World Applied Sciences Journal 9 (8): 945-949, 2010
ISSN 1818-4952

Relationship Between Salivary Lactate Concentration with Blood Lactate and Heart Rate

[1]*Amirsasan Ramin,* [1]*Sari-Sarraf Vahid,* [1]*Nikookheslat Saeed*
[2]*Rahimzadeh Ghader and* [3]*Letafatkar Khodadad*

[1]Department of Physical Education and Sports Science University of Tabriz, Tabriz, Iran
[2]Tabriz Petrochemical; TRACTORSAZI Football Club, Tabriz, Iran
[3]PhD Student in Sport Medicine, University of Tehran, Tehran, Iran

Abstract: we studied the relationship between salivary lactate concentration with blood lactate and heart rate of male soccer players during a soccer-exercise session. Twelve trained soccer male players with mean Age 18±0.7 years; Height 173.6±4.4 cm, Weight 67.8±4.6 kg, Body Fat%: 14.30±3.8; Vo_2max: 54±3 ml/kg/min enrolled in this study. Subjects undertake a kind of soccer small-sided game (3 v_s 3) inside the marked area (25×25 meters). Intensities of game were controlled by heart rate at six stages (rest, warm up, after five min playing with %60, %70, %80 and %90 of reserve heart rate). Each stage had five min rest and blood and saliva samples were collected in rest period. Data were analyzed by repeated measured and Spearman correlation at significance level 0.05. The results revealed the significant difference between six stages of protocol in blood and saliva lactate concentrations. In addition, there was significant correlation between saliva and blood lactate concentrations in stages five and six [r=0.79, p<0.05; r=0.56, p<0.05] of protocol respectively. There was correlation between heart rate and saliva lactate concentration [r=0.6, p<0.05; r=0.68, P<0.05] in stages five and six respectively. Based on this study results, concluded that this kind of procedure would be valid as a non invasive method for physiological investigations. The breakpoints of blood and salivary lactate were similar during the games. Thus the visual lactate threshold (VLT) would have been used by this kind of protocols. On the other hand, In this study field technique of salivary lactate analysis was found for first time and this will be very importa nt for clinical, biological and physiological studies about physical activity.

Key words: Salivary lactate concentration · Heart rate · Soccer-exercise session · Ventilatory thresholds · Noninvasive estimation of lactate threshold · Aerobic capacity

INTRODUCTION

The lactate level of blood and its threshold are one of the most important indexs of aerobic endurance and performance. The average exercise intensity during soccer has been reported to be approximately 75% of VO2max, near the anaerobic threshold. It has also been shown that players with the highest aerobic power cover the greatest distances during a game [1]. However, the association between aerobic capacity and distance covered does not necessarily mean that aerobic capacity is the primary determinant of performance in soccer [2,3]. It has been shown that the training status of professional male soccer players increases through changes in lactate and ventilatory thresholds that occurs with no change in VO2max. Therefore, lactate studies, its determination and effective factors on it are very important. For example heart rate at lactate threshold may vary based on mode of exercise and when using heart rate to estimate blood lactate concentration, coaches and athletes should be aware that different modes of exercise elicit a different blood lactate concentration at a given heart rate depending on exercise mode used [4]. The most reliable method to lactate investigation and its changes is blood sampling and it is an invasive method [5-8]. Salivary sampling for analysis of lactate has advantages compared with blood sampling as it is a low stress, noninvasive method. Some of noninvasive methods

Corresponding Author: Amirsasan Ramin, Department of Physical Education and Sports Science, University of Tabriz, Tabriz, Iran, Tel: +984113393255, E-mail: amirsasanramin@gmail.com.

have been used to determine of lactate threshold [9-14]. On the other hand, some studies have used salivary electrolytes and lactate as a non invasive method [3, 4-8]. There are any studies with soccer specific protocol in this field.

The aim of this study was noninvasive estimation of lactate threshold by using specific soccer training with emphasis to training specificity principle with use determination of correlation between blood and salivary lactate and between heart rate and salivary lactate to determine visual lactate threshold.

MATERIALS AND METHODS

Twelve youth and amateur soccer players in one group (VO2max: 54±3.5 ml/kg/min, age: 18±0.7) participated in this study (Table1).

