INTERNATIONAL JOURNAL OF SOCCER AND SCIENCE
Volume 2 – Number 1 – 2004
ISSN: 1409-4444

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UNIVERSITY OF COSTA RICA

International Journal of Soccer and Science®
Volume 2, N° 1, 2004

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VALIDITY OF LACTIC ACID IN AN INTERVAL STRESS TEST (PROBST TEST) TO DETERMINE A SOCCER PLAYER´S ANAEROBIC THRESHOLD

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ABSTRACT

García López, J.; Rodríguez Marroyo, J.A.; Morante Rábago, J.C.; González Montesinos, J.L.; Mora Vicente, J. y Villa Vicente, J.G.(2004). Validity of Lactic Acid in an Interval Stress test (Probst Test) to Determine a Soccer Player´s Anaerobic Thresholdr. **International Journal of Soccer and Science, 2(1), 3-19**. *The objective was to prove the validity of incremental, progressive, maximum and discontinuous strength protocols in order to evaluate the anaerobic, interval and specific threshold (UAn) of professional soccer players through a course that simulates the effort produced during this sport. For this, the UAn was determined in 23 players from Spain's Professional Soccer League (First Division) who took the Probst Test and 48 hours later took the Lactic Acid Test on the soccer field using the same course. The results show elevated and important correlations ($r=0.79$ and $p<0.001$) between the heart rates and cardiac rhythms in the UAn that were obtained in both tests. For the Probst Test, the UAn was identified both manually through mathematics, the first being the one that was most closely related to the Lactic Acid Test, especially when analyzing the UAn speed. It was concluded that the Probst Test is a valid field test to determine the UAn interval of soccer players as an indicator of the player's own specific level of resistance. This finding allows work groups to determine the percentage of improvement in the player's resistance during sensitive periods such as preseason or evaluate the physical fitness level of the player throughout the season.*

Key words: *Soccer, Anaerobic Threshold, Probst, Lactic Acid, Cardiac Rhythm*

INTRODUCTION

The anaerobic metabolism is very important not only in individual sport disciplines of medium and long duration (more than 10 minutes), but also in sports that require an extended effort of more than 2 minutes: running, swimming, cycling, rowing, skiing… (Bergh and cols., 2000; MacDougall and cols., 1991; López and Legido, 1991). Frequent references can be found that stress the importance of aerobic resistance in collective sports, in general, and in soccer and basketball, in particular (Colli and Faina, 1987; Bangsbo, 1998), since games last between 40 and 90 minutes respectively. In addition, these sports combine the physical actions of both aerobic and anaerobic metabolisms (low and high intensity respectively) (Franco, 1998; Sanuy and cols., 1995).

Although the decisive actions of the sport (speed and number of plays,…) are considered to be anaerobic activities, aerobic resistance can have a greater level of importance during recuperation periods than during the actual strength performance activity (Bangsbo, 1998), especially when considering the randomization involved in the

duration, activity time/pauses, distance and occurrence of intense physical efforts during the game.

As an aerobic resistance indicator, the maximum consumption of oxygen is used (VO2máx) along with the Anaerobic Threshold (UAn) (Wasserman and cols., 1967). The latter proved to be more sensitive to the effects of training (Navarro, 1998) and to a large extent predicted the results of the tests that lasted longer (López and cols., 1995).

There are three basic methodologies for determining the UAn: The Lactic Acid and Ergospirometric Tests and the Cardiac Rhythm (Rodríguez and Aragonés, 1992). A wide range of tests have been designed based on these methodologies (direct and indirect, laboratory and in the field). However, these tests have only been evaluated in individual sports and cyclical and continuous efforts, applying them afterwards to evaluate the UAn in collective sports (George y cols., 1996). For this reason, they do not appear to be specific for sports modalities that are acyclic, discontinuous or involving intervals of effort.

The Probst Test uses an incremental, progressive and maximum protocol with 30 second pauses for recuperation between the running speed and the maximum heart rate for each strength interval (Probst, 1989a; Probst and cols., 1989b). It was created as an adaptation to the Conconi Test (continuous running and cycling in increments of 0,5 Km/h each 200m) in order to evaluate the aerobic resistance of the soccer players (running intervals with increments of 0.6 Km/h each 280 m, with 30 second pauses between intervals). The objective of this work is to prove the validity of this incremental, progressive, maximum and discontinuous strength protocol in order to evaluate the UAn in experienced professional soccer players that are in the maximum category of their sport and compare these results with a classic Lactic Acid Test.

METHODOLOGY

Subjects

23 players from the Real Valladolid S.A.D. Team which is part of the Division I Spanish Soccer League (26.9+-2.9 years of age, 77.2 ± 5.7 Kg y 179.9 ± 5.5 cm) including the team's technical staff participated in this study voluntarily and with their consent.

