Artículo de investigación

The relationship between the hematologic indices (PDW, WBC count, MPV) at the admission time and descending ST segment after thrombolysis in patients with myocardial infarction

La relación entre los índices hematológicos (PDW, recuento de GB, MPV) en el momento de la admisión y el segmento ST descendente después de la trombolisis en pacientes con infarto de miocardio

Relação entre os índices hematológicos (PDW, contagem de leucócitos, MPV) na admissão e descendente do segmento ST após trombólise em pacientes com infarto do miocárdio

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Abstract

WBC count and the platelet index (MPV) at the admission time of patients with STEMI, are the strong predictors for undesirable outcomes of patients. The objective of the present study was to determine the relationship between the hematologic indices including MPV and WBC count at the admission time of patients with ST resolution index in patients with STEMI who were treated by thrombolytic agents.

In this prospective study, venous blood samples of 114 patients with STEMI were taken to determine PDW, MPV and WBC count at patients' referral time and before thrombolytic therapy. According to ST resolution index in 90 minutes after thrombolytic therapy, patients were classified in two groups with ST resolution less than 50% and ST resolution of 50% or more. Finally, values of the laboratory indices above were compared between two ST-resolution groups that this issue was carried out using the SPSS version 21 software.

In assessing through ROC curve analysis, it was determined that measuring MPV is not

Resumen

El recuento de glóbulos blancos y el índice de plaquetas (MPV) en el momento de la admisión de los pacientes con STEMI, son los factores predictivos fuertes para los resultados no deseados de los pacientes. El objetivo del presente estudio fue determinar la relación entre los índices hematológicos, incluido el recuento de MPV y WBC en el momento de la admisión de los pacientes con índice de resolución de ST en pacientes con STEMI que fueron tratados con agentes trombolíticos.

En este estudio prospectivo, se tomaron muestras de sangre venosa de 114 pacientes con STEMI para determinar el recuento de PDW, MPV y WBC en el tiempo de referencia de los pacientes y antes de la terapia trombolítica. Según el índice de resolución de ST en 90 minutos después de la terapia trombolítica, los pacientes se clasificaron en dos grupos con resolución de ST inferior al 50% y resolución de ST del 50% o más. Finalmente, los valores de los índices de laboratorio anteriores se compararon entre dos grupos de resolución de

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considered as an accurate and effective index in predicting ST resolution after thrombolysis (Area Under Curve: 0.574). WBC count was not an applicable indicator for predicting ST resolution after thrombolysis, as well (Area Under Curve: 0.660). Finally, the results of multiple logistic regression model showed that the only predictor of ST resolution less than 50% is the history of using statins so that history of using statin increased the probability of ST resolution less than 50% for 7 times (P: 0.028, OR: 7.306).

There is not a relationship between the occurrence of complete ST resolution (more than 50%) and the values of both MPV and WBC indices. So, measuring these two indicators may not have the enough validity for predicting ST resolution after thrombolysis. According to our study, patients with history of using statins have a lower prevalence of complete ST resolution (more than 50%).

Keywords: Hematologic indices, thrombolysis, myocardial infarction, ST segment

ST que este problema se llevó a cabo utilizando el software SPSS versión 21.

Al evaluar a través del análisis de la curva ROC, se determinó que la medición de MPV no se considera como un índice preciso y eficaz para predecir la resolución de ST después de la trombólisis (área bajo la curva: 0.574). El recuento de WBC tampoco fue un indicador aplicable para predecir la resolución de ST después de la trombolisis (Área bajo la curva: 0.660). Finalmente, los resultados del modelo de regresión logística múltiple mostraron que el único predictor de resolución de ST inferior al 50% es el historial de uso de estatinas, de modo que el historial de uso de estatinas aumentó la probabilidad de resolución de ST inferior al 50% en 7 veces (P: 0,028), O: 7.306).

No existe una relación entre la aparición de una resolución completa de ST (más del 50%) y los valores de los índices de MPV y WBC. Por lo tanto, la medición de estos dos indicadores puede no tener la suficiente validez para predecir la resolución del ST después de la trombólisis. Según nuestro estudio, los pacientes con antecedentes de uso de estatinas tienen una prevalencia más baja de resolución completa de ST (más del 50%).

