSTEMI hastalarında SAP tanılı hastalara göre sayısal ve istatistiksel olarak anlamlı saptandı [13,37 (5,47-27,75) ve 5 (3,83-12,42), p=0,006]. Başvuru anında bakılan PTX3 değerleri Gensini skoru ile ilişkili saptandı (r=0,299, p=0,026). Sekizinci saatte bakılan PTX3 değerleri uzun dönem kardiyovasküler mortalite için bağımsız öngördürücü olarak saptandı (Hazard oranı: 1,294, %95 güven aralığı: 1,024-1,653, p=0,039).

Sonuç: PTX3, NSTEMI hastalarında uzun dönemde kardiyovasküler mortalite için yüksek riskli bireylerin belirlenmesinde yardımcı olabilir.

Anahtar Kelimeler: Akut koroner sendrom, Gensini risk skoru, pentraksin-3, uzun vadeli prognoz

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INTRODUCTION

Acute myocardial infarction (AMI) is an important cause of death worldwide. The onset of critical processes for coronary artery stenosis is partial or complete coronary artery occlusion due to rupture of atherosclerotic plaque[1]. Biomarkers such as creatine kinase and troponin have been used for the early diagnosis of myocardial damage, and it has been shown that these markers can also be used in the prognosis of patients[2].

Vascular inflammation plays an important role in the pathophysiology of atherosclerosis and coronary artery disease (CAD) (stable or acute coronary syndrome)[3]. Pentraxin 3 (PTX3) is a multimeric acute phase protein and is an inflammatory glycoprotein like C-reactive protein (CRP)[4]. CRP is in the short pentraxin group; PTX3 is in the long pentraxin group. Unlike CRP synthesized by hepatocytes, PTX3 can be directly synthesized by a variety of cells, such as cells found in atherosclerotic lesions, vascular endothelial cells, smooth muscle cells, and fibroblasts[5]. It has been shown in previous studies that there is an increase in PTX3 levels in patients with AMI and unstable angina pectoris[6,7].

The Gensini score system is a scoring system developed for the assessment of the severity of CAD[8]. The morphology and anatomy of the coronary arteries and the severity of the stenosis are evaluated in the scoring system[9]. Strong correlations were observed between the risk of cardiovascular disease in the long and short term and the Gensini score[10].

In this study, we aimed to investigate the relationship between consecutively measured the Gensini score of serum PTX3 levels and cardiovascular mortality in long-term follow-up in patients with non-ST elevation myocardial infarction (NSTEMI).

MATERIALS AND METHODS

Study Design

In our retrospectively planned study, 119 patients were included. As a result of regular periodic follow-ups (clinic and polyclinic), a total of 55 cases, 18 of whom were NSTEMI and 37 of whom had stable angina pectoris (SAP) (with evidence of coronary artery ischemia, myocardial perfusion scintigraphy or treadmill exercise test) were included in the study. Percutaneous coronary intervention (PCI) was applied to all patients. Our study consists of patients included in the study between February and August 2010 in a tertiary health center.

NSTEMI was defined as ST segment depression or transient ST segment elevation, T wave inversion and troponin positivity in at least two adjacent leads on electrocardiography in addition to typical chest pain lasting longer than 10 minutes. All NSTEMI patients consisted of patients who were hospitalized within 24 hours of the onset of chest pain.

The SAP group was defined as those with at least one coronary artery lesion requiring PCI in coronary angiography (CAG).

Coronary blood flow after PCI was evaluated with the thrombolysis in myocardial infarction (TIMI) frame number[11]. Patients with TIMI 3 after the procedure were included in the study.

PTX3 levels were measured 3 times for each patient. They were measured at baseline (before CAG), at 8th hour (after PCI), and at 24th hour (time after the first measurement).

Patients with a history of persistent ST segment elevation, newly developing left bundle branch block, malignancy, renal failure (serum creatinine >2.0 mg/dL), acute or chronic inflammatory disease were not included in the study.

Approval was obtained from the Çanakkale Onsekiz Mart University Local Ethics Committee for the study (decision no: 2011-KAEK-27/2021-2100169941, date: 24.11.2021), and our study was carried out in accordance with the Declaration of Helsinki.

