The Relationship Between Aging and P Wave Dispersion

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ABSTRACT

Objective: Atrial fibrillation (AF), commonly observed in advanced ages, displays striking age dependent increase and increased P wave dispersion (PWD) has been shown to be a predictor of AF. In this study we sought to determine whether P wave duration and PWD increase with aging.
Method and Results: Eighty-three elderly subjects (group-I mean age 75±8 years) and 40 healthy young subjects (group-II, mean age 37±6 years) participated in this study. 12-lead ECG recorded at a paper speed of 50mm/s was obtained from each participant. Maximum (Pmax) and minimum P wave duration (Pmin) was measured manually with a caliper and the difference between two values was defined as PWD. Pmax and PWD were significantly higher in group-I compared to group-II. (98±8 vs. 93±8 p=0.01, 41±12 vs. 34±13 p=0.002, respectively). Among the elderly population when those with cardiovascular disorders such as hypertension, coronary artery disease and heart failure were excluded, Pmax and PWD were still significantly higher than the young population. (Pmax: 98±7 vs. 93±7, p=0.02 and PWD: 42±11 vs. 34±13, p=0.002). Moreover, on correlation analysis a positive correlation was detected between Pmax and PWD and aging. (r=0.29, p=0.004; r=0.30, p=0.003 respectively).
Conclusion: PWD shows age dependent increase and may be a useful marker for estimation the risk of developing AF seen in advanced ages

Key Words: Aging, p wave dispersion, atrial fibrillation

ÖZET

Yaş ile P Dalga Dispersiyonu Arasındaki Ilişki

Amaç: İleri yaşlarda yagın olarak görülen atriyal fibrilasyon; yaş bağımlı olarak çarpıcı bir artış göstermektedir ve artmış p dalga dispersiyonunun atriyal fibrilasyonun bir ön gördürücüsü olduğu gösterilmiştir. Bu çalışmada, yaşla birlikte p dalga dispersiyonunun artıp artmadığını araştırdık.
Metod ve Bulgular: 83 yaşlı hasta (grup-1; yaş ortalaması 75±8 yıl) ve 40 sağlıklı genç birey (grup-2; yaş ortalaması 37±6 yıl) bu çalışmaya dahil edildi. Her bir katılımcıdan 50 mm/s kağıt hızında 12-derivasyonlu EKG kaydı alındı. Maksimum ve minimum p dalga süreleri cetvel ile manuel olarak ölçüldü ve her iki değer arasındaki fark P dalga dispersiyonu (PDD) olarak tanımlandı. grup-1 maksimum p dalga süresi ve PDD anlamlı şekilde grup-2'den yüksek idi (98±8 ve 93±8 ms p=0.01; 41±12 ve 34±13 ms p=0.002, sırasıyla). Yaşlı grup arasında hipertansiyon, koroner arter hastalığı ve kalp yetersizliği gibi kardiyovasküler hastalıkları olanlar dışlandığında bile maksimum p dalga süresi ve PDD yine de genç popülasyondan yüksek idi (Pmax: 98±7 ve 93±7 ms , p=0.02; PDD: 42±11 ve 34±13ms, p=0.002). Üstelik, korelasyon analizinde maksimum p dalga süresi, PDD ve yaş arasında pozitif bir korelasyon saptandı (r=0.29, p=0.004; r=0.30, p=0.003 sırasıyla).
Sonuç: PDD yaş bağımlı artış göstermektedir ve ileri yaşlarda görülen atriyal fibrilasyon gelişim riskini tahmin etmek için faydalı bir gösterge olabilir.

Anahtar Kelimeler: Yaşlılık, p dalga dispersiyonu ve atriyal fibrilasyon

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INTRODUCTION

Aging is a physiological process associated with histologic and anatomic changes in the cardiovascular system as well as the other systems. The prevalence of coronary artery disease (CAD), rhythm disturbances including atrial and/or ventricular arrhythmias have gradually increased with aging (1). Moreover, electrocardiographic abnormalities have commonly been observed in the elderly whether or not there is a history of heart disease. This is probably due to age associated changes in the impulse formation and conduction system, including loss of pacemaker and conducting cell and fibrosis as well as increased incidence of mitral annular and aortic calcification, hypertension and CAD(1). Atrial fibrillation (AF), associated with increased risk of cardiovascular morbidity and mortality, is one of the most common arrhythmias observed in elderly subjects and it displays striking age dependent increase. Framingham Heart Study showed that the 2year incidence of this arrhythmia increases sharply with age: 0.5% among 5060 years, 4.8% among 6069 years and 12.7% among 7079 years(2). Yamashita et al.(3) have showed an independent direct effect of aging on this arrhythmia although this agedependent increase is thought to be associated with an increase in coexisting heart disease. PWD is a new electrocardiographic marker that has been shown to be a predictor of AF development(46). We have speculated that PWD may alter in advanced ages and there may be a relationship between aging and PWD. Therefore in this study, we sought to determine whether aging influences P wave duration and PWD, irrespective of other clinical variables.

