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ÖZGÜN ARAŞTIRMA/ORIGINAL ARTICLE

Primer Perkütan Koroner Girişim Uygulanan ST Elevasyonlu MI Hastalarında Enfarkt Lokalizasyonuna Göre Kalp Hızı Türbülansı Parametrelerinin Değerlendirilmesi

Heart Rate Turbulence According to Infarct Localization in ST Elevation MI Patients Who Underwent Primary Percutaneous Coronary Intervention

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Acute coronary syndromet
Turbulence onset
Turbulence slope

ÖZ

Amaç: ST elevasyonlu miyokard enfarktüsü (MI) hastalarında kalp hızı türbülansı parametrelerini enfarktüs lokalizasyonuna ve enfarktla ilişkili artere göre değerlendirmek.

Gereç ve Yöntem: Bu çalışmaya primer perkütan koroner girişim uygulanan toplam 96 hasta dahil edildi. Hastalar enfarktüsün lokalizasyonuna göre iki gruba ayrıldı. Atriyal fibrilasyon, MI veya koroner arter baypass öyküsü olanlar, sadece posterior veya lateral lokalizasyonlu enfarktüsü veya sistemik enflamatuvar hastalıkları olan hastalar çalışma dışı bırakıldı. Tüm katılımcılar için transtorasik ekokardiyografi yapıldı ve taburculuktan önce 24 saat holter kaydı alındı. Kalp hızı türbülansı parametreleri, Schmidt kriterleri kullanılarak hesaplandı.

Bulgular: Türbülans eğimi düzeyleri tüm çalışma popülasyonunda normal sınırlardaydı ve gruplar arasında fark istatistiksel olarak anlamlı değildi (p = 0,483). 21 hastada türbülans başlangıç düzeyleri anormaldi; bunların 15'i anterior miyokard enfarktüsü geçiren gruptaydı ve inferior miyokard enfarktüs grubunda diğerlerine göre anlamlı olarak daha düşüktü (p = 0,005). Circumflex arter,anterior miyokard enfarktüslü hastalarda enfarktla ilişkili arter olduğunda; fark anlamlıydı ve p değeri 0,007 idi.

Sonuç: Kalp hızı türbülansı parametrelerinden türbülans başlangıcı erken dönemde miyokard enfarktüsü sonrası bir risk belirleyici olabilir ve enfarkt ile ilişkili arter bu kararda rol oynayabilir.

ABSTRACT

Objective: To evaluate heart rate turbulence parameters in ST elevation myocardial infarction (MI) patients according to localization of infarction and infarct related artery.

Material and Method: A total of 96 patients who underwent primary percutaneous coronary intervention were included in this study. They were grouped into two according to localization of infarction. Patients with atrial fibrillation, prior MI or coronary artery bypass, only posterior or lateral localization infarct or systemic inflammatory diseases were excluded. Transthoracic echocardiography was performed and 24- hour holter record was taken before discharge for all the participants. Heart rate turbulence parameters were calculated using Schmidt's critearias.

Results: Turbulence slope levels were at normal range in all study population and the difference was not statistically significant between groups (p= 0.483); turbulence onset levels were abnormal in 21 patients; 15 of them were in anterior group and it was significantly lower in inferior infarction group than anteriors (p= 0.005). When circumflex artery is the infarct related artery in anterior myocardial infarction patients; the difference was significant and p value was 0.007.

Conclusion: Heart rate turbulence; not turbulence slope but turbulence onset may be a risk determinator after myocardial infarction at early period and infarct related artery may play a role in this decision.

Introduction

Coronary artery disease is a growing health problem in all societies, including developed countries. Although mortality has been reduced by primary percutaneous intervention, no significant progress can be reported on early and late complications and adverse life conditions. Events such as arrhythmias; cardiac rupture may be seen in early complications, which may be fatal. Late complications are usually associated with a decrease in ejection fraction. Due to the prolongation of life expectancy, acute ST-elevation myocardial infarction (MI) cases, which are frequently encountered in the elderly population, cause both comorbidity and complications.

