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Relationship between left atrial functions, P-terminal force and interatrial block in chronic haemodialysis patients

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Abstract. – OBJECTIVE: Interatrial block (IAB) connotes a P wave duration ≥ 110 msec on electrocardiography (ECG). P-terminal force corresponds to a biphasic P wave with its terminal negative phase ≥ 40 msec x mm in V1 derivation on ECG. IAB and P-terminal force are closely related parameters and they are accepted as predictors for left atrial dysfunction, left atrial dilatation, atrial fibrillation and strokes. Left atrial functions in chronic haemodialysis patients becomes worse in the course of time because of long standing pressure and volume overload. The aim of this study is to evaluate the relationship between IAB, P-terminal force and left atrial functions.

PATIENTS AND METHODS: 68 chronic haemodialysis patients and 60 control subjects were included in the study. Conventional echocardiography and left atrial dynamic functions were measured in all cases. The subjects with IAB and P-terminal force on ECG were identified.

RESULTS: Left ventricular size, wall thickness and left atrial diameters were significantly greater in haemodialysis patients than the control group ($p < 0.001$). 42 (62%) patients had IAB (≥ 110 msec) and 45 (66%) patients had P-terminal force (≥ 40 msec x mm) in the haemodialysis group. Left atrial reservoir, conduit and pump functions were significantly lower in the haemodialysis group than the control group ($p < 0.001$). There was a statistically significant correlation between left atrial functions, IAB (≥ 110 msec) and P-terminal force (≥ 40msec x mm) in all parameters ($p < 0.001$).

CONCLUSIONS: This study showed that decreased left atrial functions in chronic haemodialysis patients are closely correlated with IAB and P-terminal force.

Key Words:
Interatrial block, P-terminal force, Haemodialysis.

Introduction

Interatrial block (IAB) is characterized by atria impulse delay due to an anomaly in Bachmann bundle[1,2]. It is defined as a P wave ≥ 110 msec on electrocardiogram (ECG)[3]. Nowadays, IAB is accepted as a marker of left atrial (LA) dilatation and dysfunction, atrial fibrillation and embolic strokes[4,5]. Another defined parameter related to left atrial dilatation is P-terminal force. P-terminal force corresponds to a biphasic P wave with its terminal negative phase greater than one small square (≥ 40 msec x mm) in V1 derivation on ECG. IAB and P-terminal force are strongly related parameters[6].

The major complication responsible for approximately half of deaths among end stage renal failure patients is cardiovascular events[7,8]. Left atrial volume is one of the most important parameters in assessment of cardiovascular risk and all cause mortality among chronic haemodialysis (HD) patients[9]. Chronic HD patients are exposed to higher volume and pressure load for longer times. After a while left atrial volume increases, although its functions decrease due to this hemodynamic stress. LA is not only a passive conduit chamber but also it has dynamic functions. The dynamic functions are evaluated in three phases, namely, reservoir, conduit and pump functions. The reservoir function refers to the storage of blood draining from the pulmonary venous system during left ventricular systole, the conduit function represents ventricular diastole and the pump function is the active contraction phase during late diastole[10]. As far we know there is no study in the literature evaluating the relationship between left atrial functions, IAB and P-terminal force. In this study we aimed to evaluate the association between these parameters.

Patients and Methods

68 HD patients undergoing dialysis for more than three months and 60 healthy control sub-

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jects were included in the study. HD patients were selected among those who go four to five hours haemodialysis (Fresenius 4008-S, Refurbished, Germany) three times a week. Among HD patients there were 12 patients with diabetic nephropathy, 14 patients with glomerulonephritis, 12 patients with interstitial nephritis, 9 patients with amyloidosis, 11 patients with pyelonephritis and 10 patients with unknown aetiology. 28 of the HD patients were undergoing antihypertensive treatment. The subjects in the control and HD group were similar in age and sex. There was no known disease in the control group. Patients with atrial fibrillation, uncontrolled hypertension, known coronary artery disease, moderate to severe valvular disease, chronic obstructive lung disease and left ventricular dysfunction were excluded. The study was conducted according to the principles of Declaration of Helsinki. All of the patients and the control group subjects were informed and written informed consents were obtained.

Interatrial block and P-terminal force measurement

Evaluation of IAB and P-terminal force was performed after ECG calibration adjusted at a speed of 50 mm/sec and an amplitude of 10 mm/mV. IAB was defined as a P wave duration ≥ 110 msec in any of the 12 leads of surface ECG. P-terminal force was described as a biphasic P wave with its terminal part ≥ 40 msec x mm in V1 derivation (Figure 1).