Participants undertaked a kind of soccer small-sided game (3V 3) without a goalkeeper or goal inside the marked area (25×25 meters) [12]. The sided game consisted of keeping the ball despite the opponent's efforts to take the ball. Intensities of game were controlled by heart rate (polar beat T31, N22965) at six stages (rest, warm up, after five min playing with 60%, 70%, 80% and 90% of reserve heart rate and every 30 second was recorded to control intensity thus there were 10 heart rate during five min activity) (Fig. 2). Each stage had five min rest and blood (fingertip) and salivary nonexcited samples [23] were collected in rest period.

Data were analyzed by repeated measured, Spearman correlation at significance level 0.05 and scheffe follow-up test.

Salivary lactate was analysed with enzymatic method by spectrophotometr and blood lactate was analysed by portable lactometer analyzer. (Lactate SCOUT) (Table 2).

RESULTS

Table 1 showes the subjects demographic datas.

The results showed significant difference between six stages of protocol in blood and saliva lactate concentrations. In addition, there was significant correlation between saliva and blood lactate concentrations in stages five and six [r_5=0.79, p_5<0.05; r_6=0.56, p_6<0.05] in protocol respectively. There was correlation between heart rate and saliva lactate concentration in stages five and six respectively [r_5=0.6, p_5<0.05; r_6=0.68, P_6<0.05]. (Table3,4,5,6).

DISCUSSION AND CONCLUSION

Lactate cocentrations of blood and saliva were changed from 1.57, 0.31 MmOl/L at rest to 5.55, 0.68 in end of sixth stage respectively. It means that blood and saliva lactate icreased when training itensity increased (Fd if=32.93, P<0.001) and (Fd if=13.18, P<0.001). It was in agreement with most of studies about blood lactate

Table 1: Subject demographic date (N=12)

	Statistics	
Variables	Mean	SD
Age (years)	18	0.7
Height (cm)	173.6	4.4
Weight (kg)	67.8	4.6
BMI	22.5	1.1
Fat (%)	14.3	3.8
HR (REST)	62.3	3.8
VO2max	54.0	3.5

Table 2: Mean values of indexs in different stages

Stage Index	Rest	Warm up	After 60% of RHR	After 70% of RHR	After 80% of RHR	After 90% of RHR
HR	3.8±62.3	5.4±0122	1.4±146.1	2.8±161.6	.2.1±173.8	2.0±187.0
Blood lactateMmol/l	.0.5±1.6	0.4±1.7	0.7±2.1	.1.6±3.5	2±4.9	.1.5±5.6
Saliva lactate Mmol/l	0.0±0.3	0.1±0.3	0.0±0.4	0.2±0.5	0.2±0.6	0.2±0.7

Table 3: Relationship between blood and saliva lactate (Stage 5)

		(Stage 5) Saliva lactate
(Stage 5) Blood lactate	r	0.79
	α	0.002

Table 4: Relationship between blood and saliva lactate (Stage 6)

		(Stage 6) Saliva lactate
(Stage 6) Blood lactate	r	0.56
	α	0.05

Table 5: Relationship between saliva lactate and heart rate (Stage 5)

		(Stage 5) Saliva lactate
HR (Stage 5)	r	0.60
	α	0.038

Table 6: Relationship between saliva lactate and heart rate (Stage 6)

		(Stage 6) Saliva lactate
HR (Stage 6)	r	0.68
	α	0.014

[2, 1, 5, 11, 18, 20, 22, 25, 30, 31] and saliva lactate [3, 4, 9, 28, 33]. The correlation between saliva and blood lactate concentrations in stages five and six was in agreement with Santos and Segura [28, 29]. Our saliva and blood lactate correlation results was contrary with Askari et al. [3]. It is not known how long it takes for the salivary lactate to form after the blood goes into the salivary gland, but this time did not influence the results found in our experimental model, because the Blood and saliva collections were carried out simultaneously.

However, this is an important factor to consider when researchers study the behavior of salivary lactate concentrations in progressive tests whose stages lasts less than 3 min when the interval among each sample is short and the lactate concentration could not be in balance with plasma lactate [28]. Thus this process maybe has influence their results. Correlation between heart rate and blood lactate has been shown in many studies [1,2,5,11,18,20,22,25,30,31] but there are any studies that investigate correlation between heart rate and saliva lactate same as present study.However,the model of blood and saliva lactate variations related to training intensity (shape and slope) in present study was same as other methods with cycle ergometer and treadmile (Figure 1). From this standpoint,we can transfer physiological studies from laborarory to field and reduce costs. On the other hand,we can relate this studies to training specificity principle. To pay attention to variation of curve slope and with performing of specific training for many kind of sports, determination of lactate threshold by noninvasive salivary lactate analysis is possible. Onset of saliva lactate accumulation (OSLA) same as OBLA can be defined and we use it to control training intensity.