Coronary Angiographic Analysis and Interventional Procedure

CAG was performed via the femoral or radial artery using the Judkins technique. Coronary arteries were evaluated from images obtained from at least two different angles. PCI was performed using standard technique. Non-ionic low osmolality contrast material was used during the procedure. Angiographic images were evaluated by two interventional cardiologists who were unaware of the study. Quantitative analyses of angiographic images were completed using an automated system (GE Medical Systems). Stenoses greater than 50% for the left main coronary artery and more than 70% for the other coronary arteries were considered clinically significant. The CAG procedure and treatments of the patients were performed within the framework of the current American College of Cardiology/American Heart Society recommendations in the years of the study[12].

Blood Sample Collection and Laboratory Analyses

Blood samples were taken into ethylenediaminetetraacetic tubes and centrifuged and stored at -70 °C until the day the blood samples were to be studied. PTX3 was measured by enzyme-linked immunosorbent assay using the assay kit of Perseus Proteomics Inc., Tokyo, Japan.

Gensini Score Calculation

Gensini score was calculated by considering the degree of stenosis of the lesion in the coronary artery and segment in which it is located. Scoring was done according to the percentage of the degree of stenosis. One point was given for

a 0-25% stenosis, 4 points for a 25-50% stenosis, 8 points for a 75-90% stenosis, 16 points for a 90-99% stenosis, and 32 points for a 100% fully occluded stenosis. The Gensini score was obtained by multiplying the scores given with the coefficients for each segment defined in the literature[8].

Study Endpoints and Follow-up

Follow-up continued for 10 years. The endpoint of the study was cardiovascular mortality. Cardiovascular mortality was defined as decompensated heart failure, fatal arrhythmias disrupting hemodynamics, and deaths due to AMI or unexplained sudden death.

Statistical Analysis

Statistical data were obtained using the Statistical Package for the Social Sciences (SPSS) 20.0 (SPSS Inc, Chicago, IL, USA) application. The Kolmogorov-Smirnov test was used to evaluate the distribution of continuous variables. Continuous variables obtained as a result of the analysis were expressed as mean±standard deviation; categorical variables were expressed as percentages and numbers. Data that failed the Kolmogorov-Smirnov test of normality were expressed as median and width between quartiles of 25-75%. The t-test and Mann-Whitney tests were used to compare the parameters conforming to normal distribution, respectively. Chi-square analysis was used to compare categorical variables and Spearman correlation analysis was used for correlation analysis. Multivariate Cox regression analysis was performed to identify independent predictors of cardiovascular mortality. Kaplan-Meier analysis was performed for PTX3 values measured at the eighth hour for cardiovascular mortality. 95% confidence intervals (CI) were calculated with standardized beta coefficients. P values below 0.05 were considered statistically significant.

RESULTS

Our study consisted of 55 patients in two groups, NSTMI (11 men, 7 women) and SAP (24 men, 13 women). While the median age of the NSTEMI group was 62 (50-64), the median age of the SAP group was 59 (54-64). Demographic and laboratory data of the patients are shown in Table 1. There were no differences between the groups in terms of medical treatments before admission to the cardiology clinic. When PTX3 levels were examined; while no difference was observed between baseline and 24th-hour values, PTX3 values measured at the eighth hour were higher in the NSTEMI group compared to the SAP group (p=0.006). When the responsible occlusive lesions were compared between the groups, no statistical difference was observed (p=0.947) (Table 1). After 10 years of follow-up, cardiovascular mortality was observed in 6 patients in the NSTEMI group and 2 patients in the SAP group (p=0.011). The median length of life was 63 (49-76) months in the NSTEMI group and 84 (80-88) months in the SAP group (p=0.009) (Table 1).

In the correlation analysis, a significant correlation was observed between baseline PTX3 levels and Gensini score (r=0.299, p=0.026) (Table 2).

In Cox regression analysis, PTX3 levels measured at the eighth hour were found to be an independent predictor of cardiovascular mortality in the NSTEMI group (Hazard ratio: 1.294, 95% CI: 1.024-1.653, p=0.039) (Table 3).

As a result of receiver operating characteristic analysis, the cut-off for PTX3 values measured at the eighth hour was determined as 10.37 (75% sensitivity and 97% specificity p<0.001). Kaplan-Meier analysis for cardiovascular mortality was performed and is shown in Figure 1.

DISCUSSION

In this study, we investigated the relationship of serum PTX3 levels with Gensini score and cardiovascular mortality in long-term follow-up in NSTEMI patients. As a result of the study; while PTX3 levels measured at the time of admission were found to be associated with the severity of CAD, PTX3 measured at the eighth hour was observed to predict cardiovascular mortality in 10-year follow-ups.

