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Comprehensive Echocardiographic Evaluation in Acute Pulmonary Embolism

Akut Pulmoner Emboli Hastalarında Ayrıntılı Ekokardiyografik Değerlendirme

[1]Zeynettin Kaya, [2]Abdullah Tuncez, [3]Mehmet Tekinalp, [4]Mustafa Karanfil, [4]Mehmet Kayrak, [4]Kurtuluş Özdemir

[1]Mevlana University, Department of Cardiology
[2]Konya Numune State Hospital, Department of Cardiology
[3]Konya Beyhekim State Hospital, Department of Cardiology
[4]Necmettin Erbekan University, Meram Faculty of Medicine, Department of Cardiology

Özet

Çalışmamızın temel amacı akut pulmoner emboli (PE) hastalarında konvansiyonel ve doku doppler ekokardiyografik parametrelerdeki farklılıkları değerlendirmektir. Tanımlayıcı ve kesitsel çalışmamıza, Ocak 2010 ve Temmuz 2010 tarihleri arasında Selçuk Üniversitesi Meram Tıp Fakültesi Hastanesi'nde akut PE tanısı konan 54 hasta ve hastalar ile benzer demografik özellikleri ve komorbiditeleri olan sağlıklı 29 gönüllü dâhil edildi. Hasta ve kontrol grubunun geleneksel iki boyutlu ve doppler ekokardiyografik verileri yanında doku doppler ekokardiyografik parametreleri kaydedildi. Hasta ve kontrol grubunda elde edilen değişkenler karşılaştırıldı. Hasta ve kontrol grupları arasında demografik özellikler ve komorbiditeler açısından istatiksel farklılık yoktu. Hasta grubunda sağ ventrikül (SğV) ejeksiyon fraksiyonu (EF) belirgin düşük (46.2 karşı 60.5; P<0.001), sistolik pulomoner arter basıncı anlamlı yüksek (45 mmHg karşı 24.7 mmHg; P<0.001) ve inferior vena cava (İVC) kollaps indeksi istatiksel anlamlı düzeyde düşük (0.36 karşı 0.62; P<0.001) tespit edildi. Pulsed wave doku doppler tekniği ile değerlendirilen SğV miyokard performans indeksinin (MPİ) akut PE hastalarında kontrol grubuna göre anlamlı düzeyde arttığı (0.53 karşı 0.43; P<0.001), SğV E/Em oranının anlamlı olarak daha yüksek olduğu (6.5 karşı 5.0; P=0.04) ve SğV izovolümetrik relaksasyon zamanının anlamlı şekilde uzadığı(67msn karşı 57msn; P<0.001) tespit edildi. Özellikle SğV EF, İVC kollaps indeksi, Sm, MPİ, E/Em gibi ekokardiyografik parametreler akut PE olgularının tanısında kullanılabilecek değişkenler olarak tespit edilmiştir.

Anahtar kelimeler: Akut pulmoner emboli-ekokardiyografi-doku doppler görüntüleme

Abstract

The main aim of the study was to evaluate differences in conventional and tissue doppler echocardiographic parameters in patient with acute pulmonary embolism (PE). Our descriptive and cross-sectional study population included 29 healthy voluntary controls and 54 patients with diagnosis of acute PE who were admitted to Selcuk University, Meram School of Medicine Hospital between January 2010 to July 2010. Two-dimensional and doppler echocardiaographic parameters, tissue doppler parameters were recorded and these parameters were compared between patient and control groups. There was not statistically significant difference between two groups with regard to demographic features and comorbidities. Right ventricular (RV) ejection fraction (EF) was detected to be significantly lower (46.2 vs. 60.5; P<0.001), whereas systolic pulmonary artery pressure was found to be significantly higher (45 mmHg vs. 24.7 mmHg; P<0.001) and inferior vena cava (IVC) collaps index was also found to be significantly lower (0.36 vs. 0.62; P<0.001) in patient group. RV myocardial performance index (MPI) values were evaluated by pulsed wave tissue doppler technique and significantly increased in acute PE group compared to control group (0.53 vs. 0.43; P<0.001). Furthermore, RV E/Em was found significantly higher (6.5 versus 5,0; P=0.04) and RV isovolumetric relaxation time (IVRT) was significantly prolonged in acute PE group compared to control group (67 msec vs.57 msec; P<0.001). Especially RV EF, IVC collaps index, Sm, MPI, E/Em can be used as different echocardiograhic parameters for the diagnosis of acute PE.

