Track test to assess the lactic ability in high level runners

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ABSTRACT

The anaerobic ability (AnA) is given by the sum of the alactic and lactic (AlA) ability. The cycloergonometer has been used at the maximal 30-second strength (max_{30}) to the AnA approach (mean power and fatigue index). Presently, the AnA is not directly measured, and it is required an operational approaching, such as the measurement of the performance and the blood lactate concentration ([La]). In high-level velocity runners, it is expected that on long-endurance, that is, 60 seconds (max_{30}) strength there would be a higher AnA demand, and aiming the ecological validity, it must be applied on the track. The purpose of this study was to make a comparison between the derived variables of the (max_{30}) and (max_{60}) in runners. Eight male national and international 19-27 years old athletes were submitted to max_{30} and max_{60} running tests on an official synthetic track, where it was performed an arterialized blood collection from the ear lobule immediately 1, 3, 5, 7.5, and 10 minutes after the strength. To make a comparison between the max_{30} and the max_{60}, it was used the *t*-Student test and the simple Pearson's correlation to check the association between variables. The lactate concentrations were significantly higher at max_{60} than at max_{30} (20.9 ± 1.2 vs. 18.2 ± 1.9 mM, $p < 0.05$). Oppose to this, the mean velocities were significantly lower (7.9 ± 0.2 vs. 9.1 ± 0.2 $m.s^{-1}$, respectively). Significant correlations were found between max_{30} and max_{60} ($r = 0.92$; $p < 0.05$). However, it was not seen the same as to the lactate ($r = 0.62$; $p > 0.05$). According to these athletes' characteristics, who are highly tolerant to elevated [La], the derived test variables with duration/distance close to the 60 s/500 m seem to be more adequate as AnA indexes.

Keywords: Anaerobic test. Blood lactate. Bioenergetics.

INTRODUCTION

The anaerobic ability (AnA) is a determinant factor of the performance in demanding sportive contests of prolonged maintenance to the high power energy supply, and its equation is given by the sum of the phosphagen/alactic and glycolytic/lactic ability. In the assessment process of the AnA, there is no accordance to the "golden patterns" in this measurement, and generally, the physical/mechanical work/power measurements generated from predominantly anaerobic strengths are used with 30 to 120 seconds duration protocols[1-3]. In some situations, these strengths are at the same time the lactate concentrations ([La]) are measured[4], together with an assessment of the maximal accumulated Oxygen deficit[5,6]. Another increasingly used approach is the derivation of the anaerobic participation from the determination of the critic power[7,8].

The maximal strength 30-seconds tests on an cycloergonometer (max_{30}) – such as the Wingate test – has been used to set the AnA approach in athletes using the mean power and the fatigue index for that purpose[9]. From the analysis of several studies, Bar-Or[9] has concluded that the correlations between the indexes of the Wingate test and the anaerobic performance task are high, but not enough to be used as predictor of the success in other specific tasks, justifying the search for more specific methods for the majority of non-cyclist athletes. Furthermore, it is expected that the max_{30} has insufficient duration to be used as an index of the lactic ability, since it is required a higher duration to that extent.

Withers *et al.* found that well trained cyclists attained higher [La] values at 60 and 90 s strengths than at 30 s, with the higher Oxygen deficit appearing on the 60^{th} second. Studying 5 to 120 s strengths, Yamamoto and Kanehisa[11] have verified that the [La] increases up to the 60^{th} second, remaining constant at higher durations. Opposite to this statement, studies performed on an ergometric bicycle has shown that despite the trend for an increasing [La] with an increase in the test duration, it was found no significant differences between the [La] at 30, 40, and 60 s strengths (13.0 ± 2.1 to 14.6 ± 1.3 mM) in highly trained road cyclists[2]. In accordance to this, Dudek *et al.*[12] have found similar [La] values between 30 and 45 s strengths (12.7 ± 2.6, and 12.5 ± 4 mM) in non-athlete individuals.