Palabras clave: índices hematológicos, trombólisis, infarto de miocardio, segmento ST.

Resumo

A contagem de leucócitos e o índice plaquetário (VPM) no momento da admissão de pacientes com IAMCSST são fortes preditores de desfechos indesejáveis dos pacientes. O objetivo do presente estudo foi determinar a relação entre os índices hematológicos, incluindo MPV e contagem de leucócitos no momento da admissão de pacientes com índice de resolução de ST em pacientes com STEMI que foram tratados por agentes trombolíticos.

Neste estudo prospectivo, amostras de sangue venoso de 114 pacientes com IAMCST foram tomadas para determinar a contagem de PDW, MPV e leucócitos no momento do encaminhamento dos pacientes e antes da terapia trombolítica. De acordo com o índice de resolução de ST em 90 minutos após a terapia trombolítica, os pacientes foram classificados em dois grupos com resolução de ST menor que 50% e resolução de ST de 50% ou mais. Finalmente, os valores dos índices laboratoriais acima foram comparados entre os dois grupos de resolução ST que esta questão foi realizada usando o software SPSS versão 21.

Na avaliação através da análise da curva ROC, determinou-se que a medição do VPM não é considerada como um índice preciso e eficaz na predição da resolução de ST após trombólise (Area Under Curve: 0,574). A contagem de leucócitos também não foi um indicador aplicável para prever a resolução de ST após trombólise (Area Under Curve: 0.660). Finalmente, os resultados do modelo de regressão logística múltipla mostraram que o único preditor de resolução de ST inferior a 50% é a história de uso de estatinas para que a história de uso de estatina aumente a probabilidade de resolução de ST menor que 50% por 7 vezes (P: 0,028 , OR: 7,306).

Não há relação entre a ocorrência de resolução completa do ST (mais de 50%) e os valores dos índices de MPV e WBC. Portanto, a medição desses dois indicadores pode não ter validade suficiente para prever a resolução de ST após trombólise. De acordo com nosso estudo, pacientes com história de uso de estatinas têm uma menor prevalência de resolução completa de ST (mais de 50%).

Palavras-chave: índices hematológicos, trombólise, infarto do miocárdio, segmento ST

Introduction

In the recent decade, several observations led to the confirmation of the benefits of evaluation and monitoring of ST resolution indices after occurrence of STEMI. For the first time, Schroder et al found that ST resolution predicts the risk of mortality and congestive heart failure in patients treated by fibrinolytic therapy, effectively (Schröder et al., 1994; Schröder et al., 1995). Another studies confirmed the relationship between the degree of ST resolution and mortality. In another study by Ito et al, it was determined that epicardial normal blood store is not sufficient for evaluation and providing adequate myocardial reperfusion (Ito et al., 1992; Ito et al., 1996). In fact, new reperfusion regimens were developed to improve the limitations of two fibrinolytic and anticoagulant therapies (Ohman et al., 1997; Antman et al., 2000) and these therapies may be particularly useful in providing coronary micro-circulation (SPEED, 2000).

ST resolution is currently evaluated in many clinical trials and managing patients. Primary studies on ST resolution showed this fact that patients with sharper ST resolution had a lower level of infarction compared to the patients with stable ST-elevation (Neumann et al., 1998). Further studies confirmed that there is a significant relationship between ST resolution and clinical outcomes of the patients. In a large study on 7426 patients, it became clear that two third of patients with ST resolution more than 50% were four hours after thrombolysis therapy so that these patients had a thirty-day mortality rate of 3.5% against the mortality of 7.4% in patients with ST resolution less than 50% (de Lemos et al., 2000). On the other hand, Schorder et al developed a new three-part definition for the total resolution of 180 minutes ST elevation after thrombolysis which was included complete resolution (more than 70%), relative (between 30 to 70%) and without resolution (less than 30%). In trials on fibrinolytic treatments, a strong relationship between ST resolution and the reduction in the mortality of patients was observed (Schröder et al., 1999). In newer studies, it was determined that evaluation of ST resolution even in 3 to 4 first hours after the beginning of fibrinolytic therapy, can determine the risk of death as well as heart failure in patients (Purcell, Newall & Farrer, 1997; Carlsson et al., 1999; de Lemos et al., 2000, 101(3); de Lemos et al., 2000, 140(3)). In addition, it has been determined that patients with complete ST resolution within 60 minutes had a much lower risk for these two consequences than those patients with ST resolution within 90 minutes (Matetzky et al., 1998). Due to the slower beginning of fibrinolytic streptokinase activation, 90 minutes is a very limited time for the creation of ST resolution and therefore 180 minutes is considered as an acceptable time to assess streptokinase activity in the creation of reperfusion (Schröder et al., 1999). In addition, along with predicting mortality, the degree of ST resolution is capable to predict the left ventricular dysfunction and heart failure. So that the more complete ST resolution is related to the more limited size of infarction and more improvement of left ventricular function (Saran et al., 1990; Matetzky et al., 1999; Shah et al., 2000). Similar to mortality, the risk of heart failure in a wider and faster ST resolution cases, has been associated with a reduction in the risk of heart failure (Andrews et al., 2000).