Key words: Acute pulmomary embolism; Echocardiography; Tissue doppler echocardiography

INTRODUCTION

Acute pulmonary embolism (PE) is a relatively common cardiovascular emergency. Acute PE can cause a life threatening, potentially reversible right ventricle (RV) failure because of the occlusion of pulmonary arterial bed. It is difficult to make the differential diagnosis of PE and cannot be diagnosed as it does not have a specific clinic presentation. Despite this, early diagnosis is very important because the early treatment is very effective. In USA the prevelance of acute PE is 0.4% in the hospitalized population between 1979-1999 (1). According to prospective cohort studies the average mortality rate is 7-11% (2). Echocardiography is frequently used in the diagnosis, differential diagnosis and prediction of the prognosis of acute PE cases. The major cause of mortality in PE is RV failure. In 80% of images of proven PE cases compatible with RV dilatation and hypokinesia can be seen (3).

Yazışma Adresi: Zeynettin Kaya, Mevlana University, Department of Cardiology, Konya
e-posta: zeynettinkaya@yahoo.com
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Except traditional two dimensional and doppler echocardiography, tissue doppler echocardiography became center of interest in acute PE cases; new tissue doppler findings have been defined in the prognosis and diagnosis. The aim of our study is to evaluate the effect of acute PE over the conventional and tissue doppler echocardiography findings.

MATERIAL AND METHOD

Study Population

Our research is a cross sectional and descriptive study made by healthy volunteers and acute PE cases. Fifty-four patients with acute PE diagnosed in Selcuk University, Meram School of Medicine between January 2010 and July 2010 and twenty-nine volunteers who have similar demographic properties and co-morbidities as the control group were enrolled in study. Exclusion criterias were known atrial fibrillation and peripheral arterial disease, acute stroke, acute coronary syndrome, decompensated heart failure, history of percutaneous coronary intervention or bypass surgery within the last 1 month and poor image quality. The local ethics committee of Selçuk University approved the study.

Study Protochol

Diagnosis of acute PE was made to the European Heart Association 2008 guidelines for diagnosis and treatment of acute PE (4). In order to confirm the diagnosis pulmonary computerized tomography angiography (Siemens Somatom-Sensation 64 CT scanner) was performed. Patients were taken to the coronary intensive care unit. Echocardiographic examination (Philips HD 11 XE) Ultrasound System) was done as soon as possible according to the clinical condition of patients. The echocardiographic examination was performed at the left decubit position and at the end of expirium. The measurements were recorded as the average of three consecutive heart beats. RV ejection fraction (EF) was measured from apical four chamber window by Simpson's method. The patients were divided into two groups as patients with RV failure (EF<45) and without RV failure (EF≥45). At apical four chamber view the pulsed wave curser was placed to the tip of tricuspid and mitral valve and E, A speeds and E deceleration times were measured. Pulmonary vein systolic flow (Ps), pulmonary vein diastolic flow (Pd), pulmonary vein atrial reverse flow (Ar) speeds were measured by placing the pulsed wave curser on right superior pulmonary vein at apical four chamber view. RV ejection volume was measured by subtracting end systolic volume of RV from end diastolic volume of RV measured by Simpson's method at apical four chamber view. Systolic pulmonary artery pressure (PAPs) was measured with Bernoulli equation by using the peak flow which was acquired by placing continuous wave doppler to tricuspid valve regurgitation flow jet. The inferior vena cava (IVC) collapse index was measured by dividing the end expirium diameter of IVC to the value found by subtracting the end expirium diameter of IVC from end inspirium diameter of IVC which were acquired by using M-mod technique at subcostal view.

Tissue doppler echocardiography was performed to the patients and control group additionally to conventional echocardiography. At four chamber view by placing the pulsed wave tissue doppler curser on RV free wall, interventricular septum and RV free wall annulus level; Sm, Em and Am speeds, izovolumetric relaxation time(IVRT) and izovolumetric contraction time(ICT) were measured. LV tissue doppler values were acquired by taking the average values of lateral wall and interventricular septum. Myocardial performans index (MPI) is calculated as the ratio of sum of IVRT and ICT acquired from tissue doppler traces to ejection time (5). LV tissue doppler values are calculated as the average of lateral and interventriculer septum values.

