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Increased P wave dispersion in high performance soccer players and its relationship with sport practice time

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ARTICLE INFORMATION

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Acronyms
AF: atrial fibrillation
Pd: P-wave dispersion
Pmáx: maximum P wave
Pmín: minimum P wave

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ABSTRACT

Introduction y Objetive: P wave dispersion and its maximum duration have been linked with increased risk for developing atrial fibrillation. These variables have been little studied in elite athletes. Our objective was to characterize the P wave dispersion and its maximum duration in high performance soccer players, and correlate them with other variables.

Method: Cross-sectional study conducted at the end of the preparation period (December 2010), prior to the national championship. 24 athletes of the provincial soccer team of Villa Clara, Cuba were studied. Electrocardiographic variables were measured with manual digital caliper.

Results: Mean age of athletes was 24.04 ± 4.72 years and the average sport practice time was 13.38 years. The athletes studied showed higher values of maximum P wave duration (111.57 ms *vs.* 96.0 ms, P <0.001) and P wave dispersion (49.26 ms *vs.* 38.0 ms, P = 0.006). There was a positive and significant correlation between the dispersion of such wave and sport practice time (r = 0.52, p = 0.009).

Conclusions: P wave dispersion and its maximum duration are increased in the soccer players studied, so there is a positive linear correlation between the former and sport practice time.

Key words: Electrocardiogram, Soccer players, P-wave dispersion

Dispersión de la onda P incrementada en futbolistas de alto rendimiento y su relación con el tiempo de práctica deportiva

RESUMEN

Introducción y Objetivo: La dispersión de la onda P y su máxima duración se han vinculado con el riesgo incrementado para desarrollar fibrilación auricular. Estas variables han sido escasamente estudiadas en deportistas de elite. El objetivo fue caracterizar la dispersión de la onda P y su máxima duración en futbolistas de alto rendimiento, y correlacionarlas con otras variables.

Método: Estudio de corte transversal realizado al final de la etapa de preparación (diciembre 2010), previo al campeonato nacional. Se estudiaron 24 atletas del equipo provincial de fútbol de Villa Clara, Cuba. Las variables electrocardiográficas fueron medidas con cáliper digital manual.

Resultados: La media de edad de los atletas fue de 24,04 ± 4,72 años y el tiempo promedio de práctica deportiva, 13,38 años. Los atletas estudiados mostraron valores más elevados de máxima duración de la P (111,57 ms *vs.* 96,0 ms; p < 0.001) y de dispersión de la onda P (49,26 ms *vs.* 38,0 ms; p= 0.006). Existió una correlación positiva y significativa entre la dispersión de dicha onda y el tiempo de práctica deportiva (r=0,52; p=0.009).

Conclusiones: La dispersión de la onda P y su máxima duración están incrementadas en los futbolistas estudiados, por lo que existe una correlación positiva y lineal entre la primera y el tiempo de práctica deportiva.

Palabras clave: Electrocardiograma, Jugadores de fútbol, Dispersión de la onda P

INTRODUCTION

Atrial fibrillation (AF) is the only arrhythmia that is more common in athletes in comparison with the general population, particularly in veteran athletes who have trained intensively for years. Practicing sports like swimming, cycling or soccer in a continuous, intense and prolonged way, triples the risk of long-term AF. In most cases this chronic arrhythmia is due to hypertension, advanced age or underlying heart disease, but in 30 per cent of cases it occurs in the absence of structural heart disease or other identifiable causes of arrhythmia[1].

The prolongation of intra-and interatrial conduction times is translated as inhomogeneous propagation (electrical heterogeneity) of the sinus impulse which is characteristic in patients with paroxysmal AF[2]. It has also been proved that P-wave dispersion (Pd) is a sensitive and specific ECG marker which allows a better identification of patients with paroxysmal history of lone AF and healthy subjects[3].

However, Pd research has not been widely developed in the context of high performance sport. In a recent study, conducted by our group, it was found that this parameter was prolonged in elite athletes with years of sports experience, who practiced water polo, weightlifting and long-distance race[4]. This time it was decided to investigate whether there is also a Pd increase in high performance soccer players and whether this correlates with sport practice time or other variables.

METHOD

Research Classification: Observational, descriptive and transversal study.

Study population and sample

The 24 athletes members of the provincial soccer team of Villa Clara, first category, with training based at the Manuel "Piti" Fajardo Institute of Physical Culture in Villa Clara, Cuba.

Variables studied and their definition

Study variables were obtained at the end of the preparation stage (December 2010) prior to the start of the national championship.

