Original Article

Role of Laboratory Parameters in the Diagnosis of OMI/NOMI

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Abstract

Aim: The occlusion myocardial infarction (OMI) and non-OMI (NOMI) paradigms aim to improve the quality to ensure effective diagnosis and treatment. Due to the lack of universally accepted diagnostic criteria, the study aimed to investigate the correlation between laboratory parameters commonly analyzed in the emergency department in patients with and non-segment elevation myocardial infarction and OMI/NOMI definitions.

Materials and Methods: Demographic characteristics, mortality status, laboratory parameters and thrombolysis in MI (TIMI) scores of patients were recorded. Patients with TIMI scores of 0-2 and 3 were considered OMI and NOMI. Findings were considered significant when p<0.05.

Results: In 107 patients, white blood cell value was 10.3 (8.30-2.8) and neutrophil was 7.30 (5.45-10.0) in the OMI group (p values=0.023, 0.008). The median troponin was 0.68 (0.15-4.82), C-reactive protein (CRP) was 11.8 (4.3-26.5), in the OMI group (p=0.014, 0.004). Upon logistic regression analysis, the neutrophil was independent in OMI/NOMI discrimination. The effectiveness of neutrophil in determining OMI, sensitivity, specificity, positive predictive value, and negative predictive value were 82.69%, 40.00%, 56.58%, and 70.97%, respectively (area under the curve: 0.650), when the neutrophil was set to 5.1×10^9/L.

Conclusion: Neutrophil level can be considered an independent variable for the differentiation of OMI/NOMI patients. Troponin and CRP values significantly differ between these two groups.

Keywords: Acute coronary syndrome, biomarkers, coronary occlusion, myocardial infarction

Introduction

The concepts of ST-segment elevation myocardial infarction (STEMI) and non-STEMI (NSTEMI) have accounted for a significant proportion of diagnoses requiring emergency intervention for >30 years (1). It is well-established that these concepts, which are currently used to determine acute coronary occlusion and the need for urgent reperfusion, are inadequate in selecting patients who require rapid intervention (2). STEMI diagnosis was based on the criteria associated with the Fourth Universal Definition of Myocardial infarction (MI) (3), and patients who did not meet the definition of STEMI were included in the NSTEMI group. Although NSTEMI is considered myocardial necrosis causing incomplete blood flow interruptions in the coronary arteries, total coronary artery occlusion was observed in almost 30% of patients with

NSTEMI (1-6). The gap in studies has not been adequately closed, even though guidelines recommend urgent (<2 hours) invasive evaluation regardless of electrocardiogram (ECG) findings in patients with persistent chest pain, hemodynamic instability, severe heart failure, and/or arrhythmia (7,8). As a result, patients with NSTEMI are deprived of emergency reperfusion therapy, which may lead to large infarct areas and an approximately 1.5-fold higher risk of short/long-term mortality (1,5). Observational studies have indicated that early intervention in patients with NSTEMI and total coronary occlusion is potentially beneficial (4).

The occlusion MI (OMI) and non-OMI (NOMI) paradigms have recently been debated for the aforementioned reasons and basically aim to early identify patients diagnosed with NSTEMI but actually have total coronary occlusion. Therefore, these patients may benefit from early intervention. By definition, OMI

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is MI caused by total coronary artery occlusion requiring acute reperfusion (1). Although its definition does not mention any specific examination, it has a conceptual definition, suggesting the inadequacy of using ECG alone for the diagnosis of acute coronary occlusion (1). There are several drawbacks to the OMI concept. First, universally accepted diagnostic criteria are lacking, and the various definitions suggested in the literature are unclear. Second, although ECG is not the only factor in the definition, it is still a crucial part of the paradigm. Finally, the diagnostic limitations associated with ECG also impact the concept of OMI. Therefore, it may be efficient to use objective biomarkers that can be assessed within a relatively shorter presentation time and support the diagnosis of OMI, especially in emergency department settings. The current study aimed to investigate the correlation between laboratory parameters commonly analyzed in the emergency department of patients with NSTEMI and OMI/NOMI definitions.

Materials and Methods

Study Design and Setting

The present study was designed as a cross-sectional observational study. The study was conducted in the emergency department of a tertiary university hospital. The emergency department had an admission rate of 300,000 patients/year, and the required approval for the commencement of the study was obtained from the Karabük University Faculty of Medicine, Non-Interventional Clinical Research Ethics Committee (decision number: 2024/1744, date: 05.05.2024). All study data were anonymized, and statistical analyses were performed thereafter.

