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ÖZGÜN ARAŞTIRMA / RESEARCH STUDY

Myocardial Performance Index in Patients with Coronary Slow Flow

Koroner Yavaş Akımın Miyokard Perfomans İndeks Üzerine Etkisi

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ABSTRACT

Objective: This study was aimed to investigate the left ventriculer myocardial performance index (Tei index) in patients with coronary slow flow phenomenon

Material and Methods: 25 patients with slow coronary flow (15 men; 10 women; mean age 51 ± 12 years) and 20 subjects with angiographically normal coronary arteries (12 men; 8 women; mean age 52 ± 12 years) were included in the study. All the subjects underwent echocardiography and tissue Doppler imaging to determine left ventriculer (LV) diastolic functions and left ventriculer myocardial performance index (LV MPI).

Results: Conventional echocardiography parameters, maximal velocity of early diastolic filling (p=0,02), ratio of maximal early to late diastolic filling (p=0,037) were significantly lower, deceleration time of early diastolic filling was significantly higher (p=0,043) in the patient group. Among tissue Doppler parameters the mitral annulus peak early diastolic velocity and ratio of early to late diastolic velocity were lower in patients group than in controls (p <0,001) but isovolumetric relaxation time were significantly increased in patients group than controls (p<0,001). LV MPI was significantly prolonged in coronary slow flow group (p < 0,001). TIMI frame count was negatively correlated with the mitral lateral annulus early diastolic velocity and the ratio of mitral lateral annulus early to late diastolic velocity whereas it was positively correlated with mitral isovolumetric relaxation time and LV MPI.

Conclusion: Our findings demonstrate that patients with coronary slow flow phenomenon affects diastolic functions and LV MPI. Therefore, patients with coronary slow flow phenomenon should be carefully followed-up.

Keywords: Ventriculer function; coronary circulation; echocardiography.

ÖZET

Amaç: Bu çalışmada koroner yavaş akımı olan hastalarda sol ventrikül miyokard performans indeksinin (Tei indeksi) incelenmesi amaçlanmıştır.

Gereç ve Yöntem: Koroner yavaş akımı olan 25 hasta (15 erkek; 10 kadın; ort yaş 51 ± 12 yıl) ve koroner arterleri normal olan 20 olgu (12 erkek; 8 kadın; ort yaş 52 ± 12 yıl) çalışmaya alınmıştır. Tüm hastaların ekokardiyografi ve doku doppler görüntüleme ile sol ventrikül diyastolik fonksiyonları ve miyokard performans indeksi saptandı.

Bulgular: Koroner yavaş akımı olan grupta maksimal erken diyastolik dolum hızı, maksimal erken diyastolik dolum hızının geç diyastolik akım hızına oranı (p=0,037) anlamlı derecede düşük saptanırken; erken diyastolik dolum hızı deselerasyon zamanı anlamlı derecede yüksekdi (p=0,043). Hasta grubunda, kontrol grubuna göre doku doppler parametreleri arasında mitral anulus erken pik diyastolik hız ve erken diyastolik akım oranı anlamlı derecede düşük saptandı (p<0.001) ancak izovolümetrik relaksasyon zamanı anlamlı derecede artmış olarak bulundu (p<0.001). Sol ventrikül miyokard performans indeksi koroner yavaş akımı olan grupta anlamlı derecede uzamıştır(p < 0.001). TIMI kare sayısı ile mitral lateral anulus erken diyastolik hız ve mitral lateral anulus erken diyastolik hızın geç diyastolik hıza oranı arasında negatif korelasyon saptanırken, izovolümetrik relaksasyon zamanı ve sol ventrikül miyokard performans indeksi ile pozitif korelasyon saptanmıştır.

Sonuç: Çalışmamızda koroner yavaş akımlı hastalarda diyastolik fonksiyonların ve miyokard performans indeksinin etkilendiğini gösterdik. Bu nedenle koroner yavaş akımı olan hastalar dikkatli bir şekilde takip edilmelidir.

Anahtar Kelimeler: Ventriküler fonksiyon; koroner dolaşım; ekokardiyografi.