Statistical Analysis

Normal distribution of data (parametric and non-parametric) were evaluated by Kolmogrov Smirnow test. At comparision of parametric data's Student s t test, comparision of non- parametric data Mann Whitney U test were used. Chi-Square test was used to establish whether the difference between the control group and the patient group's comorbidities and demographic characteristics were statistically significant. For correlation analysis Spearman test was used. P values smaller than 0.05 was accepted as statistically significant. All statistical analysis were made by SPSS (version 15.0, SPSS, Chicago, İllinois, USA)

RESULTS

Demographic characteristics and comorbid conditions were similar in both groups. Immobilization and surgical history were higher in patients compared to the controls as it was expected (Table 1). Average RV EF values were significantly lower than control (Figure-1). There was not a significant difference of E, A, EDT values measured by pulsed wave doppler acquired from mitral and tricuspid valve inflows between the acute PE patients and the control group. Although the Ps/Pd ratios were similar, Ar was significantly higher in the acute PE group. RV ejection volume was low in the acute PE group but the difference was not statistically significant. IVC collapse index was significantly lower in the acute PE group. Ratio of RV end diastolic volume to left ventricle (LV) end diastolic volume was remarkably higher in the acute PE group (Table 2). The difference of LV lateral wall and interventricular wall Sm values which were acquired by tissue doppler technique was not significant between acute PE and control group, but the Sm value of RV was significantly lower (Figure 2). RV E/Em ratio was significantly higher in the acute PE group, similarly RV IVRT was prolonged in acute PE group significantly. Between acute PE and control groups LV E/Em and LV IVRT values did not have a significant difference. It was seen RV

Tablo 1. Demographic characteristics and comorbid conditions of patients with acute pulmonary embolism and the control group

	Akut PE n: 65	Kontrol n:29	P değeri
Sex			
Female, %	49	48	0,93
Male, %	51	52	
Age (years)	58.4±17.7	55,8±17.0	0,49
CAD, %	6.1	10.3	0.47
HT, %	27.6	31	0.74
DM, %	15.3	17.2	0.82
Smoking, %	21.5	17.2	0.63
Malignancy, %	13.8	3.4	0.13
Stroke, %	9.2	10.3	0.86
Pregnancy, %	3	3.4	0.92
Dyslipidemia, %	12.3	10.3	078
Immobilization, %	50.7	0	0.00
Surgery, %	27.6	2.4	0.00
Others, % 6	0	0.17	

CAD: Coronary artery disease; HT: Hypertension; DM; Diabetes Mellitus

Tablo 2. Conventional echocardiographic findings of acute PE group and control group

	Acute PE n:54	Control n:29	P
RV EF (%)	46.2	60.5	0.00
Tricuspid EDT (msn)	172	194	0.09
Tricuspid E/A	1.01	1.07	0.41
Mitral EDT (msn)	188.2	188.4	0.98
Mitral E/A	0.90	1.03	0.10
Ps/Pd	1.19	1.18	0.83
Ar (cm/sn)	31.7	28.9	0.03
RV ejection volume (ml)	24.3	25.2	0.69
PAP-sistolic (mmHg)	45.0	24.7	0.00
IVC collaps index (%)	0.36	0.62	0.00
RV area/LV area	0.84	0.59	0.00

MPI and LV MPI values were significantly higher in the acute PE group. (Table 3)

Tablo 3. Tissue Doppler echocardiography findings in the acute PE patients and control group.

