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The Role of Prognostic Nutritional Index in Predicting Multivessel Disease in Patients with ST-Segment Elevation Myocardial Infarction

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Abstract: Acute coronary syndromes (ACS) are common diseases and one of the most common causes of death in the world. The most feared ACS is ST segment elevation myocardial infarction (STEMI). Approximately 50% of STEMI patients have lesions in multivessel disease (MVD), and this is associated with poor outcomes. In this study, we aimed to evaluate prognostic nutritional index (PNI) in patients with STEMI and MVD. 1708 patients diagnosed with STEMI were included in the study. The patients' blood parameters, electrocardiography and echocardiography findings, coronary angiography images were recorded and calculations were made. The mean follow-up period was 38.8±10.3 months. The mean age of 1708 patients was 56.7±12.3 years, and 1370 (80.2) of the patients were male. Lower PNI was associated with MVD (+). Mortality was observed more in the MVD (+) group ($p<0.001$). In addition, PNI was observed to be negatively correlated with the Syntax Score (SS), which indicates vascular severity ($r=-0.347$). In STEMI patients, PNI can predict high SS and be used as an indicator of MVD. ©2023 NTMS.

Keywords: ST elevation Myocardial Infarction; Multivessel Disease; Prognostic Nutritional Index; Mortality.

1. Introduction

Cardiovascular diseases are the most common cause of death worldwide. Coronary artery disease (CAD) is responsible for most of these deaths [1]. Acute coronary syndromes (ACS) are a form of CAD that require urgent intervention [2]. Due to the pharmacological treatment and reperfusion strategies developed in recent years, morbidity and mortality have decreased. However, ACS still remain a frightening reality. ACS include ST-elevation myocardial infarction (STEMI), non-ST-elevation myocardial infarction (NSTEMI) and unstable angina pectoris (UAP) [2]. STEMI is the most feared scenario among CAD diagnoses because it has a high risk of resulting in mortality if urgent percutaneous coronary intervention (PCI) is not performed. Coronary angiography (CAG) has been used successfully for a long time in the treatment of STEMI. During CAG, infarct related artery (IRA) is intervened, but approximately 50% of the patients may have lesions in many different vessels. Multivessel disease (MVD) is defined as significant stenosis (>70%) in two or more major coronary arteries of 2.5 mm diameter or more [3] and this is associated with poor outcomes [4]. In the presence of MVD, the clinician's treatment method may vary depending on the patient's general condition, hemodynamics and lesion characteristics. Bainey et al showed that complete revascularization reduced cardiovascular death compared with revascularizing the IRA alone [5]. Similarly, complete revascularization is recommended in ACS patients [2]. However, data on how and when this

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should be done are not yet clear. In order to decide the revascularization strategy (IRA PCI, multivessel PCI), the patient's hemodynamics, clinical status and comorbidities, such as hypertension (HT), diabetes mellitus (DM), chronic obstructive pulmonary disease (COPD), along with the complexity of their disease, should be evaluated, following the principles of myocardial revascularization management. In the current guideline, in the presence of MVD in STEMI patients, coronary intervention is recommended at the index procedure or within 45 days [2]. Therefore, starting the procedure by predicting the presence of MVD will provide a significant advantage to the clinician. This prediction will enable the clinician to make faster and more accurate decisions about the patient and choose the right equipment.

It has been shown that both nutritional parameters and inflammatory pathways play a role in CAD [6]. Prognostic nutritional index (PNI) is a new marker that reflects both nutritional status and inflammatory status, calculated based on serum albumin levels and lymphocyte count [7]. The PNI was calculated as 10× serum albumin (g/dl)+0.005× total lymphocyte count (per mm^3). Nutritional status is related to atherosclerosis and the severity of coronary artery disease [8]. Similarly, recent studies have emphasized that inflammation plays a major role in the initiation and progression of atherosclerosis [9]. Therefore, it is thought that PNI, which is a marker that shows both nutritional status and inflammation, may be associated with CAD. In our study, we aimed to evaluate PNI in predicting MVD in STEMI patients.