- Maximum P wave (Pmax): it is the P wave of longest duration found in a 12-lead electrocardiogram tracing.
- Minimum P wave (Pmin): it is the P wave of shortest duration found in a 12-lead electrocardiogram tracing.
- Pd: is the difference between Pmax and Pmin.
- Sport practice time: time gone by, in years, since the beginning of training in such sport until the time of the research.

Also, the following variables were obtained: age, heart rate, height and weight.

Electrocardiograms were digitized by optical scanning and the measurement method was the manual digital caliper. Measurements were made by two electrocardiographists of experience, and when there was a mismatch greater than 10 ms, a third expert was consulted to reach consensus. In the electrocardiographic registry Q waves distorted by artifacts or those overly flat (<0.1 mV), which did not allow adequately

to determine their start and end were discarded.

Statistical Analysis

The mean and standard deviation of all the variables studied were determined, and in order to verify that these had normal distribution the Kolmogorov-Smirnov test was performed. Once normal distribution was demonstrated, the Student's t test for a mean was used, and in this way the values obtained were compared with global reference values[5]. The simple linear correlation, using SPSS version 11.0 for data processing was also performed.

RESULTS

Average age of the soccer players studied was 24.04 ± 4.72 years and average time of sport experience was 13.38 years (Table 1).

Maximum P-wave duration was found in lead aVR (101.20 ± 13.14 ms) and minimum in lead aVL (69.64 ± 22.63 ms). Figure 1 shows the behavior of P-wave duration for each lead.

Athletes studied showed a greater Pmax (111.57 ms vs. 96.0 ms, P <0.001) and Pd (49.26 ms vs. 38.0 ms, P = 0.006) compared to reference values, and the differences observed were significant (Table 2). It was impossible to compare the value of Pmin because there were no recent publications that made reference to that figure.

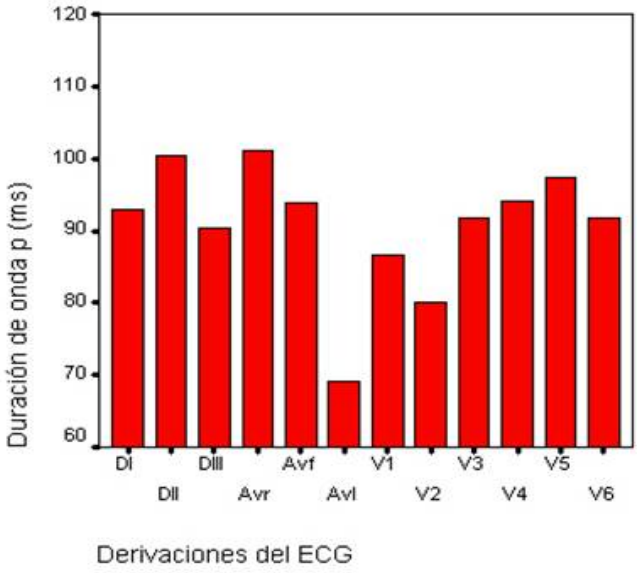

Figure 1. P wave duration, according to the different ECG leads.

Table 3 shows the simple linear correlation coefficients that were obtained by correlating the Pd and Pmax (dependent variables) with independent variables such as age, time of sport practice, weight, height and heart rate. It should be noticed that all correlations were positive, but lacked statistical significance. That is, the correlated independent variables exert a very weak influence on the Pmax and Pd.

However, Figure 2 shows that there is significant positive correlation between Pd and sport practice time (r = 0.52, p = 0.009).

Table 1. General characterization of the athletes studied.

Variables	Mean	Standard Deviation n=24	Maximum value	Minimum value
Age (years)	24,04	± 4,72	36	18
SPT (years)	13,38	± 5,85	25	3
Weight (kg)	73,27	± 9,99	100	61
Height (m)	1,77	± 0,07	189	165

SPT: sport practice time

Table 2. Pmax, Pmin and Pd duration in athletes studied and comparison with established reference values.

P wave (ms)	Athletes n=24	Reference values	P values
Maximum duration	111,57 ± 9,80	96,0 ± 11,0	< 0.001
Minimum duration	62,31 ± 16,13	Not recently published	---
Dispersion	49,26 ± 18,31	38,0 ± 10,0	0.006

DISCUSSION

A study conducted by the *Hospital Clínico de Barcelona* suggests that high-intensity exercise, performed for many

years, may predispose to suffer AF[1], and similar conclusions were offered in a meta-analysis that brought together 665 ex-athletes with a mean age of 51 ± 9 years[6].

Table 3. Correlation coefficients and statistical significance obtained from Pmax and Pd with anthropometric variables.

