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BLOOD LACTATE CURVE, VELOCITY AT THE OBLA, AND HEART RATE DURING INCREMENTAL RUNNING TEST IN SOCCER PLAYERS

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The blood lactate curve, the onset of blood lactate accumulation (OBLA) and the velocity at the OBLA may serve as a basis for individually assessing as well as for diagnosis of endurance performance, and they play an important role in physical fitness estimation or endurance training prescription. This study aimed to determine the running velocity corresponding to the OBLA in soccer players during an incremental running test (IRT), with a view to estimate the physical fitness and to prescribe an optimum training intensity workload.

Twenty four professional football players (23.10 ± 2.21 years) performed a five step incremental running test 5x1000 m with increasing velocity –V. The recovery interval between each running distance was 3min. The OBLA was identified individually as the point corresponding to a blood lactate concentration of 4mmol/L. The velocity at which a blood lactate accumulation of 4mmol/L occurred was referred to as the V_{OBLA}.

The changes in running velocities during the five steps related with big alteration in blood lactate and heart rate responses; the BLC of 2.71 mmol/L and the HR of 152b/min after the first step increased to 8.53 mmol/L and 186 b/min at the end of the fifth step. The mean of V_{OBLA} was 4.19 ± 0.12 m/s, which represented 70.54% of the Vmax. The inter-individual differences in BLC during the incremental running test in football players may be explained with the specification of their post in the field. The use of perceived exertion in association with HR and/or lactate will be useful for avoiding a risk of overtraining and lack of necessary training intensity.

Key words: *blood lactate concentration, V_{OBLA}, soccer players.*

Introduction: For many years the blood lactate curve and lactate thresholds have become important in the diagnosis of endurance performance [3; 14; 16; 20]. The speed at lactate threshold (LT) considered one of the best predictor of distance running performance [2]. Beneke R. et al. (2011) related the blood lactate concentration threshold (BLC) to maximum aerobic power and athletic endurance performance and reported a high correlation between them. LT may be highly correlated to performance of TT-cycling [19]**.** Santos-Concejero J. et al. (2014) confirmed that the onset of blood lactate accumulation (OBLA) is highly associated to running performance according to 10000 and 3000 meters in well-trained long- and middle-distance runners. In elite runners, the OBLA occurred at a higher running speed endurance performance and reported a high correlation between them [13]. Furthermore, the importance of lactate threshold in intermittent games has also been studied [11; 18]. Yoshida et al. (1993), observed the relationships between running velocity (V) in a 3000-m race and V at the lactate threshold, and also with v at the onset of blood lactate accumulation (V_{OBLA}) in female distance runners during a treadmill running test. The blood lactate curve and lactate thresholds may serve as a basis for individually assessing as well as for diagnosis of endurance performance, [1; 5; 11; 15]. Furthermore, Binder R. et al. (2008) indicated that the determination of lactate threshold during cardiopulmonary exercise testing plays an important role in physical fitness estimation or training prescription. The Incremental tests using analyses of (BLC) are widely used to evaluate endurance athletes [8; 9; 10; 13]. Denadai BS, et al., (2005), concluded that the OBLA can be utilized in soccer players to estimate the maximal lactate steady state (MLSS)**.**

In addition, various scientific studies [1; 3; 5; 14; 15; 16; 17; 19; 20; 21] reported that the value of LT parameters serves to prescribe an optimum training intensity workload in endurance training. Abe et al. (2015) reviewed that the OBLA or LT have been used in a number of studies and demonstrated significant improvements in the aerobic fitness level or performances not only for healthy older sedentary populations [12], but also for different groups of endurance athletes.

The Incremental tests using analysis of (BLC) are used to prescribe an optimum training intensity workload [10; 14; 17; 21].

