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P Wave Dispersion in Patients with Mitral Stenosis and Effects of Percutaneous Mitral Balloon Valvuloplasty on P Wave Dispersion

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MİTRAL DARLIKLI HASTALARDA P DALGA DİSPERSİYONU VE PERKÜTAN MİTRAL BALON VALVÜLOPLASTİ İŞLEMİNİN P DALGA DİSPERSİYONU ÜZERİNE ETKİSİ

ÖZET

P dalga dispersiyonu (PDD), yeni bir elektrokardiyografik parametre olup, sinüzal uyarıların intra-atriyal ve inter-atriyal nonhomojen ve kesintili iletilmesi ile ilişkilidir. PDD maksimum ve minimum P dalga süreleri arasındaki fark olarak ifade edilebilir. Yakın zamanda yayınlanmış çalışmalarda uzamış P dalga süresi ve artmış P dalga dispersiyonunun yüksek atrial fibrilasyon riski ile ilişkili olduğu bildirilmiştir. Bu çalışmanın amacı mitral darlıklı hastalarda P dalga dispersiyonunu belirlemek ve perkütan mitral balon valvüloplasti (PMBV) işleminin P dalga dispersiyonu üzerine etkisini değerlendirmektir. Çalışmaya PMBV adayı 29 mitral darlıklı hasta (26 bayan, 3 erkek; yaş 33±6 yıl) ve 27 sağlıklı gönüllü (24 bayan, 3 erkek; yaş 32±7 yıl) kontrol grubu olarak dahil edildi. İşlemden bir gün önce hasta ve kontrol grubundaki tüm kişilerin elektrokardiyogramları çekildi ve transtorasik ekokardiyogramları yapıldı. İşlem sonrası birinci gün, birinci ay, ve altıncı ayda çalışmaya dahil edilen hasta gruplarındaki tüm kişilerin elektrokardiyogramları çekildi. Hasta grubundaki kişilerin transtorasik ekokardiyogramları işlem sonrası birinci gün, birinci ay ve altıncı ayda tekrarlandı. Çekilen elektrokardiyogramlardan maksimum ve minimum P dalga süreleri ölçüldü ve PDD hesaplandı. Mitral darlıklı hasta grubunda maksimum P dalga süresi ve PDD sağlıklı kontrol grubuna göre istatistiksel olarak anlamlı derecede daha yüksek saptandı ($p<0.001$). Ancak, minimum P dalga süreleri acısından hasta ve kontrol grubu arasında istatistiksel olarak anlamlı fark yoktu. PMBV sonrası birinci gün, birinci ay ve altıncı ayda yapılan ölçümlerde maksimum P dalga süresi ve PDD'nun işlem öncesi ölçülen bazal değerlere göre ilerleyici bir şekilde istatistiksel olarak anlamlı derecede azaldığı tespit edildi ($p<0.001$). Birinci gün, birinci ay ve altıncı ayda ölcülen maksimum P dalga süresi ve PDD kendi aralarında karşılaştırıldığında yine istatistiksel olarak anlamlı azalma tespit edildi ($p<0.01$). Ancak, minimum P dalga sürelerinde anlamlı bir değişiklik gözlenmedi. PDD'nda ki azalma ile ekokardiyografik parametrelerdeki düzelme arasında istatistiksel olarak anlamlı korelasyon saptanmadı. Sonuç olarak, yüksek atrial fibrilasyon riskini gösteren PDD mitral darlıklı hastalarda sağlıklı bireylere göre istatistiksel olarak anlamlı derecede daha yüksektir. PMBV sonrası PDD kısa ve uzun dönemde istatistiksel olarak anlamlı derecede düşmektedir. ***Türk Kardiyol Dern Arş 2002; 30: 161-165***

Anahtar kelimeler: *P dalga dispersiyonu, mitral darlığı, perkütan mitral balon valvüloplasti*

P wave dispersion (PWD) is a new electrocardiographic marker that has been associated with inhomogeneous and discontinuous propagation of sinus impulses [1,2]. It can be defined as the difference between maximum and minimum P wave duration. The prolongation of intraatrial and interatrial conduction time, the inhomogeneous propagation of sinus impulses are well known electrophysiological characteristics of the atrium prone to fibrillate [1,2]. Furthermore, prolonged P wave duration and increased PWD have been reported to carry an increased risk for atrial fibrillation (AF) [2,3]. Rheumatic mitral stenosis (MS) is frequently seen in developing countries and causes significant morbidity and mortality [4]. Percutaneous mitral balloon valvuloplasty (PMBV) is the procedure of choice in patients who have symptomatic, hemodynamically severe MS and are suitable for this procedure [4-6]. This procedure is highly successful with a low complication rate and significant short- and long-term improvement in both hemodynamics and symptoms [7,8].

The objectives of this study were to determine (1) PWD in patients with MS, and (2) the effects of PMBV on PWD.