Variables	Correlation coefficient	P values
Age/Pd	0,315	0.133
Weight/Pd	0,162	0.449
Height/Pd	0,257	0.226
HR/Pd	0,047	0.827
SPT/Pmax	0,182	0.394
Age /Pmax	0,214	0.315
Weight /Pmax	0,206	0.333
Height /Pmax	0,216	0.310
HR /Pmax	0,014	0.949

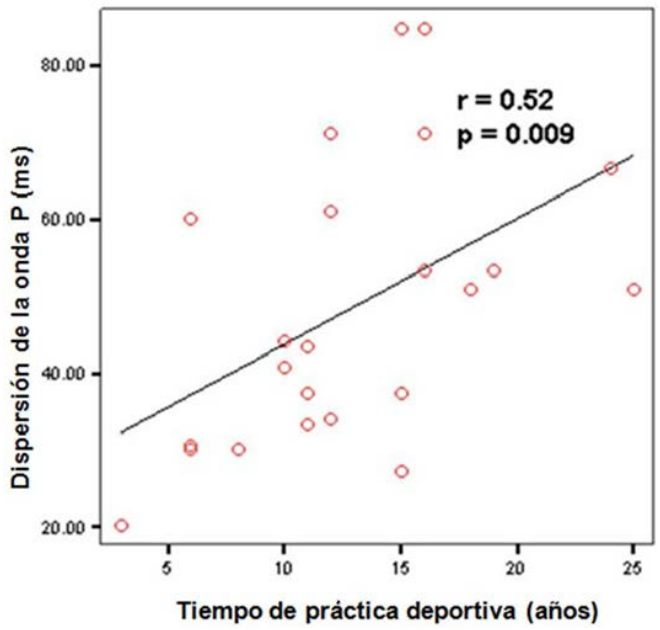

Figure 2. Correlation between sport practice time and P wave dispersion.

Elosua *et al.*[7] observed in a cohort study, a higher incidence of lone AF in marathon runners than in the sedentary general population. It has been noted that time of active sports practice of more than 1500 hours may be associated with lone AF[8].

However, not all studies have been able to find the relationship between AF and its increased prevalence in athletes. Bjornstad *et al.*[9] found no cases of AF or atrial flutter in 30 athletes practicing endurance sports over a 15-year follow-up.

Considering the almost undeniable relationship between high performance sport, especially endurance sports, and AF, a few work groups have been interested in trying to find electrocardiographic predictors of AF occurrence in athletes. The idea is based on the demonstration that Pd and its duration would be useful in this scenario, since it has been useful in others, such as hypertension, obesity and diabetes mellitus as well as in hypertrophic cardiomyopathy[10].

However, it is necessary to establish at the beginning of this field of work which the behavior of these ECG parameters in elite athletes is.

Karakaya *et al.*[11] in their study comparing atrial predictors, concluded that although there are changes in the morphology of the athlete's heart, there are no significant differences between the values of Pmin, Pmax and Pd when comparing the healthy population and trained athletes. They even claimed that these parameters can not be used as predictors of AF in athletes.

A recent study by our group[4], that analyzed three aerobics sports, concluded that there is a relationship between sport practice time and the Pd value, and showed that this dispersion is increased in the high-performance athletes studied with respect to non-athlete healthy controls. Metin *et al.*[12], who studied 27 well-trained female basketball players, documented significant increases in Pd compared with controls (49.07 vs. 41.15 ms), and so occurred with the Pmax (94.62 vs. 86.53 ms).

In the present study we have replicated our previous findings in other sports.

Yirdis *et al.*[13] recently reported that body weight, height and body mass index were correlated with P wave in youth who applied to enter a sports school, similar results were also obtained in the work with female basketball players conducted by Metin *et al.*[12]. In our previous experience the statistical significance of these correlations could not be reproduced[4], and

the same occurred in the present research.

These athletes have spent on average half of their lives practicing soccer intensely, so their hearts have been under different workloads than similar non-athlete subjects. Accordingly, they have undergone electrophysiological changes that have been expressed by the Pmax and Pd prolongation, which is undoubtedly related to the active sport practice as suggested by Figure 2, since apparently there is a cumulative effect.

The significant correlation between sport practice time and Pd shows that as training time goes by, some progressive and adaptive changes in the atrial muscle occur, which can be demonstrated by analyzing this indicator. Our results suggest that there is influence of systematic physical exercise on atrial conduction. The sympathetic stimulation that occurs during exercise is linked to the development of AF[14,15], probably sympathetic stimulation which is more persistent in endurance sports, favors the development of electrical remodeling, even years before morphological changes are detectable by echocardiography. These aforementioned changes when linked to the anatomical ones that the athlete's heart undergoes may be the necessary components for the development of AF.