It is known that there are many factors that determine the prognosis. Age, concomitant diabetes mellitus or hypertension, clinical presentation, or localization of infarction are the major ones. Although there are risk scores that can be used to determine the risk after hospitalization and discharge, new developing techniques can give an idea for the post-MI period. Heart rate turbulence (HRT) is a noninvasive, easy, short-term result test that can determine the prognosis for atherosclerotic disease. It consists of turbulence onset and turbulence slope values which can be calculated by taking 24-hour holter record and shows abnormal baroreflex sensitivity and increased sympathetic tone. It is a possible indicator of increased risk of ventricular arrhythmia and sudden cardiac death (1, 2). In the present study, we evaluate heart rate turbulence parameters in ST elevation MI patients, underwent primary percutaneous intervention, according to infarction area.

Material and Method

Study population

This prospective study consisted of 96 consecutive patients who underwent primary percutaneous intervention because of ST elevation MI. 47 patients (48%) with anterior localization and 49 with inferior. Patients with atrial fibrillation, prior MI or coronary artery bypass, only posterior or lateral localization infarct or systemic inflammatory diseases were excluded. The study was approved by the Clinical Research Ethics Committee of Diskapi Training and Research Hospital (no:24, date: 26/8/2010). The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a priori approval by the institution's human research committee.

Echocardiographic examination

Transthoracic echocardiography was performed for all the participants; left ventricular ejection fraction, any valvular disease, diastolic and right ventricular functions were examined.

Holter monitoring

24- hour holter record was taken before discharge (Cardioscan 12 Holter system V 12.5.0075a DMS 300-3A Holter Recorder). Heart rate turbulence parameters were calculated using Schmidt's critearias. Turbulence onset (TO), early sinus acceleration after a vetricular premature complex (VPC) ; and turbulence slope (TS), a measure of the late sinus deceleration after a VPC. TO is obtained using the formula: $[(RR_1 + RR_2) - (RR_{-2} + RR_{-1})] / (RR_{-2} + RR_{-1}) \times 100$ and expressed as a percentage. RR_1 and RR_2 are the first and second sinus RR intervals after VPC, and RR_{-1} and RR_{-2} are the first and second sinus RR intervals preceeding the VPC. TS is calculated as the maximal positive slope among all slopes of a series of regression lines obtained from all sequences of 5 consecutive RR intervals included between the first and 20^{th} RR interval following the compensatory post-VPC pause, and expressed as ms/RR. ≥0 % for turbulence onset and ≤2.5 ms/RR for turbulence slope were considered as abnormal (1-3).

Blood samples

Venous bood samples were obtained at emergency service and during follow-up in hospital. Cardiac troponin and Ck-MB levels, lipid parameters, renal function tests and whole blood counts were determined.

Statistical Analysis

Statistical analysis was carried out using SPSS program version 17.0 (SPSS Inc., Chicago, IL, USA). Categorical variables are presented as frequencies and continuous variables as mean ± st.dev. Continuous variables with a normal distribution was analyzed with Student t test while Mann Whitney U test was used for nonnormally distrubuted variables. Pearson's method was used for correlation analysis. A p value <0.05 was considered as statistically significant.

Results

Anterior MI group consisted of 14 females (29%) and 33 males (71%) and inferior MI group consisted of 45 males (91%) and 4 females (9%). The mean age of the groups were 55.27 ± 13.97 and 51.42 ± 12.52 respectively (p=0.158). For both groups, comorbidities were similar and it was not statistically significant. The characteristic properties of the groups are shown in Table 1.