Selection of Patients

The study included patients who presented to the emergency department with symptoms suggestive of acute coronary syndrome (ACS) between January 1, 2023, and December 31, 2023. Patients diagnosed with STEMI, patients aged <18 years, pregnant, with peri/myocarditis, secondary myocardial injury due to other diseases, those with incomplete data, and those without angiography or unavailable images were excluded. Among the remaining patients, those diagnosed with NSTEMI were included in the study.

Measurements

Demographic characteristics, including age, sex, comorbidities (diabetes mellitus, hypertension, history of cardiac disease, malignancy, chronic obstructive pulmonary disease, chronic renal failure, cerebrovascular disease), and in-hospital mortality status were recorded. Laboratory parameters [(white blood cell (WBC)], platelets, neutrophils, lymphocytes, monocytes, urea, creatinine, aspartate transferase, alanine transaminase (ALT), sodium, potassium, chlorine, C-reactive protein (CRP), and high-sensitivity troponin I levels were recorded. Furthermore, the angiography images of the patients were assessed by a cardiologist who did not have information about the comorbidities and laboratory results of the patients based on the Thrombolysis in MI (TIMI) Coronary Grade Flow classification (9). Based on this classification, TIMI 0 was considered total occlusion without collateral circulation; TIMI 1, flow after the lesion but incomplete distal filling or distal collateral flow after total occlusion; TIMI 2, complete but delayed distal filling after the lesion; and TIMI 3, no lesion, which restricts flow (8).

The OMI/NOMI classification was established by researchers based on TIMI scores. Patients with TIMI scores of 0-2 were considered to have OMI, whereas those with TIMI scores of 3 were considered to have NOMI. Accordingly, based on the OMI/NOMI subgroups, the relationship between the groups and demographic characteristics and laboratory parameters was reviewed.

Outcome

The outcome was considered to determine the relationship between the OMI and NOMI subgroups and the laboratory parameters.

Statistical Analysis

Data analysis was calculated using Jamovi version 2.3.38. continuous data were expressed as means ± standard deviation for normally distributed data or as median with 25th-75th centiles if they did not normally distribute. Categorical data are presented as numbers and percentages. To compare two groups of continuous variables, we used Student's t-test (for normally distributed variables) or the Mann-Whitney U test (for non-normally distributed variables). The χ^2 test or Fisher's exact test was used to compare categorical variables. All tests were two-tailed. To examine independent variables related to OMI, binary logistic regression analysis was conducted. First, we included variables with p<0.05 in the comparison analysis and univariate logistic regression analysis. If data had p<0.05 in the univariate analysis, they were included in the multivariate logistic regression analysis. Receiver operating characteristic curve analysis was used to evaluate the performance of predictive models for OMI, and reference limits were predicted using Youden's index. Findings were considered significant when p<0.05 unless otherwise specified.