In our study the increase in Pd was secondary to a significant increase in Pmax. The findings presented are of uncertain significance as they may be part of the athlete's physiology or point to athletes with higher atrial vulnerability to develop AF in the future. Further research is needed to clarify this issue which was not an aim of this study, although it leaves open a new field to work.

The limitations of this study are the small sample size and lack of patient follow-up.

CONCLUSIONS

Pd is increased in the soccer players studied, there is also a positive linear correlation between Pd and sport practice time.

REFERENCES

1. Mont L, Sambola A, Brugada J, Vacca M, Marrrugat J, Elosua R, *et al*. Long-lasting sports practice and lone atrial fibrillation. Eur Heart J. 2002;23(6):477-482.
2. Dilaveris P, Stefanadis C. P wave dispersion: A valuable non-invasive marker of vulnerability to atrial fibrillation. Proceedings of the 2nd ISHNE Atrial Fibrillation Worldwide Internet Symposium; 2007 April 1-30. London: St. Jude Medical; 2007. Disponible en: http://af-symposium.grupoakros.com.ar/2007/lectures/ing_dilaveris_polychronis.pdf
3. Dilaveris PE, Gialafos EJ, Sideris SK, Theopistou AM, Andrikopoulos GK, Kyriakidis M, *et al*. Simple electrocardiographic markers for the prediction of paroxysmal idiopathic atrial fibrillation. Am Heart J. 1998;135(5 Pt 1):733-8.
4. Puerta RC, Aliz EL, Lopez-Calleja MA, Ramirez RR, Peña GP. Increased P wave dispersion in elite athletes. Indian Pacing Electrophysiol J. 2011;11(3): 73-80.
5. Gialafos EJ, Dilaveris PE, Synetos AG, Tsolakidis GF, Papaioannou TG, Andrikopoulos GK, *et al*. P-wave analysis indices in young healthy men: data from the digital electrocardiographic study in Hellenic Air Force Servicemen (DEHAS). Pacing Clin Electrophysiol. 2003;26(1 Pt 2):367-72.
6. Abdulla J, Nielsen JR. Is the risk of atrial fibrillation higher in athletes than in the general population? A systematic review and metaanalysis. Europace. 2009;11(9):1156-9.
7. Elosua R, Arquer A, Mont Ll, Sambola A, Molina L, García-Morán E, *et al*. Sport practice and the risk of lone atrial fibrillation: a case control study. Int J Cardiol. 2006;108(3):332-7.
8. Sorokin AV, Araujo CG, Zweibel S, Thompson PD. Atrial fibrillation in endurance trained athletes. Br J Sports Med. 2011;45(3):185-8.
9. Bjornstad HH, Bjornstad TH, Urheim S, Hoff PI, Smith G, Maron BJ. Long-term assessment of electrocardiographic and echocardiographic findings in Norwegian elite endurance athletes. Cardiology. 2009;112 (3):234-41.
10. Köse S, Aytemir K, Sade E, Can I, Özer N, Amasyali B, *et al*. Detection of patients with hypertrophic cardiomyopathyat risk for paroxysmal atrial fibrillation during sinus rhythm by P-wave dispersion. Clin Cardiol. 2006;26(9):431- 4.
11. Karakaya O, Saglam M, Barutcu I, Esen AM, Ocak Y, Melek M, *et al*. Comparison of the predictors for atrial rhythm disturbances between trained athletes and control subjects. Tohoku J Exp Med. 2005;207(2):165-70.
12. Metin G, Yildiz M, Bayraktar B, Yusecir I, Kasap H, Cakar L. Assessement of the P wave dispersion and durations in elite women basketball players. Indian

Pacing Electrophysiol J. 2010;10(1):11-20.

13. Yildiz M, Aygin D, Pazarli P, Sayan A, Semiz O, Kahyaoglu O, *et al*. Assessment of resting electrocardiogram, P wave dispersion and duration in different genders applying for registration to the school of physical education and sports - results of a single centre Turkish Trial with 2093 healthy subjects. Cardiol Young. 2011;21(5):545-50.
14. Ozdemir O, Soylu M, Demir AD, Topaloğlu S, Alyan O, Geyik B, *et al*. P-wave durations in patients experiencing atrial fibrillation during exercise testing. Angiology. 2007;58(1):97-101.
15. Yigit Z, Akdur H, Ersanli M, Okcun B, Guven O. The effect of exercise to P wave dispersion and its evaluation as a predictor of atrial fibrillation. Ann Noninvasive Electrocardiol. 2003;8(4):308-12.