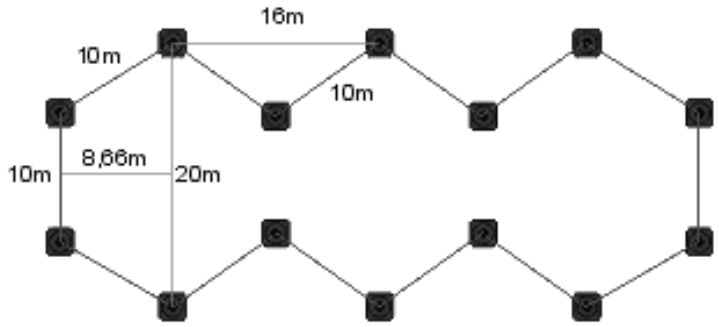
Instrumentation

- Detecto® Scale and Tallymeter (model D52, U.S.A.)
- TVREF-v1.0 ® software for the Probst Test (DSD, León, Spain) (figure-1b).
- Portable Computer: Toshiba Satellite Pro 405CS ® with Sony ENG 203 speakers ®.
- Metric fiberglass tape 10 and 25m (Kangros®).
- 14 Tecnival, S.A. buoys. 10 m between each buoy along the circuit, Figure –1.
- Polar Advantage-NV® Pulsometers (Polar Electro OY, Kempele, Finland).
- 4 automatic article® lancets (Boehringer Mannheim S.A., Germany).
- 50 µl Analox® Capillary Tubes (GMRD-092, Analox Instruments LTD, England).
- Sterilization Material: latex gloves, cotton, alcohol, etc.
- Electroenzymatic Lactate Analyzer by Analox® (P-LM4®, Analox Instruments LTD).

Procedure

10 days after the beginning of preseason, a stress test was performed using the Probst interval methodology (Probst, 1989a). For this, the TVREF-v1.0. software was used. The test consisted of running a cycle that traced figure-1 at an initial speed of 10.8 Km/h, stopping for 30 seconds every 280 m (2 times around the circuit), so that each strength interval began and ended at the same buoy. The speed was increased by 0.6 Km/h for each period. Information about the maximum heart rate (FCMax) and minimum (FCMin) for each period was obtained from this first test; the anaerobic interval threshold (UAnI) was obtained by inflection in the progressive evolution of the maximum heart rate of each of the interval tests (Figures 2a and 2b), both manually and from an observational level (UAnI) as well as through the mathematical model of Tokmakidis and Léger (UAnIM) (Tokmakidis y Léger, 1992).

Figure-1.-Probst Test cycle (adapted from Probst, 1989)



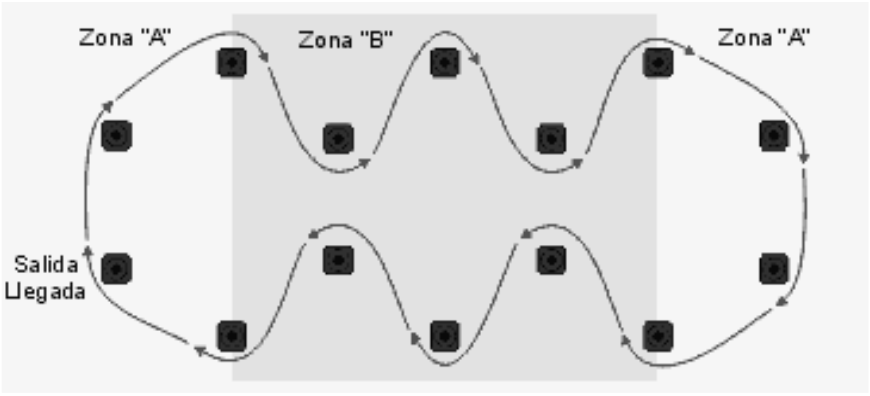


Figure-2a.-Manual determination UAn (UAnI): interval (V-UAnI) velocity and heart rate (FC-UAnI)