In this study we found field technique of salivary lactate analysis for first time and this will be very important for clinical, biological and physiological studies about physical activity.

ACKNOWLEDGEMENT

Gratitude is expressed to the subjects that participated in this study as well as to each of the assistants who were instrumental in the collection of the data. This study was funded by a product grant from the University of Tabriz (Tabriz, Iran). The researchers independently collected, analyzed and interpreted the results and have no financial interests in the results of this study. Also, dissemination of the results in this study does not constitute endorsement by the researchers or their institutional affiliations.

REFERENCES

1. Anderson, C.S. and A.D. Mahon, 2007. The relationship between ventilatory and lactate threshold in boys and men. Res Sports Med., 15(3): 189-200.
2. Aguilo, A., P. Tauler, A. Sureda, N. Cases, J. Tur and A. Pons, 2007. Antioxidant diet supplementation enhances aerobic performance in amateur sportsmen. J. Sports Sci.
3. Asgari, A., 2004. Effect of exercise on blood and saliva lactate in heithy and chemical injured subjects. (Military medical).
4. Ben-Aryeh, H., *et al.,* 1989. Effect of Exercise on Salivary Composition and Cortisol in Serum and Saliva in Man. J. Dent. Res., 68(11): 1495-1497.
5. Candotti, C.T., J.F. Loss, O. Melo Mde, M. La Torre, M. Pasini, L.A. Dutra, J.L. de Oliveria and L.P. de Oliveria, 2008. Comparing the lactate and EMG thresholds of recreational cyclists during incremental pedaling. Can. J. Physiol. Pharmacol., 86(5): 272-278.
6. Chicharro, J.L., 1997. Saliva composition and exercice. *http://www.sportsci.org/encyc/Saliva.doc.*
7. Chicharo, J.L., 1995. Anaerobic threshold in children: determination from saliva analysis in field tests. Eur. J. Appl. Physiol., 70(6): 541-544.

