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Evaluation of Hemogram, Biochemistry, Inflammatory Markers and Electrolyte Levels in Patients with Acute Myocardial Infarction

Akut Miyokard İnfarktüslü Hastalarda Hemogram, Biyokimya, İnflamatuar Belirteçler ve Elektrolit Düzeylerinin Değerlendirilmesi

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ABSTRACT

Objective: *Hemogram, biochemistry, serum electrolyte, and inflammatory marker levels are altered in patients with acute myocardial infarction. When diagnosing and monitoring patients with acute myocardial infarction using cardiac-specific biomarkers, the levels of these markers should also be under control. We looked into the diagnostic and therapeutic value of hemogram, biochemistry, inflammatory markers, and electrolyte levels in acute myocardial infarction patients.*

Material and Method: *It is a descriptive epidemiological study. Within the scope of the study, all patients aged 18 years and over and diagnosed with acute myocardial infarction in the Emergency Department and Cardiology Department of Kahramanmaraş Sütçü İmam University Faculty of Medicine Hospital between 01.01.2022 - 31.12.2022 were included retrospectively. Hemogram, biochemistry, serum electrolyte and inflammatory marker levels were investigated in acute myocardial infarction patients.*

Results: *Leukocyte, neutrophil, procalcitonin and C-reactive protein values were significantly higher in patients with acute myocardial infarction. Although platelet/lymphocyte ratios were high, no significance was found. In patients with acute myocardial infarction, glucose values measured at the time of stress were found to be high (hyperglycaemia). When we analysed the serum lactate levels of patients with acute myocardial infarction, it was found to be significantly higher.*

Conclusion: *In patients with acute myocardial infarction, hemogram, biochemistry, serum electrolyte and inflammatory marker levels are altered. The levels of these markers should also be controlled during the diagnosis and follow-up of acute myocardial infarction patients with cardiac specific biomarkers. We believe that hemogram, biochemistry, inflammatory markers and electrolyte levels may contribute to the prediction of early serious complications in patients with acute myocardial infarction.*

Keywords:
Myocardial İnfarction
Hemogram
Biochemistry
Electrolic Levels
Inflammatory Markers

ÖZET

Amaç: *Akut myokard infarktüsü hastalarında hemogram biyokimya serum elektrolit ve inflamatuar belirteç düzeylerinde değişiklikler olmaktadır. Akut myokard infarktüsü hastalarının kardiyak spesifik biyobelirteçler ile tanı ve takibi esnasında bu belirteçlerin düzeyleri de kontrol edilmelidir. Bu çalışma ile hemogram, biyokimya, inflamatuar belirteçler ve elektrolit düzeylerinin akut myokard infarktüslü hastaların tanısındaki ve yönetimindeki yerini araştırmayı amaçladık.*

Gereç ve Yöntem: *Çalışma tanımlayıcı tipte bir epidemiyolojik araştırmadır. Çalışma kapsamında retrospektif olarak 01.01.2022 – 31.07.2022 tarihleri arasında Kahramanmaraş Sütçü İmam Üniversitesi Tıp Fakültesi Hastanesi Acil Servis'inde ve Kardiyoloji bölümünde akut myokard infarktüsü tanısı almış 18 yaş ve üstü tüm hastalar dahil edildi. Akut myokard infarktüsü hastalarında hemogram biyokimya, serum elektrolit ve inflamatuar belirteç düzeyleri incelendi.*

Bulgular: *Akut myokard infarktüslü hastalarda lökosit, nötrofil, prokalsitonin, C-reaktif protein değerleri anlamlı derecede yüksek saptandı. Platelet/lenfosit oranlarının yüksek çıkmasına rağmen anlamlılık saptanmadı. Akut myokard infarktüslü hastalarda stres anında ölçülen glikoz değerleri yüksek (hiperglisemi) saptandı. Akut myokard infarktüslü hastaların serum laktat düzeylerini incelediğimizde anlamlı derecede yüksek saptandı.*