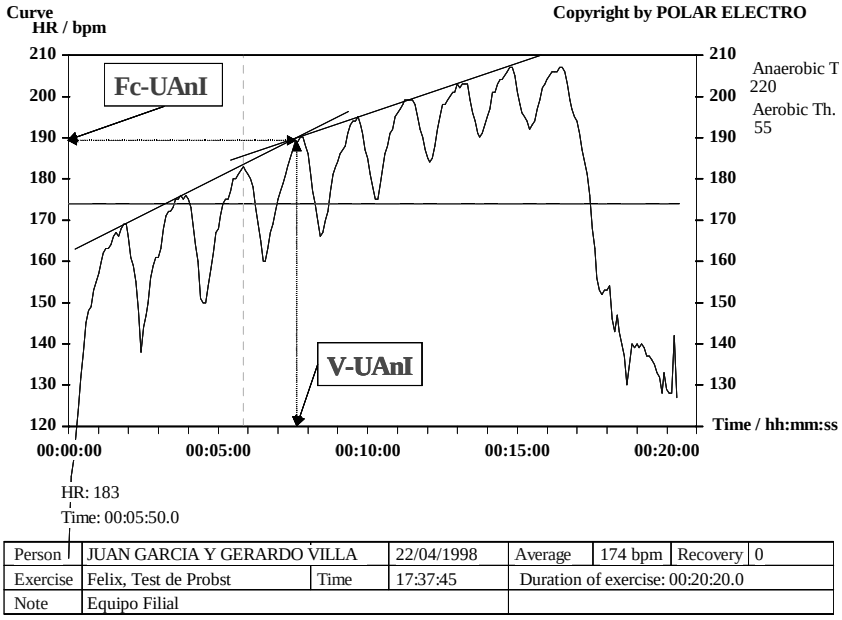
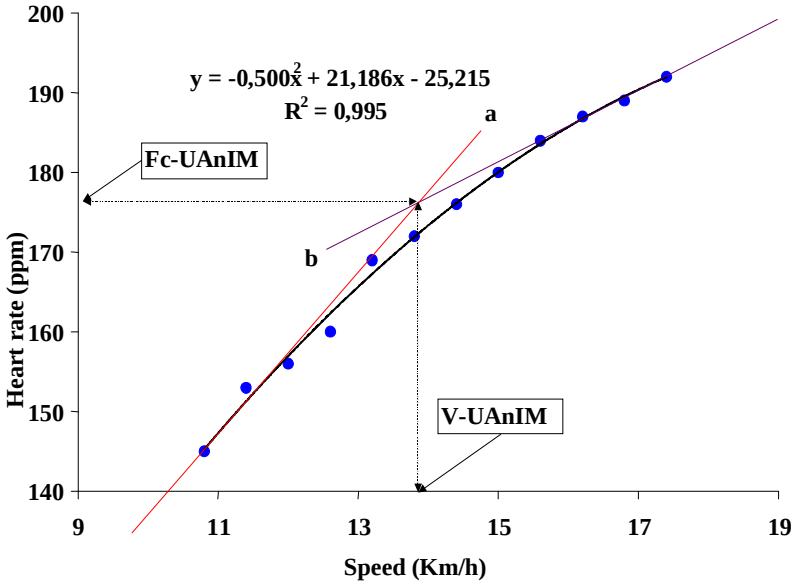
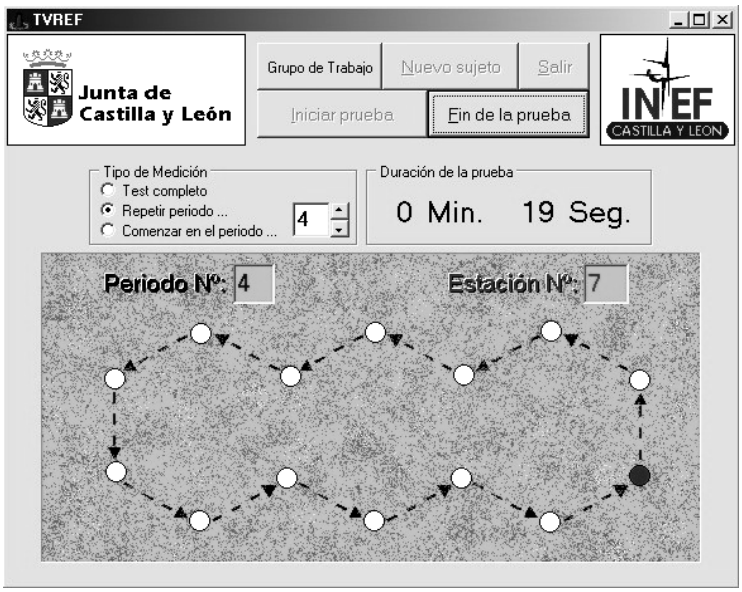


Figure-2b.-Mathematical model (Tokmakidis and Léger, 1992) interval UAn (UAnIM): speed (V-UAnIM) and heart rate (FC-UAnIM)



A tool was designed with the TVREF-v1.0 software for maintaining the speed of a period or stage during a period of time which the evaluator considered timely (Figure 3). After 48 hours, the Lactic Acid Test was performed on the soccer field on the same circuit as the Probst Test. The subjects were asked to complete a minimum of 5 stages with 1.2 Km./h in between each stage (10.8, 12, 13.2, 14.4 and 15.6 Km/h) (Figure-4). Each stage lasted 3 minutes after which there was a rest period for 1 minute in order to take simples of arterialized blood from the earlobe while registering the heart rate (Figure-5). After obtaining the lactic acid for each level (Lac), the lactic anaerobic threshold was determined (UAL) by the Mader methodology, referred to as displacement speed with a lactic acid of 4mmol/l (Mader and cols 1976; López and Legido, 1991).