Table 1. The characteristics of study patients, and stastistical analysis

DM: diabetes mellitus, HT: hypertension

	Anterior MI (n=47)	Inferior MI (n=49)	p value
Gender			
Female, n	14	4	
Male, n	33	45	
Age	55.27 ± 13.97	51.42 ± 12.52	0.158
Smoking, n (%)	29 (61%)	35 (71%)	0.222
Heart Rate (/bpm)	76.68 ± 9.20	75.32 ± 9.44	0.479
DM, n (%)	14 (29%)	13 (26%)	0.726
HT, n(%)	10 (21%)	10 (20%)	0.918

There was not any difference in means of whole blood counts and biochemical tests for two groups except low-density lipoprotein (LDL) cholesterol levels and cardiac troponin. Both of them were higher in anterior localization MI group and the difference was statistically significant. (p=0.023 for LDL and p=0.044 for troponin levels). Cardiac functions were examined by transthoracic echocardiography and ejection fraction was mentioned lower at anterior MI patients, but it was not statistically significant. The summary of laboratory tests and echocardiography results of patients are listed in Table 2.

Turbulence onset and turbulence slope were calculated using Schmidt's criteria for the groups. While turbulence slope values were at normal range in both of the groups and the difference was not significant; turbulence onset values were abnormal at 21 patients and 15 of them were in anterior MI group. Also the difference between groups was statistically significant (Table 3).

Table 3. Turbulence onset and slope values of groups, and statistical analysis

TO: turbulence onset, TS: turbulence slope

[a] *p value is statistically significant*

	Anterior MI (mean ± SD)	Inferior MI (mean ± SD)	p value
TO	-1.31 ± 2.62	-3.58 ± 4.81	0.005[a]
TS	11.00 ± 19.92	13.89 ± 20.28	0.483

Table 2. Laboratory tests and echocardiography results of groups, and statistical analysis

WBC: White blood cell, PLT: platelets, MPV: main platelet volüme, CK MB: creatinine cinase MB, LDL: low density lipoprotein cholesterol, HDL: high density lipoprotein cholesterol, LVEF: left ventricle ejection fraction, LVEDD: left ventricle end diastolic diameter, E: mitral early diastolic velocity, A: mitral late diastolic velocity, IVRT: ısovolomic relaxation time, ET: ejection time, TAPSE: tricuspid anuler plane systolic excursion.

[a] *p value is statistically significant*

	Anterior MI (n=47)	Inferior MI (n=49)	p value
Laboratory tests			
Hemoglobin (g /dL)	14.82 ± 1.61	14.50 ± 2.22	0.575
WBC (10^3/µL)	12.93 ± 36.43	12.43 ± 35.43	0.634
PLT (10^3/µL)	270.95 ± 71.99	263.95 ± 81.52	0.754
MPV (fL)	8.61 ± 1.04	8.71 ± 1.45	0.794
CK MB (µg/L)	96.52 ± 79.44	81.26 ± 60.33	0.533
Troponin (ng/L)	33.86 ± 28.33	23.29 ± 22.05	0.044[a]
LDL (mg/dL)	133.04 ± 45.64	103.45 ± 41.51	0.023[a]
HDL (mg/dL)	38.95 ± 10.36	42.45 ± 11.33	0.270
Kreatinin (mg/dL)	0.91 ± 0.19	0.99 ± 0.31	0.307
Echocardiography results			
LVEF (%)	47.91 ± 8.20	50.48 ± 7.15	0.104
LVEDD (mm)	47.54 ± 6.03	46.83 ± 4.77	0.654
E (cm/sn)	5.91 ± 1.90	6.66 ± 1.80	0.169
A (cm/sn)	6,66 ± 1,20	7,91 ± 1,55	0,003[a]
E' (cm/sn)	9,16 ± 2,54	10,79 ± 3,53	0,074
A' (cm/sn)	12,75 ± 4,49	12,66 ± 3,10	0,941
S (cm/sn)	9,16 ± 2,01	9,70 ± 2,21	0,380
IVRT (msn)	98,43 ± 18,97	99,25 ± 18,98	0,884
ET(msn)	262,34 ± 27,61	274,00 ± 34,25	0,207
TAPSE	2,20 ± 0,41	2,04 ± 0,55	0,242

We determined no significant difference in the heart rate turbulence parameters of the patients in terms of the number of balloon and stent used or the comorbidity status of participants. P values were > 0.05 for all of the determinants; only the higher troponin levels were associated with abnormal values of both turbulence onset and slope values and there was a positive and significant correlation with TO and cardiac troponin (r = 0.381 and p=0.000) (Table 4, Figure 1).