Sonuç: *Akut myokard infarktüsü hastalarında hemogram, biyokimya, serum elektrolit ve inflamatuar belirteç düzeylerinde değişiklikler olmaktadır. Akut myokard infarktüsü hastalarının kardiyak spesifik biyobelirteçler ile tanı ve takibi esnasında bu belirteçlerin düzeyleri de kontrol edilmelidir. Akut miyokard infarktüslü hastalarda hemogram, biyokimya, inflamatuar belirteçler ve elektrolit düzeylerinin erken dönem ciddi komplikasyonları önceden belirlemede katkılarının olabileceği kanısındayız.*

Anahtar Kelimeler:
Myokard İnfarktüsü
Hemogram
Biyokimya
Elektrolit Düzeyleri
İnflamatuar Belirteçler

INTRODUCTION

Cardiovascular diseases are currently the main cause of death in industrialized nations, and in the ensuing decades, they are predicted to overtake them in emerging nations. The most prevalent form of cardiovascular disease and the main cause of death is coronary artery disease (CAD). CAD is not only a health problem but also an important social problem because of its economic burden and negative effect on quality of life (1).

Myocardial ischaemia is myocardial damage resulting from a disturbance in the balance between myocardial oxygen supply and demand. Myocardial ischaemia is

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often caused by an atherosclerotic lesion. Acute Coronary Syndrome (ACS) is due to coronary arterial spasm at the site of the atherosclerotic lesion, erosion or rupture of the atherosclerotic lesion and reduced coronary blood flow due to platelet aggregation or thrombus formation. It is responsible for most of the deaths related to CAD and is closely related with its complications (2).

Acute Myocardial Infarction (AMI) is defined as irreversible myocardial cell damage and necrosis caused by severe and prolonged ischaemia. The most often utilized and crucial variables in the diagnostic assessment of patients with AMI symptoms are electrocardiography (ECG) and biochemical markers such troponins, creatine kinases, and myoglobin. Other markers that may aid in the diagnosis include serum electrolytes, ischaemia-modified albumin, cardiac fatty acid binding protein, high-sensitivity C-Reactive Protein (hs-CRP), and Brain Natriuretic Peptide (BNP) (3).

Mg plays a vital role in many cellular processes. It is closely associated with a wide range of enzymes and metabolic activities that control carbohydrate, fat, protein and electrolyte metabolism. Mg is a cardioprotective element that causes systemic and coronary vasodilatation, has antiplatelet activity and protects myocytes from calcium (Ca) influx during reperfusion. Mg deficiency or reduced dietary Mg intake plays an important role in the aetiology of cardiovascular diseases such as thrombosis, atherosclerosis, ischaemic heart disease, AMI, hypertension (HT), cardiac arrhythmias and congestive heart failure (CHF).

Potassium (K) decreases renal vascular resistance, boosts glomerular filtration rate, inhibits platelet aggregation and arterial thrombosis, slows proliferation of vascular smooth muscle cells, and inhibits free radical production among vascular endothelial cells and macrophages (4). It has been reported that cardiovascular diseases are less common in societies consuming primitive diets containing high levels of K and in vegetarians living in industrialised cultures (5). A higher risk of sudden cardiac mortality and ventricular arrhythmias has also been linked to hypokalaemia.

Ca is one of the most important cations in the body and plays a critical role in cardiac contraction, enzymatic activity and electrophysiological properties. Ca flow must be balanced for the maintenance of the steady state in the myocardium (6). High serum Ca levels have also been shown to be an independent risk factor for coronary heart disease such as AMI.

According to the National Health and Nutrition Examination Survey, low sodium (Na) intake is thought to be associated with coronary vascular disease. There are reports that low Na levels activate renin-angiotensin activity and sympathetic nervous system, increase insulin resistance and these increase the risk of cardiovascular disease (7).

Hyperglycaemia that develops during the stress process; The aim of this adaptation, which is the physiological response of the organism to stress, in which increased cytokines, stress hormones with anti-insulin effect and changes in insulin sensitivity are observed, is to provide glucose to vital organs. With acute hyperglycaemia, impairment in leukocyte function, increase in free oxygen radicals, blood pressure changes, increase in vascular permeability, angiogenesis, capillary occlusion, electrolyte changes, acid-base balance disturbances, immunity disorder and acceleration of catabolism may be observed. AMI is one of the events that cause stress hyperglycaemia. In-hospital mortality rate after AMI is even higher in patients with stress hyperglycaemia (8).