METHODS

Eighty-three elderly subjects living in a local care home (Group-I) and 40 healthy hospital staff (Group-II) participated in this study. Twelve-lead ECG was recorded for each subject at a rate of 50 mm/s in the supine position (Hewlett Packard page writer 300pi, USA). Measurement of P wave duration was carried out manually using a caliper. The onset of P wave was defined as the point of the first visible upward departure of the trace from the bottom of the baseline for positive waves and as the point of first downward departure from the top of baseline for negative waves. The return to the baseline of the bottom of trace in positive waves and of the top of the trace in negative waves were considered to be the end of the P wave. The difference between the maximum (P max) and minimum P (P min) wave duration was calculated from the 1 2-lead ECG and was defined as the PWD. At least three consecutive beats were measured in each lead. When the end of the P wave could not reliably be determined these leads were excluded from the study and also, to improve accuracy all measurements were performed with magnifying lenses for defining the electrocardiogram deflection. Moreover, to minimize measurement errors analyses of ECG parameters (Pmin, Pmax and PWD) were performed in duplicate on two separate days and by two independent observers who were unaware of the clinical details.

Statistical Analysis

Statistical analysis was performed with SPSS for Windows version 10.0 (SPSS Inc. Chicago, Illinois). Data are presented as mean ? SD. For continuous variables unpaired student t-test and for categorical changes chi-square test was used. Pearson's correlation analysis was performed to investigate the association between age and P wave duration or PWD. Intra and inter-observer variabilities for ECG parameters were also tested by means of Pearson's correlation test and it yielded minimal variability ($r=0.98$ $p<0.0001$ and $r=0.96$ $p<0.0001$, respectively). A p value <0.05 was considered to indicate statistical significance.

RESULTS

Baseline characteristics of the both groups are shown in Table-I. Mean age, systolic and diastolic blood pressures were significantly higher in the elderly population than the control group. Mean heart rate, body mass index were similar in both groups. All participants were in sinus rhythm. The number of leads in which P wave duration could be measured was similar in both groups (range 9 to 12). Pmax wave duration and PWD were significantly higher in group-1 than those of group-II. (98±8 vs. 93±8 p=0.01, 41±12 vs. 34±13 p=0.002, respectively; Figure-I and II)

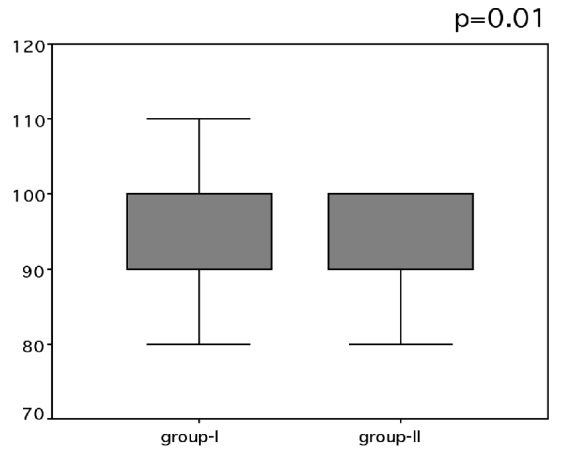

Figure 1: Comparison of maximum P wave duration in both groups. Group-I: Elderly subjects, Group-II: Young subjects.

However, there was no significant difference in Pmin duration. (57±10 vs. 59±10 p=0.4). Among the

Table 1: General characteristics of study subjects

Variable	Group-I	Group-II	p values
Number (male/female)	48/35	26/14	NS
Age, years	75±8	37±6	<0.001
Body mass index, kg/m2	27±7	28±5	NS
Systolic blood pressure, mmHg	142±25	130±16	0.01
Diastolic blood pressure, mmHg	83±15	78±7	0.01
Heart rate, beats/min.	77±11	79±11	NS

NS: Statistically not significant

elderly population, when those with cardiovascular disorders such as hypertension, CAD and heart failure were excluded; Pmax and PWD were still significantly higher than the young population. (Pmax: 98±7 vs. 93±7 p=0.02 and, PWD: 42±11 vs. 34±13 p=0.002). Moreover, on correlation analysis a positive correlation was detected between age and Pmax and PWD (r=0.29, p=0.004, r=0.30 p=0.003 respectively) (Figure-III and IV).