As we pointed out at the beginning of the result section, in anterior MI group the troponin levels were higher and the difference was significant. Based on these results, it is possible to explain that the heart rate turbulence parameters especially turbulence onset levels in this group can be expected to be abnormal. When anterior MI patients were divided into subgroups according to infarct related artery (IRA); left anterior

Table 4. Turbulence onset and slope levels according to comorbidities and the number of balloons or stents used, and statistical analysis

[a] p value is statistically significant

	TO (mean ± st.d.) and p value	TS (mean ± st.d.) and p value
HT		
Yes (n, %) ; (20,20)	-2.83 ± 4.29	8.52 ± 5.40
No (n, %) ; (76, 80)	-2.37 ± 4,00	13.51 ± 22.29
	0.656	0.324
DM		
Yes (n, %) ; (27, 28)	-3.37 ± 4.61	8.01 ± 4.90
No (n, %) ; (69, 72)	-2.12 ± 3.77	14.22 ± 23.27
	0.172	0.174
Smoking		
Yes (n, %) ; (65,67)	-2.76 ± 4.64	10.94 ± 18.12
No (n, %) ; (31, 33)	-1.87 ± 2.28	15.69 ± 23.60
	0.318	0.281
Number of balloons used		
>= 1 ; n=43	-2.17 ± 3.19	13.13 ± 21.72
<1 ; n=52	-2.75 ± 4.67	12.06 ± 18.95
	0.492	0.797
Number of stents used		
>= 2 ; n=20	-2.14 ± 3.83	6.59 ± 3.66
<2 ; n=76	-2.56 ± 4.11	14.02 ± 22.23
	0.680	0.141
Troponin levels		
>=20 ; n= 45	-1.06 ± 3.51	7.62 ± 2.98
<20 ; n=51	-3.71 ± 4.11	16.76 ± 26.76
	0.001[a]	0.025[a]
Heart rate		
>=76 ; n= 52	-2.24 ± 3.36	15.96 ± 26.55
<76 ;n= 44	-2.75 ± 4.75	8.35 ± 4.53
	0.541	0.064
Hyperlipidemia		
LDL >= 100 ; n=60	-3.16 ± 4.14	12.80 ± 20.84
LDL <100 ; n=36	-1.56 ± 3.77	8.08 ± 4.33
	0.186	0.350

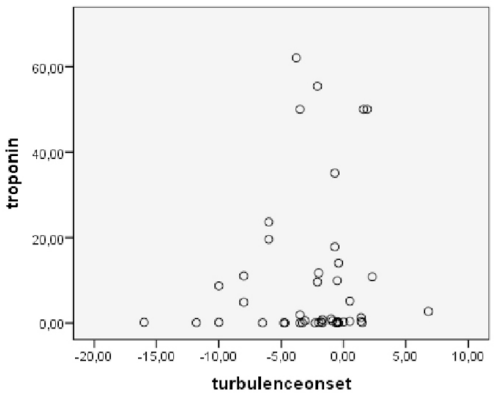

Figure 1. Distribution of turbulence onset levels according to cardiac troponin levels

decending or circumflex artery; we viewed that if the IRA is CX, both cardiac troponins and TO levels were higher than the others. p value was 0.027 and 0.007, respectively. Mean heart rates of this group was also higher from the others (Table 5). Subgroup analysis were performed also for inferior MI group and the difference was not statistically significant in terms of infarct related artery (p=0.317 for TO and 0.238 for TS) (Table 6).