Figure-3.-Effort protocol screen "Software Repeat period" of TVREF-v1.0.



Before both tests, all of the soccer players performed a warm-up session that was divided into a general warm-up and a pre-game stretch led by the physical trainer. After the pre-game warm-up each soccer player went to the assigned buoy in which a pulsometer was adjusted on them and during the second test the player was prepared for the blood sampling. In order to become familiarized with the displacement rhythm, test circuit, etc., the players did a test run around the sample circuit at a pace that corresponded to the first period of the test. After resolving any possible doubts that arose, the soccer players stretched lightly for 5 minutes before beginning the test.

Figure-4.- Calculus methodology for lactic acid UAn (UAL) to 4 mmol/l. Speed-lactic acid exponential curve and adjust value (R2). Speed within lactic acid UAn (V-UAL)

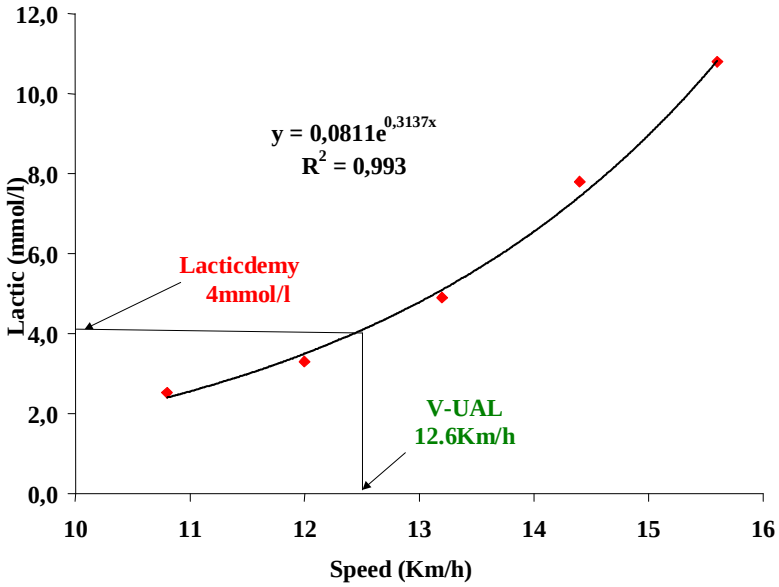
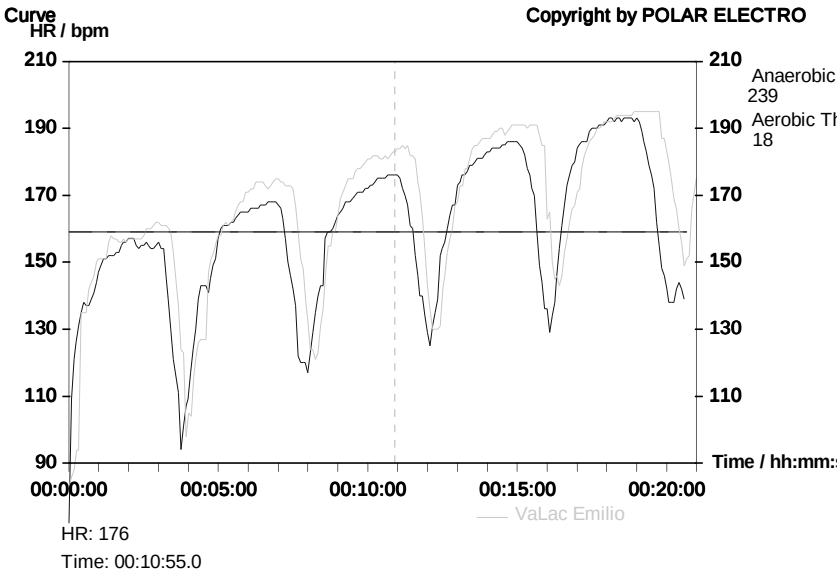


Figure-5.-Heart rate values registered from two soccer players during the realization of the lactic acid test. One of the players completed 5 stages of the test (10.8-12.0-13.2-14.4-15.6 Km/h), and the other completed a 16.8 Km/h stage



Person	JUAN GARCIA Y GERARDO VILLA	Date	19/07/1998	Average	159 bpm	Recovery 0
Exercise	VaLac-Caminero	Time	9:50:01	Duration of exercise: 00:21:39.2		
Note	1,6 - 2,7 - 3,7 - 6,6 - 12,2					