PTX3 is an acute phase protein that is similar in structure and function to CRP and belongs to the same family. PTX3 is associated with cardiovascular diseases and is released at high rates from atherosclerotic lesions[13,14]. Previous studies have shown that PTX3 is increased in ACS patients and that PTX3 can be used in the risk classification, especially in NSTEMI patients[15,16].

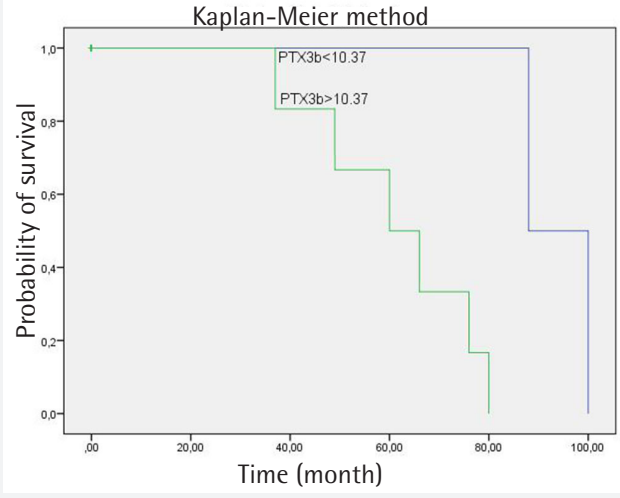

Figure 1. Kaplan-Meier analysis for cardiovascular mortality

Table 1. Baseline characteristics and pentraxin-3 levels of study patients

Clinical characteristics	NSTEMI (n=18)	SAP (n=37)	p value
Age, year	62 (50-64)	59 (54-64)	0.495
Gender (female/male)	7/11	13/24	0.786
Diabetes (n, %)	6 (33.3)	12 (32.4)	0.947
Hypertension (n, %)	12 (66.7)	29 (78.4)	0.510
Body mass index (kg/m^2)	27.7 (25-31.4)	28 (26.1-30.4)	0.788
Smoking status (n, %)	10 (55.6)	16 (43.2)	0.391
SBP, mmHg	132.33±24.13	128.68±16.72	0.568
DBP, mmHg	75.89±12.39	73.70±7.22	0.495
Heart rate. minute	76±16.19	75.16±13.32	0.850
Biochemical variables			
Glucose (mg/dL)	106 (97-138.5)	111 (97-132.5)	0.969
Creatinine (mg/d)	0.94±0.17	1.08±0.28	0.066
Hemoglobin (g/dL)	13.32±1.57	13.53±1.52	0.520
White blood cell (x10^3/mL)	7.9 (6.8-9.8)	8.1 (6.7-9.3)	0.603
LDL (mg/dL)	98 (76-151.5)	121 (98-143)	0.384
HDL (mg/dL)	39.29±10.77	42.28±8.44	0.311
NYHA	1 (1-2.5)	1 (1-2)	0.717
LVEF	60 (53.75-62.5)	60 (53.5-61.5)	0.760
Gensini score	17 (11.12-32)	10 (2.25-48.75)	0.364
$PTX3_a$	5.01 (3.40-7.44)	3.62 (2.04-8.61)	0.206
$PTX3_b$	13.37 (5.47-27.75)	5 (3.83-12.42)	0.006
$PTX3_c$	4.44 (3.41-7.59)	4.48 (3.12-8.52)	0.747
Medical treatment before admission (n)			
Aspirin	17	29	0.244
Statin	12	18	0.208
Beta blocker	14	20	0.089
Responsible artery with lesion, n			0.947
LAD	7	16	
Cx	6	11	
RCA	5	10	
Cardiovascular mortality (n)	6	2	0.011
Length of life (month)	63 (49-76)	84 (80-88)	0.009

NSTEMI: Non-ST elevation myocardial infarction, SAP: Stable angina pectoris, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, LVEF: Left ventricular ejection fraction, LDL: Low-density lipoprotein, HDL: High-density lipoprotein, NYHA: Functional classification of the New York Heart Association, $PTX3_a$: Serum blood level at the time of admission, $PTX3_b$: Serum blood level measured at the eighth hour, $PTX3_c$: Serum blood level measured at the 24th hour, LAD: Left anterior descending artery, Cx: Left circumflex, RCA: Right coronary artery

