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ARAŞTIRMA / RESEARCH

Evaluation of shock index and modified shock index in estimation of MACE parameters in patients with ST elevated myocardial infarction

ST elevasyonlu miyokard enfarktüslü hastalarda MACE parametrelerinin tahmininde şok indeksi ve modifiye şok indeksinin değerlendirilmesi

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Abstract

Purpose: Shock index and modified shock index were used to evaluate the hemodynamic status of patients with trauma, pulmonary embolism and aortic dissection. In this study, we aimed to evaluate the effectiveness of shock index and modified shock index as an indicator of major adverse cardiac event parameters in patients with ST elevated myocardial infarction.

Materials and Methods: A total of 194 patients with ST elevated myocardial infarction were included in the study. Shock index and modified shock index were evaluated regarded to predicting major adverse cardiac event and major adverse cardiac event parameters separately.

Results: A total of 194 patients were included in the study. The 7-day mortality was 2.4% in the shock index <0.66 group and 11.6% in the shock index ≥ 0.66 group. The rate of development of major adverse cardiac event was 4.0% for shock index <0.66 and 17.4% for shock index 0.66. The 7-day mortality was 3.0% in the modified shock index <0.93 group and 11.1% in the modified shock index 0.93 group. The rate of major adverse cardiac event was 3.8% in the modified shock index <0.93 group and 19.4% in the modified shock index ≥ 0.93 group.

Conclusion: Shock index and modified shock index are useful methods for estimating both major adverse cardiac event and major adverse cardiac event parameters separately.

Keywords:. STEMI, shock index, modified shock index, MACE

Öz

Amaç: Şok indeksi ve modifiye şok indeksi travma, pulmoner emboli ve aort diseksiyonu olan hastaların hemodinamik durumunu değerlendirmek için kullanılmıştır. Bu çalışmada ST elevasyonlu miyokard infarktüs hastalarında majör istenmeyen kardiyak olay parametrelerinin bir göstergesi olarak şok indeksi ve modifiye şok indeksinin etkinliğini değerlendirmeyi amaçladık.

Gereç ve Yöntem: Çalışmaya ST elevasyonlu miyokard enfarktüsü olan toplam 194 hasta dahil edildi. Şok indeksi ve modifiye şok indeksinin majör istenmeyen kardiyak olayı ve majör istenmeyen kardiyak olay parametrelerini ayrı ayrı öngörme açısından değerlendirildi.

Bulgular: Çalışmaya toplam 194 hasta dahil edildi. 7 günlük mortalite şok indeksi <0.66 grubunda %2.4 ve şok indeksi ≥ 0.66 grubunda %11.6 idi. Majör istenmeyen kardiyak olay gelişme oranı şok indeksi <0.66 için %4.0 ve şok indeksi ≥0.66 için %17.4 idi. 7 günlük mortalite modifiye şok indeksi <0.93 grubunda %3.0 ve modifiye şok indeksi ≥0.93 grubunda% 11.1 idi. Majör istenmeyen kardiyak olay gelişme oranı modifiye şok indeksi <0.93 grubunda % 3.8 ve modifiye şok indeksi ≥ 0.93 grubunda% 19.4 idi.

Sonuç: Şok indeksi ve modifiye şok indeksi, hem majör istenmeyen kardiyak olay gelişimini hem de majör istenmeyen kardiyak olay parametrelerini ayrı ayrı hesaplamak için faydalı yöntemlerdir.

Anahtar kelimeler: Stemi, şok indeksi, modifiye şok indeksi

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INTRODUCTION

The most important step of preventing complications and mortality in ST-elevated myocardial infarction (STEMI) is the early risk classification of the patients as in many other diseases. There are many scoring systems such as "The Thrombolysis in Myocardial Infarction (TIMI) risk score" and "The Global Registry of Acute Coronary Events (GRACE) risk score" used to assess the risk status of these patients. But these scoring systems are made up of many parameters that make it difficult to keep in mind. In addition, some of these parameters are depend on laboratory tests, which make their use difficult. However, it is vital to make a quick decision about the patients in the emergency department, so more practical methods are needed for risk assessment[1,2]. Shock index (SI), which is used as a predictor of hemodynamic stability and mortality in trauma patients, has also begun to be used in patients with pulmonary embolism and aortic dissection. A high shock index score has been founded to be associated with increased mortality in studies[3,4,5].