Blood samples for the lactic acid analysis were taken through a microsampling method in which a sample of capillary blood was taken from the earlobe and analyzed by an automatic elecroenzymatic analyzer. Prior to that, the earlobe was made hyperemic after being sterilized with alcohol and massaged with a vasodilating ointment (Finalgon®). The earlobe was then punctured with an autoclix-P® lancet with a sterile micro needle that rapidly penetrated 0.5 cm into the earlobe. Then, approximately 25 µl of capillary blood was obtained in heparinized capillary tubes with fluorides and nitrates in their interior to avoid cellular glycolysis. These capillary tubes were stirred for 3 minutes before the ends were closed and refrigerated for later analysis. 7 µl of blood was needed for each result made by the previously calibrated lactate analyzer. In a graphic processor the exponential increase in lactic acid was determined as a result of the intensity of the effort made (running speed). The speed that corresponded to a lactic acid of 4mmol/l was identified and considered as the lactic acid threshold of the subject (López and Legido, 1991) (Figure-4).

Statistical Analysis

The data regarding the heart rate of the pulsometer transferred to the computer through the Polar Advantage® interface, allowing for an immediate comparison among the different players (Figure-5) since all of the players were connected to the pulsometer at the same time and the periods of effort (progressive increase in the heart rate) were able to be differentiated from the recuperation periods (quick drop in the heart rate).

The graph was elaborated on a Microsoft Excel version 7.0 spreadsheet and the statistics on Statistica version4.5 for Windows. The results show the average and the average error standard. In order to investigate the differences between the variables in the Probst Test and the Lactic AcidTest, a non parametric test has been used for the collected gathered (Wilcoxon). In order to calculate the correlations between the variables the non parametric Spearmen Test was used. The different significance levels of "p" are: n.s. = non significant, $p>0.05$; * = $p<0.05$; ** = $p<0.01$; *** = $p< 0.001$.

RESULTS

Table-1 shows the results obtained during the Probst Test after the 23 soccer players reached a maximum speed of 17.0±0.1 km/h (VMáx-UAnI) and a maximum heart rate of 191±2 ppm (FCMáx-UAnI), which represented 99.4% of the theoretical maximum heart rate (220 – age), the maximum strength index level. It also describes the heart rate at the UAn interval (FC-UAnI), identified in 20 of the 23 soccer players (in other words, in 86.96% of them) at a heart rate of 181±2 ppm, which represented 94.5±0.4% of the maximum heart rate (%FCMáx-UAnI), corresponding to a speed of 14.2±0.2 km/h at the anaerobic interval threshold (V-UAnI), which made up 83.5±1.0% of the maximum speed reached during the test (%V-UAnI).

Table-1.-Heart rate and speeds obtained during the Probst Test. Medium values and E.E.M. Minimum and maximum values (Range)

VARIABLES	N	Medium±E.E.M.	Range
$V_{Máx}$-UAnI (Km/h)	23	17.0±0.1	16.3-18.0
$FC_{Máx}$-UAnI (ppm)	23	191±2	176-201
FC-UAnI (ppm)	20	181±2	164-192
%$FC_{Máx}$-UAnI (%)	20	94.5±0.4	91.5-97.4
V-UAnI (Km/h)	20	14.2±0.2	12.6-16.2
%V-UAnI (%)	20	83.5±1.0	72.4-90.4

Table-2 shows the results of the Lactic Acid Test. This test was performed in 20 of the 23 soccer players (all team members except for the goalies). The data was analyzed by the Probst methodology in 18 of the soccer players in which the anaerobic interval threshold was able to be determined (UAnI) in order to compare the results. The maximum speed reached (VMáx-UAL) was 16.0±0.1 km/h and the maximum heart rate during the test (FCMáx-UAL) was 190±1 ppm, which represents 98.3% of the maximum theoretical heart rate (220 – age). The heart rate corresponded to an intensity effort of 4 mmol/l lactic acid (FC-UAL) and when determined in all of the soccer players it was 174±2 ppm. In other words, 91.5±0.4% of the maximum heart rate reached during the test (%FCMáx-UAL), corresponded to a UAn speed (V-UAL) of 12.6±0.1km/h, which represents 78.6±1.0% of the maximum speed reached during the test (%V-UAL). One can observe in the same table, the average, minimum and maximum values of baseline lactic acid and the different speeds of the Lactic Acid Test.

