Continuous training increase on the lactate threshold improves soccer players’ performance

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Original Article


ABSTRACT: It has been described that the continuous training at the lactate threshold improves performance leading to a decrease of the lactate concentrations or at the threshold of intensity. Here we measured changes in soccer athletes’ performance that were submitted to a continuous training at the lactate threshold speed, in addition to soccer conventional training. Soccer athletes (n=17) aged 18 and 20 years old were randomly divided into two groups. The former received both continuous and conventional trainings (EG, n=10), whereas the latter just conventional training (CG, n=7). The lactate threshold speed increased after the two first training weeks in both groups. In EG the lactate threshold’s speed increased during the following four weeks. Our results showed a decrease in the lactate concentration in the EG at the same velocity. These data indicate that the soccer players’ performance can be improved by a combination of both training methods.

Keywords: Continuous training, Lactate, Soccer.

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INTRODUCTION

Progressive increases in the exercise intensity intensify the glycolytic pathways, increasing the conversion of pyruvate to lactate (Blomstrand & Saltin, 1999; Krsarak et al., 2000; Baldwin et al., 2000). Starting from a determined work intensity, the blood lactate concentration increases non-linearly, marking a transition point called lactate threshold (Pyne et al., 2001; Castagna et al., 2002), which is considered a greater exercise intensity in which the organism can keep balanced the production of lactate with its removal (Messonier et al., 1997; Gladden et al., 2000; Brooks, 2001). The threshold lactate has been used to infer the predominance of the metabolic pathway generator of glycolytic or oxidative energy in different exercise intensities (Yoshida et al., 1997; Nicholson & Sleivert, 2001; GOMES et al., 2003).

It is believed that the endurance training contributes for modifications in the users’ performances in several sports modalities (Perret et al., 2000; Helgerud et al., 2001; Roberts et al., 2002). Soccer is a sport in which there are constant changes in the energy transformation demand. For this reason, the training prescription should provide the athlete with the possibility of performing it in different levels of intensity, and should minimize the fatigue effects mainly caused by the match duration (Helgerud et al., 2001; Castagna et al., 2002).

In the present study, we sought to examine alterations in soccer players’ performance caused by the continuous training, at a speed of threshold lactate added to the conventional training.

MATERIALS AND METHODS

The sample of the study was comprised of healthy professional soccer players (n=17), aged 18-20, in full activity. They did not make use of dietic supplementation, pharmaceuticals or ana- bolic androgenic steroids, took part in it voluntarily by means of a written consentment, and were explained about the research natures. Finally, they were randomly divided in two groups: Experimental (EG, n=10) and Control (CG).

The individual remained for two weeks without training, and were evaluated according to Stegmann et al.’s Test (1981), when the lactate threshold was determined according to Baldwin et al. (2000). The athletes ran briefly on belt conveyor during 5 minutes at 10km/h with a three-minute repose. Immediately after the data collection, the individual would run for more 5 minutes, with an increase of 1km/h, and the blood was collected after new three- minute repose. This procedure was repeated with an increase of 1 km/h, until the obtained lactate concentration presented some difference greater or equal to 1mM in relation to previous stage.

Figure 1 - Experimental Drawing - The tests of threshold lactate were carried out on the last day of every fortnight (T0-T5) and the training intensity was reset according to the results. The period of training and without training are indicated.

<table>
<thead>
<tr>
<th>Week</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test</td>
<td>T0</td>
<td>T1</td>
<td>T2</td>
<td>T3</td>
<td>T4</td>
<td>T5</td>
<td></td>
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<td></td>
<td>Without training</td>
<td>Training</td>
<td>Without training</td>
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</table>

RESUMEN

La adición del entrenamiento continuo en el umbral de lactate aumenta la performance de jugadores de football.

El entrenamiento continuo ministrado en la intensidad del umbral de lactato es conocido como capaz de mejorar la performance medida en las concentraciones de lactato del umbral o la intensidad en que este ocurre. En ese estudio evaluamos las modificaciones en la performance de jugadores de football que recibieron entrenamiento continuo en la velocidad del umbral de lactato sumado al entrenamiento convencional del equipo. Los jugadores (n=17) fueron divididos en dos grupos: GE, entrenamiento continuo con entrenamiento convencional (n=10) y GC recibiendo solamente el entrenamiento convencional (n=7). La velocidad del umbral de lactato creció en las dos primeras semanas de entrenamiento em los dos grupos. En el GE la velocidad del umbral siguió creciendo en las cuatro semanas siguientes. Los aumentos en la velocidad de umbral sugerirían una mejor capacidad de hacer los esfuerzos necesarios en un partido de football disminuyendo la posibilidad de fadiga. Nuestros resultados indican que la performance de los jugadores es mejorada por la adición de entrenamiento continuo al entrenamiento convencional.