Recent studies have shown that SI can also be used as a marker of mortality in patients with STEMI[5,6,7]. Unlike TIMI and GRACE, SI does not require personal information such as the patient's medical history, diagnostic blood tests or imaging results. For this reason, SI stands out as a practical method that can be easily used and calculated quickly.

Then, Modified shock index (MSI) was developed considering that diastolic blood pressure was important as well as systolic blood pressure[8]. MSI has been shown to be superior to SI in demonstrating 7-day mortality in STEMI[9]. There are few studies evaluating and comparing the efficacy of SI and MSI in predicting the development of MACE and MACE parameters separately in STEMI patients in the emergency department. More studies are needed on this subject. The aim of this study was to evaluate the effectiveness of SI and MSI as an indicator of major adverse cardiac event (MACE) parameters in STEMI patients.

MATERIALS AND METHODS

This is a retrospective cross-sectional study. This study was conducted in the emergency department (ED) of Katip Çelebi University Atatürk Training and Research Hospital. The hospital had an annual ED visits of 350,000.

Ethics committee approval (16/06/2016, IRB number:179) was obtained from the Katip Çelebi University non-interventional clinical research ethics committee. Written consent was obtained from all patients included in the study. This study was carried out in accordance with the Helsinki Human Rights Act.

Sample

A total of 194 consecutive patients over 18 years of age who were admitted to emergency department with acute STEMI between January 2011 and December 2016 were included in this study. Patients whose medical data could not be reached were excluded from the study. STEMI was defined as at least 2.5 mm ST segment elevation in men under 40 years of age or at least 2 mm ST segment elevation in men over 40 years of age seen in at least two adjacent leads on ECG or at least 1,5 mm ST segment elevation in leads V2 and V3 in woman and / or at least 1 mm ST segment elevation in leads other than V2 and V3 in women (in the absence of left ventricular hypertrophy or left bundle branch block)[8].

In this study, MACE was defined as the development of at least one of the following within 7 days; any life-threatening arrhythmia including ventricular tachicardia (VT) and ventricular fibrillation (VF) developped during hospital stay, cardiogenic shock defined as persistent hypotension (SBP <90 mmHg) that does not respond to fluid replacement and requires intra-aortic balloon pump or intravenosus inotropic treatment, heart failure defined as Killip Class 2 or more and STEMI related mortality.

The Killip classification is used to categorize severity of heart failure following myocardial infarction. According to Killip classification; class I means no rales or third heart sound, Class II means pulmonary congestion with rales over 50% of the lung fields and sinus tachycardia or third heart sound, Class III means pulmonary edema with rales over 50% of the lung fields and Class IV means cardiogenic shock[10,11].

Procedure

The medical and demographic data of the patients were screened retrospectively from the electronic database of the hospital. Age, gender, previous medical history, blood pressure and pulse rate at the time of admission, presence of hearth failure findings, development of VF or VT during hospital stay and coronary angiography results of patients were

recorded. SI and MSI were calculated by using heart rate and blood pressure results. SI was calculated as the ratio of heart rate to systolic blood pressure and MSI was calculated as the ratio of heart rate to mean arterial pressure (MAP). In addition, MAP was calculated with the following formula. (MAP = [(DBP × 2) + SBP] /3). The relationship between the obtained data and MACE was evaluated separately.