Table-2.-Heart rates, speed displacements and lactic in the Latic Acid Test. Medium values, E.E.M. and results range

VARIABLES	N	Medium±E.E.M.	Range
$V_{Máx}$-UAL (Km/h)	18	16.0±0.1	15.6-16.8
$FC_{Máx}$-UAL (ppm)	18	190±1	174-198
FC-UAL (ppm)	18	174±2	160-187
%$FC_{Máx}$-UAL (%)	18	91.5±0.4	84.2-95.4
V-UAL (Km/h)	18	12.6±0.1	11.5-13.4
%V-UAL (%)	18	78.6±1.0	72.6-85.9
Lactate-Base (mmol/l)	18	1.1±0.1	0.8-1.3
Lactate-10.8 Km/h (mmol/l)	18	2.5±0.1	1.5-3.5
Lactate-12.0 Km/h (mmol/l)	18	3.3±0.2	2.0-4.4
Lactate-13.2 Km/h (mmol/l)	18	4.9±0.2	3.5-7.0
Lactate-14.4 Km/h (mmol/l)	18	7.8±0.3	5.8-10.9
Lactate-15.6 Km/h (mmol/l)	18	10.8±0.3	7.5-12.2
Lactate-16.8 Km/h (mmol/l)	6	11.7±0.3	10.4-12.2

Table -3 shows the heart rate registered during the Probst Test (FC-PROBST) and the Lactic Acid Test for each of the stages, having analyzed in the latter the maximum cardiac heart rate (FCMed-LAC) at the last minute of each of the stages. When a speed of 14.4 Km/h is reached, the maximum heart rate of the Lactic Acid Test quickens significantly more ($p<0.05$) than the maximum Herat rate registered in the Probst Test. The same occurs at 15.6 Km/h for the maximum heart rate ($p<0.01$) and the average heart rate ($p<0.05$). But it does not reach the intensity of the efforts reached by the Probst Test.

Table-3.-Heart rates registered in the Probst test and in the lactic acid test at different running speeds. Medium values and E.E.M. * = Means statistically significant differences with the maximum heart rates for the same speed ($p<0.05$)

SPEED (Km/h)	n	FC-PROBST (ppm)	$FC_{Máx}$-LAC (ppm)	FC_{Med}-LAC (ppm)
10.8	18	158±2	158±2	157±2
11.4	18	163±2		
12	18	167±2	167±2	167±2
12.6	18	171±2		
13.2	18	175±2	175±2	175±2
13.8	18	178±2		
14.4	18	181±2	183±1*	183±1
15	18	183±2		
15.6	18	186±2	189±2*	188±2*
16.2	17			
16.8	16	189±1	-	-
17.4	8			
18	5	192±2	-	-

When the maximum speeds of the Probst Test (VMáx-UAnI) and the Lactic Acid Test (VMáx-UAL) are compared, it can be observed that the latter is significantly lower than 1.2 Km/h ($p<0.001$). There are also significant differences ($p<0.001$) between the speed at the UAn interval when following the methodology for the Probst Test (V-UAnI) and the speed at the UAn determined by lactic acid methods (V-UAL) which is greater than 1.6 Km/h in the Probst and equivalent to 12.7%.

The maximum heart rates reached after many tests are close to the maximum theoretical heart rate and are not significantly different from each other. However, the heart rate threshold calculated through the Probst Interval Method (FC-UAnI) is 7 ppm above ($p<0.001$) the heart rate threshold calculated by lactic acid methods (FC-UAL).

Table-4 shows the relationship between the maximum heart rate, threshold and maximum speeds and thresholds obtained by the Probst Test and the Lactic Acid Test. In the table, one can appreciate how the dependency of the heart rates in the UAn interval that were determined manually and mathematically (FC-UAnI and FC-UAnIM,

respectively) is significantly elevated (r=0.77 and p<0.001). The same occurs with the lower dependency regarding the speeds at which they are identified (V-UAnI and V-UAnIM, respectively), with the value for r =0.45 y p<0.05.

Table-4.-Relations between speeds and maximum heart rates, speeds and heart rates in the UAn registered in the Probst tests and in the lactic acid test. Statistical significant levels of the corelations (p): n.s = significant; * = p<0.05; ** = p<0.01; *** = p<0.001

VARIABLES	1	2	3	4	5	6	7	8	9
1-$V_{Máx}$-UanI									
2-$FC_{Máx}$-UanI	n.s.								
3-V-UanI	0.45*	n.s.							
4-FC-UanI	n.s.	0.84***	n.s.						
5-V-UanIM	0.56*	n.s.	0.45*	n.s.					
6-FC-UanIM	n.s.	0.89***	n.s.	0.77***	n.s.				
7-$V_{Máx}$-UAL	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.			
8-$FC_{Máx}$-UAL	n.s.	0.86***	n.s.	0.77***	n.s.	0.79***	n.s.		
9-V-UAL	0.45*	n.s.	0.79***	n.s.	n.s.	n.s.	n.s.	n.s.	

The results obtained also reflect that VMáx-UAnI is related to the speed threshold determined by the three methodologies: speed during the UAn interval determined manually, speed during the UAn interval determined mathematically (V-UAnIM) and the speed of the lactic acid UAn with the value of r = 0.45, 0.56 and 0.45 respectively and a statistical significance level of p<0.05. In a more intense manner, FCMáx-UAnI is related to the heart rate threshold determined by the aforementioned methodologies: FC-UAnI, FC-UAnIM and FC-UAL, with the value of r = 0.84, 0.89 and 0.82, respectively and a statistical significance level of p<0.001; it is also related to the maximum heart rate in the Lactic Acid Test (FCMáx-UAL) with a value of r =0.86 and p<0.001 (Table-4).