The blood lactate concentrations (BLC) have been used to monitor exercise intensity during both resistance and dynamic exercises [1; 6]. In particular, Seiler and Kjerland, (2006), showed that more than 75% of an entire training program was set at an exercise intensity corresponding to/or under the individual lactate threshold (LT), even for junior national-level cross-country skiers world-class cyclists highly trained long distance. However, several invasive blood samplings are required to determine the exercise intensity corresponding to the individual LT or OBLA [1]. The blood lactate concentration orientated intensity domains have been established [22] in three methods of training: 1.Training up to an intensity at which the (BLC) clearly exceed resting BLC, light- and moderate –intensity training focusing active regeneration of high volume

endurance training (the intensity is < threshold). 2. Heavy endurance training at work rates up to maximal statdy state intensity (the threshold ≤ Intensity≤ max.lac.st.state). 3. Severe exercise intensity training between max.lac.Stady State and maximum oxygen uptake intensity mostly organized as interval and tempo work (the intensity is > max. lac. stady state . High- performance endurance athletes combining very training volume with high aerobic power dedicated 70-90% of their training to intensity domain 1, where the intensity < threshold) in order to keep glycogen homeostasis within sustainable limits, [4; 7]. So, **the aim** of this study was to determine the running velocity corresponding to the onset blood lactate accumulation OBLA in soccer players during an incremental running test (IRT) using analyses of blood lactate concentration (BLC) with a view to estimate the physical fitness and to prescribe an optimum training intensity workload.

Materials and Methods: Twenty four professional football players (age: 23.10 ± 2.21years old) gave their informed consent, and performed a five step incremental running test 5x 1000m with increasing velocity – V, the recovery interval between each running distance was 3min. The players were requested to increase their running speed over the course of the session roughly from an initial 3.80 m/s in the first step. We also determined the maximal running velocity in 1000m distance.

Lactate concentrations were measured dynamically in the second minute after each step through micro-methods. Capillary blood samples were taken from a hyperaemic earlobe. HR was registered with sport tester PE – 3000 (Finland). Times of running 1000m distance during 5 steps were recorded. "Lactate curve" – dependence between L concentration and load intensity was determined using a graphic. The onset blood lactate accumulation (OBLA) was identified individually as the point corresponding to a blood lactate concentration of 4mmol/L. The velocity at which a blood lactate accumulation of 4mmol/L occurred was referred to as the V_{OBLA}.

Results: The indices lactate (mmol/L) and velocity (m/s) was evaluated for each 1000m distance of the incremental running test (mean ± SD), they are as follows (table 1, and graph 1): the lactate in the first step was; L_1 – (2.71 ±1.02), followed by L_2 – (3.29 ± 0.90) in the second step, when continued to increase with higher rate in the third step; L_3– (4.85 ±1.12), and in the fourth step; L_4 – (6.54 ±1.63) and finishing in the fifth step with; L_5-(8.53 ± 2.18). To each of these lactate result concentrations corresponded a velocity. The V_1 in the first step was (3.74 ± 0.13), followed by V_2 – (4.02 ± 0.11), and V_3 – (4.36 ±0.13), when V_4 – (4.62±0.14), and V_5 – (4.93 ± 0.18). We note that the best achievement by soccer players in 1000m distance was Vmax– (5.94 ± 0.16). The last velocity step was 83% of Vmax. The velocity at which a blood lactate accumulation of 4mmol/L occurred was V_{OBLA} (4.19 ± 0.12), that corresponded to 70.54% of the Vmax.

We observed that during the test, there was an increase in the velocity, means 0.3m/s, and with that increase from 3.74 to 4.93 m/s., the lactate concentration increased gradually with the heart rate. A mean of 2.71 mmol/L and 152 b/min at the end of the first step to 8.53 mmol/L and 186 b/min at the end of the fifth step. We note that there was an inter-individual difference between soccer players in lactate parameter; the coefficient of variation during the incremental running test was between 23.09 % and 37.64 %, indicating that there was heterogeneity in the players concerning the lactate concentration.

