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Biochemical Changes from Preparation to Competitive Period in Soccer

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Abstract

The aim of the current study was to indicate the biochemical changes during the preparation and competitive soccer period. The literature review showed that biochemical parameters such as transaminases, enzymes and other factors change significantly from the preparation to the competitive period. The sample of the study included twenty five professional soccer players whose biochemical parameters assessed in the beginning of the preparation period, in the middle, in the end of the preparation period, as well as in the middle of the competitive period. The parameters that were assessed were SGPT, SGOT, γ-GT, CPK, LDH, calcium, potassium, magnesium, sodium, creatinine, triglycerides, urea, uric acid, creatinine and B-12. The results showed that SGPT, SGOT and CPK reduced during the preparation period whereas they increased in the competitive period. Furthermore, LDH, urea, uric acid and creatinine reduced from the beginning of the preparation period to the competitive period. Calcium also reduced during the competitive period whereas magnesium, sodium and B-12 increased. These changes are probably explained by the training aim to improve the aerobic and anaerobic capacity of the players throughout the training sessions of the preparation period.

Keywords: Biochemical, training, enzymes, electrolytes, soccer

Introduction

Soccer is considered as a high intensity sport which combines both aerobic and anaerobic conditions. Players have to cover long distances as well as a high number of accelerations and decelerations, physical contacts, sprints, direction changes, throwing, catches, passes and kicks (Gacesa, Barak, & Grujic, 2009; Gil, Gil, Ruiz, Irazusta, & Irazusta, 2007; Hoff, 2005; Reilly, 2005). Thus soccer training is a very demanding procedure in which the players are continuously subjected to various physiological, psychological and physical intensities (Bangsbo, 1994; Reilly, 2003). Elite players perform more than 1000 repetitive motor activities during a game, finding that highlights the need for a demanding soccer training (Mohr, Krustrup, & Bangsbo, 2003; Reilly, 2003). All these activities require muscles to contract concentrically and eccentrically so as to produce strength (Proske & Morgan, 2001). However, performing soccer exercises excessively muscle damage is caused (Komi, 2000). Specifically, metabolic and mechanical factors cause muscle damage following intense prolonged training. In order to determine the level of muscle damage past research is focused in biochemical factors (Brancaccio, Lippi, & Maffulli, 2010; Clarkson & Hubal, 2002; Totsuka et al., 2002) which alter because of training (Bangsbo, 1993).

Enzymes

Serum glutamic oxaloacetic transaminase (SGOT), serum glutamate pyruvate transaminase (SGPT) and gamma-glutamyl transferase (γ-GT) are enzymes released on the muscle by the liver. These are the most sensitive and widely used enzymes which help the body to metabolize proteins. They are usually entered in the blood stream when there is muscle damage. Creatine phosphokinase (CPK) is an enzyme that buffers the ATP and ADP concentrations by catalyzing the transaction of high-energy phosphate between phosphocreatine and ADP (Brancaccio et al., 2010). CPK consist a marker for the early detection of muscle overload and damage potential in soccer players (Lazarim et al., 2009). Furthermore, an enzyme which is related to muscle damage is lactate dehydrogenase (LDH) which catalyzes the conversion of pyruvate acid to lactate and back. It plays an important role in cellular respiration, the process by which glucose is converted into energy for cells.

Electrolytes

Electrolytes are crucial for the formation of bodily tissues and for conducting impulses from the nerves to the muscles. Electrolytes are crucial for a wide variety of physiologic and metabolic processes in the human body. Specifically electrolytes are involved in muscle contraction, normal heart rhythm, nerve impulse conduction, oxygen delivery, protein synthesis, enzyme activation, immune functions, antioxidant activity, bone health, and acid-base balance of the blood (Speich, Pineau, & Ballereau, 2001). Humans' body loses electrolytes through perspiration which have to be replaced. Calcium is an electrolyte involved in a variety of physiologic processes associated with energy metabolism and muscle contraction. Magnesium is essential for many muscle actions as it accelerates the conversion of nutrients into energy for the muscles. It also keeps the muscles supplied while a lack of magnesium may cause muscle cramps (Verheijen, 1998). Similarly, potassium ensures that all impulses between brain and muscles are transmitting quickly without any disturbance (Verheijen, 1998). Studies showed that accumulation of potassium in muscle interstitium and a concomitant change in muscle membrane potential play an important role in the development of fatigue during exercise (Nielsen, Mohr, Klarskov, Kristensen, Krustrup, Juel, & Bangsbo, 2004; Nordsborg, Mohr, Pedersen, Nielsen, Langberg, & Bangsbo, 2003).