In the same manner the V-UAnI is intensely related to V-UAL (r=0.79 and p<0.001). If the UAn is expressed in terms of heart rate, the heart rate in the Lactic Acid Test (FC-UAL) is more intensely related to the UAn heart rate determined manually FC-UAnI (r=0.80 and p<0.001) than its mathematical determination (r=0.70 y p<0.01).

There is a high correlation between the maximum heart rate and the Lactic Acid Test (FCMáx-UAL) and the heart rate corresponding to the average threshold speed through the Probst methodology (manual and mathematical) and the Lactic Acid Test with values for r= 0.77, 0.79 and 0.80, respectively and with a statistical significance level of p<0.001 (Table-4).

DISCUSSION

In resistance sports (cyclical sports) the VO2máx and, above all, the UAn could be determining factors in the performance of a sport activity more than could be observed in team sports (acyclic sports). These, instead, are greater than what is found in sedentary or disciplines that last a short period of time (power disciplines) (Reilly, 1997; Bangsbo, 1998).

Relationship between the speed and heart rate during the UAn interval and the Lactic Acid Test

They are based on the loss of the lineal relationship between the running speed or work load and the heart rate taken at high levels of effort and evaluated for its high correlation to the lineal loss of the lactic acid-speed displacement relationship (Conconi y cols, 1982). This relationship is still controversial and polemical for some authors due to the scarce reproducibility as well as the lack of a rupture point or, sometimes, its poor relationship with the lactic acid threshold (Van Halden and cols, 1988; López-Calbet and cols., 1995).

In our investigation, the heart rate threshold relationship is higher than others described by other authors. This contributes to validate that the anaerobic interval threshold (UAnI). Gremion and Gobelet (1992) performed a study with 13 professional soccer players, 10 long-distance skiers, 29 long-distance runners and 7 cyclists in whom they performed stress tests (Conconi and Lactic Acid Tests on a treadmill), comparing the heart rate threshold determined according to the Conconi methodology (UAnC), the UAn at 4 mmol/l (UAn4) and the individual UAn according to the Stegman methodology (UAnI); the relationship was approximately UAnC-UAnI for r=0.69, approximately UAnC-UAn4 for r=0.57 and approximately UAnI-UAn4 for r=0.53. The lowest numbers corresponded to the soccer players and possibly were conditioned because they are not used to being evaluated on the continuous and cyclical running course used by the methodology of the Conconi Test.

In another intermittent sport such as tennis, Coen and cols. (1988) performed a Lactic Acid Test on 12 tennis players and 15 runners. After 48 hours the athletes were evaluated according to the Conconi Test in order to determine the heart rate threshold (UAnC, UAn4 and UAnI) following the Conconi methodology, the lactic acid threshold at 4 mmol/l and the individual threshold. The relationship among the three methodologies oscillated between r=0.72 and r=0.78, the case that was most similar to our investigation.

One of the differences from other studies performed on soccer players which only correlated the UAn heart rates (Gremion and Gobelet, 1992). This study has demonstrated that correlation is equally as important for variable speed with values for r = 0.79 and $p<0.001$. In this regard, some authors have criticized the Conconi methodology because a correlation was not obtained between the threshold speeds in the Lactic Acid Test and the Conconi Test (Van Handel and cols., 1988; Lacour y cols., 1988; Tokmakidis and Léger, 1992).

Tiberi and cols. (1988), while studying 10 long distance runners, were also not able to find a relationship between the heart rate in the UAn as determined by the Conconi Test and Lactic Acid Test that in the same protocol identified the threshold at 4 mmol/l, 3.5 mmol/l and the individual threshold of each subject according to the Keul methodology; the relationship among these methodologies and the Conconi one were 0.53, 0.59 and 0.27, respectively. Our study determined the Lactic Acid UAn at 4 mmol/l in soccer players (who are not very familiar with continuous three-minute efforts) on a zigzag course (the circuit for the Probst Test requires a greater effort), even though the demonstrated relationship among the threshold variables have been high.

When the three UAn determination methods were contrasted (heart rate, venilatory and metabolic) in medium distance athletes and the relationship among the heart rate and the VO2 in the UAn was analyzed, authors demonstrated contradictory results (Tiberi and cols. 1988; Maffuli and cols. 1994). The threshold at 4 mmol/l presented the worst correlation with the ventilatory threshold in all of the variables that were analyzed. However, regarding the field tests, the speed relationships were $r=0.90$ ($p<0.001$). In this regard, the criticism towards the use of a fixed lactic acid threshold (López and Legido, 1991; Thorland and cols., 1994) does not agree with the Maffulli and cols. (1994) results. They state that that the use of a threshold at 4 mmol/l to evaluate the UAn is useful because it requires less time in the field when evaluating such a large group of athletes ($n=20$ for the Lactic Acid Test).