Echocardiography

The echocardiography of all subjects included in the study were performed in the left lateral position with a 2.5 MHz transducer of Vingmed ultrasound system (Vingmed System 6S, General Electric, Horten, Norway). Records were evaluated later (EchoPAC PC; GE Vingmed Ultrasound AS, Horten, Norway). Left ventricular end systolic (LVESd) and diastolic diameters (LVEDd), left atrial (LA) diameter and interventricular septal (IVS) thickness were measured in M-mode in parasternal long axis view[11]. Left ventricular ejection fraction (LVEF) was measured by Simpson's method. LA volumes were calculated with the biplane area method in apical 4-chamber views[12]. Maximal volume at mitral valve opening time (SAVmax), minimal volume at the start of atrial systole (electrocardiographic P wave = SAVprea) and at mitral valve closing time (SAVmin) were measured. LA dynamic functions were calculated by the formulas using these volumes:

- Reservoir function: (SAVmax-SAVmin)/SAVmax) x 100
- Conduit function: (SAVmax-SAVprea)/SAVmax) x 100
- Pump function: (SAVprea-SAVmin)/SAVprea) x 100

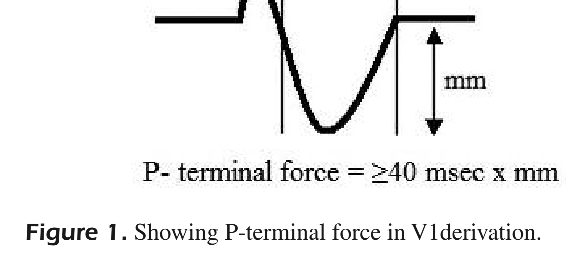

Figure 1. Showing P-terminal force in V1derivation.

Statistical Analysis

Statistical analysis was performed by SPSS 18.0 (SPSS Inc, Chicago, IL, USA) package computer programe. The Kolmogorov-Smirnov test was used in order to analyze the distribution of the variables. Numerical data was given as mean ± standard deviation and categorical data was given as percentages (%). Chi-square test was used for cathegorical variables. The Student's *t*-test was used in the comparison of parametric variables between chronic HD patients and the control group. Pearson's correlation analysis was used to evaluate the relationship between IAB, P-terminal force, LA functions and LA diameter. $p < 0.05$ was assumed to be statistically significant.

Results

Demographic, electrocardiographic and echocardiographic data of study and control groups is presented in Table I. Both groups were similar in age, gender, Body Mass Index (BMI), systolic and diastolic blood pressures. The HD group had 42±13.5 months dialysis period. LVEDd, LVESd, IVS thickness and LA diameters were significantly greater in HD patients than the control group ($p < 0.001$). Ejection fractions were similar in both groups ($p = 0.12$). IAB (≥ 110 msec) was found in 42 (62%) of patients in the HD group. IAB was not detected among the control subjects. P-terminal force (≥

Table I. Demographic, electrocardiographic and echocardiographic data of haemodialysis patients and the control group.

	Haemodialysis group (n=68)	Control group (n=60)	*p*-value
Age	37 ± 6.1	38.3 ± 6.5	0.69
Gender (F/M)	38/30	35/25	0.59
BMI (kg/m²)	24.8 ± 3.3	23.5 ± 2.9	0.19
Dialysis time (months)	42 ± 13.5	-	-
SBP (mm Hg)	135 ± 15	125 ± 15	0.11
DBP (mm Hg)	82 ± 12	74 ± 11	0.25
LVEDd (mm)	51.5 ± 4.0	45 ± 3.9	<0.001
LVESd (mm)	35.4 ± 4.7	30 ± 2.6	<0.001
IVSd (mm)	12.2 ± 1.5	10.1 ± 1.5	<0.001
LVEF Simpson's (%)	59.9 ± 9.5	62.1 ± 8.4	0.12
LA (mm)	42.5 ± 4.6	32.2 ± 2.9	<0.001
Interatrial block (≥110 msec) (n, %)	42 (62)	0	<0.001
P-terminal force (n, %)	45 (66)	8 (13)	<0.001
Reservoir function (%)	42.8 ± 7.8	54.8 ± 4.3	<0.001
Pump function (%)	35.8±6.5	46.6±6.4	<0.001

BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, LVEDd: Left ventricular end diastolic diameter, LVESd: Left ventricular end systolic diameter, IVSd: Interventricular septum diastolic diameter, LVEF: Left ventricular ejection fraction, LA: Left atrial diameter

40 msec x mm) was detected in 45 (66%) of patients in the HD group and in 8 (13%) subjects in the control group. The left atrial reservoir, conduit and pump functions were significantly lower in HD group than the control group ($p < 0.001$) (Table I).