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INTRODUCTION

Coronary slow flow (CSF) is identified by delayed contrast dye opacification of coronary arteries without occlusive disease (1). Its pathophysiology and clinical implications are not clearly understood (2). Previous studies have shown that an association between endotelial inflammation and coronary microvascular dysfunction (3- 5). Myocardial velocity determined by tissue Doppler imaging is a new technique that has been used recently to analyze left ventricular function. The development of tissue Doppler imaging opens up the possibility of also assessing left ventricular function (6, 7). Myocardial performance index (MPI), which is helpful in evaluating systolic and diastolic function together, are quite limited. Accordingly, the aim of the present study is to investigate LV diastolic functions and MPI in patients with CSF using tissue Doppler-derived parameters.

MATERIAL and METHODS

Twenty five patients with angiographically evaluated CSF but otherwise normal epicardial coronary arteries and 20 subjects with angiographically normal coronary arteries were selected as control group. All patients underwent a coronary angiography because of suspected coronary artery disease. The exclusion criteria were as follows: previous coronary artery disease, congestive heart failure, coronary ectasia, signs of valvular heart disease, pulmonary disease, pulmonary hypertension, diabetes mellitus, hypertension, left bundle branch block, a rhythm other than sinus and pericarditis. All medications were stopped 48 hours before the time of echocardiography. Fasting venous blood samples were taken to determine levels of blood glucose, electrolytes, total cholesterol, high density lipoprotein cholesterol (HDL), low density lipoprotein cholesterol (LDL) and triglycerides. The study was approved by the ethics committee of our hospital and informed consent was obtained from all patients.

Coronary Angiography

All patients underwent a coronary angiography by the femoral approach using the standart judkins technique. Iopromide contrast and 6F diagnostic catheter were used in all subjects. All the cineangiograms were evaluated by an experienced cardiologist. Coronary slow flow was identified by using thrombolysis in myocardial infarction (TIMI) frame count (TFC) method (7). In briefly, the first frame, when there was more than 70% lumen opacification with antegrade filling was accepted. When contrast dye reached distal landmarks, final frame was determined. The distal landmarks were the distal bifurcation of the left anterior descending artery, the distal bifurcation of the segment with the longest total distance in the left circumflex artery and in the right coronary artery, first branch of the posterolateral artery. Left anterior descending (LAD) is the longest artery among major coronary arteries. In order to obtain corrected TFC, LAD frame counts were divided by 1.7 as previously reported (7). LAD and left Circumflex (Cx) arteries TIMI frame counts were evaluated in the right anterior oblique projection with caudal angulation. For the right coronary artery, left anterior oblique projection with cranial angulation was used. The mean TFC was calculated for the LAD, Cx and RCA. Gibson et al has reported cutoff values for TFC (for LAD: 36.2 ± 2.6 ; for Cx: 22.2 ± 4.1; for RCA: 20.4 ± 3.0) (8). Any TFC values above these levels were considered coronary slow flow.

Echocardiography

All patients underwent a complete transthoracic echocardiography and tissue Doppler study using multiple views in left lateral decubitus position. This study was performed using a 3,5 Mhz transducer on a Vivid 7, GE ultrasonographic system. Echocardiographic measurements were made in accordance with the criteria recommended by American Society of Echocardiography (9). The mitral inflow velocity was traced and the following variables were measured: peak velocity of early (E) and late (A) filling and deceleration time (DT) of the E wave velocity. In the parasternal long-axis view, the RV diameter was measured using the M-mode from the RV anterior wall to right side of the interventricular septum on the R-wave of the electrocardiogram. LV longitudinal functions were assessed by Pulsed TDI. The diastolic indices of myocardial early (Ea) and atrial contraction (Aa) peak velocities and myocardial systolic wave (Sa) velocity were measured and the ratio of Em/Am was calculated. Isovolumetric contraction time, ejection time, and the isovolumetric relaxation time for each wall were calculatede isovolumetric relaxation time for each wall were calculated. The LV MPI was calculated as the sum of the isovolumetric contraction and relaxation times divided by ventricular ejection time (10). The average of the values from the two walls was presented as the mean MPI

Statistical Analysis

SPPS version 10.0 software package was used for statistical analysis. Categorical variables were compared via Chi-square test. Normally distributed variables were compared across groups by means of student t test whereas variables which did not normally distribute were compared by means of Mann Whitney U test. Pearson's correlation analysis was used to evaluate relation between the variables. All the data were expressed as mean ± standard deviation, p value of < 0,05 was considered significant.