According to Bruyn and cols. (1991), one of the reasons why determining the UAn by heart rate inflection was not reliable was the fact that there were doubts regarding the inflection reproducibility. This was demonstrated in incremental tests performed on 4 triathletes, in different exercise modalities (swimming, cycling and running) during two different seasons. The same conclusions were obtained in the Jones and Doust study (1995) which evaluated 15 well-trained runners on a treadmill during a time interval of 8 days and concluding that it was more of a cardiology artifact.

López-Calbet and cols. (1995) calculated the reproducibility of the Conconi test on a treadmill 6 times during 3 months on 23 physical education students (15 men and 8 women), concluding this time that the threshold speed varied from 12-15%, while the heart rate varied only by 5%. However, as the authors themselves demonstrate, while the speed and heart rate threshold can oscillate between 0-20%, these variables only oscillated between 0-8% at the end of the exercise. In this regard, the Probst Test, independent of its validity or lack thereof in determining the UAn interval, possesses valuable information about the maximum speed and maximum heart rate reached in stages or intervals above those that correspond to the hypothetical anaerobic threshold, which could mean that there is a greater potential or anaerobic capacity along with the fact that the 30 second pauses can contribute to altering the possible “cardiologic artifact” in the heart rate progression.

Overestimating the threshold speed and heart rate

The speed and frequency of the UAn interval have been significantly higher in the Probst Interval Test when compared to the Lactic Acid Test on its own circuit. In the same manner, the heart rates (at 14.4 Km/h) in the Lactic Acid Test are never stabilized possibly from having surpassed the corresponding strength intensity threshold as

determined in the Probst Interval Test at 14.2 Km/h and 12.6 km/h in the Lactic Acid Test. When Maffulli and cols. (1994) compared the speeds in the ventilatory UAn, the Lactic Acid Test and the Conconi Test, these differences were not observed; however one noticeable difference from these and other authors that used continuous protocols along a straight line to determine the UAn is that the Probst methodology involves a zigzag course with constant changes of direction. It is possible, in such a circuit with these characteristics (more challenging), that a stable metabolic rate never be reached, perhaps due to the fact that the interval efforts are characteristic of acyclic sports; even though they are intermittent actions that are continuous, they do not necessarily have to be very stable at a metabolic level, and even more, at higher intensities.

In this sense Reilly (1997) identified a greater metabolic expenditure along with higher lactic acid rates for displacements not performed along a straight line. Dribbling a ball on a treadmill at speeds of 9, 10.5, 12 and 13.5 Km/h was analyzed and values of 2.6, 3.2, 4 and 5.6 mmol/l, were obtained respectively. This meant that at 12 Km/h a rate of 4 mmol/l had already been reached along a straight line at 13.5 Km/h (1.5 Km/h more) and the lactic acid values were 3.9 mmol/l. Another study quantifies the metabolic expenditure in different types of running without a ball: lateral defensive displacement going backwards…, in general, unordinary displacements in which it was observed that the expense of "extra" energy unproportionally increased the speed of the movement (similar to what occurs at intervals or states of the Probst Test). For this reason, Reilly (1997) recommends the use of these types of exercises in order to be able to better economize movement.

The relationship between the speed in the UAn determined by the heart rate inflection or by a lactic acid test and the maximum speed in the Probst Test was similar ($r=0.45$ y $p<0.05$). As a result, the UAn interval does not appear at a constant value for the maximum speed, the argument that is made to the Conconi Test. In the same manner, the relationship between the heart rate in the UAn interval and/or Lactic Acid Test with the maximum heart rate of the Probst Test has not been very different ($r=0.84$ and 0.82, respectively). As a result, the heart rate does not appear as a constant value or at least the reason for this is not attributed to the characteristics of the Probst Test since in longer periods or stages (Lactic Acid Test), the heart rate behavior has also been linked to the maximum heart rate for this test.

Finally our study, determining the UAn by a manual or observational method is more trustworthy than the mathematical method since it doesn't obtain relationships with the lactic acid threshold for the speed values, although it does obtain relationships for the heart rate. However, perhaps the best solution is to make the mathematical determination compatible with the manual adjustment which is what some authors (López-Calbet and cols., 1995), refer to as an interactive determination, thereby eliminating, to a certain extent, the subjectivity level of the evaluator.

In conclusion, although differences were found between the speed and heart rate in the UAn for the lactic acid and inflection methods, the heart rate in the Probst Test which is possibly related to the different methodological procedures and the high correlation among these variables indicate that it could be a valid field test in order to identify the anaerobic, interval and specific threshold of this sport.

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