In high level runners, it is expected that on a high-duration strength, that is, 60 s (max_{60}), there is a higher demand for AnA than at max_{30} strength[13], and aiming the ecologic validity, the test must be applied on a track. A typical example of that approach in the athletic training routine is the application of tests such as the 500 m running[14,15], that in well anaerobic trained athletes has duration between 60 and 75 s. So, despite it is expected high lactate levels at max_{30} supplied by the higher lactic power in those athletes, it is expected that in strengths such as max_{60}, it can be found higher [La] values. As to this topic, there is a gap in the literature with comparative approaches in high level runners when it is applied the field test. The purpose of this study was to make a comparison between the derived variables of the max_{30} and max_{60} in high level runners.

METHODOLOGY

Eight national and international level (23.8 ± 3.3 years) runners with high level performance on 100 m (10.45 s to 10.78 s), 200 m (20.26 s to 21.40 s), and 400 m (45.80 to 48.70 s) running were submitted to max_{30} and max_{60} running test on a 400 m official synthetic track. Every individual signed an informed consent term, agreeing to participate in the study, according to the Ethics Com-

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mittee in Research with Human Beings of the Santa Catarina State University. The test sequence was randomly determined with 24 to 90 hour intervals. Next to each running, it was collected 20 µl of arterialized blood from the ear lobule (previously prepared with Finalgon®) on the exact 1, 3, 5, 7.5 and 10 moment after the strength to measure the [La]. The [La] determination in the total deproteinized blood with perchloride acid was performed through a spectrophotometer (Guilford 300N) using an enzymatic method with NADH extinction, following a description made by Mader *et al.*[16]. The highest individual [La] value found during each after-test collection was used to the analysis, and the maximal [La] in every measurement was found between 3 and 7.5 minutes. The glycolytic power generated along the tests was calculated dividing the blood's [La] by the time of the exercise ($mM.s^{-1}$), assuming an increasing linear relationship between these variables.

For the comparison of the amounts of the central trend between the max_{30} and max_{60}, the *t*-Student test was used for dependent sampling, with application of the simple Pearson's correlation to check the association between results, being considered significant those differences with higher than 95% probability ($p < 0.05$).

RESULTS

Table 1 shows the results for the variables assessed at max_{30} and max_{60}. It was impossible for two individuals to perform the max_{60} test, one for being injured and the other by the residual fatigue derived from prior training sessions to the test, according to report made by his coach.

TABLE 1
Mean values (± SD) of the distance, velocity, lactate concentration, and glycolytic power in 30 and 60 second tests

	Distance (m)	Velocity ($m.s^{-1}$)	[La] mM	Glycolytic Power ($mM.s^{-1}$)
max_{30}	272.1 ± 4.8*	9.1 ± 0.2*	18.2 ± 1.9*	0.61 ± 0.07*
max_{60}	471.0 ± 12.2	7.9 ± 0.2	20.9 ± 1.2	0.35 ± 0.02

* Significant difference between max_{30} and max_{60} ($p < 0.05$).

It was found significant differences between the assessed variables at max_{30} and max_{60}, with r = 0.92 ($p < 0.05$), between the velocities and the low correlation between the [La] (r = 0.62; $p < 0.05$). It was found no significant correlations between the $Dmax_{30}$ and $[La]max_{30}$ (r = –0.44; $p > 0.05$), but they were significant between the $Dmax_{30}$ and $[La]max_{60}$ (r = 0.82; $p < 0.05$) (figure 1 and 2).

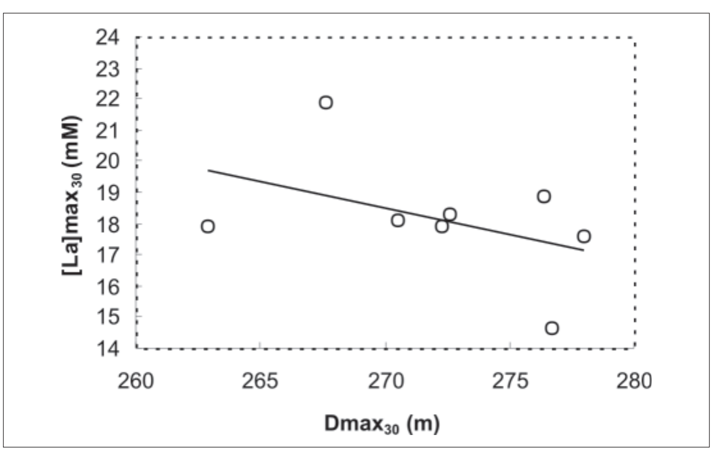

Figure 1 *– Relationship between the higher lactate concentration ($[La]max_{30}$) and distance ran (Dmax) after the 30 second running test (r = –0.44; $p > 0.05$). Regression equation with confidence interval (95%): $[La]\ max_{30}$ = –0.17 (–0.52; 0.18) • ($Dmax_{30}$) + 64.13 (–30.91; 159.16).*