Sodium is an important mineral which a main function is to regulate the fluid balance of the body (Verheijen, 1998).

Other parameters

Triglycerides are important to human life and are the main form of fat in the body (Kelley & Kelley, 2009). Simply put, they are fat in the blood and are used to provide energy to the muscles. As a blood lipid, it enables the bidirectional transference of adipose fat and blood glucose from the liver. Urea and uric acid are waste products excreted from the body. They are related with tissue damage through which they reflect imbalances of protein metabolic homeostasis and increase protein catabolism. Creatinine is a nitrogen derived from creatine dehydration which is measured in the blood or urine. The largest site of creatinine production is the skeletal muscle which mass changes because of creatinine proportional alterations. Vitamins play a crucial role in biochemical functions as regulators of electrolyte metabolism as well as cell and tissue growth. B-complex vitamins have several important functions in the body, including energy production, synthesis and repair of muscle tissues, hemoglobin synthesis, and adequate immune functions. Vitamin B12, like the other B vitamins, is important for protein metabolism. It is associated to the formation of red blood cells and the maintenance of the central nervous system (Woolf & Manore, 2006).

It is obvious that these biochemical factors are related to the muscle damage because of training. In our knowledge this was the first study in Greek soccer superleague that examines the differences between these parameters throughout a season. Therefore the aim of the current study was to examine the biochemical changes throughout a season.

Methods

Participants

The study sample included twenty five soccer players aged 25.7 ± 2.1 who were members of a professional Greek team that participated in Superleague for the season 2013-2014. They were initially informed about the procedures, the risks, the requirements, the ethics and the benefits of the study and then they signed a consent form approved from the university research ethics committee. Parental or guardian consent was also taken for the under-18 players to participate in the current study. The participants were nonsmokers, without any metabolic disease during the study period.

Procedures

The biochemical parameters were measured in the laboratory at the beginning of the preparation period (BP), at the middle (MP) and at the end of the preparation period (EP), as well as at the middle of the competitive period (CP). Each test was scheduled at similar time of the day (08:30-09:30 am) and under similar temperature (23-25^{o}C). The measurement performed in the end of July, after four weeks in the beginning of September, after four weeks in the beginning of October and finally ten weeks later in the middle of December. Ten ml of blood samples were collected by venipuncture from the forearm vein in tubes with anticoagulant (EDTA K3) incorporated in its walls and then analyzed in blood counting device. The players did not perform any high intensity training program 48 hours before the measurements. The weight and the height of the players were recorded by a weighting scale (BC1000, Tanita, Japan) and a height cursor respectively.

Statistical analysis

The statistical analyses were performed by the SPSS package (v. 17) at a significance level .05. All the biochemical parameters were expressed as means and standard deviations. The data presented normal distribution while the homogeneity was verified by the Levene's test. Therefore the researchers conducted analysis of variance for repeated measures (ANOVA) to examine any changes between the measurements. Bonferroni correction was also used to assess the significance of the differences between the measurements.

Results

The following tables show the means and standard deviations of biochemical and physiological parameters in the periods: before preparation (BP), middle preparation (MP), end preparation (EP), and competitive period (CP). Furthermore, the 'bonferroni' column highlights the significant differences between the groups after repeated analyses of variation.

Table 1. Behavior of enzymes during preparation and competitive period in soccer.