Results

Of 1137 patients who presented to the emergency department with suspected ACS within the study period, 233 were diagnosed with NSTEMI. Patients referred to an external center who
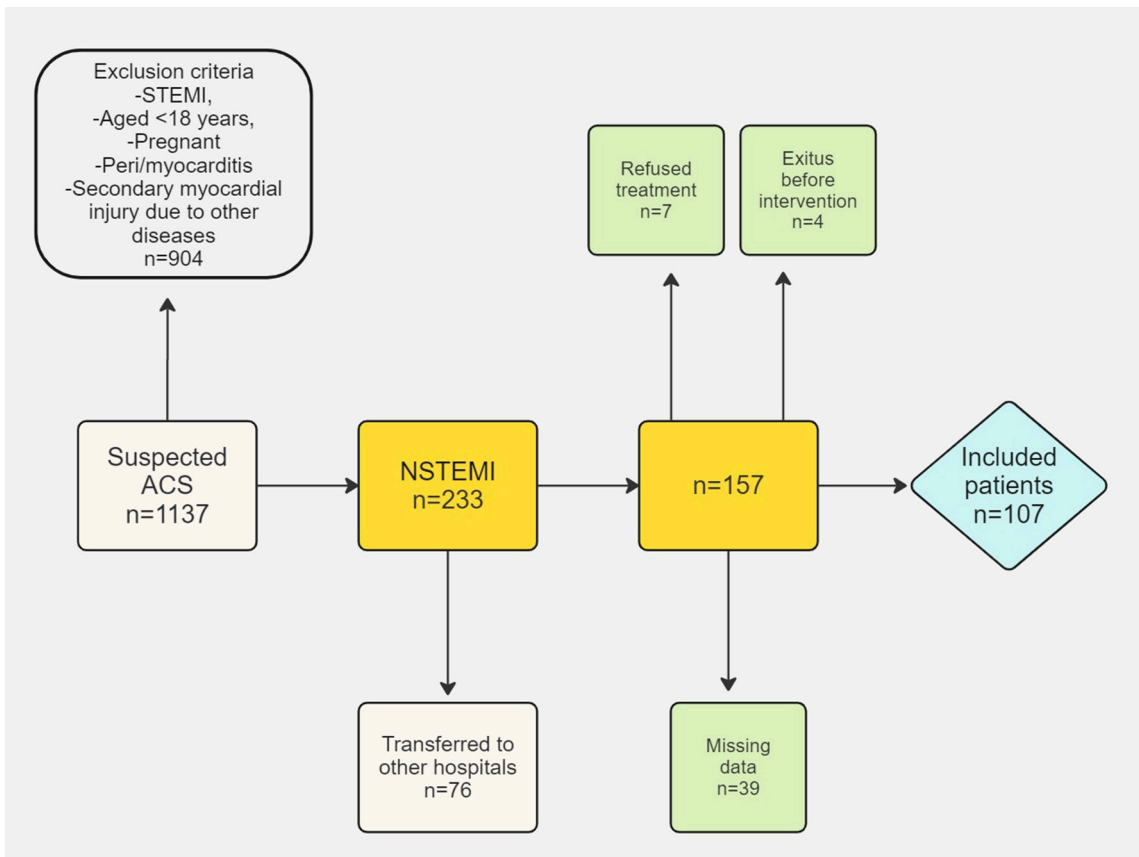
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Figure 1. Flow chart

ACS: Acute coronary syndrome, NSTEMİ: non-STEMI

had incomplete data, refused treatment, or had exits before angiography were excluded from the study. The study included 107 patients. Data for excluded patients are presented in Figure 1.

The median age of the patients included in the study was 64 years (55-74), where 65.4% were male (n=70). Upon review of the patients' comorbidities, 76.6% had hypertension (n=82), 75.7% had coronary artery disease (n=81), and 47.7% had diabetes mellitus (n=51). Mortality occurred in only 3.7% (n=4) of patients. A summary of the patients' demographic characteristics is presented in Table 1.

When the demographic data of patients were compared between the OMI and NOMI groups, no significant differences were observed according to age, sex, comorbidity, or mortality. Table 2 presents the relationship between demographic data and subgroups.

Upon review of the relationship between laboratory parameters and OMI/NOMI subgroups, the WBC count was 10.3 (8.30-2.8) and neutrophil count was 7.30 (5.45-10.0) in the OMI group, whereas the WBC count was 9.0 (6.80-10.6) and neutrophil count was

Table 1. Demographic data of the patients	
Variable (n=107)	**Median (Q1-Q3)**
Age (year)	64 (55-74)
	n (%)
Gender Female Male	37 (34.6) 70 (65.4)
Comorbidities Hypertension Coronary artery disease Diabetes mellitus Chronic obstructive pulmonary disease Cerebrovascular event Chronic renal failure	82 (76.6) 81 (75.7) 51 (47.7) 8 (7.5) 8 (7.5) 9 (8.4)
Mortality Yes No	4 (3.7%) 103 (96.3%)

5.90 (3.95-7.90) in the NOMI group (respectively p values=0.023, 0.008). When troponin values were evaluated, the median troponin was found to be 0.68 (0.15-4.82) in the OMI group, which was higher than that in the NOMI group (p=0.014).

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Apart from these values, in the OMI group, ALT was found to be 23.5 (17.0-30.0) and CRP was 11.8 (4.3-26.5), and these values were found to be higher than the NOMI group (p=0.027, 0.004). There were no significant correlations between the other laboratory parameters and the groups (p>0.05). A summary of the relationships between parameters and subgroups is presented in Table 3.