The special importance of predicting ability of ST resolution is mainly related to its relationship with epicardial blood flow. In a study, it was determined that under thrombolysis and 90 minutes after it, patients with ST resolution less than 70% had 10-fold higher mortality than the patients with ST resolution more than 70% (van't Hof et al., 1997). Interestingly, there was no difference between two groups with TIMI II and TIMI III and ST resolution in terms of being complete or relative. It was observed through monitoring that patients with faster recovery of stable ST had faster improvement and restoration of infarction that this issue has been independent from TIMI degree. In another study, ST resolution and not the grade of TIMI was the predictor of mortality and heart failure (Andrews et al., 2000; van't Hof et al., 1997).

Other evidences showed the prognostic value of ST resolution derived from the experiences related to primary PCI in patients with STEMI. After the successful primary PCI in patients with STEMI, continuous ST elevation had been associated with weaker recovery of left ventricular function and therefore increased mortality (Andrews et al., 2000; van't Hof et al., 1997; Somitsu et al., 1997). Risk of death and heart failure in patients with increased level of ST after PCI had been increased because of increased extent of infarction (Claeys et al., 1999; Dissmann et al., 1993; Kondo et al., 1993). In addition, it is proposed that ST resolution is associated with providing tissue reperfusion. By creating the ST resolution at 90 minutes after fibrinolysis, reperfusion has been completely developed in both epicardial and microvascular levels that leads to an excellent outcome in the patient. Another important point in this regard was the companying role of other risk factors in patients with STEMI including age, high weight, infarction, the onset of treatment, evidences of brain involvement, diabetes and hypertension with the history of coronary heart disease (Miida et al., 1994). Interestingly, in both groups of patients with and without any of mentioned risk factors, the presence of ST resolution has still been a predictor of lower mortality in these patients (Morrow et al., 2000). Recently, it has determined that some factors such as previous cardiac biomarker level before fibrinolytic therapy can be stronger predictors of mortality alongside the lack of ST resolution (Ohman et al., 1996; Stubbs et al., 1996; Ohman et al., 1999). It has also been shown that the evaluation of myoglobin immediately before fibrinolysis along with evaluation of ST resolution 60 to 90 minutes before the therapy can provide more complete information on predicting undesirable outcomes in patients that increased myoglobin associated with the lack of 90-minutes ST resolution increase the risk of mortality up to 25 times (Stubbs et al., 1996).

Recently, the role of other factors and biomarkers especially hematologic factors related to ST resolution has been evaluated. As we know, platelets play a basic role in the pathogenesis of atherosclerosis and the spread of thrombotic coronary events. Platelets are mainly produced in stressful conditions such as acute coronary syndrome that platelets will be the high stimulator of B2 thromboxan production (van der Loo & Martin, 1999). The Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW) are considered as the risk factors of MI occurrence and stroke and finally mortality in patients with STEMI (Huczek et al., 2005; Massberg, Schulz & Gawaz, 2003; Sabatine et al., 2002). Also, leukocytosis plays an important role in the occurrence and progression of atherosclerosis and acute coronary syndrome (Vagdatli et al., 2010). But, what has been still unclear for the researchers is the role these hematologic indices in evaluating the adequacy of reperfusion following the thrombolytic therapy especially in relation to or in association with occurrence of ST resolution.