2. Material and Methods

2.1. Study Population

Patients who applied to our tertiary center between 2015 and 2022 and had ST segment elevation on their (ECG) were included in the study. The definitive diagnosis of STEMI was established by the typical clinical and ECG findings. Patients with non-ST-elevation acute coronary syndromes such as NSTEMI and UAP, patients with false ST segment elevation on ECG, cancer patients and patients with inflammatory diseases were excluded from the study. 1708 STEMI patients who received a definitive diagnosis and were hospitalized for treatment were included in the study. The study protocol was approved by the local institutional ethics committee, and written informed consent was received from each patient.

2.2. Electrocardiographic and angiographic analysis

For ECG examination, 12-lead ECG (10 mm/mV and 25 mm/s) records at admission were used. (Cardiofax V, Nihon Kohden Corp., Tokyo, Japan) The diagnosis of STEMI was made as determined by current guidelines [10, 11]. During admission, blood samples were taken from the peripheral vein and hemogram parameters and biochemical parameters were studied from these blood samples. Since patients with ST elevation on their ECG required urgent revascularization, they were taken to the coronary angiography (CAG) laboratory without waiting. CAG was performed using the Seldinger technique using the femoral or radial route (whichever is appropriate for the patient). Treatment methods are left to the clinician's choice depending on the location and characteristics of the lesion. Multivessel disease (MVD) is defined as significant stenosis (>70%) in two or more major coronary arteries of 2.5 mm diameter or more. The SYNTAX score was derived from the summation of the individual scores for each separate lesion defined as ≥50% luminal obstruction in vessels ≥1.5 mm and all other lesion characteristics considered in the SYNTAX score have an additive value.

The SYNTAX scores were calculated for all patients using dedicated software (available at http://www.syntaxscore.com/calc/start.htm). After CAG, the patients were taken to the coronary intensive care unit and monitorized. In addition, the patient's past disease information, physical examination findings, blood tests, ECG and echocardiography (ECHO) data were obtained from hospital records. Death status was learned from hospital records or ÖBS (Turkish Ministry of Health death notification system) records

2.3. Statistical analysis

SPSS Statistics for Windows, Version 22.0 (SPSS Inc. Chicago, IL, USA) was used for all statistical analyses. For categorical variables, percentages were used. Continuous variables were presented as mean±standard deviation or median (interquartile range) depending on their suitability for normal distribution. Parametric variables were evaluated with the t test, and categorical variables were evaluated with the chi-square test. Mann-Whitney U test was used in the analysis of variables that did not comply with normal distribution. ROC curve analysis was performed to find the PNI cut-off value. Additionally, pearson correlation analysis was applied to determine the correlation between PNI and Syntax Score (SS). Variables with a p value <0.05 were considered statistically significant.

3. Results

The mean age of 1708 patients was 56.7±12.3 years, and 1370 (80.2) of the patients were male. The mean follow-up period was 38.8±10.3 months. More deaths were observed in the MVD (+) group during follow-up [126 (18.2) vs 91 (8.9), p<0.001]. MVD (+) group was older and had more comorbid diseases than the MVD (-) group (p<0.001 for age, p=0.019 for HT, p=0.034 for DM). As expected, SS was higher in the MVD (+) group (p<0.001). Basal demographic data were given in Table 1.

Table 1: Basal characteristics of the groups.

Variables	MVD (+) (n=689)	MVD (–) (n=1019)	p
Age (year)	59.1±11.7	55.1±12.3	**<0.001**
Gender (male,%)	538 (78.1)	832 (81.6)	0.070
Smoker (n,%)	354 (51.4)	582 (57.1)	**0.019**
HT (n,%)	307 (44.6)	387 (38)	**0.007**
DM (n,%)	180 (26.1)	221 (21.7)	**0.034**
COPD (n,%)	38 (5.5)	50 (4.9)	0.577
Syntax Score	19.7±4.8	14.5±2.9	**<0.001**
EF (%)	46.6±8.4	47.6±8.1	0.041
Glucose (mg/dL)	159.9±84.8	143.9±68.4	**<0.001**
Creatine (mg/dL)	0.98±0.47	0.91±0.45	**<0.001**
Hemoglobin (g/dL)	13.5±1.9	13.8±1.7	**0.007**
WBC (10^3/μL)	12.3±3.9	12.4±3.6	0.423
Lymphocyte (10^3/μL)	1.89±0.9	2.01±1.09	0.101
Platelet (10^3/μL)	255.3±68.1	259.5±65.3	0.127
Albumin (g/dL)	3.68±0.49	3.77±0.49	**0.003**
PNI	46.2±7.1	47.8±8.1	**0.005**
CRP (mg/L)	12.3 (6.5-18.7)	9.2 (5.3-15.7)	**<0.001**
Troponin I (ng/mL)	2.1 (0.78-4.86)	1.89 (0.7-4.56)	0.279
Total cholesterol (mg/dL)	177.8±43.6	178.8±44.4	0.828
LDL cholesterol (mg/dL)	113.9±37.9	114.2±39.4	0.991
HDL cholesterol (mg/dL)	38.7±12.3	38.9±12.4	0.606
Triglyceride	137.3±83.1	138.7±96.3	0.425
Follow-up (month)	38.9±11.1	38.7±9.7	0.365
Mortality (n,%)	126 (18.2)	91 (8.9)	**<0.001**