Upon logistic regression analysis of the parameters, the neutrophil count was independent of OMI/NOMI discrimination (Table 4). Upon receiver operating characteristic analysis aimed

to test the effectiveness of neutrophil value in determining OMI, sensitivity, specificity, positive predictive value, and negative predictive value were 82.69%, 40.00%, 56.58%, and 70.97%, respectively (area under the curve: 0.650) (Figure 2), when the neutrophil value was set to 5.1×10^9/L.

Discussion

In the present study, neutrophil counts were significantly higher in the OMI group, suggesting that neutrophil counts can be an independent parameter for differentiating OMI from NOMI.

Table 2. Relationship between demographic characteristics and OMI/NOMI subgroups			
Variable	**OMI** 52 (48.6%)	**NOMI** 55 (51.4%)	**p value**
Age (year) Median (Q1-Q3)	62.0 (54.8-72.5)	68.0 (57.5-75.0)	0.270
Male n (%)	36 (69.2)	34 (61.8)	0.420
Comorbidities n (%) Hypertension Coronary artery disease Diabetes mellitus Chronic obstructive pulmonary disease cerebrovascular event Chronic renal failure	36 (69.2) 36 (69.2) 23 (44.2) 4 (7.7) 2 (3.8) 5 (9.6)	46 (83.6) 45 (81.8) 28 (50.9) 4 (7.3) 6 (10.9) 4 (7.3)	0.078 0.129 0.489 0.934¥ 0.165¥ 0.663¥
Mortality n (%) Yes No	3 (5.8) 49 (94.2)	1 (1.8) 54 (98.2)	0.282¥
OMI: Occlusion myocardial infarction, NOMI: Non-OMI ¥ Fisher's exact test was used			

Table 3. Relationship between laboratory parameters and OMI/NOMI subgroups			
Variable	**OMI n (%)**	**NOMI n (%)**	**p value**
	Mean ± SD	**Mean ± SD**	
K mEq/L	4.52±0.51	4.37±0.56	0.161¥
	Median (Q1-Q3)	**Median (Q1-Q3)**	
WBC (10^9/L)	10.3 (8.30-12.8)	9.0 (6.80-10.6)	0.023*
Lymphocyte (10^9/L)	1.70 (1.28-2.40)	2.30 (1.40-2.50)	0.231
Neutrophil (10^9/L)	7.30 (5.45-10.0)	5.90 (3.95-7.90)	0.008*
Platelet (10^9/L)	218 (166-259)	208 (172-264)	0.658
Monocyte (10^9/L)	0.53 (0.43-0.73)	0.490 (0.430-0.695)	0.658
Urea (mg/dL)	41 (33-59)	40 (31-48)	0.218
Creatinine (mg/dL)	0.850 (0.700-1.13)	0.900 (0.700-1.10)	0.767
AST (U/L)	33.0 (23.8-52.3)	27 (20-36)	0.071
ALT (U/L)	23.5 (17.0-30.0)	19.0 (13.5-24.0)	0.027*
Na mEq/L	139 (137-140)	139 (137-140)	0.855
Cl mEq/L	106 (103-107)	104 (10-107)	0.670
CRP mg/L	11.8 (4.3-26.5)	4.0 (2.1-9.5)	0.004*
Trop ng/mL	0.68 (0.15-4.82)	0.21 (0.03-1.19)	0.014*
K: Potassium, WBC: White blood cell, AST: Aspartate aminotransferase, ALT: Alanine transaminase, Na: Sodium, Cl: Chlorine, CRP: C-reactive protein, Trop: Troponin, Occlusion myocardial infarction, NOMI: Non-OMI, SD: Standard deviation ¥Student's t-test was used p<0.05. Mann-Whitney U test was used			

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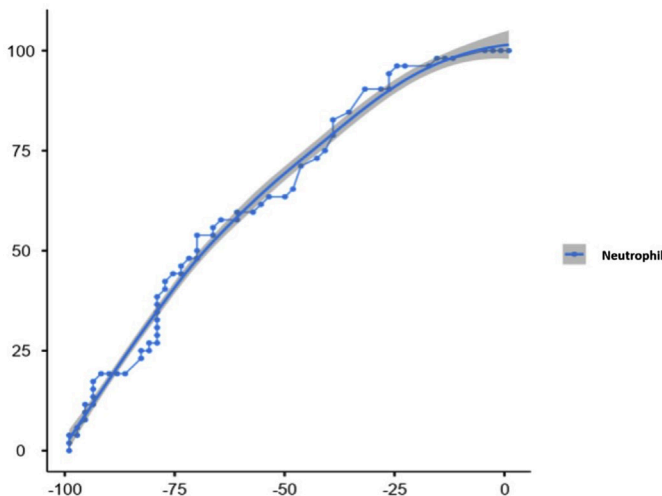| Table 4. Logistic regression analysis of parameters				
Parameter	Estimate	Odds ratio	%95 confidence interval	
CRP	0.00385	1.004	0.991	1.017
Troponin	-0.09825	0.906	0.810	1.014
Neutrophil*	-0.14552	0.865	0.751	0.995
CRP: C-reactive protein Omnibus χ^2 (3) = 9.95 p=0.019 R^2 = 0.121 (Negelkerke) * p<0.005				