	BP[1]	MP[2]	EP[3]	CP[4]	Bonferroni	Normal range
SGPT	29.28 (*1.23*)	20.35 (*1.07*)	21.88 (*1.26*)	22.44 (*1.36*)	*1>2; 1>3; 1>4*	*0-40*
SGOT	45.11 (*3.02*)	32.38 (*1.96*)	33.28 (*1.82*)	39.63 (*1.46*)	*1>2;1>3;2<4; 3<4*	*0-30*
γ-GT	17.46 (*1.29*)	17.06 (*1.01*)	18.42 (*1.43*)	16.46 (*.93*)		*9-31*
CPK	474.69 (*50.40*)	274.55 (*24.63*)	248.10 (*31.13*)	368.08 (*30.00*)	*1>2;1>3;2<4; 3<4*	*38-174*
LDH	593.87 (*52.90*)	534.07 (*20.41*)	568.47 (*27.27*)	486.76 (*12.50*)	*3>4*	*105 - 333*

According to the table 1 biochemical parameters alter throughout a training mesocycle. Specifically, it was found that SGPT enzyme reduced from BP to MP, while it was increased during CP. However the only significant difference was between BP with MP, EP, and MP that SGPT was significantly higher in BP. Similarly, SGOT enzyme reduced from BP to MP, while it was increased during CP. SGOT was significantly higher in BP compared to MP and EP. Furthermore, SGOT in MP and EP was significantly lower than its values in CP. In contrast γ-GT did not alter significantly among the measurements. Regarding CPK it was reduced from BP to MP and EP, while it was increased during CP. However, the only significant difference was the reduction from BP to MP and EP. The CP CPK value was also significantly higher than MP and EP. Finally LDH was reduced from BP to MP and CP. This reduction was significant only between the EP to CP.

Table 2. Behavior of electrolytes during preparation and competitive period in soccer

	BP[1]	MP[2]	EP[3]	CP[4]	Bonferroni	Normal range
Calcium	9.61 (.05)	9.39 (.06)	9.63 (.05)	9.34 (.04)	*1>2; 3>4; 1>4*	*9-11*
Potassium	4.76 (.09)	4.59 (.06)	4.78 (.06)	4.72 (.04)		*3.5-5.5*
Magnesium	2.08 (.04)	2.29 (.03)	2.29 (.03)	2.25 (.03)	*1<2; 1<3; 1<4*	*1.8-3.6*
Sodium	136.79 (.29)	138.92 (.23)	137.54 (.15)	172.62 (31.28)	*1<2; 1<4*	*135-147*

The table 2 shows how the electrolytes alter throughout a mesocycle of a soccer season. Specifically it was found that calcium significantly reduced from BP to MP and CP, while it was also reduced from EP to CP. It was also increased from MP to the EP but not significantly. Similarly, potassium reduced from BP to MP and from EP to CP but not significantly. The increase from the MP to EP also was not significant. Moreover, magnesium was significantly increased from BP to MP, EP, and CP. Finally, sodium was significantly increased from BP to MP and CP.

Table 3. Behavior of several biochemical parameters during preparation and competitive period in soccer.

	BP[1]	MP[2]	EP[3]	CP[4]	Bonferroni	Normal range
Triglycerides	105.99 (14.03)	102.76 (3.11)	109.94 (2.19)	101.88 (3.25)		*40-200*
Urea	45.08 (1.24)	41.42 (.66)	42.14 (.40)	37.89 (.84)	*1>4; 2>4; 3>4*	*20-40*
Uric Acid	6.98 (.27)	6.31 (.10)	6.03 (.07)	4.89 (.13)	*1>3; 1>4; 2>4; 3>4;*	*3.4-7.0*
Creatinine	1.12 (.03)	1.05 (.02)	1.01 (.01)	.87 (.02)	*1>3; 2>4; 3>4*	*1.0-2.0*
B-12	348.03 (19.90)	420.60 (18.92)	424.25 (13.40)	470.69 (21.30)	*1<2; 1<3; 1<4*	*200 - 900*

According to the table 3 it was found that triglycerides were reduced from BP to MP as well as from EP to CP. On the other hand, urea concentration was reduced from BP to MP and EP as well as to CP. However the only significant reduction was from BP and MP to CP as well as from MP to CP. Moreover it was found that uric acid reduced from BP to MP, EP, and CP as well as from MP and EP to CP. However the significant reduction was from BP to EP and CP as well as from MP and EP to CP. Although creatinine was reduced from BP to MP, EP, and CP the only significant reduction was from BP to EP, from MP to CP, as well as from EP to CP. Finally, B-12 was gradually increased from BP to MP, EP, and CP but the only significant increase was from BP to, MP, EP, and CP.