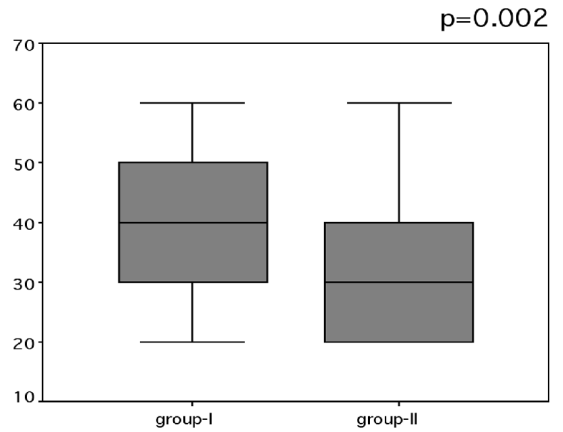

Figure 2: Comparison of P wave dispersion in both groups. Group-I: Elderly subjects, Group-II: Young subjects.

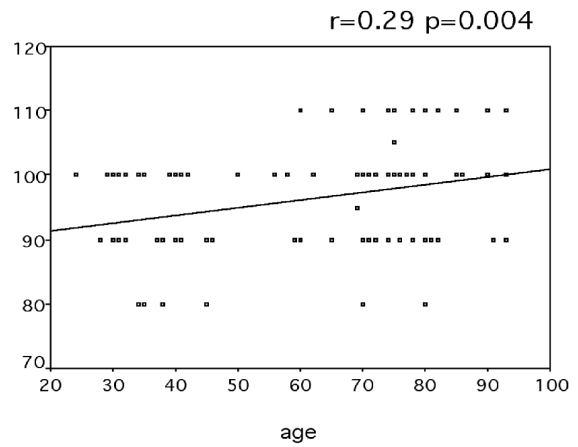

Figure 3: The relationship between P wave duration and age.

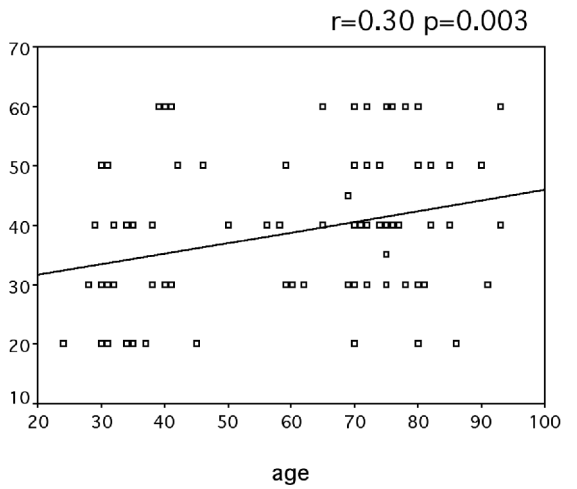

Figure 4: The relationship between P wave dispersion and age.

DISCUSSION

The present study demonstrates that P wave duration and dispersion increase with aging and there may be a close correlation between PWD and aging. Previously, P wave duration changes have been shown in a variety of cardiac conditions such as diastolic dysfunction, myocardial ischemia, and acute coronary syndromes (7-9). However, the relationship between aging and P wave duration and PWD has not been well defined to date. Therefore, we attempted to investigate the age-related changes in P wave duration and PWD.

Abnormalities of the 12- lead ECG are common in the elderly. It has been suggested that shifts in the frontal plane axis, interventricular conduction defects (including lengthening of the PR interval) and a reduction in QRS voltage may reflect normal aging. A large community-based study of 5150 persons aged over 65 years determined the prevalence of major ECG abnormalities in those who had and those who did not have a history of hypertension or CAD. Major ECG abnormalities were defined as: ventricular conduction defects, major Q-QS waves, left ventricular hypertrophy, isolated major ST-T wave abnormalities, atrial fibrillation, first-degree atrioventricular block (10). In addition,

AF is one of the most common arrhythmias observed in advanced ages and increases in an age dependent fashion whether or not there is a history of heart disease. Accordingly, PWD is a simple and new electrocardiographic marker that has been proposed to identify patients at risk for paroxysmal AF (11,12). It has been reported to be associated with the inhomogeneous and discontinuous propagation of sinus impulses and the correlation between the presence of intraatrial conduction abnormalities and the induction of paroxysmal AF has been well documented (5,6,11,12). Our findings indicate that that PWD is increased and P wave duration is prolonged in the elderly population, regardless of the presence of heart disease.