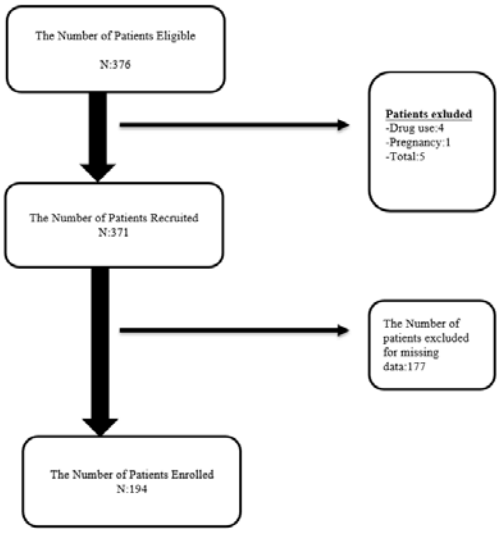

Figure 1. Patient flow chart

In this study, the cut off values for MSI and SI were determined as 0.93 and 0.66 respectively according to the sensitivity and specificity value of the data obtained from the ROC analysis. The area under the curve for SI was 0.751 (SI: 0.621-0.881; p <0.001 at 95% confidence interval). The cut off value obtained in the highest sensitivity and specificity was 0.66 (sensitivity 70%, specificity 69%). The area under the curve for MSI was 0.713 (MSI: 0.579-0.847; p = 0.00495% at %95 confidence interval). The cut off value obtained in the highest sensitivity and specificity was 0.93 (sensitivity 70%, specificity 72%). According to these values, 4 groups were determined as SI≥0.66 and SI <0.66, MSI≥ 0.93 and MSI <0.93.

Statistical analysis

Data were analyzed using SPSS software version 20.0 (SPSS Inc, Chicago, IL). Frequency distributions were employed for categorical variables. Mean and SD values were employed for descriptive statistics of numerical variables. ROC analysis was used to determine the cut-off value for SI and MSI according to the values with the highest sensitivity and specificity. To understand the accuracy of SI and MSI in estimating MACE and MACE parameters separately, the area under the ROC curve was calculated. When comparing two independent groups, Mann Whitney u test was used for variables that did not conform to the normal distribution (Killip classes of 2 and above, mortality rates within 7 days, VT-VF, age, systolic and diastolic blood pressures, pulse rate, MAP, SI and MSI). Independent sample t-test was used for the distribution of the mean age according to the gender of the patients and Fisher's Exact test was used for the distribution of categorical variables according to the mortality rate within 7 days and single logistic regression analysis was performed for the variables that were thought to be effective in the development of mortality within 7 days. P value lower than 0.05 was considered statistically significant.

RESULTS

A total of 194 patients were included in the study. 73.71% (n = 143) of the patients were male. The mean age of the female patients was 65.2 ± 12.19 years and the mean age of male patients was 56.36 ± 11.69 years. The mean age of women was higher than that of men (p <0.001). When the mean age between SI≥0.66 and MSI≥0.93 groups were considered, it was found to be higher in MSI≥0.93 group (58.68 ± 11.20 years vs 60.27 ± 11.53 years, respectively; p> 0.05).

We found that both MSI and SI were successfull in predicting presence of MACE (p = 0.003, p <0.001, respectively.) However MSI was found to be more meaningful than SI in predicting MACE. When the presence of MACE and subgroups were compared according to SI (SI <0.66 vs SI≥0.66), the 7-day mortality was 2.4% for the SI <0.66 group and 11.6% for the SI≥ 0.66 group (p = 0.008). The rate of presence of MACE was 4.0% for SI <0.66 and 17.4% for SI≥0.66 (p = 0.003). No difference was found between the groups (SI <0.66 vs SI≥0.66) in terms of presence of CHF and presence of VT / VF (p> 0.05). There was no difference between the groups (SI <0.66 vs SI≥0.66) in terms of age, sex, MI history, HT, HL, smoking, presence of LAD lesion, presence of RCA lesion, presence of Cx lesion, two-vessel lesion and multiple vessel lesion (p> 0.05) (Table 1).