8. Chicharo, J.L., *et al.* 1999. The salivary amilas, lactate and electromyographic response to exercise. Jpn. J. Physiol., 49: 6551-6554.
9. Chicharro, J.L., *et al.*, 1994. Saliva electrolytes as a useful tool for anaerobic threshold determination. Eur. J. Appl. Physiol. Occup. Physiol., 68(3): 214-218.
10. Crisafulli, A., F. Tocco, G. Pittau, M. Caria, L. Lorrai and F. Melis, 2006. Detection of lactate threshold by including haemodynamic and oxygen extraction data. Physiol. Meas., 27(1): 85-97.
11. Davis, J.A., V.J. Ciaozzo, T.W. Storer and P.H. Pham, 2008. Lactate threshold at the same fat-free mass and age is larger in men than women. Eur. J. Appl. Physiol. [Epub ahead of print].
12. Dellal, A., K. Chamari, A. Pintus, O. Girard, T. Cotte and D. Keller, 2008. Heart rate responses during small-sided games and short intermittent training in elite soccer players: A COMPARATIVE STUDY. J. Strength Cond Res., 22(5): 1449-1457.
13. Dumke, C.L., D.W. Brock, B.H. Helms and G.G. Haff, 2006. Heart rate at lactate threshold and cycling time trails. J. Strength Cond Res., 20(3): 601-607.
14. Eniseler, N., 2005. Heart rate and blood lactate concentrations as predictors of physiological load on elite soccer players during various training activities. J. Strengh Cond Res., 19(4): 799-804.
15. Folke, M., 2008. Estimation of the lactate threshold using an electro acoustic sensor system analyzing the respiratory. Med. Biol. Eng. Comput., 46(9): 969-942.
16. FIFA., 2002. Physical preparation/development and training.
17. Karapetian, G.K., H.J. Engles and R.J. Gretebeck, 2008. Use of heart rate variability to estimate LT and VT. Int J. Sports Med., 29(8): 652-657.
18. Kulaputana, O., S. Thanakomsirichot and W. Anomasiri, 2007. Ginseng supplementation does not change lactate threshold and physical performance in physically active Thai men. J. Med. Assoc Thai., 90(6): 1172-1179.
19. Larson, A.J., 2006. Variations in heart rate at blood lactate threshold due to exercise mode in elite cross-country skiers. J. Sterngh Cond Res., 20(4): 855-860.
20. Marlin, L., F. Sara, S. Antoine-Jonville, P. Connes, M. Etinne-Julan and O. Hue, 2007. Ventilatory and lactate threshold in subjects with sickle cell trait. Int. J. Sports Med., 28(11): 916-920.
21. McMillan, K., J. Helgerud, S.J. Grant, J. Newell, J. Wilson, R. Macdonald and J. Hoff, 2005. Lactate threshold response to a season of professional British youth soccer. Br J. Sports Med., 39: 432-436.
22. Moreira, S.R., G. Arsa, H.B. Oliveria, L.C. Lima, C.S. Campbell and H.G. Simoes, 2008. Methods to identify the lactate and glucose thresholds during resistance exercise for individuals with type 2 diabetes. J. Strength Cond Res., 22(4): 1108-1115.
23. Navazesh, M. And C.M. Christensen, 1982. A comparison of whole mouth resting and stimulated salivary measurement procedures. J. Dent Res., 61: 1158-62.
24. Omiya, K., H. Itoh, N. Harada, T. Maeda, A. Tajima, K. Oikawa, A. Koike, T. Aizawa, L.T. Fu and N. Osada, 2004. Relationship between double product break point, lactate threshold and ventilatory threshold in cardiac patients. Eur. J. Appl. Physiol., 91(2-3): 224-229.
25. Plato, P.A., M. McNulty, S.M. Crunck and A. Tug Ergun, 2008. Predicting lactate threshold using ventilatory threshold. Int. J. Sports Med., 29(9): 732-737.
26. Merle, L. And J.K. Foss-Steven, 2004. Physiological Basis for Exercise and Sport; sixth edition. Mc Graw Hill. Text Book.
27. Robbins, J.L., B.D. Duscha, D.R. Bensimhon, K. Wasserman, J.E. Hansen, J.A. Houmard, B.H. Annex and W.E. Kraus, 2009. A gender specific relationship between capillary density and anaerobic threshold. J. Appl. Physiol. [Epub ahead of print].
28. Santos, R.V., A.L. Almedia, E.C. Caperuto, E. Jr Martins and L.F. Costa Rosa, 2006. Effects of a 30-km race upon salivary lactate correlation with blood lactate. Comp. Biochem. Physiol. B. Biochem. Mol. Biol., 145(1): 114-117.
29. Segura, R., C. Javierre, K.L.L. Ventura, M.A. Lizarraga, B. Campos and E. Garrido, 1996. A new approach to the assessment of anaerobic metabolism: measurement of lactate in saliva. Br. J. Sports Med., 30(4): 305-309.
30. Soller, B.R., Y. Yang, S.M. Lee, C. Wilson and R.D. Hagan, 2008. Noninvasive determination of exercise-induced hydrogen ion threshold through direct optical measurement. J. Appl. Physiol., 104(3): 837-844.

31. Sporis, G., L. Ruzic and G. Leco, 2008. The anaerobic endurance of elite soccer players improved after a high-intensity training intervention in the 8-week conditioning program. J. Strenght Cond Res., 22(2): 559-566.
32. Sari-Sarraf, V., T. Reilly, D. Doran and G. Atkinson, 2008. Effects of Repeated Bouts of Soccer-Specific Intermittent Exercise on Salivary IgA. Int. J. Sports Med 2008; 29: 366-371 DOI: 10.1055/s-2007-965427.
33. Valenzano, A., S. Basanisi, D.E.M. Rosas, G. D'Arienzo, D.I. Bari, A. Ajazi, A. Federici and G. Cibelli, 2008. Determination of the anzerobic therwshold by salivary lactate assay. Am. J. Physiol., Endocrinal Metab.
34. Watt, M.J. and M. Hargreaves, 2002. Effect of epinephrine on glucose disposal during exercise in humans: role of muscle glycogen. Am. J. Physiol. Endocrinal Metab., 283(3): E578-583.
35. William, D. Mc Ardle, Frank I. Katch and Victory L. Katch, 0000. Exercise physiology (Energy and Nutrition).