Comparison of the Predictors for Atrial Rhythm Disturbances between Trained Athletes and Control Subjects

OSMAN KARAKAYA, MUSTAFA SAGLAM, IRFAN BARUTCU, ALI METIN ESEN, YUCEL OCAK, MEHMET MELEK, DAYMI KAYA, MUHSIN TURKMEN, ERSEL ONRAT, NIHAL OZDEMIR and CIHANGIR KAYMAZ

Kosuyolu Heart Education and Research Hospital, Department of Cardiology, Istanbul, Turkey,

Kocatepe University, Department of Sport College, Afyon, Turkey, and

Kocatepe University, Faculty of Medicine Department of Cardiology, Afyon, Turkey

KARAKAYA, O., SAGLAM, M., BARUTCU, I., ESEN, A.M., OCAK, Y., MELEK, M., KAYA, D., TURKMEN, M., ONRAT, E., OZDEMIR, N. and KAYMAZ. C. Comparison of the Predictors for Atrial Rhythm Disturbances between Trained Athletes and Control Subjects. Tohoku J. Exp. Med., 2005, 207 (2), 165-170 —— Atrial rhythm disturbances, particularly atrial fibrillation (AF), are frequently encountered in trained athletes. P wave dispersion (PWD) is a recent electrocardiographic (ECG) marker that reflects velocity of atrial impulse propagation. However, it remains unknown whether the P wave duration and PWD are different between athletes and sedentary controls. In this study we therefore determined the P wave duration and PWD, markers for conduction abnormalities, in trained athletes and controls. Fifty athletes and sex and age-matched 40 healthy sedentary controls were included in the study. All of the athletes were the members of a local athletic college and they were regularly maintaining their sportive activities; the duration of athletic competition was 7.7 ± 3.3 years and the average athletic time was 10.1 ± 1.6 hours/week. The 12-lead surface ECG was obtained from each subject in the supine position. The P wave duration was measured, and the difference between the maximum and minimum P wave duration was defined as the PWD. Distribution of sex, age, body mass index, blood pressure was similar in athletic groups and controls. Heart rate was significantly lower in the athletes than in the controls (66 ± 7 vs 73 ± 9 beats/min, p < 0.05). Maximum and minimum P wave durations were not statistically different in athletic group and controls (115 ± 6 vs 114 ± 4 ms and 74 ± 8 vs 74 ± 7 ms, respectively). In addition, PWD did not differ significantly in both groups (41 ± 6 vs 40 ± 7 ms, respectively). Thus, athlete’s heart is not associated with prolonged P wave duration and increased PWD, indicating that P wave duration or PWD could not be used as a predictor for AF developed in trained athletes. ——— athlete’s heart; P wave dispersion; atrial fibrillation

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Received June 13, 2005; revision accepted for publication July 28, 2005.
e-mail: drkarakaya@yahoo.com
Top-level athletes often exhibit morphologic changes in the heart, including increases in the left ventricular chamber size, wall thickness, and mass, called “athlete’s heart” (Pelliccia and Maron 1997). The athlete’s heart has been shown to be associated with rhythm and conduction alterations, QRS voltage changes caused by ventricular hypertrophy, and repolarization abnormalities, as a consequence of morphologic and physiological cardiac adaptation that occurs with regular physical training (Huston et al. 1985; Kasikcioglu et al. 2005). In contrast, we have recently showed that QT interval duration and dispersion is not different in trained athletes and control subjects (Turkmen et al. 2004). However, it has been shown that highly trained athletes may be more susceptible particularly to some types of arrhythmias, such as bradyarrhythmia and atrial fibrillation (AF) (Coumel 1996; Furlanello et al. 1998).

P wave duration and dispersion (PWD), defined as the difference between maximum and minimum P wave duration, are the new electrocardiographic (ECG) markers that reflect velocity of atrial impulse propagation (Dilaveris et al. 2000; Dilaveris and Gialofos 2001). P wave duration and PWD have been reported to be influenced by the autonomic tone, which induces changes in atrial size and the velocity of impulse propagation (Dilaveris et al. 1998, 2000). Furthermore, prolonged P wave duration and increased PWD have been reported to represent a risk for AF (Dilaveris et al. 1998; Aytemir et al. 2000). Therefore, taking together with the high prevalence of AF in trained athletes, we have speculated that P wave duration and PWD might be altered in athlete’s heart and compared P wave duration and PWD in trained athletes and healthy sedentary control subjects.