Discussion

This is the first study in Greek soccer documenting the time course of biochemical changes during a preparation and a competitive period. The main findings were a significant reduction of SGPT, SGOT and CPK during the preparation period, variables that increased during the competitive period. On the other hand γ-GT did not change significantly. Furthermore, LDH reduced in the middle of the preparation period and competitive period compared to before preparation and end preparation period respectively. Regarding electrolytes, calcium significantly reduced in the middle of the preparation period and the competitive period compared to before preparation and the end preparation period respectively. Moreover, magnesium and sodium were increased from the beginning of the preparation period to the middle of the competitive period. Potassium was a variable that did not change throughout a season. The study also concluded a continuously reduction of urea, uric acid, and creatinine from the beginning of the preparation period to the middle of the competitive period. Finally, B-12 continuously increased from the beginning of the preparation period to the middle of the competitive period. In contrast to these changes triglycerides did not change significantly during the measured period.

Enzymes

In contrast to the findings of the current study the literature review suggest that exercise increases SGPT values (Fathi & Majid, 2015; Foran, Lewandrowski, & Kratz, 2003; Joksimovic et al., 2015; Kim, Lee, & Kim, 2007; Lippi et al., 2008) as well as SGOT values (Foran, Lewandrowski, & Kratz, 2003; Kim, Lee, & Kim, 2007; Lippi et al., 2008). These differences are probably affected by the duration and the intensity of training (Buchheit, Voss, Nybo, Mohr, & Racinais, 2011; Hurley et al., 1995). However SGOT increased during the competitive period finding which the literature review supports. Concerning γ-GT, past research confirms the current study findings which suggest that it is not affected by training (Buchheit, Voss, Nybo, Mohr, & Racinais, 2011; Celenk, Akil, & Kara, 2013). Similarly CPK reduced during the preparation period while it was increased in the competitive period. This reduction is in contrast of past research (Buchheit, Voss, Nybo, Mohr, & Racinais, 2011; Celenk, Akil, & Kara, 2013; Fallon, Sivyer, Sivyer, & Dare, 1999; Hortobagyi & Denahan, 1989; Kratz et al., 2002). Besides, Lippi and colleagues (2011) conclude that intense exercise increases CPK (Lippi et al., 2011). Furthermore, a twice daily football training leads to significant increases of CPK during the fourth day of training that starts a decrease till the 10^{th} day probably because of training adaptations (Ehlers, Ball, & Liston, 2002). Moreover, the conflict of the results may be because of the intensity of training as past research showed that CPK do not change with low and middle level exercises but only intense exercise has a great effect on it (Stansbie, Aston, Dallimore, Williams, & Willis, 1983). Moreover, CPK is affected by training intensity and duration (Buchheit, Voss, Nybo, Mohr, & Racinais, 2011; Hurley et al., 1995) as well as the training adaptations (Ehlers, Ball, & Liston, 2002) suggestions that probably affect the results. In contrast to the literature review (Brown, Day,

& Donnelly, 1999; Friden, Sfakianos, & Hargens, 1989; Gombacci, Tamaro, Simeone, Crocetti, & Stupar, 2002; Kobayashi, Takeuchi, Hosoi, Yoshizaki, & Loeppky, 2005; Nosaka, Clarkson, & Apple, 1992; Mena, Maynar, & Campillo, 1996) the study showed that LDH reduced from the end of the preparation period to the middle of the competitive period. The longitudinal effects of training on LDH are probably the reason for a no-significant increase of this parameter from the beginning of the preparation period to the end.