Acute myocardial infarction is a clinical syndrome in which evidences of myocardial ischemia is associated with symptoms of myocardial necrosis in the electrocardiogram, biochemical tests and imaging modalities. One of the types of acute myocardial infarction is determined by ST segment elevation in the electrocardiogram and necrosis of all walls (Khademvatani et al., 2016; Yalcin et al., 2015; Khademvatan et al., 2014; Heris et al., 2014). Using the rapid, accurate and non-invasive methods to evaluate the efficacy of reperfusion and thrombolysis therapies in patients with acute myocardial infarction is an essential issue. In the recent decade, many observations have been made about the efficacy of monitoring of ST segment changes as a simple and accessible method in patients with acute myocardial infarction treated by reperfusion and ST resolution was significantly considered in this regard (Darabad et al., 2014; Poorrafsanjani & Darabad, 2014). For the first time in 1994, it was determined that this index can even predict the risk of death and occurrence of congestive heart failure in patients under fibrinolytic therapy. In this regard, further studies showed that there is a strong significant relationship between the degree and severity of ST resolution and the risk of mortality following the above mentioned therapies and therefore this indicator was really considered as a prognostic measure in patients treated by reperfusion (thrombolytic and also interventional).

Both inflammatory and coagulative hematologic indicators play essential roles in the occurrence and pathogenesis of acute coronary syndrome. It has been approved in studies that there is a significant relationship between the platelet size considered as mean platelet volume and the platelet activity. On the other hand, the platelets with higher mean platelet volume (MPV) are more active in terms of metabolic and enzymatic ranges and therefore have more

thrombotic effects. In addition, an increase in MPV level has been an independent risk factor for the clinical reverse-outcomes in patients with acute myocardial infarction. However, the relationship between MPV and myocardial reperfusion disorders is not still fully understood.

On the other hand, the role of inflammation has been fully known as a potential risk factor for developing cardiovascular events. Leukocyte response observed during STEMI indicates the role and is considered as an essential component of systemic inflammatory response to myocardial injury. WBC count in time of admission of the patients is a strong predictor for increasing mortality and morbidity of patients with STEMI. In this regard, it is found that there is a relationship between the increase in WBC count and the reduction of epicardial and myocardial blood flow in patients with STEMI.

Along with the above studies, the present study was conducted aimed to evaluate the relationship between the hematologic indices including MPV and WBC count in the time of admission and ST resolution index in patients with STEMI treated by thrombolytics. This study was carried out in Azerbayjan Province for the first time, but its similar studies have been done in Tabriz and Yazd which are mentioned in scientific literature section.

Method

In this prospective case-control study, basic details of the patients such as demographic information, height, weight and body mass index (BMI), history of heart disease risk factors such as familial history of heart diseases, hypertension, hyperlipidemia, diabetes mellitus and smoking, history of drug use especially using heart drugs, previous history of cardiovascular interventions, history of myocardial infarction, history of heart failure, previous history of cerebrovascular events, history of renal failure, history of peripheral arterial hypertension and history of chronic obstructive pulmonary disease were extracted from the patients' records data and registered in the special questionnaire of the project. At the patients' referral time and prior to thrombotic therapy, venous blood samples were taken to measure PDW, MPV indices and WBC count and data were registered in the patients' records. Patients were treated by thrombolysis in an equal condition (including streptokinase 1.5 million units in 20-30 minutes) with a German-made Streptase drug. ST elevation was measured from the J point in ST segment as well as in two electrocardiograms during the initial hospitalization and 90 minutes after thrombotic therapy. According to ST resolution index, 90 minutes after thrombotic therapy, patients were classified in two groups of ST resolution less than 50% and ST resolution of 50% or more. Finally, values of the above laboratory indices were compared between two ST resolution groups.

Criteria to enter the study:

The presence of STEMI diagnostic criteria are based on clinical symptoms (continues typical chest angina for more than 30 minutes), ECG changes (ST segment elevation more than 2 mm in pre-cordial lids and more than 1 mm in limb lids in more than two adjacent lids) and increased cardiac enzymes, 2) receiving thrombolytic treatments, 3) the first occurrence of myocardial infarction.