Table 2. PTX3 levels and correlation analysis between variables

	$PTX3_a$		$PTX3_b$		$PTX3_c$	
	r	p	r	p	r	p
Age	0.276	0.459	0.059	0.668	0.107	0.435
Gensini score	0.299	0.026	0.264	0.051	0.203	0.138
NYHA	0.025	0.855	0.253	0.063	0.134	0.328

$PTX3_a$: Serum blood level at the time of admission, $PTX3_b$: Serum blood level measured at the eighth hour, $PTX3_c$: Serum blood level measured at the 24th hour, NYHA: Functional classification of the New York Heart Association

Table 3. Cox regression analysis showing independent predictors of cardiovascular mortality

	Univariate		Multivariate	
	HO (CI % 95)	p	HR (CI %95)	p
Age	1.052 (0.941-1.176)	0.372		
LVEF	1.126 (0.875-1.145)	0.356		
Gensini score	1.000 (0.969-1.033)	0.978		
$PTX3_a$	0.867 (0.585-1.287)	0.479		
$PTX3_b$	1.123 (1.008-1.251)	0.035	1.294 (1.014-1.653)	0.039
$PTX3_c$	1.009 (0.894-1.138)	0.889		

$PTX3_a$: Serum blood level at the time of admission, $PTX3_b$: Serum blood level measured at the eighth hour, $PTX3_c$: Serum blood level measured at the 24th hour, HR: Hazard ratio, CI: Confidence interval

Identifying high-risk groups in ACS patients and initiating optimal treatment in the early period are important to prevent cardiovascular events. Cardiac troponins and CRP are among the most studied biomarkers in ACS patients[17,18]. The most important disadvantage of CRP is its elevation in various conditions such as inflammation, malignancy and vasculitis[19]. PTX3 is released more specifically from the cells in atherosclerotic region[20]. Following AMI; while PTX3 plasma levels peak in approximately seven and a half hours, CRP levels peak within 50 hours[21]. In the light of all this information, PTX3 is a special biomarker in ACS patients, unlike CRP. As a matter of fact; PTX3 which was examined in patients with NSTEMI and unstable angina pectoris in the first six hours after the onset of chest pain was found to be more specific in a study in which it was compared with neutrophil activating peptide 2 and cardiac troponin I[22].

As can be understood from the case studies in the literature, it is possible that biomarkers have certain limitations in themselves. In our study, we thought that it would be more beneficial to study blood samples in consecutive time periods, not just once, in order to minimize this. When our study results were evaluated, especially when basal PTX3 levels were evaluated, no difference was observed between the NSTEMI and SAP groups. Although the Gensini score, which we used to evaluate the severity of CAD, was numerically higher in the NSTEMI group than in the SAP group in our study, it was not statistically significant. When the previous literature data is interpreted; although the lesions in the coronary arteries are evaluated anatomically and morphologically with the Gensini score, it is not possible to evaluate the content of the plaque causing the stenosis and the inflammatory activity. Therefore, although a correlation was observed with Gensini score and baseline PTX3 values in our study, it would be more accurate for PTX3 values measured consecutively after PCI to provide information about the structure of plaque in the coronary arteries and in terms of the correlation with long-term results. In our study, the eighth hour PTX3 level in the patients after PCI was found to be statistically and numerically significant in the NSTEMI group. As a matter of fact, it has been shown that the deterioration of the vessel layers after coronary stenting causes an increase in PTX3 levels. We think that a similar mechanism is effective in monitoring PTX3 levels higher than basal PTX3 values in our patients. It is known that neutrophils, monocytes and macrophages cause an increase in PTX3 levels in arterial thrombus in patients with AMI[23]. In addition to coronary artery stenting, the higher values that were measured at the eighth hour in the NSTEMI patient group compared to the SAP group may be responsible for the increase in PTX3 levels of increased neutrophil, monocytes and macrophage counts in the coronary arteries in NSTEMI patients. In addition, autopsies performed in patients with ACS have shown that inflammatory activity and extracellular matrix compositions differ phenotypically. Larger necrotic nuclei and higher macrophage activity have been demonstrated, particularly in ruptured plaques[24]. When all this information is evaluated, it is possible that there will be an increase in PTX3 levels after PCI, although vascular patency is achieved with PCI in unstable plaques in NSTEMI patients.