When the presence of MACE and subgroups were compared according to MSI (MSI <0.93 and MSI≥0.93), no difference was found between the

groups in terms of age, gender, history of MI, HT, HL, presence of LAD lesion, presence of RCA lesion, presence of Cx lesion, two vessel lesion and multiple vessel lesion (p> 0.05). The 7-day mortality was 3.0% for the MSI <0.93 group and 11.1% for the MSI≥0.93 group (p = 0.020). The presence of VT / VF was 0.8% in the MSI <0.93 group and 6.3% in the MSI≥ 0.93 group (p = 0.020). The presence of CHF was 0.0% for the MSI <0.93 group and 3.2% for the MSI≥0.93 group (p = 0.038). The rate of presence of MACE was 3.8% in the MSI <0.93 group and 19.4% in the MSI≥ 0.93 group (p <0.001) (Table 1).

When the factors affecting the mortality of the cases were examined; factors other than history of MI, multivessel disease and LAD lesion were not found to have significant effect on mortality. The presence of MI history, multiple vessel lesion and LAD lesion were found to be effective on mortality (p <0.05). Age, systolic BP, MAP, SI and MSI were also significant factors related to mortality (p <0.05) (Table 2). In the multivariate correlation analysis, in which presence of MACE was evaluated, the MSI (p>0,05) and SI (p>0,05) were found to be ineffective in the predicting presence of MACE (Table 3).

Table 1. **Success rates of SI and MSI according to groups in predicting MACE and the other parameters**

Variable	**Total (n=194)**	**SI<0.66 Mean±SD (n=144)**	**SI≥0.66 Mean±SD (n=50)**	**p**	**MSI <0.93 Mean±SD (n=194)**	**MSI ≥0.93 Mean±SD (n=1)**	**p**
Age (year)	58.68 ± 12.42	58.68 ± 13.08	58.68 ± 11.20	1.000	57.93 ± 12.78	60.27 ± 11.53	0.979
Gender	143 (%73.1)	89 (%71.2)	54 (%78.3)	0.287	100 (%75.8)	44 (%69.8)	0.347
Previous MI history	33 (%17)	16 (%12.8)	17 (%24.6)	0.036	22 (%16.7)	11 (%17.5)	0.853
DM	45 (%23.2)	29 (%23.2)	16 (%23.2)	0.999	28 (%21.2)	17 (%27.0)	0.342
HT	86 (%44.3)	53 (%42.4)	33 (%47.8)	0.469	56 (%42.4)	30 (%47.6)	0.438
HL	20 (%10.3)	13 (%10.4)	7 (%10.1)	0.956	15 (%11.4)	5 (%7.9)	0.484
Smoking	72 (%37.1)	44 (%35.2)	28 (%40.6)	0.460	47 (%35.6)	26 (%41.3)	0.528
SBP (mmHg)	134.63 ± 29.92	146.78 ± 26.79	112.84 ± 21.67	0.000	143.24 ± 27.40	116.31 ± 26.79	0.000
DBP (mmHg)	77.04 ± 15.22	81.26 ± 14.21	69.39 ± 14.04	0.000	82.17 ± 13.39	66.11 ± 13.01	0.000
MAP (mmHg)	96.28 ± 18.34	103.20 ± 16.10	83.75 ± 15.32	0.000	102.60 ± 15.87	82.84 ± 15.93	0.000
Pulse rate (/min)	80.61 ± 15.24	77.46 ± 13.04	86.32 ± 17.27	0.000	77.06 ± 12.05	88.16 ± 18.39	0.000
LAD lesion	123 (%63.4)	77 (%61.6)	46 (%66.7)	0.486	81 (%61.4)	43 (%68.3)	0.392
CX lesion	83 (%42.8)	53 (%42.4)	30 (%43.5)	0.566	56 (%42.4)	28 (%44.4)	0.825
RCA lesion	101 (%52.1)	67 (%53.6)	34 (%49.3)	0.885	68 (%51.5)	33 (%52.4)	0.883
Two vessels lesions	43 (%22.2)	29 (%23.2)	14 (%20.3)	0.642	29 (%22.0)	15 (%23.8)	0.924
Multiple vessels lesions	39 (%20.1)	22 (17.6)	17 (%24.6)	0.244	24 (%18.2)	15 (%23.8)	0.332
Mortality (7 days)	11 (%5.7)	3 (%2.4)	8 (%11.6)	0.008	4 (%3.0)	7 (%11.1)	0.020
VT/VF development	5 (% 2.6)	2 (%1.6)	3 (%4.3)	0.250	1 (%0.8)	4 (%6.3)	0.020
CHF	2 (%1.0)	0 (%0.0)	2 (%2.9)	0.056	0 (%0.0)	2 (%3.2)	0.038
MACE	17 (%8.8)	5 (%4.0)	12 (%17.4)	0.003	5 (%3.8)	12 (%19.4)	0.000