**Materials and Methods**

**Subjects**

A total of 50 well-trained athletic students (16 soccer players, 12 runners, 7 wrestlers, 5 basketball players, 5 badminton players, 3 cyclists, 2 handball players) with a training history of many years were included in the study. All of the athletes were the members of a local athletic college and they were regularly maintaining their sporting activities and training programs on direction of the experienced trainers. Forty sex and age matched healthy sedentary subjects consisted of control group. A detailed history was taken and each participant underwent a systemic physical examination to exclude cardiovascular or other relevant disease before attending to the study. Those who had the history of overt cardiovascular or any other systemic disorders and those on medications known to alter cardiac conduction were excluded from the study. The study protocol was approved by the ethic committee of Kocatepe University Faculty of Medicine and all participants gave their informed consent.

**Measurement of P wave duration and dispersion**

From all participants 12-lead surface ECG recorded at a paper speed of 50 mm/s and 2 mV/cm standardization for 2 consecutive cycles were obtained in supine position after 15 min rest. 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 P wave duration was measured, and the difference between the maximum and minimum P wave duration was defined as the PWD. At least three consecutive beats were measured in each lead. All P-waves were checked for noise and if it was not clear, the examination was repeated. 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 (maximum and minimum P wave duration and PWD) were performed in duplicate on two separate days and by two independent observers who were unaware of the order of electrocardiograms. Intra and inter-observer coefficients of variation (standard deviation [s.d.] of differences between two observations divided by the mean value and expressed in percent) were found as 4.3% and 4.4% for maximum P wave duration and 4.4% and 4.5% for PWD, respectively.
Statistical analysis

Statistical analysis was performed with SPSS for Windows version 10.0 (SPSS Inc., Chicago, IL, USA). Data are presented as mean ± s.d. For continuous variables Student t-test and for categorical changes chi-square test was used. A p value < 0.05 was considered to indicate statistical significance.

RESULTS

Distribution of sex, age, body mass index, blood pressure was similar in athletic groups and controls (Table 1). The duration of athletic competition was 7.7 ± 3.3 years and the average athletic time was 10.1 ± 1.6 hours/week in the athletic group. Left ventricle systolic-diastolic diameters, ejection fraction, left-right atrial diameter and right ventricle diastolic diameter was similar in athletic groups and controls. However, left ventricle posterior wall thickness and interventricular septum thickness were significantly higher in athletic groups than controls (Table 1). All members had sinus rhythm. Heart rate was significantly lower in the athletes than in the controls (66 ± 7 vs 73 ± 9 beats/min, p < 0.05). Both groups had no any rhythm disturbance and conduction abnormality. The number of the leads in which P wave duration could be measured ranged from 8 to 12 leads. Maximum and minimum P wave duration was found to be similar in athletic group and control group. In addition, PWD did not differ significantly between the two groups (Table 2).

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<th>Table 1. General characteristics of study subjects</th>
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<td>Variable</td>
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<tr>
<td>Number (male/female)</td>
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<tr>
<td>Age (years)</td>
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<tr>
<td>Body mass index (kg/m²)</td>
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<td>Systolic blood pressure (mmHg)</td>
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<td>Diastolic blood pressure (mmHg)</td>
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<td>Heart rate (beats/min)</td>
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<td>LVDd (cm)</td>
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<td>LVDs (cm)</td>
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<td>EF (%)</td>
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<td>LVPWd (cm)</td>
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<td>IVSd (cm)</td>
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<td>LA (cm)</td>
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<td>RA (cm)</td>
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<td>RV (cm)</td>
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NS, statistically not significant; LVDd, left ventricle diastolic diameter; LVDs, left ventricle systolic diameter; EF, ejection fraction; LVPWd, left ventricle posterior wall thickness in diastole; IVSd, interventricular septum thickness in diastole; LA, left atrial diameter; RA, right atrium diameter; RVDd, right ventricle diastolic diameter.

<table>
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<tr>
<th>Table 2. Comparison of the P wave duration and dispersion in athletic group and control group</th>
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<td>Variable</td>
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<tr>
<td>Maximum P wave duration, ms</td>
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<td>Maximum P wave duration, ms</td>
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<td>P wave dispersion, ms</td>
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NS, statistically not significant.
not differ in athletic group from that of controls (Table 2). When the ECG parameters were compared between men and women, no statistically significant difference was observed in both groups.