When blood parameters were examined, it was observed that hemoglobin was lower and glucose and creatinine were higher in the MVD (+) group compared to the MVD (-) group (p=0.007, p<0.001, p<0.001, respectively). In terms of inflammation parameters, albumin was lower and CRP was higher in the MVD (+) group compared to the MVD (-) group (p=0.003, p<0.001, respectively). Similar to albumin, PNI was significantly lower in the MVD (+) group (p=0.005). Basal demographic data were given in Table 1.

We performed ROC analysis to find the PNI cut-off value in our cohort and determined the cut-off value of 46.5. In Kaplan-Meier survival analysis with patients below and above this value, it was seen that the survival of patients with low PNI was lower (p<0.001). The Kaplan-Meier analysis is shown in Figure 1.

SS increases with the number of affected vessels and existing lesions. In this case, SS is expected to be high in the group with MVD (+). However, in some single-vessel diseases, SS may be high depending on the lesion location and characteristics. Therefore, correlation analysis was performed between PNI and SS, and it was determined that PNI and SS showed a negative correlation (r:-0.347, p<0.001). The correlation analysis chart is given in Figure 2.

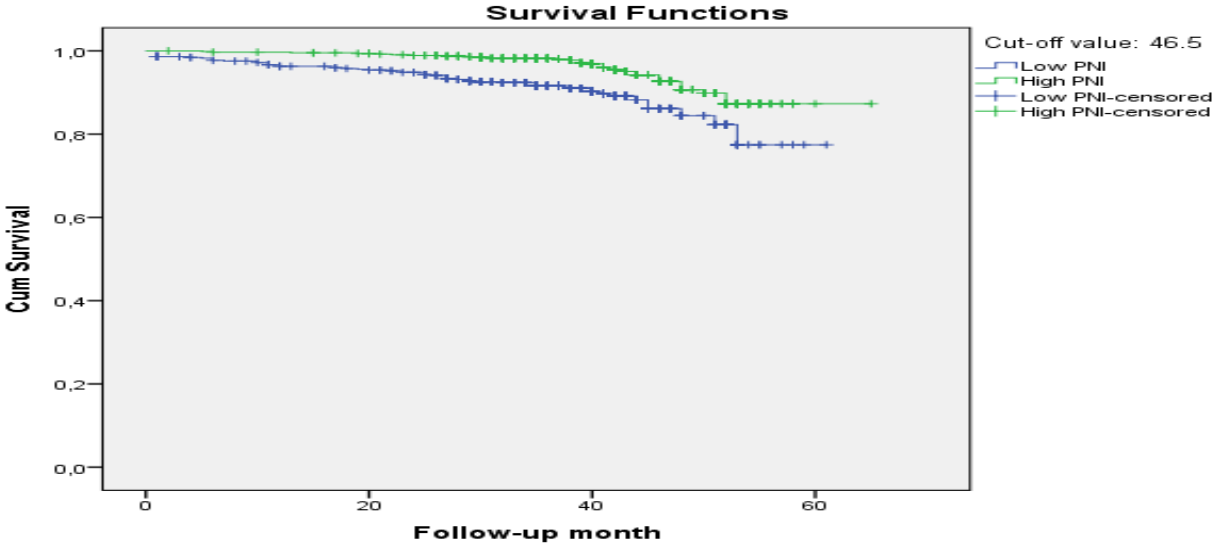

Figure 1: Kaplan-Meier survival analysis according to PNI cut-off value.