Patients with IAB (≥ 110 msec) had significantly lower left atrial reservoir, conduit and pump functions than the patients without IAB ($p < 0.001$). Left atrial diameters were significantly greater in IAB cases than those without IAB ($p < 0.001$). Patients with P-terminal force (≥ 40 msec x mm) had significantly lower left atrial reservoir, conduit and pump functions than the patients without P-terminal force ($p < 0.001$). Left atrial diameters were significantly greater in patients with P-terminal force than the patients without P-terminal force ($p < 0.001$) (Table II).

A statistically significant correlation was detected between all parameters related to left atrial

Table II. The comparison of left atrial diameters and functions between patients with and without interatrial block and P-terminal force.

	Interatrial block (+) (n=42)	Interatrial block (-) (n=26)	*p*-value
Reservoir function (%)	35.5 ± 6.5	46.2 ± 8.9	<0.001
Conduit function (%)	15.8 ± 3.5	21.2 ± 5.1	<0.001
Pump function (%)	31.4 ± 4.6	39.4 ± 7.2	<0.001
Left atrial diameter (mm)	46.8 ± 5.6	38.4 ± 3.9	<0.001
	P-terminal force (+) (n=45)	**P-terminal force (-) (n=23)**	***p*-value**
Reservoir function(%)	37.2 ± 5.9	44.8 ± 6.7	<0.001
Conduit function (%)	15.9 ± 3.7	20.7 ± 5.2	<0.001
Pump function (%)	32.5 ± 5.2	39.8 ± 7.1	<0.001
Left atrial diameter (mm)	45.5 ± 5.7	39.5 ± 5.5	<0.001

Table III. The comparison of left atrial diameters and functions between patients with interatrial block and P-terminal force.

	Interatrial block (≥ 110 msec)	*p*-value	P-terminal force (≥40msec x mm)	*p*-value
Reservoir function(%)	r = 0.48	<0.001	r = 0.41	<0.001
Conduit function (%)	r = 0.36	<0.001	r = 0.39	<0.001
Pump function (%)	r = 0.33	<0.001	r = 0.37	<0.001
Left atrial diameter (mm)	r = 0.55	<0.001	r = 0.45	<0.001

functions and left atrial diameters in patients with IAB and P-terminal force ($p < 0.001$) (Table III).

Discussion

In this study it was shown that chronic HD patients had greater left atrial volumes and lower left atrial functions, which are well correlated with IAB and P-terminal force.

LA dynamic functions, which are calculated by LA volumes, are affected by numerous pathologic conditions. The most common pathology leading LA dilatation is left ventricular hypertrophy. There is a significant relationship between left ventricular hypertrophy and LA dilatation and dysfunction[13]. In our study both IVS thickness and LA diameters and volumes in chronic HD patients were significantly greater than the control group. LA dynamic functions calculated using LA volumes were similarly lower in the HD group. Although their blood pressures were under control, these changes were inevitable in haemodialysis patients because of chronic hemodynamic stress.

IAB and P-terminal force diagnosed simply on surface ECG can be used as predictors for LA dilatation and dysfunction. The amount of delay in IAB is directly correlated with LA dilatation[14]. LA dilatation can lead to atrial tachyarrhythmias, principally atrial fibrillation, and embolic events[4,5,15]. In a study, Elbey et al[16] demonstrated that there was a significant correlation between LA dilatation and the prevalence of IAB and P-terminal force in patients with mitral regurgitation. Moreover, in patients with mitral stenosis, it was shown that IAB and P-terminal force were similarly more frequent in patients with LA dilatation and they were correlated with the level of left atrial dilatation[17]. In our work LA diameters were significantly greater in chronic HD patients than the control group. IAB and P-terminal force had a considerably high prevalence (62%, 66%, respectively). LA functions were found to be lower in HD patients with IAB and P-terminal force than those without IAB and P-terminal force. When these prevalences were correlated with the LA reservoir, conduit and pump functions, we found a statistically significant relationship between these parameters. As a result, IAB and P-terminal force in chronic HD patients, which are well correlated with LA dilatation and dysfunction, and diagnosed easily on surface ECG, can be used as predictors for cardiovascular events. Additionally, some different treatment strategies can be used for highly encountered atrial fibrillation and complications like embolic events. However, further studies are needed.

Conclusions

IAB and P-terminal force have considerably higher prevalence in chronic HD patients. These ECG parameters are closely correlated with left atrial diameter and functions.

Conflict of Interest

The Authors declare that there are no conflicts of interest.

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