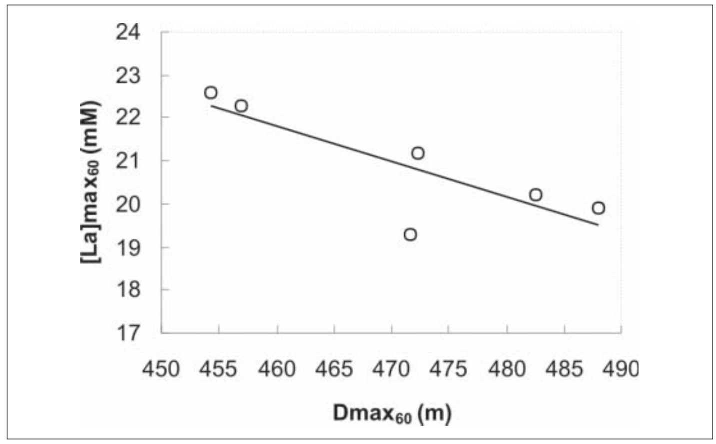

Figure 2 *–Relationship between the higher lactate concentration ($[La]max_{60}$) and the distance ran (Dmax) after the 60 second running test (r = –0.82; $p < 0.05$). Regression equation with confidence interval (95%): $[La]\ max_{60}$ = –0.08 (–0.16; –0.002) • ($Dmax_{60}$) + 59.51 (21.99; 97.03).*

DISCUSSION

The obtainment of evidences to a test validity can be made verifying the logic validity (or face) of the content, criterion (concurrent and predictive) and *constructo*[17]. In the Sciences of the Sports field, the most used is the one in which the result of a test is compared and/or associated to the amounts attained in another one, and the last one is used as main reference criterion. Nevertheless, in several situations the criterion employed may not contain sufficient and/or satisfactory elements to make the desired interpretations from its explanation; this is the case of the assessment of the AnA in runners.

Here, it was assumed the presupposition that at the light of the present knowledge, the specific performance assessment at the lab does not aggregate any value to the tests which are applied in these athletes' day-to-day training.

In the present study, the measurement of the [La] was used as reference criterion. In the analysis, uneven weights were found in the relationships between the [La] and the distances ran with no significant correlations between the $Dmax_{30}$ and $[La]\ max_{30}$ (r = –0.44; $p < 0.05$), and significant association between the $Dmax_{60}$ at the $[La]\ max_{60}$ (r = –0.82; $p < 0.05$). This last figure can be fitted in the higher level found by other authors, with competitive performance in 400/800 s running and 30-60 s duration treadmill running (r between –0.67 and –0.89)[18-22]. Despite the limitations of the size of the sampling in the present study, the higher value of the association between $Dmax_{60}$ and the $[La]\ max_{60}$ is in accordance to the theoretical model proposed, stating that the max_{60} is more dependent from the AnA than the max_{30}, and it can be more adequate to deplete it. As to the $Dmax_{30}$, some variables such as the power and the alactic ability may have a more significant weight in determining the result of this test with less influence in the final $Dmax_{60}$ results.

Despite these statements, one must be caution when trying to support the [La] validity as being a direct AnA reflexion. The peak [La] after intense exercising is frequently used as a measure to indicate the energy releasing by the lactic[20], but there is much controversy on the meaning and consequences of the lactate production during and after the exercise[23-25].

Some determining factors for this discussion and its consequent implications are associated to the possible [La] dependences on "foreign" factors, such as the lactate diffusion ability[26], blood volume[27,28], and variability of its measurement[19]. Furthermore, the [La] cannot reflect the muscular lactate production, and it even does not allow indication of the energy derived by the phosphagenic system. Thus, although the [La] indicate the extension of the use of the anaerobic glycolysis, it cannot be considered the AnA quantitative measure. Besides, the [La] is not recommended as base to compare the AnA in different individuals[6], and it can be mentioned as an indirect method, and probably, as much valid as the usually used tests[4]. Consequently, its usage as a criterion is the limitation to the inferences found in this study.