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PATIENTS and METHODS

The study population consisted of two groups: Group I consisted of 29 patients with MS (26 women, 3 men; aged 33±6 years) who were candidate for PMBV and group II consisted of 27 healthy volunteers (24 women, 3 men; aged 32±7 years). All patients were in sinus rhythm and none of them were taking type I or type III antiarrhythmic agents. None of the patients had previous history of documented paroxysmal AF. Patients who had coronary artery disease, hypertension, diabetes mellitus, hyperthyroidism, pericardial effusion, chronic obstructive pulmonary disease, ventricular preexcitation, bundle branch block, atrioventricular conduction abnormalities, or abnormal serum electrolytes were excluded from the study. Twelve-lead electrocardiogram (ECG) was recorded for each patient one day before PMBV and repeated at first day, at the end of the first month and at sixth month after successful PMBV at a rate of 50 mm/s in the supine position. ECGs were coded and all annotations were masked. P wave duration was measured from the onset to the offset of the P wave. The onset and offset of the P wave were defined as the junction between the P wave pattern and isoelectric line. After completion of the measurements, all ECGs were decoded. PWD was defined as the difference between maximum and minimum P wave duration. Transthoracic and transesophageal echocardiographic examination were performed 24 hours before procedure and repeated at first day, at the end of the first month and at sixth month after PMBV. Mitral valve anatomy was scored by two dimentional echocardiography on the basis of Wilkins' echo scorring system [9]. Left atrial diameter was measured by M-mode echocardiography and mitral valve area was calculated by pressure half time method. Mean transmitral diastolic gradients were also calculated by Doppler studies. Color flow Doppler was used to detect the presence of mitral regurgitation. Pulmonary artery systolic pressure was calculated by the help of continuous wave Doppler studies using the Bernoulli equation. The technique of PMBV has previously been described [5]. PMBV was performed by the antegrade, transseptal approach with Inoue balloon catheter (Toray Industries, Inc., Houston, Texas). Right and left heart pressure measurements, including simultaneous left atrial and left ventricular pressures were obtained before and after PMBV. Oxygen saturation of blood samples from the superior and inferior vena cava, pulmonary artery and aorta were measured before and after PMBV. PMBV procedure considered successfull if the mitral valve area was higher than 1.5 cm^2, without >2+ mitral regurgitation and left to right shunt (Qp/Qs>1.5).

All numeric variables were expressed as mean±SD and categorical variables were expressed as percentage. Statistical analysis was performed using unpaired t-test, repeated-measures analysis of variance and Pearson correlation test. A p value < 0.05 was considered statistically significant.

RESULTS

There was no statistically significant difference between two groups in respect to age and gender (p>0.05). All patients successfully underwent PMBV. Statistically significant improvement in left atrial diameter, mitral valve area, pulmonary artery pressure and mean mitral gradient were achieved in all patients (p<0.0001 in all, table 1). Baseline maximum P wave duration and PWD of group I were significantly higher than those of group II (P maximum; 128.6±9.3msec vs 102.4±7.8msec, p<0.001, PWD; 54.1±7.3msec vs 26.7±7.5msec, p<0.001, respectively). However there was no statistically significant difference between group I and group II regarding minimum P wave duration (74.3±6.9msec vs 79.4±7.2msec, p>0.05, respectively). Maximum P wave duration and PWD decreased progressively at first day, at the end of the first month and at sixth month after PMBV (table 2). However, no significant change was detected between echocardiographic variables measured at first day, at the end of the first month and at sixth month after PMBV (p>0.05, table 1). There was no statistically significant difference between the values of minimum P wave duration measured before PMBV, at first day, at the end of the first month and at sixth month after PMBV(p>0.05, table 2). There was no statistically significant correlation between the decrease in PWD and the improvement in echocardiographic parameters (p>0.05, table 3). No episode of paroxysmal AF was detected during the 6 month follow-up period.

Table 1. Effects of PMBV on patients' echocardiographic variables

Variables	Before PMBV	After PMBV		
		1st day*	1st month*	6th month*
Left atrial diameter (cm)	4.70±0.32	4.40±0.25	4.32±0.58	4.35±0.34
Mitral valve area (cm^2)	1.12±0.21	2.07±0.27	2.04±0.38	2.00±0.53
Pulmonary artery pressure (mmHg)	46±8	36±7	34±6	35±7
Mean mitral gradient (mmHg)	14±4	5±3	6±3	5±4

*PMBV= percutaneous mitral balloon valvuloplasty *p<0.0001 vs before PMBV*

Table 2. Effects of PMBV on P wave duration and dispersion

Variables	Before PMBV	After PMBV		
		1st day	1st month	6th month
P max (msec)	128.6±9.3	118.5±9.2*	113.3±9.5*‡	105.3±8.*¶
P min (msec)	74.3±6.9	75.2±7.2†	75.5±8.3†	74.8±8.5†
PWD (msec)	54.1±7.3	41.3±8.3*	35.1±8.9*‡	29.1±7.7*¶

*PMBV= percutaneous mitral balloon valvuloplasty; P max= maximum P wave duration; P min= minimum P wave duration; PWD= P wave dispersion. *p<0.001 vs before PMBV, † p>0.05 vs before PMBV, ‡p<0.01 vs 1st day, ¶p<0.01 vs 1st month*