The underlying mechanism for the increase in PWD is uncertain but it is likely to be associated with structural and physiologic changes seen in the cardiovascular system in advanced ages. These changes occur either in the cardiac conduction system or in the cardiac anatomy. There is an age-dependent decline in the number of myocytes, owing to fibrosis and cellular atrophy. By the age of 75 sinus node cells may be as few as 10% of the number present at age 20 (13). Aging influences the structure and electrophysiologic properties of the atria. With increasing age, the atria become enlarged and the myocardium is infiltrated by collagen and amyloid, along with the prolongation of refractoriness(14-17). Thus, degenerative changes in the structure and electrical activity of atrium may result in prolonged P wave duration and increased PWD.

On the other hand, the incidence of significant CAD without symptoms, namely silent myocardial ischemia increases with aging. However only about 20 percent of people older than 80 have clinically evident CAD and over 50 percent have significant CAD at autopsy(18,19). Accordingly, a close association has been shown between myocardial ischemia and P wave duration and PWD(8,9). Consequently, increase in PWD might have resulted from silent ischemia frequently observed in the elderly population.

Neurohumoral systems relevant to cardiovascular regulation are uniformly affected by aging: the sympathetic nervous system is overactive and circulating level of vasopression and atrial natriuretic factor are enhanced, while the activity of the renin-angiotensin system is blunted (20-22). On the other hand, the autonomic nervous system has been proposed to be involved in the genesis of AF, which has been classified according to increased vagal tone or adrenergic tone (23). P wave duration and PWD have been reported to be influenced by the autonomic tone, which induces changes in the velocity of impulse propagation (24). Also, Tukek et al.(25) observed that PWD and Pmax were increased in patients with paroxysmal AF when compared with controls and that Valsalva maneuver normalized these changes and concluded that increased sympathetic activity may cause significant increase in PWD. Therefore, neurohumoral factors and altered autonomic system regulation occuring in advanced ages may be the other reasons that may facilitate development of intraatrial conduction abnormalities.

Study Limitations

There are some limitations of the study. To assess PWD we used 12 leads-ECG, instead of signal averaged electrocardiogram which measures PWD more accurately (26). Therefore, measurement errors performed during manual evaluation is the main limitation of the study. However, manual measurement of PWD has been well accepted and has been used in several studies (5,6,27). Moreover, our inter and intra-observer measures yielded minimal variability. In addition, we studied on an extremely heterogeneous population and the diagnosis of CAD and rhythm disturbances were excluded solely depending on the clinical history and physical examination. In fact, we did not perform further noninvasive examination such as 24-hour Holter monitorization or treadmill exercise test. However, when we excluded those with cardiovascular risk factors, PWD was still significantly higher in the elderly subjects compared to those of healthy subjects. Therefore, we think that increased PWD and prolonged P wave duration is not affected from confounding factors.

In conclusion, our study shows that PWD follows an age-dependent increase and may be an early predictor of AF development in advanced ages. Structural and physiologic changes involving conduction system, silent myocardial ischemia and blunted autonomic regulation of the heart appear to be main responsible mechanisms.

REFERENCES

1. *Fleg JL, Kennedy HL. Cardiac arrhythmias in a healthy elderly population: Detection by 24-hour ambulatory electrocardiography. Chest 1982; 81:302-307.*

2. *Kannel WB, Abbot RD, Savage DD, McNamara PM. Coronary heart disease and atrial fibrillation: The Framingham Study Am Heart J 1983;106:389-396.*

3. *Yamashita T, Murakawa Y, Hayami N, et al. Relation between aging and circadian variation of paroxysmal atrial fibrillation. Am J Cardiol 1998; 82:1364-1367.*

4. *Altunkeser BB, Ozdemir K, Gok H, Temizhan A, Tokac M, Karabag T. Can P wave parameters obtained frm 12-lead surface electrocardiogram be a predictor for atrial fibrillation in patients who have structural heart disease? Angiology 2003;54:475-9.*