RESULTS

The basic characteristics of the two groups are presented in Table I. There were no differences between the study group and control group. Comparisons of the echocardiographic parameters among the two groups are shown in Table II. Conventional echocardiography parameters, maximal velocity of early diastolic filling ratio of maximal early to late diastolic filling were significantly lower (p=0,037) and deceleration time of early diastolic filling was signify cantly higher (p=0,043) in the patient group. Among tissue Doppler parameters the mitral annulus peak early diastolic velocity (9.3 ± 1.2 cm/sn, 12.9 ± 1.9 cm/sn, p < 0,001) and ratio of early to late diastolic velocity (0.84 ± 0.2 cm/sn, 1.2 ± 0.3 cm/sn, p < 0,001) were lower in patients group than in control group but isovolumetric relaxation time (77 ± 6 msn, 65 ± 6 msn, p < 0,001) were significantly increased in patients group than controls. LV MPI index was significantly prolonged in coronary slow flow group (0.48 ± 0.02, 0.41 ± 0.23, p < 0,001) (Table III). Mean TFC was positively correlated with the left ventricle MPI index (r = 0.628, p < 0,001) and mitral IVRT (r = 0,640, p < 0,001). There was a strong inverse correlation between mean TFC and left ventricle Ea and Ea/Aa ratio (r = −0,638, p < 0,001; r = −0,495, *p* = 0,001, respectively)(Table IV).

Table I: Demographic and clinical characteristics of the groups.

Parameters	Patients (n=25)	Controls (n=20)	p
Mean age(years)	51 ± 12	52 ± 12	NS
Male/Woman	15 / 10	12 / 8	NS
Body Mass Index (kg/m²)	28 ± 5	28 ± 3	NS
Family History	4	3	NS
Smoking	7	6	NS
Diabetes Mellitus	2	4	NS
Dislipidemia	4	7	NS
Glucose(mg/dl)	95 ± 18	109 ± 42	NS
Serum creatinine (mg/dl)	0.9 ± 0.2	0.8 ± 0.2	NS
Hemoglobin (g/dl)	14.1 ± 1.5	13.9 ± 1.3	NS
Total cholesterol (mg/dl)	182 ± 56	185 ± 43	NS
Triglyceride (mg/dl)	149 ± 60	160 ± 78	NS
High density lipoprotein (mg/dl)	38 ± 7	40 ± 13	NS
Low density lipoprotein (mg/dl)	120 ± 37	113 ± 37	NS

NS: Non significant, data are expressed as means±SD.

Table II: Echocardiographic parameters between the patients group with the control group.

Parameters	Patients(n=25)	Controls(n=20)	P value
LVEDD (mm)	48.07±3.82	48.47±3.95	NS
LVESD (mm)	29.8±4.78	30.43±4.22	NS
IVS (mm)	10.08 ±1.33	9.90±1.19	NS
LVEF (%)	68.01±7.01	66.31±6.59	NS
RVEDD (mm)	28.78±3.15	28.47±3.67	NS
LA diameter (mm)	36.35±3.81	36.94±3.08	NS
RA diameter (mm)	32.99±4.93	31.31±4.72	NS
Mitral E (cm/sn)	69.90±16.98	81.90±16.00	**0,02**
Mitral A (cm/sn)	73.27±16.03	70.77±15.93	NS
Mitral E/A ratio	0.99±0.33	1.21±0.37	**0,037**
Mitral E DT (msn)	209.07±27.91	192.22±25.68	**0,043**

LVEDD: left ventricle end-diastolic diameter, LVESD: left ventricle end-sistolic diameter, IVS: interventriculer septum, LVEF: left ventricle ejection fraction, RVEDD: right ventricle end-diastolic diameter, LA: left atrium, RA: right atrium, NS: non significant, data are expressed as means±SD.

Table III: Left ventricular tissue doppler echocardiography parameters.