C-Reactive Protein (CRP) is an acute phase protein found in serum/plasma and its level increases in the inflammatory process. It is a sensitive marker whose level increases in acute/chronic inflammation and infection. It is secreted from the liver via IL-6 (9). Inflammation and thrombosis play a very important role in the pathophysiology of atherosclerosis. Platelets (PLT) and leukocytes (neutrophils) are essential components of these processes associated with the development of atherosclerosis and acute coronary syndromes. In patients with AMI and other inflammatory diseases, CRP, procalcitonin (PCT), "white blood cells count, neutrophil, lymphocyte, platelet and the ratios of these values to each other (neutrophil lymphocyte ratio (NLR) and platelet lymphocyte ratio (PLR))" among complete blood count parameters are used as inflammatory markers (10, 11).

The role of trace elements in cardiovascular diseases has been the subject of many studies. High copper (Cu) and low zinc (Zn) levels have been found in patients with AMI. Iron (Fe) levels are at normal levels. A close relationship between high copper levels and haemodynamic parameters has been found. It was concluded that serum copper and zinc levels are valuable in terms of showing the degree of myocardial depression in AMI (12).

According to the literature, higher serum lactate levels indicate a greater extent of myocardial damage/necrosis due to myocardial infarction and more myocardial oedema. It has been reported that the risk of mortality may increase in AMI patients, especially in those with an initial serum lactate >2.5 mmol/L (13).

Although there are several studies on AMI and hemogram, biochemistry, serum electrolytes and inflammatory markers, there are limited data on the value of these markers in patients with AMI. We aimed to investigate the role of hemogram, biochemistry, inflammatory markers and electrolyte levels in the diagnosis and management of patients with AMI.

MATERIAL AND METHOD

It is a descriptive epidemiological study. Within the scope of the study, all patients aged 18 years and over and diagnosed with AMI in the Emergency Department and Cardiology Department of Kahramanmaraş Sütçü İmam University Faculty of Medicine Hospital between 01.01.2022 - 31.12.2022 were included retrospectively. No sample was selected within the scope of the study. The study was approved by the decision of Kahramanmaraş Sütçü İmam University Faculty of Medicine Clinical Research Ethics Committee session no: 2022/35, decision no: 03, dated 29.11.2022. The study is consistent with the principles of the Declaration of Helsinki.

Sociodemographic data such as age and gender and laboratory tests such as hemogram, biochemistry, inflammatory markers and electrolyte levels were analysed. Laboratory tests include hemogram,

biochemistry, routine inflammatory markers, C-reactive protein (CRP), procalcitonin, complete blood count parameters, white blood cell count (WBC), neutrophils, lymphocyte, neutrophil lymphocyte ratio, platelet (PLT), platelet lymphocyte ratio, zinc, copper, magnesium, sodium, potassium, calcium, chlorine, phosphate, lactate, pH and glucose levels.

The study's data were statistically evaluated using the SPSS v.23.0 package application (SPSS Inc, Chicago, Illinois, USA). Descriptive statistics, such as frequency and percentage for qualitative data and frequency, mean, and standard deviation for numerical data, were provided for reviewing the study's data. Utilizing both analytical (Kolmogorov Smirnov and Shapiro Wilks tests) and visual (histogram) techniques, the parameters' adherence to a normal distribution was assessed. If parametric assumptions were satisfied, one group t test, student t test, and one-way analysis of variance (ANOVA) were used in the comparison of quantitative data for parameters with a given mean, parameters between two groups, and parameters between more than two groups. For comparisons of parameters with a specific mean, Mann-Whitney U test was utilized if parametric assumptions were not met. Whitney Parameter comparisons between two groups were conducted using the U test, while comparisons involving more than two groups were conducted using the Kruskall Wallis test. To compare qualitative data, the Chi-Square test was applied. The statistical significance level was set at $p<0.05$.