MI:Myocardial infarction, DM:Diabetes mellitus, HT:Hypertension, HL:Hyperlipidemia, SBP:Systolic blood pressure, DBP:Diastolic blood pressure, MAP:Mean arterial pressure, LAD: Left Anterior Descending CX:Circumflex, RCA:Right coronary artery, VT:Ventricular tachicardia, VF: Ventricular fibrillation, CHF: Congestive heart failure, MACE: Major advers cardiac event

Table 2. Factors affecting mortality

		Exitus				Total		p
		Yes		No				
		N	%	n	%	n	%	
Gender	Male	6	54.5	137	74.9	143	73.7	0,161
	Female	5	45.5	46	25.1	51	26.3	
MI history	Yes	5	45.5	28	15.3	33	17	***0,023***
	no	6	54.5	155	84.7	161	83	
DM	Yes	5	45.5	40	21.9	45	23.2	0,132
	No	6	54.5	143	78.1	149	76.8	
HT	Yes	6	54.5	80	43.7	86	44.3	0,542
	No	5	45.5	103	56.3	108	55.7	
HL	Yes	1	9.1	19	10.4	20	10.3	1,000
	No	10	90.9	164	89.6	174	89.7	
Smoking	Yes	4	36.4	68	37.2	72	37.1	1,000
	No	7	63.6	115	62.8	122	62.9	
LAD lesion	Yes	11	100	112	61.2	123	63.4	***0,008***
	No	0	0	71	38.8	71	36.6	
RCA lesion	Yes	8	72.7	93	50.8	101	52.1	0,158
	No	3	27.3	90	49.2	93	47.9	
CX lesion	Yes	8	72.7	75	41	83	42.8	0,057
	No	3	27.3	108	59	111	57.2	
Two vessels lesion	Yes	2	18.2	41	22.4	43	22.2	1,000
	No	9	81.8	142	77.6	151	77.8	
Multiple vessels lesion	Yes	7	63.6	32	17.5	39	20.1	***0,001***
	No	4	36.4	151	82.5	155	79.9	
CHF	Yes	0	0	2	1.1	2	1	1,000
	No	11	100	181	98.9	192	99	
VT/VF	Yes	0	0	5	2.7	5	2.6	1,000
	No	11	100	178	97.3	189	97.4	

	Exitus		Total	p
	Yes	No		
	Median (Min.-Max.)	Median (Min.-Max.)	Median (Min.-Max.)	
Age	69 (53-77)	58 (30-95)	58.5 (30-95)	***0.007***
SBP (mmHg)	110 (80-170)	134 (70-225)	130 (70-225)	***0.009***
DBP (mmHg)	70 (40-90)	80 (40-140)	80 (40-140)	0.207
Pulse rate (/min)	80 (44-144)	80 (45-150)	80 (44-150)	0.696
MAP (mmHg)	84 (60-110)	96.67 (50-160)	96.67 (50-160)	***0.035***
SI	0.75 (0.37-1)	0.61 (0.32-1.26)	0.61 (0.32-1.26)	***0.006***
MSI	1.02 (0.67-1.31)	0.82 (0.5-1.68)	0.83 (0.5-1.68)	***0.027***