Parameters	Patients (n=25)	Controls (n=20)	P
LV S wave peak velocity (cm/sn)	10.7±2	10.4±2.4	NS
LV E wave peak velocity (cm/sn)	9.3±1.2	12.9±1.9	**< 0,001**
LV A wave peak velocity (cm/sn)	11.6±2.6	11.3±2	NS
LV Ea/Aa ratio	0.84±0.2	1.2±0.3	**< 0,001**
Ea DT (msn)	16.9±2.8	15.8±2.1	NS
IVRT (msn)	77±6	65±6	**< 0,001**
LV MPI	0.48±0.02	0.41±0.23	**< 0,001**

LV:Left ventricle, Ea: Mitral lateral annulus early diastolic wave, Aa: Mitral lateral annulus late diastolic wave, DT: Mitral lateral annulus E wave deceleration time , IVRT:Isovolumetric relaxation time, MPI: Myocardial performance index, NS: Nonsignificant, Data are expressed as means±SD

Table IV. Correlations between TIMI frame count and echocardiographic parameters.

Parameters	*cLAD-r*	*cLAD-p*	*Cx-r*	*Cx-p*	*RCA-r*	*RCA-p*	*Mean-r*	*Mean-p*
Ea	-0.532	**< 0,001**	-0.656	**< 0,001**	-0.532	**< 0,001**	-0.638	**< 0,001**
Ea/Aa	-0.264	**0.044**	-0.574	**< 0,001**	-0.481	**0.001**	-0.495	**0.001**
IVRT	0.489	**0.001**	0.647	**< 0,001**	0.575	**< 0,001**	0.640	**< 0,001**
LV MPI	0.564	< 0,001	0.589	< 0,001	0.535	< 0,001	0.628	< 0,001

cLAD: corrected frame count for left anterior descending artery, Cx: Circumflex artery, RCA: Right coronary artery, IVRT: Isovolumetric relaxation time, LV MPI: Left ventricle myocardial performance index.

DISCUSSION

In this study, it has been detected that there were siginificant differences between patients with CSF and control groups in term of LV MPI and diastolic functions. In addition, TIMI frame count for coronary arteries has been demonstrated to show a negative correlation with LV MPI. LV MPI (Tei index) is a new echocardiographic parameter which correlates with invasive measurements and is used to evaluate both systolic and diastolic functions. It can be measured from the mitral annulus with pulsed-wave TDI and is not affected by cardiac rate, blood pressure, or ventricular geometry (10).

In coronary artery disease a prolonged MPI has been shown to be an important precursor of the disease before the development of systolic dysfunction (11). A number of studies have been conducted to assess the LV functions in patients with CSF (12, 13). Some authors have reported only impaired diastolic LV functions whereas some others have reported both impaired diastolic and systolic LV functions in CSF patients. Our study showed significantly impaired LV diastolic functions in CSF phenomenon, as assessed by tissue Doppler. Several mechanisms for the pathophysiology of CSF were suggested by previous studies, such as increased small vessel resistance, endothelial dysfunction, impairment of platelet function, inflammation, increased plasma endothelin levels (14). Left and right ventricular studies showed small vessel disease in patients with the coronary slow flow (15). Supporting this, some studies have showed that spontaneous episodes of the coronary slow flow phenomenon during angiography are associated with ST elevation in the absence of large vessel spasm (16). It is well known that ischemia first impairs ventricular diastolic functions (17). In time, systolic functions also deteriorate. The primary cause of impaired diastolic functions in patients with CSF in our study may be the small vessel disease which is the primary mechanism of CSF. We could not detect any significant difference between patients with coronary slow flow and control group in terms of mitral lateral annulus systolic velocities. Thus, this supports the notion that left ventricular systolic functions are not impaired in patients with CSF. The markedly prolonged MPI despite an unchanged mitral lateral annulus systolic velocity in patients with coronary slow flow compared to control group is in accord with the hypothesis that prolonged MPI stems from left ventricular diastolic dysfunction.

As a result, it has been detected that left ventricular diastolic functions deteriorates in coronary slow flow phenomenon and this deterioration is associated with increased TIMI frame count. Further studies with larger series and longer follow-up are needed to determine the effects of left ventricular systolic and diastolic dysfunctions on mortality.

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