Information on the long-term prognostic value of PTX3 is limited in the literature. It has been shown that PTX3 values measured at admission in ST-elevation myocardial infarction (STEMI) patients are associated with 2-year all-cause mortality, and another study found that PTX3 values measured at the time of admission in patients with STEMI and NSTEMI were associated with cardiovascular mortality in five-year long-term follow-up[25,26]. In our study, it is an important advantage to have 10-year follow-up data, and another important difference is that consecutive PTX3 values were examined. Although PTX3 values measured at the time of admission were associated with Gensini score, PTX3 values measured at the eighth hour in long-term follow-up were found to be an independent predictor of cardiovascular mortality.

In-hospital mortality rates are lower in patients with NSTEMI than in patients with STEMI. However, long-term mortality rates are higher in NSTEMI patients compared to STEMI patients[27]. Therefore, early risk assessment in NSTEMI patients is important in long-term follow-up. PTX3, measured consecutively, can provide clinicians with important information about both the assessment of CAD severity and long-term cardiovascular mortality in NSTEMI patients.

Study Limitations

The most important limitation of our study is that it was conducted with a limited number of patients. However, it was seen in which time period PTX3 levels measured in NSTEMI patients could be used to predict cardiovascular mortality. In our study, superior imaging devices such as 3-dimensional optical coherence tomography could not be used to evaluate the plaque causing stenosis in the coronary arteries and the severity of CAD. However, the Gensini score was used to evaluate the severity of CAD, as suggested in the literature.

CONCLUSION

PTX3 levels are associated with long-term adverse cardiovascular outcomes in hospitalized and treated patients with a diagnosis of NSTEMI. PTX3 can be used for risk classification in NSTEMI patients.

Ethics

Ethics Committee Approval: The study were approved by the Çanakkale Onsekiz Mart University Local Ethics Committee for the study (decision no: 2011-KAEK-27/2021-2100169941, date: 24.11.2021).

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices - Concept – Design - Data Collection or Processing - Analysis or Interpretation - Literature Search - Writing: U.K., B.K., E.E.

Conflict of Interest: No conflict of interest was declared by the authors.