MI:Myocardial infarction, DM:Diabetes mellitus, HT:Hypertension, HL:Hyperlipidemia, SBP:Systolic blood pressure, DBP:Diastolic blood pressure, MAP:Mean arterial pressure, LAD: Left Anterior Descending CX:Circumflex, RCA:Right coronary artery, VT:Ventricular tachicardia, VF: Ventricular fibrillation, CHF: Congestive heart failure, SI:Shock index, MSI:Modified shock index

Table 3. Multivariate correlation analysis to determine the effectiveness of MSI and SI in predicting MACE

Correlations					**Adjusted R Square**	**ANOVA[a]**	
		MACE	MSI	SI		F	Sig.
Pearson Correlation	MACE	1.000	.221	.253	.056	6.709	.002
	MSI	.221	1.000	.928			
	SI	.253	.928	1.000			
Sig. (1-tailed)	MACE	-	.001	.000			
	MSI	.001	-	.000			
	SI	.000	.000	-			

Unstandardized Coefficients			Collinearity Statistics
Model	B	Sig.	VIF
Constant	-.190	0.44	-
MSI	-.155	.590	7.227
SI	.661	.066	7.227

SI:Shock index, MSI:Modified shock index, MACE: Major advers cardiac event

DISCUSSION

STEMI is one of the diseases with the highest mortality rate in the world. Morbidity and mortality related to STEMI can be reduced with urgent intervention. Since patients with STEMI have a high risk of mortality especially in the first hour, a careful risk and prognostic assessment should be made for these patients immediatelly in the emergency department. Both SI and MSI are practical methods that can be used in risk assessment of STEMİ. MSI indicates stroke volume and systemic vascular resistance. A high MSI denots a low value of stroke volume and low systemic vascular resistance, a sign of hypodynamic circulation. A low MSI indicates that stroke volume and systemic vascular resistance are high, and the patient is in a hyperdynamic state, which can also be a sign for serious conditions. There were different cut off values for SI and MSI used in different studies[9,12,13].

Shangguan et al in their study reported that MSI is more meaningful than SI in determining MACE and mortality in both trauma and nontrauma patiens[14]. In this study with more patients, although both SI and MSI were found to be successful in predicting MACE, MSI was more valuable than SI. Therefore, diastolic blood pressure measurement has gained importance in STEMI patients.

In a study by Shangguan et al., SI was reported to be successful in predicting CHF development[14]. In this study we found that while MSI was effective in prediction of CHF, while SI was not. Abreu et al. in their study stated that high MSI values were significant in determining VT / VF[12]. When we evaluateded the predictive power of SI and MSI in VT and VF development; it was seen that only MSI predicts VT / VF development and SI did not predict it. Liu et al demonstrated that MSI was more successful in predicting mortality compared to heart rate and blood pressure while SI did not predict mortality[9]. In a study conducted with 159 patients with acute pulmonary embolism, evaluating the success of SI and echocardiography findings in predicting in-hospital complications and mortality, a SI score of 1 or higher was found to be associated with increased mortality[3]. In a study by Goins et al., MSI and SI were reported to be a significant predictor for 30-day in-hospital mortality[15]. Singh et al. reported that MSI and SI were a good predictor of mortality, but MSI was found to be more valuable than SI[16]. In this study in accordance to the literatüre, increased SI and MSI found to be associated with mortality rate.

In the study conducted by Jomaa et al. it was found that in-hospital mortality and complications increased as the age increased. Similarly, Balzi et al. Reported an increased mortality in older age[17,18]. In this study, it was observed that mortality increased with increasing age.

There are some limitations of the study. Retrospective nature is the first limitation. Secondly; data such as previous medical history, medications, smoking habit information and physical examination findings could not be reached due to deficiencies in the patient cards and these patients had to be excluded from the study. Since a shock status was not developed in any of the patients participated in the study, we could not evaluate this group. Therefore,

further studies with larger patient groups are needed. Consequently, SI and MSI are useful methods for estimating both presence of MACE and MACE parameters separately. Based on these results, SI and MSI can be used as a practical method in emergency department in order to make early risk classification in STEMI patients. We think that SI and MSI can assist in quantifying the risk and guide early treatment in STEMI patients.

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