Electrolytes

The results showed a reduction of calcium values from the beginning of the preparation period to the middle of the preparation period and the middle of the competitive period finding that is probably explained by the fact that high intensity training of preparation period maintains high the calcium levels in the end of the preparation (Dressendorfer, Petersen, Lovshin, & Keen, 2002). In accordance to other studies the current concludes no effects of training on potassium (Boning, Tibes, & Schweigart, 1976; Kratz et al., 2002). However it was increased during an entire football season (Meyer & Meister, 2011). The increase of the magnesium is also supported by the research (Meyer & Meister, 2011). In accordance to past research (Boudou et al., 1987; Kraemer, & Brown, 1986) the current study concludes an increase of sodium during the examined period. However other studies have not found any significant difference (Foran, Lewandrowski, & Kratz, 2003; Kratz et al., 2002). The indicators of biochemical parameters are directly linked to the intensity, the adaptation and duration of training and therefore it should be deeper considered (Bijeh, Rashidlamir, Sadeghynia, & Hejazi, 2013; Brown, Day, & Donnelly, 1999; Friden, Sfakianos, & Hargens, 1989; Gombacci et al., 2002; Kobayashi et al., 2005; Mena, Maynar, & Campillo, 1996; Nosaka, Clarkson, & Apple, 1992; Schumacher, Schmid, Grathwohl, Bultermann, & Berg 2002; Thiago Santi et al., 2013). In total, any conflict in the results is probably explained by many factors such as the age, the nutrition and the training (Ostojic & Ahmetovic, 2009; Savucu, 2012; Schumacher et al., 2002; Thiago Santi et al., 2013).

Other parameters

The study showed that triglycerides reduced from the beginning to the middle of the preparation period as well as from the end of the preparation period to the middle of the competitive, but without any significance. However, the literature review confirms both this tendency (Rahnama, Younesian, Mohammadion, & Bambaeichi, 2009) and its lack of significance (Degoutte et al., 2006). A possible reason for this reduction was the exercise training (Heitkamp, Wegler, Brehme, & Heinle, 2008; Wilmore & Costill, 2005). In contrast to previous findings (Andersson et al., 2008; Bangsbo, 1993; Bangsbo, 1994b) the current study concludes that urea and uric acid reduced from the beginning of the preparation period to the competitive period. However, according to Meyer and Meister (2011) uric acid is reduced while urea concentration is increased during an entire competitive season. Furthermore, Hoffman and colleagues (2002) showed that urea and uric acid do not change after exercise. The similarity in methodology of the current study with Meyer and Meister's (2011) probably explains the partial accordance of the findings. Moreover, the longitudinal nature of the current study with different training intensities, adaptations and duration may affect the results. Concerning creatinine reduction, the only significance observed from the beginning of the preparation period to the other measurements. Although some researchers concluded the opposite findings (Lehmann, Wiedland, & Gastmann, 1997; Silva, Santhiago, Papoti, & Gobatto, 2006), Meyer and Meister's (2011) longitudinal study confirms the current findings. Furthermore, the reduction may be a symptom of overtraining which is a consequence of high intensity periods (Halson & Jeukendrup, 2004; Petibois, Cazola, Poortmans, & Deleris, 2002; Riehl, Fontana, & López, 2004; Silva, Santhiago, Papoti, & Gobatto, 2006). Finally B-12 significantly increased from the preparation to the competitive period, finding that maintain the ability of the players to perform high intensity exercise (Woolf & Manore, 2006). This finding is probably explained by the fact that the final measurement was in the middle of the competitive period.

Conclusion

In summary, the current study shows that training changes biochemical parameters of soccer players. Obviously these changes indicate the muscle damage that is caused because of training. The significant changes of biochemical parameters during the competitive period are probably explained by the training aim to improve the aerobic and anaerobic capacity of the players throughout the training sessions of the preparation period. In addition, a possible reason for biochemical changes in competitive period was probably the different playing time of each player. Therefore, soccer trainers have to evaluate the biochemical parameters of their players so as to improve the effectiveness of their training targets and to peak their performance.

Conflict of Interest

The author has not declared any conflicts of interest.

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