4. Discussion

This study showed that patients with MVD (+) had a higher mortality rate during follow-up. Moreover, PNI and MVD were related and there was a negative correlation between PNI and SS.

The SS was designed to predict the postprocedural risk associated with PCI or surgical revascularization. It is a visual estimate of CAD severity and complexity. The SS takes into account complex lesions including bifurcations, calcification, thrombus, chronic total occlusions, and small diffuse disease. The score ranges from 0 to greater than 60 in very complex coronary anatomy lesions [12]. Guidelines recommend using this score when making revascularization decisions [13]. This score can also be used to predict major adverse cardiac events after PCI [14]. In the present study, it was observed that MVD was associated with SS, and in addition, low PNI was correlated with high SS.

CAD prevalence increases with ageing [15]. Studies demonstrated a high prevalence of obstructive CAD in elderly, often with features of advanced disease [16]. In addition, comorbid diseases such as HT, DM, COPD are very common in patients with CVD [17]. In our study, in accordance with the literature, the MVD (+) group was older and had more comorbid diseases.

Having anemia in the patient can mimic the symptoms of CAD, also anemia is also associated with CAD [18]. Similarly, it was found to be related to MVD in our study

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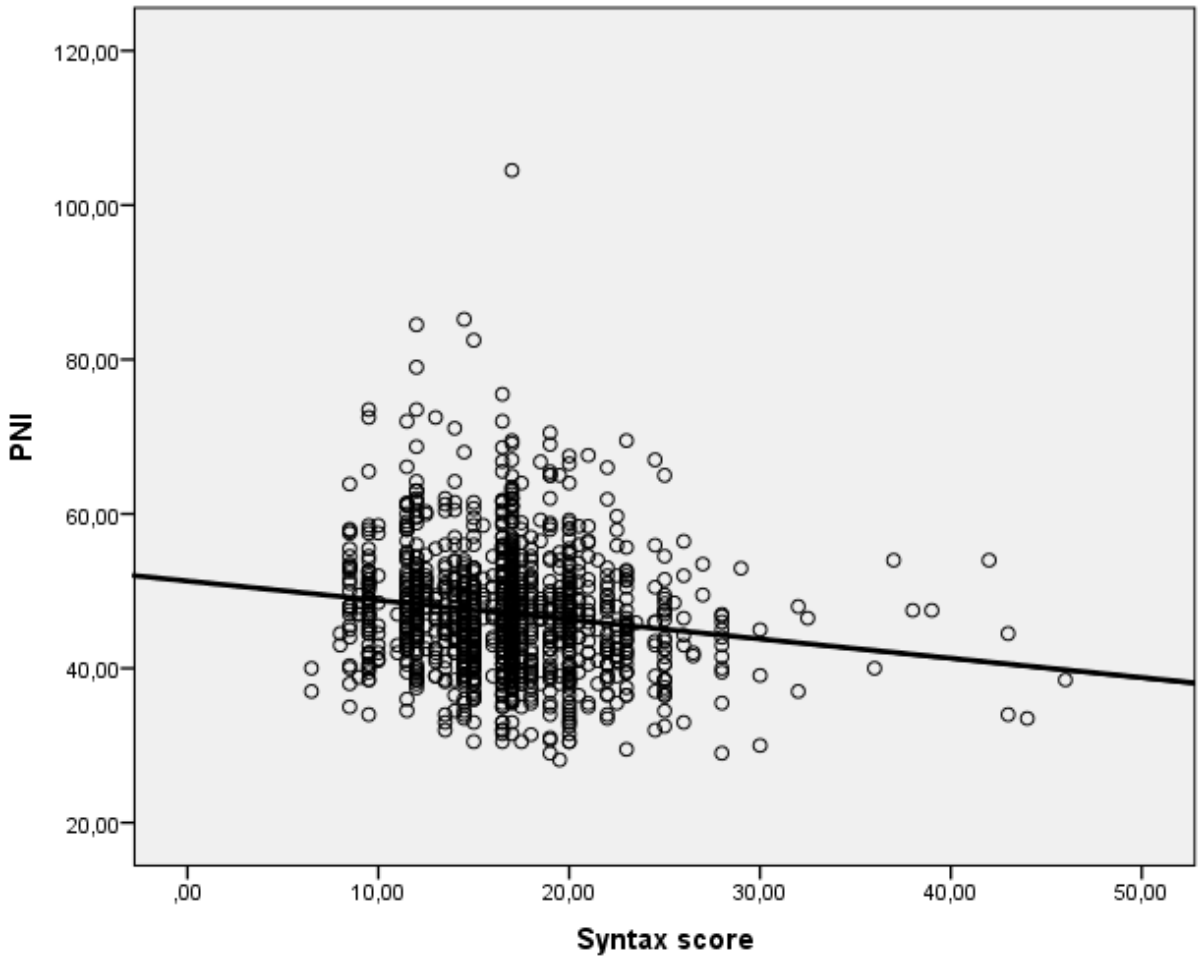