Related to the optimum duration for the LaC in runners, the present paper reports that the max_{30} is not ideal for such purpose. However, it does not answer if the max_{30} used in similar durations as the ones used in this study is the best choice to be employed rather than higher of the max_{60}. Here, for the analysis artifice, it will be used the quali-quantitative comparison of the results found and the specific knowledge gathered in the literature.

With two to three minute strengths, the [La] is significantly higher than in the max_{30}[29]. Nevertheless, at 60 and 75 s durations, it is found slightly higher amounts (20 to 22 mM), on two to eight minute strengths (17 to 18 mM)[30,31]. In 400 m running performed by long-distance runners, there is an increase in the [La], with an increase in the partial distances (100, 200, 300, and 400 m) and higher acceleration of the [La] accumulation rate appearing around the 27th second of running – identified from the curve derived from the [La] relationship vs. time[25].

Despite the [La] increment, from that duration, the acceleration rate decreases. That derivation in a running suggests that the maximal lactic power can be found in higher duration strengths than on a cycloergonometer, where this last one can be close to the first 15 s of strength[11,32].

So, the high [La] amounts found at max_{30} in the present study can be associated to the high glycolytic power these athletes have, that allows to attain higher [La] levels upon lower durations. Despite a probable lower [La] acceleration rate in intermediary distances, at max_{60}, the final values attain higher levels than at max_{30}, since at max_{60} the glycolysis remained active for more time at high rate of power supply. The difference found in the lactic power used in the tests supports these statements (table 1).

Besides of considering the [La], the option for a test duration of anaerobic variables must consider the contribution of the lactic percentage while performing it. Gollnick and Hermansen[33] have estimated that 60% of the power at max_{60} running comes from the anaerobic glycolysis. In high level runners, we have a combination of a band with higher Oxygen deficits[10], and fitted in as tolerance lactate activity, that is, 1 to 8 min[13].

Besides the duration, it seems that at max_{60} the participation of each system varies according to the activity employed, since with the increase in the muscular mass involved, there is the participation of a higher aerobic percentage[14], and an increase in the total power demand, confirming by the findings stating that the higher maximal accumulated Oxygen deficit is found in activities with higher muscular mass involved[6,35].

Although several factors may contribute to the fatigue on 50 and 90 s strengths, it can be presumed that the main determining variable is the ability in tolerating lower intracellular pH levels[13], associated to the maximal accumulated Oxygen deficit, normally found at that level[6]. Together, the above information suggests that when running with durations close to the max_{60}, the higher muscular mass involved, the higher the probability to find higher [La] values, and in more prolonged tests, it causes an increase in the percentage of aerobic participation during the test and a progressive decrease in the [La].

One of the problems found in the high intensity and higher duration tests than the ones employed in this study is that the athlete can use a rhythm strategy and does not produce a maximal strength from the beginning of the test, making difficult to interpret the results. Despite the recommendation that the tests should be performed at maximal strength from the beginning, the partial distances ran were not controlled, and this would be a demand for future studies with athletes of similar level. It is recommended to analyze several strategies that influence the partial and global results in this type of assessment.

The comparative approach used in the present study does not allow many inferences on the possible combinations between the lactic/alactic power/ability in the assessed test performance. In high output athletes, the percentual participation of each of these components on the specific skill of runners must be set. Furthermore, the methodological characteristics of athletes' training who were under the supervision of the same coach when the tests were performed, may have driven some of the results.

So, it is necessary to check the possibility to generalize the findings of the present study by applying similar approaches in several training mesocycles on other groups (for instance, female runners).

From the results found in the present study added to the data found in the literature and the characteristics of high leveled runners who have high tolerance to elevate [La] levels, it was attained evidences of the validity that those variables derived in tests with duration/distance close to the 60 s/500 m seem to be more adequate as the LaC index in runners than the 30 s tests.

All the authors declared there is not any potential conflict of interests regarding this article.

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