RESULTS

A total of 66 participants were included in the study, of which 59.1% (n=39) were male and 40.9% were female. While 24.2% (n=16) of the participants were between the ages of 65-74, 33.3% (n=22) were over 75 years old. 42.4% (n=28) of the participants who had MI were under the age of 65 (Table 1).

The mean leukocyte count of the patients who applied to the emergency department and had MI was 10.32 (SD: 2.8), and the mean neutrophil count was 7.32 (SD: 2.9). The leukocyte and neutrophil levels of the patients were found to be statistically significantly higher than the normal individuals ($p<0.001$ and $p<0.001$, respectively) (Table 2).

The mean glucose level of the patients who had MI was 173.49 (SD:92.0) and the mean lactate level was 11.39 (SD:8.9). Glucose and lactate levels of the patients were found to be statistically significantly higher than normal individuals ($p<0.001$ and $p<0.001$, respectively) (Table 2).

Some acute phase reactant levels of the participants were examined. The mean c reactive protein value of the participants was 16.62 (SD: 29.4) and the mean procalcitonin level was determined as 0.08 (SD: 0.8). C-reactive protein and procalcitonin levels were found to be statistically significantly higher in patients diagnosed with MI compared to normal individuals ($p=0.002$ and $p=0.022$, respectively) (Table 2).

The mean immature granulocyte level of MI patients admitted to the emergency department was found to be 0.05 (SD:0.05). Although the relevant value was found to be higher than the normal limits, the difference was not statistically significant ($p=0.767$). On the other hand, the mean platelet-lymphocyte ratio of the patients was found to be 170.6 (SD:144.0) and although this value was higher than the normal limits, it did not create a statistically significant difference ($p=0.74$). Other values in the study were within the range of normal values in the literature (Table 2).

The changes in the laboratory values of MI patients admitted to the emergency department by gender were examined. The mean percentage of immature granulocytes was determined as 0.43 (SD:0.49) in men and 0.48 (SD:0.32) in women. The mean percentage of immature granulocytes in women was statistically significantly higher than in men ($p=0.048$). The mean of procalcitonin was determined as 0.095 (SD: 0.10) in men and 0.061 (SD: 0.059) in women. The mean procalcitonin level in men was statistically significantly higher than in women ($p=0.035$) (Table 3).

The pH values of the venous blood gases taken from the patients in the emergency room were checked. The mean pH value was found to be 7.42 (SD:0.02) in men and 7.35 (SD:0.08) in women. The mean pH level in men was statistically significantly higher than in women ($p=0.038$). There was no statistically significant difference between the genders in terms of other parameters (Table 3).

DISCUSSION

Markers have a role in determining the disease process, in diagnosis and follow-up, in determining susceptibility to disease and in determining the appropriateness of specific treatments. Cardiac markers are fragments of cellular structures released into the circulation when myocardial damage occurs. Currently, biomarkers frequently used in the diagnosis of acute coronary syndrome are creatine kinase-MB (CK-MB), myoglobin and cardiac troponins. Various new markers are being investigated in order to diagnose acute coronary syndrome at an early stage and to provide the necessary intervention. We will review the literature by analysing hemogram, biochemistry, inflammatory markers and electrolyte levels in patients with acute myocardial infarction.

Studies have shown that individuals with AMI had significantly lower mean Na, K, and Mg levels and significantly higher mean Ca levels (4, 5, 6, 7). In our study, calcium readings were close to the top limit of

Table 1: Sociodemographic characteristics of AMI patients admitted to the emergency department

		n	%
Gender			
	Female	27	40.9
	Male	39	59.1
	Total	66	100
Age			
	25 – 44	5	7.6
	45 – 64	23	34.8
	65 – 74	16	24.2
	75 – 84	19	28.8
	85 and above	3	4.5
Total		66	100