Table 3. Correlation of P wave dispersion with echocardiographic variables

Variables	P Wave Dispersion							
	Before PMBV		After PMBV					
			1st day		1st month		6th month	
	r	p	r	p	r	p	r	p
Left atrial diameter (cm)	0.184	0.300	0.333	0.078	0.438	0.095	0.512	0.126
Mitral valve area (cm^2)	0.126	0.392	0.278	0.418	0.354	0.247	0.434	0.342
Mean mitral gradient (mmHg)	0.218	0.742	0.158	0.748	0.547	0.214	0.153	0.118
Pulmonary artery pressure (mmHg)	0.116	0.549	0.128	0.508	0.658	0.218	0.352	0.375

DISCUSSION

In the present study, we have several main findings: 1) Maximum P wave duration was significantly longer and PWD was significantly higher in patients with severe MS than in healthy control subjects, 2) Maximum P wave duration and PWD decreased progressively at first day, at the end of the first month and at sixth month after PMBV. 3) The decrease in maximum P wave duration and PWD were not correlated with the improvement in left atrial diameter, mitral valve area, pulmonary artery pressure and mean mitral gradient after PMBV.

PWD is a new electrocardiographic marker that has been associated with the inhomogeneous and discontinuous propagation of sinus impulses [1,2]. It can be defined as the difference between maximum and minimum P wave duration. Prolongation of intraatrial and interatrial conduction time and inhomogenous propagation of sinus impulses are known electrophysiological characteristics of atria prone to fibrillation [1,2]. Moreover, the correlation between the presence of intraatrial conduction abnormalities and the induction of paroxysmal atrial fibrillation has been well documented [3,10]. These electrophysiological characteristics result in increased PWD on electrocardiographic measurements. Therefore, PWD can be used to separate patients with a high risk of AF during sinus rhythm [3].

The combination of mitral valve disease and atrial inflammation secondary to rheumatic carditis cause left atrial dilatation, fibrosis within the wall of the atrium and disorganization of the atrial muscle bundles [11]. Consequently, fibrosis of the atrial wall and disorganization of atrial muscle bundles leads to electrical inhomogeneity, disparate conduction velocities and inhomogenous refractory periods within the atrial myocardium [4,11] which reflect on ECG as increased P wave duration and PWD [1,2]. Apart from the pathological changes in atrial tissue, sympathetic nervous system activation which is shown to be high in mitral stenosis [12,13] may also increase PWD.

The most striking finding of our study is that there is no correlation between the decrease in PWD and improvement in echocardiographic parameters after PMBV. It has been suggested that the prolongation of P wave duration is an accepted indicator of an interatrial conduction disturbance which can occur independent of an increase in atrial size [14]. Furthermore, Dilaveris et al [1] have reported that left atrial

maximal diameter is not a significant predictor of AF episodes. Ishimoto et al [15] have also reported that there is no correlation between filtered P wave duration and atrial enlargement. In addition, it has been suspected that the P wave prolongation might be caused in part by abnormalities in atrial electrical properties such as intraatrial or interatrial conduction disturbances or blocks [10,16]. On the contrary, some authors [17,18] reported that left atrial diameter is a significant predictor of AF episodes. We believe that some other changes like regression of fibrosis within the wall of the atrium and improvement in disorganised atrial muscle bundles which are not detectable on echocardiographic evaluation after PMBV may be the underlying mechanisms responsible from the decrease in PWD.

A relation between reduced cardiac index and increased sympathetic activity has been reported in patients with congestive heart failure [19]. Therefore, cardiac index appears to be an important determinant of sympathetic activity. In severe mitral stenosis, as in congestive heart failure, sympathetic activity may be increased in association with a reduction in cardiac index because of a significant decrease in stroke volume. Several studies have showed increased sympathetic activity in patients with mitral stenosis [12,13]. Furthermore, Tükek et al[20] reported that increased sympathetic activity causes a significant increase in PWD. Ashino et al[12] have reported that increased cardiac index after PMBV causes a significant decrease in sympathetic activity. As a result of this findings, we can suggest that the decrease in PWD measured at first day after PMBV may be related with the decrease in sympathetic activity because of an increase in cardiac index after PMBV.

In this study, the decrease in maximum P wave duration and PWD after PMBV continued progressively in the follow-up measurements at the end of the first month and at sixth month. However there was no correlation between the decrease in PWD and the improvement in echocardiographic parameters. The progressive shortening of PWD in long-term may be explained by the regression of the pathological changes of the atrial wall which results in more homogenous and organized conduction of sinus impulses.

In conclusion, PWD is significantly higher in patients with mitral stenosis indicating high risk for atrial fibrillation, than in healthy control subjects and it decreases significantly after PMBV both in short and long term. When considering the disconcordance between electrocardiographic and echocardiographic parameters, it can be suggested that there are other factors affecting atrial conduction, to be evaluated in further clinical studies.

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