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REFERENCES

1. Virani SS, Alonso A, Benjamin EJ, Bittencourt MS, Callaway CW, Carson AP, et al. Heart Disease and Stroke Statistics-2020 Update: A Report From the American Heart Association. Circulation. 2020;141:e139-e596.
2. Fox KA, Cokkinos DV, Deckers J, Keil U, Maggioni A, Steg G. The ENACT study: a pan-European survey of acute coronary syndromes. European Network for Acute Coronary Treatment. Eur Heart J. 2000;21:1440-9.
3. Libby P, Okamoto Y, Rocha VZ, Folco E. Inflammation in atherosclerosis: transition from theory to practice. Circ J. 2010;74:213-20.
4. Bottazzi B, Garlanda C, Salvatori G, Jeannin P, Manfredi A, Mantovani A. Pentraxins as a key component of innate immunity. Curr Opin Immunol. 2006;18:10-5.
5. Rolph MS, Zimmer S, Bottazzi B, Garlanda C, Mantovani A, Hansson GK. Production of the long pentraxin PTX3 in advanced atherosclerotic plaques. Arterioscler Thromb Vasc Biol. 2002;22:e10-4.
6. Peri G, Introna M, Corradi D, Iacuitti G, Signorini S, Avanzini F, et al. PTX3, A prototypical long pentraxin, is an early indicator of acute myocardial infarction in humans. Circulation. 2000;102:636-41.
7. Inoue K, Sugiyama A, Reid PC, Ito Y, Miyauchi K, Mukai S, et al. Establishment of a high sensitivity plasma assay for human pentraxin3 as a marker for unstable angina pectoris. Arterioscler Thromb Vasc Biol. 2007;27:161-7.
8. Gensini GG. A more meaningful scoring system for determining the severity of coronary heart disease. Am J Cardiol. 1983;51:606.
9. Sinning C, Lillpopp L, Appelbaum S, Ojeda F, Zeller T, Schnabel R, et al. Angiographic score assessment improves cardiovascular risk prediction: the clinical value of SYNTAX and Gensini application. Clin Res Cardiol. 2013;102:495-503.
10. Chen ZW, Chen YH, Qian JY, Ma JY, Ge JB. Validation of a novel clinical prediction score for severe coronary artery diseases before elective coronary angiography. PLoS One. 2014;9:e94493.
11. TIMI Study Group. The Thrombolysis in Myocardial Infarction (TIMI) trial. Phase I findings. N Engl J Med. 1985;312:932-6.
12. Smith SC Jr, Feldman TE, Hirshfeld JW Jr, Jacobs AK, Kern MJ, King SB, et al. ACC/AHA/SCAI 2005 guideline update for percutaneous coronary intervention: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/SCAI Writing Committee to Update the 2001 Guidelines for Percutaneous Coronary Intervention). J Am Coll Cardiol. 2006;47:e1-121.
13. Karamfilova V, Assyov Y, Nedeva I, Gateva A, Ivanova I, Cherkezov N, et al. Increased Serum Pentraxin 3 Is Associated with Prediabetes and Type 2 Diabetes in Obese Patients with Nonalcoholic Fatty Liver Disease. Metab Syndr Relat Disord. 2022;20:132-6.
14. Savchenko A, Imamura M, Ohashi R, Jiang S, Kawasaki T, Hasegawa G, et al. Expression of pentraxin 3 (PTX3) in human atherosclerotic lesions. J Pathol. 2008;215:48-55.
15. Peri G, Introna M, Corradi D, Iacuitti G, Signorini S, Avanzini F, et al. PTX3, A prototypical long pentraxin, is an early indicator of acute myocardial infarction in humans. Circulation. 2000;102:636-41.
16. Latini R, Maggioni AP, Peri G, Gonzini L, Lucci D, Mocarelli P, et al. Prognostic significance of the long pentraxin PTX3 in acute myocardial infarction. Circulation. 2004;110:2349-54.
17. Danesh J, Wheeler JG, Hirschfield GM, Eda S, Eiriksdottir G, Rumley A, et al. C-reactive protein and other circulating markers of inflammation in the prediction of coronary heart disease. N Engl J Med. 2004;350:1387-97.
18. Antman EM, Tanasijevic MJ, Thompson B, Schactman M, McCabe CH, Cannon CP, et al. Cardiac-specific troponin I levels to predict the risk of mortality in patients with acute coronary syndromes. N Engl J Med. 1996;335:1342-9.
19. Landry A, Docherty P, Ouellette S, Cartier LJ. Causes and outcomes of markedly elevated C-reactive protein levels. Can Fam Physician. 2017;63:e316-23.
20. Norata GD, Marchesi P, Pulakazhi Venu VK, Pasqualini F, Anselmo A, et al. Deficiency of the long pentraxin PTX3 promotes vascular inflammation and atherosclerosis. Circulation. 2009;120:699-708.
21. Peri G, Introna M, Corradi D, Iacuitti G, Signorini S, Avanzini F, et al. PTX3, A prototypical long pentraxin, is an early indicator of acute myocardial infarction in humans. Circulation. 2000;102:636-41.
22. Ustündağ M, Orak M, Güloğlu C, Sayhan MB, Alyan O, Kale E. Comparative diagnostic accuracy of serum levels of neutrophil activating peptide-2 and pentraxin-3 versus troponin-I in acute coronary syndrome. Anadolu Kardiyol Derg. 2011;11:588-94.
23. Savchenko A, Imamura M, Ohashi R, Jiang S, Kawasaki T, Hasegawa G, et al. Expression of pentraxin 3 (PTX3) in human atherosclerotic lesions. J Pathol. 2008;215:48-55.
24. Kurup R, Patel S. Neutrophils In Acute Coronary Syndrome. EMJ Cardiol. 2017;5:79-87.
25. Akgul O, Baycan OF, Bulut U, Somuncu MU, Pusuroglu H, Ozyilmaz S, et al. Long-term prognostic value of elevated pentraxin 3 in patients undergoing primary angioplasty for ST-elevation myocardial infarction. Coron Artery Dis. 2015;26:592-7.
26. Altay S, Çakmak HA, Kemaloğlu Öz T, Özpamuk Karadeniz F, Türer A, Erer HB, et al. Long-term prognostic significance of pentraxin-3 in patients with acute myocardial infarction: 5-year prospective cohort study. Anatol J Cardiol. 2017;17:202-9.
27. Terkelsen CJ, Lassen JF, Nørgaard BL, Gerdes JC, Jensen T, Gøtzsche LB, et al. Mortality rates in patients with ST-elevation vs. non-ST-elevation acute myocardial infarction: observations from an unselected cohort. Eur Heart J. 2005;26:18-26.