Figure 2: Scatter dot showing negative correlation of PNI and SS.

Serum creatine level is an indicator of kidney functions. The presence of chronic renal failure (CRF) is a major risk factor for developing CAD [19]. Korkmaz et al. showed that creatine level correlated with CAD and was associated with the severity of CAD [20]. Similar to the literature, in the present study, creatine levels were found to be associated with MVD.

In the MVD (+) group, there were more DM patients and the patients' glucose levels were also higher. There is much evidence that DM disease is associated with CAD, and MVD is more common in DM patients [21]. Studies shown that hyperglycemia is an independent predictor of severe CAD even in non-diabetic patients [22]. In our study, higher glucose level was associated with MVD presence.

In the past few years, the role of inflammation in the development and progression of atherosclerosis has been better understood, thus inflammatory biomarkers

are now used more increasingly in CAD screening and prognosis [23]. Among these, the most easily accessible and frequently used ones are hemogram parameters, C-reactive protein (CRP) and albumin. Studies suggest that low lymphocyte count plays role in atherosclerosis, and is associated with worse outcomes in patients with cardiac disease such as heart failure, chronic ischemic heart disease and acute coronary syndromes [24]. Additionally, albumin and CRP are also associated with CAD and disease severity [25, 26]. Albumin is an important parameter for showing nutritional status as well as inflammation. Since nutritional status is related to CAD, albumin becomes even more important [6, 8]. Considering the role that both inflammation and nutritional status play in atherosclerosis and CAD, PNI, which combines these two conditions, can be considered a more specific parameter. Studies have shown the relationship between PNI and CAD [27]. Akbuga et al. showed that PNI, was a predictor of coronary collateral development [28]. A small-scale study with a short follow-up period including ACS patients demonstrated the relationship between coronary artery severity and PNI [29]. In our study with a long follow-up period and including 1708 ACS patients, we showed that there was a significant relationship both between PNI and MVD and between PNI and SS.

5. Conclusions

PNI, which indicates nutritional status and inflammation, is a useful parameter that can be easily calculated. In this context, PNI can be used to estimate the prevalence and severity of coronary artery disease.

Limitations of the Study

The main limitation of our study was the study was retrospective, therefore the validity of the data is controversial. Second, since the clinician's treatment preferences cannot be randomized, there might be selection bias. Third, the study was conducted in a single center, it may not reflect the society.

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Conflict of Interests

The authors declare no conflict of interest.

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Author Contributions

O.B and E.A conceived and planned the hypothesis and wrote the manuscript. O.B performed the calculations. E.A are responsible for the data and supervised data analyses. All authors supported writing of the manuscript. O.B and E.A designed and directed the current topic. All authors provided critical feedback and helped shape the research, analysis and manuscript. O.B and E.A directed the final version and is responsible for final approval of the submitted manuscript.

Ethical Approval

Ethical committee approval was received from the Ethics Committee of Atatürk University (Approval Date: 07/09/2023; Approval Number: 2023/592).

Data sharing statement

Available upon request from the corresponding authors. The data are not publicly available due to compliance with privacy laws.

Consent to participate and Informed Statement

All data relevant to the study are included in the article. Informed consent was obtained from all participants included in the study.

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