Criteria to exit the study:

1)Delay to visit for more than 6 hours from the onset of symptoms, 2) presence of LBBB, 3) presence of ventricular tachycardia arrhythmias and ventricular fibrillation, 4) rhythm resulted from the pacemaker, 5) incomplete or non-judgmental electrocardiogram, 6) cases of thrombolytic inhibition including fibrinolytic therapy within the recent 24 hours, anti-coagulant therapy, having congenital hemorrhagic factors, renal insufficiency, history of malignancy, history of chronic inflammatory disease and or active infection, intra-ventricular conduction abnormalities, aortic dissection, systolic hypertension higher than 180 mmHg, history of trauma to the head or any surgery during the recent 3 months, history of thrombocytopenia, presence of cardiogenic shock, 7) presence of concurrent internal or infectious diseases effective on the laboratory parameters under the study, 8) patients who already have aspirin and clopidogrel.

Finally, SPSS version 21 software was used to analyze the data of above study.

Results

A total of 114 patients were evaluated. In terms of ST resolution, 43 cases (37.7%) and 70 cases (61.3%) had resolution of less than 50% and resolution of more than 50%, respectively. In the comparison of basic details between the patients with the resolutions less than 50% and more

than 50%, we found that in terms of sexual distribution, frequency of men in people with resolution less than 50% was 69.8% and in people with resolution higher than 50% was 90.1% that the difference was statistically significant (P: 0.006). in terms of the mean age, mean ages in the groups of resolution less than 50% and resolution higher than 50% were 62.07±12.96 years and 56.32±9.29 years old that the difference was statistically significant, as well (P: 0.007). in terms of frequency of the risk factors of heart diseases, prevalence of diabetes were 23.3% and 9.9% in the groups with resolutions less than 50% and more than 50%, respectively that was significantly higher in the first group (P: 0.052). The prevalence of hypertension in the groups with the resolutions less and more than 50% were 44.2% and 18.3% respectively and it was significantly higher in the first group (P" 0.003). in terms of the smoking history, the prevalence of smoking in the groups with resolutions less and more than 50% were 37.2 and 35.2%, respectively that no difference was seen in those groups (P: 0.829). In terms of using opium in the groups with resolutions less and more than 50%, they were 11.6% and 8.5% respectively and without a difference between those groups, as well (P: 0.745). In terms of hyperlipidemia, the prevalence of this complication in the groups with resolutions less and more than 50% were 11.6% and 7%, respectively and without a difference between those groups, as well (P: 0.402).

Prevalence of MI in the groups with resolutions less and more than 50% were 14% and 4.2%, respectively and without a difference between those groups, as well (P: 0.07). Prevalence of pulmonary diseases in the groups with resolutions less and more than 50% were 4.7% and 5.6.2%, respectively and without a difference between those groups, as well (P: 0.999). In terms of familial cardiovascular diseases, this history in the groups with resolutions less and more than 50% were 4.7% and 12.7%, respectively and without a difference between those groups, as well (P: 0.209). Also, in terms of prevalence of peripheral vascular disease, this prevalnce in the groups with resolutions less and more than 50% were 4.7% and 0%, respectively and without a difference between those groups, as well (P: 0.14).

Table 1- Basic details of patients with ST resolution of less and more than 50%

Details	Resolution less than 50%	Resolution more than 50%	p-value
Frequency of men	69.8%	90.1%	0.006
Mean age (years old)	62.07±12.96	56.32±9.29	0.007
Prevalence of diabetes	23.3%	9.9%	0.052
Prevalence of hypertension	44.2%	18.3%	0.003
Prevalence of smoking	37.2%	35.2%	0.829
Prevalence of using opium	11.6%	8.5%	0.745
Prevalence of hyperlipidemia	11.6%	7.0%	0.402
Prevalence of pulmonary diseases	4.7%	5.6%	0.999
History of cardiac diseases	4.7%	12.7%	0.209
History of peripheral vascular diseases	4.7%	0%	0.140
Using of statins	16.3%	2.8%	0.026
Using β blockers	0	4.2%	0.289
Using ACE inhibitors	18.6%	9.9%	0.181
Using Ca blockers	0	8.5%	0.082
Using anti-diabetic drugs	14.0%	5.6%	0.174
Frequency of using diuretic drugs	0	1.4%	0.999
Mean of MPV	9.42±0.77	9.59±1.00	0.377
Mean of WBC count	10027.91±2433.04	10520.00±2800.03	0.343