Palabras clave: Entrenamiento continuo, Lactato, Fútbol.

RESUMO

A adição do treinamento contínuo no limiar de lactato aumenta a performance de jogadores de futebol

É descrito que o treinamento contínuo, realizado na intensidade do limiar de lactato, é capaz de melhorar a performance, medida como a diminuição nas concentrações de lactato ou na intensidade em que o limiar ocorre. No presente estudo, medimos alterações na performance de atletas de futebol, submetidos a treinamento contínuo, na velocidade do limiar de lactato, acrescido ao treinamento convencional de futebol. Atletas de futebol (n=17), entre 18 e 20 anos, foram divididos aleatoriamente em 2 grupos: EG (n=10; treinamento contínuo + treinamento convencional) e CG (n=7; somente treinamento convencional). A velocidade do limiar de lactato aumentou após as duas primeiras semanas de treinamento, em ambos os grupos. No EG, a velocidade do limiar de lactato aumentou nas quatro semanas seguintes, o que não foi observado no CG. Após duas semanas de destreinamento, observamos significativa redução na performance de ambos os grupos. Os aumentos na velocidade do limiar sugerem uma melhor capacidade de realizar os esforços exigidos durante uma partida de futebol, diminuindo a possibilidade de fadiga. Nossos resultados indicam que a performance dos praticantes de futebol é beneficiada pelo treinamento regular, acrescido de TC, realizado em velocidade do limiar de lactato.

Palavras-chave: Treinamento contínuo, Lactato, Futebol.
After this period, the individuals were subjected to five training sessions a week, and the EG would carry out three additional sessions of 30 minutes, running in the intensity of the lactate threshold. Every two weeks, the individuals were subjected to a new test of lactate threshold, and the training intensity was reset, if necessary (Figure 1). After 10 weeks of the beginning of the experiment, the individuals were kept without training, and the test of lactate threshold was carried out at the end this period.

During the whole experimental period, the athletes’ diet was monitored, supplying approximately 65% of carbohydrates, 20% of proteins and 15% lipids, besides the usual requirements of micronutrients and suitable energy quantities.

The dependence curves of lactate were calculated with nonlinear regression at the experimental points using Sigma Plot 2002 V.8.0 (Jandell Scientific, USA), for adjustment of velocity and lactate concentration parameter, in the equation: \( \text{Lac} = a \cdot b^{\text{Vel}} \), where: \( \text{Lac} \) = lactate concentration (mM) and \( \text{Vel} \) = velocity (km/h).

The lactacidemia was measured in lactimeter Accutrent (ACCUSPORT – Spain), in arterial blood collected in the distal phalanx of the indicator finger on the right hand at the end of this period.

The temperature and relative humidity in the place were kept constant (25° C and 70%).

In order to determine the difference between the studied parameters, it was used the test T of paired Student adopting a level of significance of 5% (\( \alpha = 0.05 \)).

**RESULTS**

After the beginning of training, both groups presented in the lactate threshold velocity between T0 and T1. In the EG, the increase of continuous training to the conventional training increased the lactate threshold velocity up to T3 (Figure 2), increasing 8.3 ± 0.3%, 6.9 ± 2.4% and 5.0 ± 3.6%, in the mean of lactate threshold velocity, every two weeks. AT T4, there was no alteration in relation to T3 (Figure 2).

After the mean increase of 7.1 ± 3.1%, at the lactate threshold velocity between T0-T1, there were no alterations in this parameter in the CG, in the following weeks (Figure 2). In these weeks T3 and T4, the mean of lactate threshold velocity in the CG was smaller than the obtained values by the EG (\( p < 0.05 \)). Two weeks without

**Table 1 - Mean of blood lactate concentrations in the lactate threshold** - The value of threshold lactate represents a greater concentration before the variation between the stages was equal or greater than 1 mM, mean ± standard deviation.

<table>
<thead>
<tr>
<th>Blood Lactate (mM)</th>
<th>CG</th>
<th>EG</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0</td>
<td>4.4 ± 0.2</td>
<td>4.4 ± 0.4</td>
</tr>
<tr>
<td>T1</td>
<td>5.0 ± 0.5</td>
<td>4.8 ± 0.4</td>
</tr>
<tr>
<td>T2</td>
<td>4.8 ± 0.3</td>
<td>5.2 ± 0.5</td>
</tr>
<tr>
<td>T3</td>
<td>4.5 ± 0.3</td>
<td>5.3 ± 0.6</td>
</tr>
<tr>
<td>T4</td>
<td>4.3 ± 0.2</td>
<td>4.6 ± 0.5</td>
</tr>
<tr>
<td>T5</td>
<td>4.3 ± 0.3</td>
<td>4.7 ± 0.2</td>
</tr>
</tbody>
</table>

* Difference in relation to previous time (\( p < 0.05 \))
*b Difference in relation to T0 (\( p < 0.05 \))
** Difference in relation to CG (\( p < 0.05 \))
training (between T4 and T5) caused some equivalent reduction in the threshold lactate velocity, in both groups (Figure 3).