5. *Dilaveris PE, Gialafos EJ, Andrikopoulos GK, et al. Clinical and electrocardiographic predictors of recurrent atrial fibrillation. Pacing Clin Electrophysiol 2000;23:352-358.*

6. *Dilaveris PE, Gialafos EJ, Sideris S, et al. Simple electrocardiographic markers for the prediction of paroxysmal idiopathic atrial fibrillation. Am Heart J 1998135:733-738.*
7. *Gunduz H, Binak E, Arinc H, et al. The relationship between P wave dispersion and diastolic dysfunction. Texas Heart Inst Journal 2005;32:163-165.*
8. *Myrianthefs MM, Ellestad MH, Startt-Selvester RH, Crump R. Significance of signal-averaged P-wave changes during exercise and correlation with angiographic findings. Am J Cardiol 1991;68:1619-1624.*
9. *Myrianthefs MM, Shandling AH, Startt-Selvester RH, et al. Analysis of the signal-averaged P-wave duration in patients with percutaneous coronary angioplasty-induced myocardial ischemia. Am J Cardiol 1992;70:728-732.*
10. *Furberg CD, Manolio T, Psaty BM, et al. Major electrocardiographic abnormalities in persons aged 65 years and old. Am J Cardiol 69:1329-1335, 1992.*
11. *Buxton AE, Waxman HL, Marchlinski FL, Josephson ME. Atrial conduction: Effects of extrastimuli with and without atrial dysrhythmias. Am J Cardiol 1984;54:755-61.*
12. *Leier CV, Meacham JA, Schall SF. Prolonged atrial conduction: A major predisposing factor to atrial flutter. Circulation 1978; 57:213-216.*
13. *Wei JY: Age and the cardiovascular system. New Eng J Med 1992;327:1735-1739.*
14. *Folkow B, Svanborg A: Physiology of cardiovascular aging. Physiol Rev 1993; 73:724-764.*
15. *Kavanagh KM, Wyse DG, Mitchell LB, Duff HJ. Cardiac refractoriness. Age-dependence in normal subjects. J Electrocardiol 1989;22:221-225.*
16. *Lakatta EG, Mitchell JH, Pomerance A, Rowe GG. Human aging: changes in structure and function. J Am Coll Cardiol 1987;10 suppl A:42A-47A.*
17. *Mitchelucci A, Padeletti L, Fradella GA, et al. Aging and electrophysiologic properties in man. Int J Cardiol 1984,5:75-81.*
18. *Elveback L, Lie JT. Continued high incidence of coronary artery disease at autopsy in Olmsted County, Minnesota 1950 to 1979. Circulation 1984;70:345-349.*
19. *Wenger NK. Cardiovascular disease in the elderly. Curr Probl Cardiol 1992;17:609-690.*
20. *Ferrari AU. Modifications of the cardiovascular system with aging. Am J Geriatric Cardiol 2002;11:30-33.*
21. *Fukusaki C, Kawakubo K, Yamamato Y. Assesment of primary effect of aging on heart rate variability in humans.Clin Auton Res 2000;10:123-130.*
22. *Seals DR, Esler MD. Human ageing and sympathoadrenal system. J Physiol 2000, 528:407-417.*
23. *Coumel P. Neural aspect of paroxismal atrial fibrillation. In: falk RH, Podrid PJ, editors, Atrial Fibrillation: mechanisms and management, New York:Raven Press, 1992, pp 109-125.*
24. *Cheema AN, Ahmed MW, Kadish AH, Goldberger JJ. Effects of autonomic stimulation and blockade on signal-averaged P wave duration. J Am Coll Cardiol 1990; 26:497-502.*
25. *Tukek T, Akkaya V, Demirel S, et al. Effect of valsalva maneuver on surface electrocardiographic P wave dispersion in paroxysmal atrial fibrillation. Am J Cardiol 2000; 85: 896-899.*
26. *Guidera SA, Steinberg JS. The signal-averaged P wave duration: a rapid and noninvasive marker of risk for atrial fibrillation. J Am Coll Cardiol 1993;21:1645-1651.*
27. *Aytemir K, Ozer N, Atalar E, et al. P wave dispersion on 12-lead electrocardiography in patients with paroxysmal atrial fibrillation. Pacing Clin Electrophsiol 2000; 23:1109-1112.*