In terms of using the cardiovascular drugs, the prevalence of using statins in the groups of resolution less and more than 50% were 16.3% and 2.8%, respectively that in the first group was significantly higher than the second group (P:0.026). Frequency of beta blockers in the groups of resolution less and more than 50% were 0% and 4.2%, respectively that there was no difference between both groups (P: 0.289). Frequency of using ACE inhibitors in the groups of resolution less and more than 50% were 18.6% and 9.9%, respectively and without any difference between two groups (P: 0.181). Similarly, using the Ca blockers in the groups of resolution less and more than 50% were evaluated as 0% and 8.5%, respectively and with no difference between two groups, as well (P: 0.082). Frequency of using anti-diabetic drugs in

the groups of resolution less and more than 50% were 14% and 5.6%, respectively that the difference between the groups was not significant (P: 0.174). Also, frequency of using diuretic drugs in the groups of resolution less and more than 50% were 0% and 1.4%, respectively and without any difference between two groups, again (P: 0.999). (Table 1)

Mean of MPV in patients with resolution less than 50% was 9.42±0.77 as well as 9.59±1.00 in the patients with resolution more than 50% that the difference between two groups was not significant (P: 0.377). Mean of WBC count in patients with resolution less and more than 50% were 1027.91±2433.04 and 10520.00±2800.03, respectively and the difference between two groups was not significant (P: 0.343). (Table 1)

In the evaluation with multiple logistic regression, the only predictor of ST resolution less than 50% was using statins so than the history of using statin increased the probability of ST resolution less than 50% for about 7 times (P: 0.028, OR: 7.306).

Table 2- Logistic regression model in determining the factors related to resolution less than 50%

Index	Beta coefficient	SE	p-value	OR
Gender	-0.584	0.630	0.354	0.558
Age	-0.032	0.022	0.150	0.969
diabetes	0.299	0.651	0.646	1.349
Hypertension	0.837	0.517	0.105	2.310
Using statin	1.989	0.902	0.028	7.306

In the evaluation by ROC curve analysis, it was found that determination of MPV is not considered as an accurate and efficient indicator in predicting ST resolution after thrombolysis (area under curve: 0.574). Determining WBC count was not an applicable indicator for predicting ST resolution after thrombolysis, as well (area under curve: 0.660) (charts 1, 2)