	Akut PE n: 54	Kontrol n:29	P
RV Sm (cm/sn)	12.9	14.9	0.00
RV ICT (msn)	57	60	0.26
RV ET (msn)	236	273	0.00
RV IVRT (msn)	67	57	0.00
RV E/Em	6.5	5.0	0.04
RV MPI	0.53	0.43	0.00
Lateral Sm (cm/sn)	9.8	9.6	0.66
Lateral ICT (msn)	62	68	0.03
Lateral ET (msn)	234	274	0.00
Lateral IVRT (msn)	69	67	0.49
Lateral E/Em	8.6	8.4	0.29
Lateral MPI	0.68	0.51	0.11
Septal Sm (cm/sn)	8.4	8.4	0.99
Septal ICT (msn)	59	57	0.44
Septal ET (msn)	242	287	0.00
Septal IVRT (msn)	66	75	0.04
Septal E/Em	11.1	9.8	0.25
Septal MPI	0.62	0.46	0.01
LV ICT (msn)	61	63	0.38
LV ET (msn)	238	280	0.00
LV IVRT (msn)	68	71	0.37
LV E/Em	9.5	8.9	0.52
LV MPI	0.65	0.48	0.04

DISCUSSION

RV EF was detected to be significantly lower (46.2 vs. 60.5; P<0.001), whereas PAPs was found to be significantly higher (45 mmHg vs. 24.7 mmHg; P<0.001) and IVC collaps index was also found to be significantly lower (0.36 vs. 0.62; P<0.001) in patient group. RV MPI values were evaluated by pulsed wave tissue doppler technique and significantly increased in acute PE group compared to control group (0.53 vs. 0.43; P<0.001). Furthermore, the RV E/Em was found significantly higher (6.5 vs. 5,0; P=0.04) and RV IVRT was significantly prolonged in acute PE group compared to control group (67 msec vs. 57 msec; P<0.001). In our study 49% of acute acute PE patients were women, 51% of patients were men. Average age was 58.4 and the ratio of patients over 60 years old was 53.8%. In the previous researches it was shown that the average age of acute PE patients was 62 and 65% of patients were over 60 (6-8). In the ICOPER study the ratio of non secondary acute PE cases, namely without an underlying etiologic factor was reported as 20% (9). In our study 18.4% of acute PE cases did not have a comorbidity or triggering etiologic factor. In our study we found 13.8% of acute PE patients had malignancy; 58.4% had surgical history and immobilization alone or both at the same time as the etiologic factor.

Echocardiography is usefull to make differential diagnosis of high risk situations such as aort dissection, pericardial tamponade, myocardial infarction and cardiogenic shock while determining the RV dysfunction and dilatation. RV dilatation, deviation to left, paradoxical movement of septal wall, moderate and severe hypokinesia as an indicator of RV dysfunction, mobile thrombus at right side of the heart, pulmonary hypertension, patent foramen ovale are the parameters that can be evaluated in acute PE patients(10). Echocardiographic evaluation is important to determine this high risk group. In echocardiography, normal RV area/ LV area value is <0.6, if this ratio is over >1.0, it is associated with severe RV failure(11). Similarly, the ratio ≥0.9 is shown as an independent risk factor for mortality(12). In our study this ratio was higher in acute PE group but was found smaller than 0.9. It is seen that the data is compatible with the literature. In acute PE cases to evaluate these parameters can assist the differential diagnosis. When evaluating the conventional echocardiographic findings, EF as an indicator of RV systolic function was found significantly lower in the acute PE group which was compatible with the previous researches (11). PAPs value was significantly higher in the patient group compared to control group as it was expected. Compatible with the increased PAPs values the IVC collapse index was significantly lower in the patient group compared with the control group. RV can easily accommodate to increased preload but its accommodation to increased afterload is not good enough. If pulmonary vascular resistance increases RV ejection volume begins to decrease proportionally and at the end RV becomes dilated. This dilatation increases RV failure because of increased oxygen consumption and decreased coroner blood flow. In our study RV ejection volume was lower in the acute PE group compared to control group but this difference was not statistically significant. But this must not be forgotten that the ejection volume acquired by Simpson's method can be misleading because acute PE patients frequently have some degree of tricuspid regurgitation. In this study we compared tissue doppler findings of acute PE group and control group in addition to conventional echocardiography findings.