Table 5. Subgroup analysis of anterior MI patients, and p value

IRA: infarct related artery, CX: circumflex artery, LAD: left anterior decending artery

[a] p value is statistically significant

IRA	CX (n=13)	LAD (n=34)	p value
Troponin	48.43 ± 41.84	28.28 ± 19.14	0.027[a]
TO	0.33 ± 1.31	-1.93 ± 2.73	0.007[a]
TS	5.29 ± 2.58	13.18 ± 23.09	0.229
Heart rate	82.30 ± 5.76	74.52 ± 9.42	0.008[a]

Table 6. Subgroup analysis of inferior MI patients, and p value

IRA: infarct related artery, CX: circumflex artery, RCA: right coronary artery

IRA	CX (n=6)	RCA(n=43)	p value
Troponin	44.50 ± 6.29	120.80 ± 20.06	0.529
TO	-0.36 ± 1.70	-2.30 ± 3.16	0.317
TS	4.73 ± 1.50	21.58 ± 23.59	0.238
Heart rate	78.33 ± 0.57	76.04 ± 9.67	0.692

Discussion

Ventricular tachyarrhythmias are the most common cause of sudden cardiac death in coronary artery disease. For defining arrhythmogenic structure coronary angiography, echocardiography and signal averaged electrocardiogram (ECG) and in detecting arrhythmogenic triggering holter monitoring is used. The autonomic tone is quite difficult to define. Heart rate turbulence parameters are promising in investigating cardiovascular responses to changes in autonomic tonus and has a high value in determining the sudden cardiac death (SCD) risk especially in patients with myocardial infarction (2, 7, 9).

There has not been a study on heart rate turbulence parameters according to myocardial infarction localization. In our study, we examined the heart rate turbulence in ST elevation MI patients, who underwent

primary percutaneous coronary intervention, grouped as anterior or inferior according to infarct area. Turbulence slope was normal in all of the patients but 21 of the participitants; 15 of them were in anterior MI group; had abnormal TO levels. According to our findings; turbulence onset levels can be used as a predictor of mortality after MI and seems to be a sensitive method in early risk determination.

In a study in which 1212 patients with acute MI were taken and the primary outcomeas a fatal and non-fatal cardiac arrest was investigated, the risk of arrest in patients with abnormal heart rate turbulence parameters was 16.8 times higher (4,5).

Pinnacchio at al demonstrated that age and LVEF are the independent predictors of abnormal HRT both in subjects without any apparent heart disease and in stable coronary artery disease (8-10). In our study we did not determine any correlation between turbulence parameters and LVEF or age.

In many studies increased heart rate has been shown as an independent risk factor for SCD. The underlying cause of this relationship is unknown, but is thought to be due to decrease in parasympathetic activity (6). In this paper, although there was no difference between the groups in terms of heart rate, it was found to be higher in patients with intervention to CX in the subgroup analysis of the anterior MI group. It is possible to say that this finding was not previously found in the literature.

Cardiac troponin levels are prognostic factor after MI and the higher they are the poorer prognosis is. In anterior localization myocardial infaction and especially when CX is the infarct related artery we determined higher levels of troponin and cardiac troponins were directly proportional to turbulence onset levels.

Conclusion

This study is the first in which heart rate turbulence is assessed in ST elevation MI patients who primary intervened and grouped according to infarction area. Turbulence onset not turbulence slope, a parameter of heart rate turbulence, may be a prognostic factor for acute ST elevation MI in early period. Higher troponin levels and circumflex artery lesions need more attention for risk stratification and in hospital follow-up in terms of arrhythmias. CX feeds sinoatrial node at 40% and atrioventricular node at 10% of the people. This can be the underlying cause of the difference but larger studies with larger groups are needed to support our results.

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Ethics approve: Diskapi Training and Research Hospital, 24/26.8.2010

Patient consent: Confirmation form was taken from all patients.

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