Figure 2. Receiver operating characteristic analysis of neutrophils

Inflammation is a key determinant of atherosclerosis, and previous studies reported that increased neutrophil counts were correlated with coronary artery disease (10,11). Mangold et al. (12) reported that polymorphonuclear cells were highly active in STEMI and that extracellular traps developed by neutrophils could predict infarct size. Another study by Liang et al. (10) reported that neutrophil count was independently associated with high thrombus burden and total coronary occlusion. Previous studies have reported that the percentage of neutrophils in fresh thrombi was higher than that in lytic and organized thrombi in patients with STEMI. The number of lymphocytes was also significantly decreased. In contrast, the number of neutrophils was significantly increased in patients with coronary thrombi (13,14). The results of the present study are consistent with the data reported in the relevant pathophysiological literature. Although OMI/NOMI is a recently introduced paradigm, to our knowledge, this study is one of the few to investigate the relationship between these definitions and laboratory parameters.

In one of the few studies on this subject, patients with STEMI (-) OMI had very high troponin levels, similar to those in STEMI (+) OMI patients, and these values were higher compared with those in the NOMI group (15). In the present study, troponin levels were significantly higher in the OMI group than in the NOMI group.

Occur due to the interruption of oxygen supply to myocardial tissue due to a blockage of blood flow into the coronary vessels (16). In OMI, the cause is total occlusion of the coronary vessels, whereas in NOMI, there is a partial mismatch between oxygen demand and delivery due to non-occlusive reasons (17). Accordingly, this might have accounted for the differences in troponin levels between the two groups, and the results of our study are consistent with those of previous studies.

Certain recent studies have suggested that CRP might predict ACS and that acute phase proteins, including CRP, are considered to accumulate in the necrotic center of infarcted myocardial tissue (18,19). In the present study, there was a significant difference between the OMI and NOMI groups according to CRP levels, consistent with previous studies considering the severity of inflammatory response to total coronary occlusion. However, larger case groups should be studied to determine whether CRP is an independent variable.

The concept of OMI/NOMI is limited by the absence of universal criteria and the significant influence of ECG on the definitions. Incorporating laboratory parameters can enrich definitions and bridge gaps stemming from delays in interventional procedures caused by STEMI/NSTEMI diagnoses. Our study will be pivotal in expanding the literature on OMI/NOMI by integrating laboratory parameters.

Study Limitations

This retrospective study was designed and conducted only with patients diagnosed with NSTEMI based on the data retrieved from the hospital information system. Patients with STEMI and serial ECG findings were not included in the study, and their laboratory parameters might have affected the study data.

In addition, there is limited inter-rater reliability for the criteria of STEMI among cardiologists (20). Thus, differences may have been observed in the final diagnosis of patients examined with the preliminary diagnosis of ACS.

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Conclusion

Neutrophil levels can be considered independent variables, along with suggested indicators for the differentiation of OMI/NOMI patients. Troponin and CRP levels significantly differ between these two groups.

Ethics

Ethics Committee Approval: Ethical approval for our research was secured from the Ethics Committee of Karabük University Faculty of Medicine, Non-Interventional Clinical Research (decision number: 2024/1744, date: 05.05.2024).

Authorship Contribution

Surgical and Medical Practices: M.A., B.O.T., Concept: B.B., B.Ç., Ş.E.A., Design: B.B., B.Ç., Ş.E.A., Data Collection or Processing: B.B., M.A., B.O.T., Analysis or Interpretation: B.B., M.A., B.Ç., Ş.E.A., Literature Search: Writing: B.B., M.A., B.O.T., Ş.E.A.

Informed Consent: This retrospective study.

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

Financial Disclosure: The authors declared that this study received no financial support.

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