Table 2: Hemogram, biochemistry, inflammatory markers and electrolyte levels of AMI patients admitted to emergency department

	n	Mean ± SS	Normal Values*	p
WBC (10^9/L)	66	10.32 ± 2.8	3.39 – 8.86	<0,001a
Neutrophil (10^9/L)	66	7.32 ± 2.9	1.5 – 5	<0,001b
Percent neutrophils (%)	66	69.72 ± 13.2	40.1 – 71.4	-
Lymphocyte (10^9/L)	66	2.17 ± 1.2	1.05 – 3.17	-
Lymphocyte percentage (%)	66	21.89 ± 11.1	21.6 – 49	-
Platelet (10^9/L)	66	257.85 ± 67.3	150 – 400	-
IG (#)	66	0.05 ± 0.05	0.01 – 0.04	0.767
IG percentage (%)	66	0.45 ± 0.42	0.16 – 0.62	-
NLR (%)	66	5.28 ± 5.7	0.91 – 5.6	-
PLR (%)	66	170.6 ± 144.0	40 - 140	0.740
Glucose (mg/dL)	66	173.49 ± 92.0	74 – 100	<0,001b
CRP (mg/L)	58	16.62 ± 29.4	<5	0.002b
PCT (µg/L)	58	0.08 ± 0.08	<0.046	0.022b
Albumin (g/L)	66	40.87 ± 5.2	39.7 – 49.4	-
K (mmol/L)	66	4.42 ± 0.7	3.5 – 5.5	-
Ca (mg/dL)	65	8.99 ± 0.8	8.6 – 10	-
Na (mmol/L)	66	137.79 ± 3.1	132 – 146	-
Mg (mg/dL)	66	1.89 ± 0.3	1.6 – 2.6	-
Cu (µg/dL)	49	90.79 ± 26.9	70 – 140	-
Zn (µg/dL)	53	76.41 ± 27.7	50 – 150	-
pH	14	7.38 ± 0.07	7.35 – 7.45	-
Lactate (mmol/L)	43	11.39 ± 8.9	<2	<0,001b

Ca: calcium, CRP: c-reactive protein, Cu: copper, İG: immature granulocyte, K: potassium, Mg: magnesium, Na: sodium, NLR: neutrophil lymphocyte ratio, PCT: procalcitonin, PLR: platelet lymphocyte ratio, SS: standard deviation, WBC: white blood cell count, Zn: zinc
** Related variables were compared with normal values in the literature. When compared with normal values, parameters increasing with MI were compared with the upper normal limit and parameters decreasing with MI were compared with the lower normal limit. No correlation was observed for parameters within normal limits.*
a T-test in one group
b Wilcoxon Signed Rank Test

the reference range, whereas potassium, sodium, and magnesium values were close to the lower limit. The readings for copper and zinc were also discovered to be within the usual range. Although the electrolyte results of some of our patients were similar to the literature, this situation is not similar to the literature when the total number is considered. The reason for this may be the small number of patients in our study. Serum electrolyte levels should be checked during the diagnosis and follow-up of AMI patients with cardiac-specific biomarkers. Changes in serum electrolyte levels, especially Mg, can be used in the follow-up of AMI patients. Serum electrolyte levels may support cardiac-specific biomarkers in the diagnosis of AMI.

Inflammation markers are nonspecific in cardiac diseases, but when combined with cardiac markers, they are reported to provide useful diagnostic information in the diagnosis of ACS in the emergency department (9). Studies have demonstrated that increased CRP levels independently indicate cardiac damages (9). Leukocytes are part of the increased inflammatory process associated with increased cardiovascular risk and mortality in myocardial infarction patients. Low lymphocyte counts have been associated with increased cardiovascular events in patients with coronary artery disease. Increased PLR may lead to increased inflammatory and atherothrombosis response as a result of increased cytokine response. In cardiovascular diseases, PLR and NLR appear to be simple and applicable markers used to evaluate the inflammatory status (10, 11). Hemogram and inflammatory markers were also examined in our study. WBC, neutrophil, procalcitonin and CRP ratios were found to be significantly higher in patients with AMI. Although platelet/lymphocyte ratios were high, no significance was found. Routine hemogram examination in patients with AMI will both accelerate the diagnostic process and support the diagnosis.