In the previous researches it was shown that RV Sm values were significantly relevant with the RV EF values(13). Again in our study compatible with previous studies RV Sm values were significantly lower in the acute PE group. Additionally the E/Em value, accepted as an important indicator of LV end-diastolic pressure, which was not evaluated enough for RV yet was also evaluated in this study and we saw that this parameter was high in the acute PE cases compared with the control group. This finding shows us there is an increase in the RV end diastolic pressure compatible with the physiopathology. MPI is the combined index of ventricular systolic and diastolic functions. In the previous studies which were made with the acute PE patients it is shown

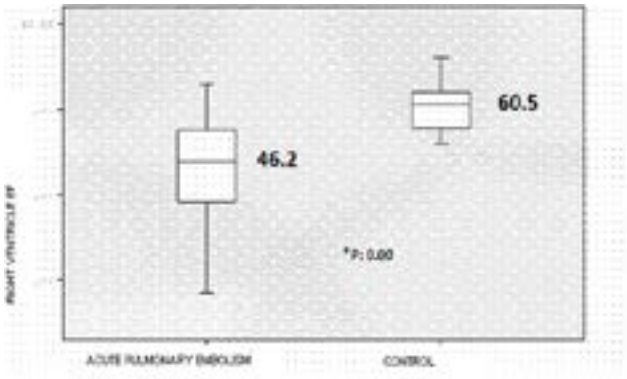

Figure 1. Avarage RV EF values of acute PE group and control group

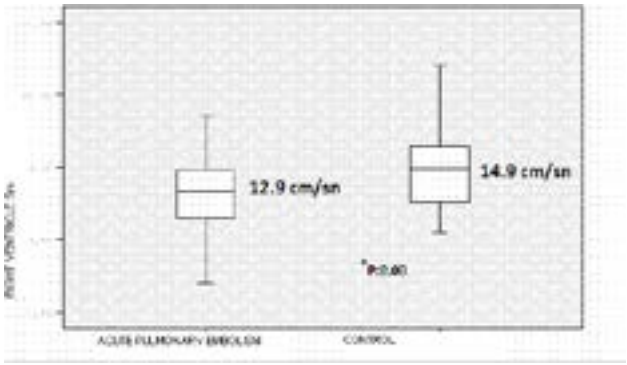

Figure 2. RV Sm values in the acute PE group and the control group.

that RV MPI value was higher in the acute PE patients. The cause of this situation was defined as the prolonged IVRT which was secondary to diastolic dysfunction caused by acute volume overload of right side of the heart(14). Compatible with the previous findings it is observed that RV IVRT was longer and RV MPI was increased in the acute PE patients. Hsiao et al. showed with the study they made with acute PE patients that RV MPI to be higher than 0.55 can be used in the diagnose of acute PE with 85% sensitivity and 78% specificity(15). In our study the average MPI value of acute PE group was 0.62 and control group was 0.46 and this finding was compatible with the literature. In our study while the differences of LV lateral wall MPI values of the two groups were not significant statistically; septal MPI value was significantly high in the acute PE group. LV MPI which is calculated as the average of septal and lateral wall MPI of LV was found higher in acute PE group especially because of changes at the septum and this made us think acute PE can affect LV functions. On the other hand evaluation of interventricular septum of acute PE patients by tissue doppler echocardiography is not adviced because of paradoxical movement(16). Compatible with our study the previous studies in the literature showed that the lateral wall MPI value of LV increased in the acute PE group especially in the acute phase compared with the control group but the increase was not statistically significant(14,16). This finding can be due to LV diastolic dysfunction and on the other hand can be because of LV filling restriction caused by the deviation of the septum to the left secondary to LV pressure overload and dilatation. LV MPI can be affected due to the effect of these factors in different degrees. When the previous studies about this subject analyzed the study that Abacı at al. made with 38 patients by using nitroglycerin they showed the change in LV diastolic filling sample with tissue doppler technique as it is with classic technique(17). Again the study Yiğit at al. made with hemodialysis patients the diastolic functions of patients younger than 45 years old they evaluated with tissue doppler echocardiography is not affected by preload but the diastolic functions of patients older than 45 change by preload(18). On the other hand Sohn at al. showed that mitral annular doppler velocity is irrelevant from preload(19). When all these factors are evaluated LV diastolic functions can be affected from both of these factors.

The study is a non-randomized study with known limitations. Another important limitation is the absence of risk stratification of patients. Otherwise, the number of patients considered to be adequate for this study.

Our study shows tissue doppler echocardiography can help in an important manner to the already known conventional echocardiographic parameters in diagnosis and predicting the prognosis of acute PE. Especially RV EF, IVC collapse index, Sm, MPI, E/Em can be used as different echocardiograhic parameters for the diagnosis of PE.

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