The mean of plasmatic lactate concentration (mM) obtained in the lactate threshold did not differ between the groups, except at T3, which was greater for the EG (p < 0.05). The EG presented lactate concentration in the lactate threshold greater than T0, in all measured timings, except for T4, whereas the CG presented lactate concentration in the lactate threshold at T3, T4 and T5 equal to T0 (p < 0.05) (Table 1).

The lactate concentration in the lactate threshold increased every two weeks, in the six first weeks for the EG, whereas for the CG, this increase only occurred in the two first weeks without training (Table 1). After the two final weeks without training (T5 in relation

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**Figure 4 - Single graphs of lactate curves for the EG -** The numbers (1-10) represent the lactacidemia behavior of each individual in the different measures during each test. The curves were calculated according to the description in the materials and methods section.
to T4), the lactate concentration at the lactate threshold was smaller for the EG, whereas for the CG remained the same (Table 1).

The analysis of the regression curves of the mean of lactate concentration (cf. Figure 6) showed for the EG some differences between T2, T3, T4 and T5 in relation to T0, and for the CG this difference between T0, T2, T3 and T4, in relation to T5. In both cases the coefficient is greater than at T0 and T5, respectively (data not shown).

**DISCUSSION**

Soccer is a sport in which the energetic demands may vary notably in a matter of second, what determines that the training should be optimized for a better performance, in different metabolic needs. During a soccer match, important variation of energy demand occurs. Momentum of high intensity alternate with others of moderate intensity, in which an optimized recovery can provide the athlete with some advantage, especially when there is a situation of high demand. The increased oxidative capacity allows recovery acceleration, and thus increasing the possibility of optimized acting during the whole match time. In this study, we examined that a 8-week conventional was not capable of causing any alterations as the ones which occur if the continuous trained is increased.

It has been demonstrated the relation between the fatigue and the depletion of glycogen reserves (Blomstrand & Saltin, 1999; Robinson et al., 1999). The major contribution of the oxidative pathways allows the athlete the possibility to spare glycogen in function to the greater use of fatty acids, contributing for some performance improvement (Ahulmen & Rathman, 2001). The increase of velocity in which occurs the lactate threshold suggests a minor possibility of fatigue, for it is associated with predominance of glycolitic metabolism, and therefore enabling some performance improvement.

The increase of the seric lactate concentration may be associated with the increase of its production and/or decrease of capacity of its removal (Messonier et al., 1997; Brooks, 2001). For trained individuals, as much production as removal may increase, however, the capacity of production may increase more than that of removal. This adaptation is in charge of the improvement in resynthesis condition of ATP through glycolytic pathway, causing

**Figure 5 - Single graphs of lactate curves for the EG - The numbers (11-17) represent the lactacidemia behavior of each individual in the different measures during each test. The curves were calculated according to the description in the materials and methods section.**
some performance improvement for athletes carrying out exercises of high intensity (Helgerud et al., 2001). Greater lactate concentration in the lactate threshold velocity, in the group which was subjected to conventional and continuous trainings (Table 1) suggest some performance improvement in the situations of high energetic demand.

The data collected demonstrated that the increase of proposed training, in increase to the one existing caused some alteration in the existing dependence between lactate and velocity, leading the lower lactate production in the same velocity (Figure 6).

The lactate production may be controlled, between other facts, by the flow of pyruvate through the mitochondria. The increase mitochondrial may be one of the facts that cause some lactacemia decrease, providing some muscular work maintenance for greater period of time, in the same intensity, or enabling the increase of exercise intensity.

During training the synthesis of contractile proteins allows increased efficiency of the muscle decreasing production of lactate. Mujika and Padilla (2001a, 2001b) demonstrated the progressive adaptation in physiological functions during the detraining, and confirmed in this study. Two weeks of detraining reduced dependence on speed of LL and changed its subordination to values that were close to those obtained in the fourth week of training. The curve of dependence of speed to the rate of lactate production after the detraining was similar to the fourth week in both groups confirming the data. Our data indicated no differences between groups in the rate of reduction of performance, which may indicate that the effect of training is more related to metabolic factors than the loss of contractile proteins (Figure 3).

Data from this study suggest that the addition of continuous training in LL to the conventional training increases the running speed in which production exceeds lactate removal mechanisms. These findings may indicate that the training given to athletes may be applied on a sub-optimal form.

REFERENCES


Figure 6 - Dependence of lactate during the different stages of training in the EG and CG. The mean of the experimental points was used to calculate the curves according to the described in the materials and methods.