Studies have shown that stress hyperglycaemia during AMI, especially in non-diabetic patients, impairs the pump function of the heart and thus leads to an increase in mortality due to heart failure. Patients with stress hyperglycaemia are also at increased risk of other cardiovascular events. Stress hyperglycaemia has been shown to be an independent predictive value in addition to smoking, hypertension, hyperlipidaemia and body mass index which are known risk factors of coronary artery disease (8). In our study, glucose values measured at the

Table 3: Hemogram, biochemistry, inflammatory markers and electrolyte levels of AMI patients admitted to emergency department according to gender

	Gender						
	Female			Male			
	n	Average	SS	n	Average	SS	p
WBC (10^9/L)	27	10.2	2.7	39	10.41	2.8	0.757a
Neutrophil (10^9/L)	27	7.34	2.9	39	7.31	2.9	0.958b
Percent neutrophils (%)	27	70.73	14.1	39	69.03	12.6	0.611a
Lymphocyte (10^9/L)	27	2.14	1.4	39	2.19	1.1	0.379b
Lymphocyte percentage (%)	27	21.92	12.1	39	21.87	10.6	0.986a
Platelet (10^9/L)	27	261.37	71.7	39	255.41	65.0	0.739b
IG (#)	27	0.053	0.048	39	0.048	0.063	0.078b
IG percentage (%)	27	0.48	0.32	39	0.43	0.49	0.048b
NLR (%)	27	5.70	6.7	39	4.99	4.9	0.784b
PLR (%)	27	183.73	155.1	39	161.53	137.1	0.351b
Glucose (mg/dL)	27	201.85	107.4	39	153.85	75.0	0.063b
CRP (mg/L)	25	11.90	10.8	33	20.20	37.7	0.603b
PCT (µg/L)	27	0.061	0.059	31	0.095	0.10	0.035b
Albumin (g/L)	27	40.0	4.4	39	41.48	5.6	0.059b
K (mmol/L)	27	4.34	0.8	39	4.47	0.7	0.231b
Ca (mg/dL)	27	9.02	0.55	38	8.97	0.88	0.645b
Na (mmol/L)	27	137.78	3.41	39	137.80	2.94	0.829b
Mg (mg/dL)	27	1.86	0.27	39	1.92	0.25	0.313b
Cu (µg/dL)	20	96.27	19.5	29	87.02	30.73	0.093b
Zn (µg/dL)	24	67.79	23.07	29	83.55	29.45	0.051b
pH	8	7.35	0.08	6	7.42	0.02	0.038b
Lactate (mmol/L)	22	11.80	10.2	21	10.96	7.6	0.865b

Ca: calcium, CRP: c-reactive protein, Cu: copper, İG: immature granulocyte, K: potassium, Mg: magnesium, Na: sodium, NLR: neutrophil lymphocyte ratio, PCT: procalcitonin, PLR: platelet lymphocyte ratio, SS: standard deviation, WBC: white blood cell count, Zn: zinc
a The p value found using Student's t test
b The p value found using the Mann - Whitney U test

time of stress were found to be high (hyperglycaemia) in patients with AMI; our glucose values were similar to the literature. AMI causes stress hormones secreted during stress with emotions such as stress/anxiety, fear of death, etc. We think that this clinical condition also increases blood glucose. Patients with AMI should have their blood glucose levels monitored, and if clinically appropriate, examinations and therapies for hyperglycemia should start without delay.

Serum lactate level has been reported to be a prognostic factor in patients with AMI (13, 14). In our study, serum lactate levels of patients with AMI were found to be significantly higher. The lactate levels of our patients with AMI are similar to the literature. Therefore, serum lactate levels should be monitored in these patients to reduce the spread of myocardial damage.

CONCLUSION

There are changes in hemogram, biochemistry, serum electrolyte and inflammatory marker levels in AMI patients. The levels of these markers should also be controlled during the diagnosis and follow-up of AMI patients with cardiac-specific biomarkers. We believe that hemogram, biochemistry, inflammatory markers and electrolyte levels may contribute to the prediction of early serious complications in patients with acute myocardial infarction. There is a need for further studies on the importance of markers to be used in the diagnosis and prognosis of AMI patients.

Conflict of Interest: No conflict of interest was declared by the authors.
Ethics: The study was approved by the Kahramanmaraş Sütçü İmam University Faculty of Medicine Clinical Research Ethics Committee session no: 2022/35, decision no: 03, dated 29.11.2022.
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