**DISCUSSION**

It is well known that high intensity dynamic endurance sports are usually associated with the rhythm and conduction abnormalities, which result from the lower intrinsic heart rate and/or changes in parasympathetic and sympathetic tones. Indeed, these morphologic and functional cardiac adaptations induced by physical training may be reflected in several athletes’ ECG variants. Therefore, the 12-lead ECG shows a broad range of abnormal patterns in trained athletes. To clarify the clinical significance of abnormal ECG patterns in trained athletes, Pellicia et al. (2000) compared ECG findings with cardiac morphology as assessed by echocardiography in 1,005 consecutive athletes who were participating in 38 sporting disciplines. Based on a variety of criteria, ECG patterns were distinctly abnormal in 14%, mildly abnormal in 26%, and normal or with minor alteration in 60%. Abnormal ECG was associated with male sex, younger age, endurance sports, and larger cardiac dimensions; structural cardiovascular diseases were rarely responsible for the abnormal ECG patterns in trained athletes. It was concluded that bizarre ECG patterns may be part of athlete’s heart syndrome (Pellicia et al. 2000). These alterations include sinus bradycardia with sinus arrhythmia, sinus pauses with occasional junctional escape beats, first-degree atrioventricular block, and even periods of Mobitz type I second-degree atrioventricular block (Zehender et al. 1990). Viitasalo et al. (1982) compared 35 highly trained male endurance athletes with 35 non-athletic matched controls. Heart rate was lower in athletes throughout the day and night, sinus pauses exceeding 2.0 occurred in 37.1% and 5.7%, respectively, with the longest PP intervals of 2.76 s and 2.6 s. First degree atrioventricular block and second degree Mobitz type I block occurred more frequently in athletes. Atrioventricular dissociation and Mobitz type II block were not observed in controls but did occur in athletes. In addition, AF is one of the most common abnormal arrhythmia in the athletes (Coumel 1996; Furlanello et al. 1998). Also, morphologic P wave changes such as notching and increase in amplitude are frequently noticed as a consequence of atrial enlargement (Fagard 2003). However, in trained athlete whether P wave duration and PWD differs from that of sedentary control subjects has not been studied to date. We have speculated that P wave duration and PWD might be altered in trained athletes because of high prevalence of AF and as a consequence of atrial enlargement in this group. We therefore attempted to compare P wave duration and PWD in athletes and sedentary control subjects and we noted that maximum P wave duration and PWD were not different in trained athletes compared to sedentary control subjects.

Cardiac arrhythmias seen in athletes range from the benign and asymptomatic to the symptomatic and even to those that are life-threaten. Athletes may be more susceptible to certain arrhythmias such as bradyarrhythmias, because of the high resting vagal tone (Balady et al. 1984; Smith et al. 1989; Zehender et al. 1990). Vagal tone influences both sinus node and atrioventricular nodal function, thereby leading to bradycardia. It is thought that athletes are more vulnerable to AF because of their high vagal tone and consequent bradycardia is like by to cause dispersion of atrial repolarization (Coumel 1996; Furlanello et al. 1998). Among the factors that can facilitate AF is depressed intratrial conduction, which would manifest itself as lengthening of the P wave duration (Buxton et al. 1984). A previous study has been shown that patients with AF have a greater increase in atrial size than those without AF as the atrioventricular interval shortened (Chen et al. 1999). Accordingly, it has also been shown that elite junior athletes have a significantly greater maximal left ventricle wall thickness, end-diastolic cavity size, and mass as well as left atrial diameter, when compared with controls (Sharma et al. 2002). Therefore, it would be expected that P wave duration and PWD could be increased in athlete’s heart. In contrast, we found no differ-
ence with respect to P wave duration and PWD in athletic and control group. However, previous reports have suggested that left atrial maximal diameter is not a significant predictor of AF episodes and there is no correlation between filtered P wave duration and atrial enlargement (Dilaveris et al. 2000; Ishimoto et al. 2000). This may in part be responsible for our failure to observe an increase in P wave duration and PWD in athletic group compared with controls. From the clinical point of view our results suggest that although frequency of AF is high among trained athletes, P wave duration and PWD could not be used as a predictor of AF developing in athletes.

Study limitations

PWD measurement errors done with manual evaluation may be a potential bias for observed results. However, to improve accuracy all measurements were performed with magnifying lenses for defining the electrocardiogram deflection and manual measurement of P wave dispersion has been well accepted and used in several studies (Dilaveris et al. 1998, 2000; Aytemir et al. 2000). To minimize measurement errors all measurements were performed in duplicate on two separate days and by two independent observers blinded to order of ECG. Moreover, our intra and inter-observer measures yielded minimal variability. On the other hand, we studied on a limited number, young and heterogeneous population, and we did not perform subgroup analysis among the athletes because each group did not contain enough athletes. Therefore, our results could not be extrapolated to the all elite athletes and should be interpreted with caution. In addition, measurement of P wave duration and PWD was performed on resting ECG records. Indeed, AF has frequently been observed during or after effort (Furlanello et al. 1998) and therefore if we had measured P wave duration and PWD after effort, a statistical significance could be achieved between athletic group and controls.

Conclusion

We conclude that athlete’s heart is not associated with prolonged P wave duration and increased PWD when compared to sedentary control subjects. Therefore, P wave duration and PWD could not be used as predictors for AF in athletes, although AF has been frequently observed in trained athletes. However, further large scale studies and long-term follow-up are needed to clarify the mechanism and predictors of atrial arrhythmia in athlete’s heart syndrome.

References


Pelliccia, A. & Maron, B.J. (1997) Outer limits of the athlete’s heart: the effect of gender and relevance to the differential