Table 1

Blood lactate concentrations (BLC), OBLA, heart rate (HR) and velocity (V) before and during the incremental running test (IRT) and maximal running velocity of 1000m distance in soccer players

Variables		Before IRT	IRT steps					OBLA	Vmax (1000m)
			1	2	3	4	5		
BLC (mmol/L)	M	1.58	2.71	3.29	4.85	6.54	8.53	4	–
	σ	0.29	1.02	0.90	1.12	1.63	2.18		
	e(%)	18.35	37.64	27.36	23.09	24.92	25.56		
V (m/s)	M	–	3.74	4.02	4.36	4.62	4.93	4.19	5.94
	σ	–	0.13	0.11	0.13	0.14	0.18	0.12	0.59
	e(%)	–	3.47	2.74	2.98	3.03	3.65	2.86	9.64
HR (b/min)	M	94	152	163	171	177	183	168	193
	σ	2.1	2.4	2.6	3.5	3.8	4.1	3.1	5.6
	e(%)	2.23	1.58	1.60	2.05	2.15	2.24	1.85	2.90

Discussion: The running velocity between the fifth and the first step (1000 m) varied from 30 % to 40 %. Furthermore, the changes in running velocities related with big alteration in blood lactate responses (110 % – 325 %) when compare the last step with the first. The high coefficient of variation in BLC during the incremental running test shows clearly the inter-individual differences in football players and may be explained with the specification of their post in the field. The critical velocity at the onset of blood lactate accumulation was V_{OBLA} (4.19 ± 0.12). In the other studies, the velocity corresponding to the OBLA = 3.5 mmol/L in soccer players in an incremental treadmill test was V_{OBLA}= 3.78 ± 0.39 m/s Denadai et al., (2005), and the velocity corresponding to the (OBLA – 4 mmol/L) for the long-distance runners was V_{OBLA}= 4.86 ± 0.36 m/s, and for the middle-distance runners was V_{OBLA}= 4.83 ± 0.36 m/s [20]. The main difference between the values of V_{OBLA} may be explained with the use of the treadmill in an incremental test in Denadai et al. (2005), study and the

running in the present study. The second reason is that, in elite runners, the role of aerobic metabolism in energy supplement increases in sustaining higher running speed and the OBLA occurred at a higher running speed endurance performance and reported a high correlation between them [10; 20]. The findings in the table and the graphic, allow to suggest that, it is important that the OBLA determined in exercise tests using stage increments of 3min and more is similar in footballers of different field posts. From data analysis, and regarding the findings of some research, the treadmill incremental tests present differences with field tests when results of OBLA are truer and conform than the treadmill measurements and results. The incremental velocity request an increase in the heart rate and the blood lactate accumulation it- self increases during the five steps.

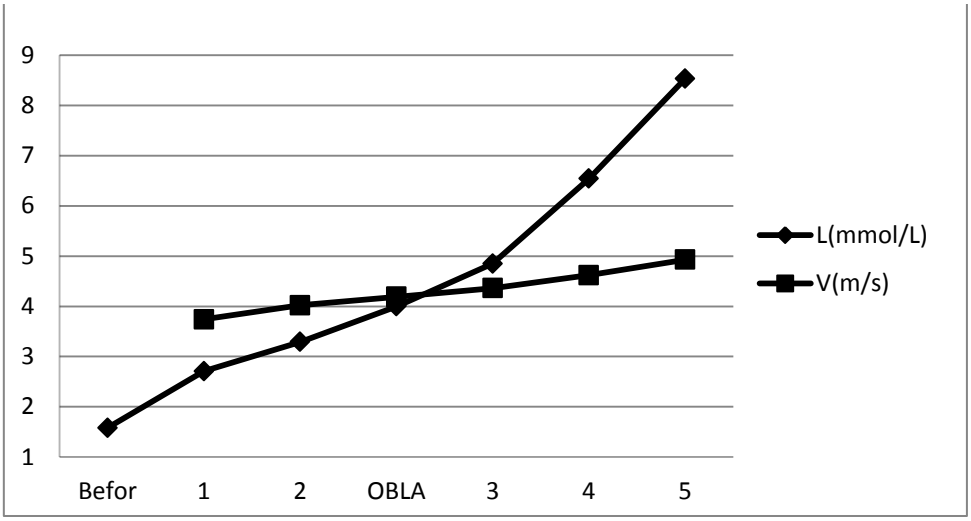

Fig. 1: Blood lactate concentrations (BLC), OBLA and velocity, during an incremental running test (IRT), in soccer players