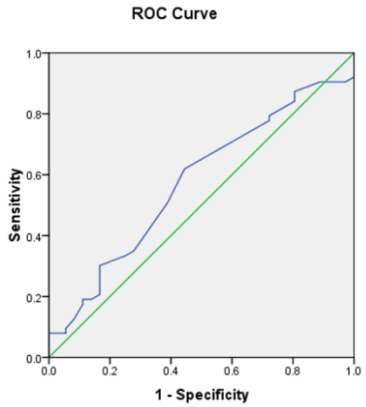

Chart 1- AUC-ROC for MPV to differentiate the resolutions less and more than 50%

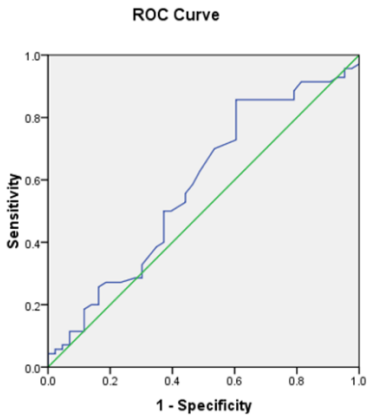

Chart 2- AUC-ROC for MPV to differentiate the resolutions less and more than 50%

Discussion and Conclusion

First of all, the purpose of this study was to evaluate the difference between MPV and WBC indices in two groups of patients with ST resolution less and more than 50% after thrombolysis. In fact, the objective was to find if these two measures have an acceptable value to differentiate ST resolutions less and more than 50% after thrombolysis or not or on the other hand, whether a cut-off point is obtained that considering that cut-off point for two MPV and WBC indicators, ST resolution less and more than 50% can be differentiated with acceptable sensitivity and specificity or not. Despite the observed numerical difference in two MPV and WBC indicators between two groups of ST resolution less and more than 50%, this difference was not statistically significant according to this study. Also, in the evaluation of area under ROC curve (AUC-ROC), it was shown that none of these indicators are valuable enough to differentiate ST resolutions less and more than 50% and therefore a cut-off point with acceptable sensitivity and specificity for such this differentiation ability cannot be determined. Unlike some conducted studies, our study was not able to determine the relationship between MPV as well as WBC with ST resolution. In Ghaffari et al study, patients with MPV higher than 8.2 fl had lower ST resolution and fewer acute heart failures. In the evaluation with regression model, MPV was the predictor for ST resolution as well as MACE occurrence (Khademvatani et al., 2016) that was completely contrary to our study. In the study of Kirbas et al, MPV value in patients with ST resolution less than 50% was lower than it in patients with ST resolution more than 50% and based on ROC curve analysis, the cut-off point of 9.3 fl for MPV was the strong predictor for predicting ST resolution with the sensitivity of 66.7% and 77.9% (Kırbaş et al., 2014) that was not contrary to our study, as well. In Varasteh et al study, patients with ST resolution less than 70% had higher values of MPV, PDW and WBC count. The best cut-off point of MPV for predicting ST resolution less than 70% was 10.05 fl with the sensitivity and specificity of 71.8% and 80.9%, respectively. Also, the best cut-off point of WBC count for predicting ST resolution less than 70% was 12.65 per thousand with the sensitivity and specificity of 42.9% and 82.7%, respectively (Varasteh-Ravan et al., 2013). Of course, the studies conducted about the relationship between ST resolution and values of the laboratory indicators are very few. In general, it seems that the disapproval reason of the relationship between ST resolution and values of MPV and WBC indicators can be the following items. First, determination of cut-off point for ST resolution has been different in various studies so that in some studies the cross section of 50% was considered and in the others, 70% was considered that can be very effective in the significance of differences between the groups. Second, the time range was mainly 1 to 4 hours in order to determine resolution after thrombolysis which affects on the laboratory indices and occurrence of a complete resolution (which was less than 6 hours in our study). Third, type of thrombolysis therapy as well as its associated treatments may be effective on the occurrence of complete resolution after thrombolysis. It is important to mention that in the above studies, the history of using aspirin and clopidogrel was not included in the exclusion criteria while in our study, patients with history of using these drugs excluded from the study and this point can be effective in the results of the study. Also, type of using technique and its accuracy estimating the laboratory indices will be an important and effective factor in determining the relationship among the indices and occurrence of a complete resolution. So, with the presence of possible contingency indicators mentioned above, it is not possible to find a significant relationship between two MPV and WBC laboratory indices and the occurrence of a complete resolution.

In this regard, history of using statin was only related to resolution occurrence among all basic indices of patients and multiple logistic regression. The obtained result was the reverse finding of Varasteh et al in which among all patients' indices, only the history of using statins was different between two groups of with and without resolution was different, but the group with the use of statin ST resolution more than 50% (Varasteh-Ravan et al., 2013). Of course, the cause of this relationship was not evaluated in their study, as well. In some studies, using statins was associated with the improvement of ST resolution (Kim et al., 2010). Although, in some other studies, there was not a significant relationship between the history of using statins and occurrence of improving complete ST resolution (Woo et al., 2011). Maybe, the relationship between using statin and ST resolution is due to the effect of drug on the inflammatory indices and predicting the occurrence and development of ischemia in

myocardial tissue, however it requires further studies and evaluation.

Finally, t can be said that in our study, there is no relationship between the occurrence of complete ST resolution (more than 50%) and the values of both MPV and WBC indicators. Therefore, there are not enough evidences that show the assessment of these indicators have the enough value for predicting ST resolution after thrombolysis based on this study. According to our study, patients with history of using statins have lower prevalence of complete ST resolution (more than 50%).

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