Conclusion: The use of perceived exertion in association with HR and/or lactate will be useful for avoiding a risk of overtraining and lack of necessary training intensity. The blood lactate concentration has to be defined individually. It allows to obtain more accurate estimate of the performance. The OBLA can be a model of soccer player training to estimate the maximal lactate steady state.

The results demonstrate that the OBLA have been used in a number of studies and has significant improvements in the aerobic fitness level or performances for different groups of physical intensities However, several invasive blood samplings are required to determine the exercise intensity corresponding to the individual OBLA. Thus, these indices are not always applied when coaching endurance athletes. The Velocity corresponds to OBLA at which and/or nearly the football player should be trained during the week.

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КРИВА ЛАКТАТУ КРОВІ, ШВИДКІСТЬ ПОЧАТКУ НАКОПИЧЕННЯ ЛАКТАТУ У КРОВІ І ЧАСТОТА СЕРЦЕВИХ СКОРОЧЕНЬ ПІД ЧАС БІГОВОГО ТЕСТУ З ПРИСКОРЕННЯМ У ФУТБОЛІСТІВ

Це дослідницький проект, який був підтриманий грантом дослідного центру для спортивних наук і фізичної активності, декана з наукових досліджень в Університеті короля Сауда.

Крива лактату в крові, початок накопичення лактату в крові (OBLA) і швидкість початку накопичення лактату у крові можуть служити основою для індивідуальної оцінки, а також призначені для діагностики продуктивності на витривалість, і вони грають важливу роль в оцінці фізичної придатності або тренування на витривалість. Метою цього дослідження є визначення швидкості бігу, що відповідає початку накопичення лактату в крові у футболістів під час бігового тесту з прискоренням, для оцінки фізичної форми і призначення оптимального навантаження та інтенсивності тренувань.

У дослідженні брали участь двадцять чотири професійних футболісти (23.10 ± 2,21 років) виконували п'ятикроковий біговий тест з прискоренням 5х1000 м із збільшенням швидкості – V. Інтервал відновлення між кожною біговою дистанцією був 3 хвилини. Початок накопичення лактату в крові був ідентифікований індивідуально як точка, що відповідає концентрації лактату в крові 4 ммоль/л. Швидкість, при якій накопичення лактату в крові становило 4 ммоль/л, відмічалася як V_{OBLA}.

Зміни в швидкості бігу протягом п'яти кроків, пов'язаних з великою зміною кількості лактату в крові і, відповідно, частоти серцевого ритму; крива лактату в крові з 2,71 ммоль/л і частота серцевих скорочень з 152 уд./хв. після першого кроку зазнає збільшення до 8,53 ммоль/л і 186 уд./хв. в кінці п'ятої стадії. Середнє значення V_{OBLA} було 4,19 ± 0,12 м/с, що становить 70,54 % від Vmax. Внутрішньо-індивідуальні відмінності в кривої лактату крові під час виконання тесту з прискоренням у футболістів можуть бути пояснені специфіко їх ігрової позиції на ігровому полі. Застосування відчутного навантаження у комплексному поєднанні з контролем частоти серцевих скорочень та/або лактату буде корисним для виключення ризику перетренованості і відсутності необхідної інтенсивності тренування.

Ключові слова: *концентрація лактату в крові, швидкість початку накопичення лактату в крові (V_{OBLA}), футболісти.*

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