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HORMONAL ANALYSIS IN ELITE BASKETBALL DURING A SEASON

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ABSTRACT: In elite basketball, the high demands of competition and training require a detailed follow-up of the effects on the player's performance and health. Controlling these effects could improve the knowledge about the players' recovery process and allow a better design of their individual workloads.

Aim: To describe the behavior of the total testosterone serum levels (T), cortisol (C) and T/C ratio.

Methodology: 8 blood samples were collected during the whole season of an elite basketball team (n=8) of the First Spanish Division (ACB). The samples were taken every 4-6 weeks, at 8:00 AM, after 24-36 hours of post-game recovery.

Results: T increases after 4 after 3.5 days of rest (6th vs. 1st, $p=0.039$; 6th vs. 5th, $p=0.041$) and decreases significantly at the end of the season (8th vs. 7th, $p=0.003$). C does not show significant variation along the season. T/C ratio shows a significant decrease at the end of the season (8th vs. 1st, $p=0.021$; 8th vs. 7th, $p=0.017$) and in VarT/C (8th vs. 1st, $p=0.005$; 8th vs. 7th, $p=0.036$).

Conclusions: Concentration values as well as percentages of variation are useful indicators to describe the studied parameters. T/C ratio and/or T could be used as recovery state indicators and could even induce, in conjunction with other indicators, necessary actions to optimize individual workloads. Future investigations should compare these variations to objective workload parameters and/or other hormonal modulators.

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Introduction

Fatigue-related mechanisms are still in a study process. Several authors have investigated possible markers from different perspectives: physical, physiological, biomechanical, and psychological. Physiological-endocrine studies are based on the fundamental role played by hormones in anabolic processes (predominant in recovery phases) and in catabolic processes (necessary to maintain energetic availability) (Urhausen et al., 1995), but hormonal response is the result of the combination of different modulators-factors (intensity, volume and type of exercise, ambient temperature, emotional state, etc.); this multifactorial characteristic should be taken into account when studying these parameters.

Testosterone (T) is a steroid hormone which has an anabolic effect in tissue. Its synthesis is controlled by the hypothalamic-hypophyseal-testicular axis and, as in cortisol (C), it increases linearly in response to exercise at a determined intensity threshold (Brownlee et al., 2006). Nevertheless, when exercise extends beyond exhaustion, Testosterone decreases reaching 40% have been observed (Keizer et al., 1989). Cortisol (C), also steroidal, is released by the cortex of suprarenal glands, under Adrenocorticotrophic hormone (ACTH) stimulus. It has catabolic effect in all cells (Virus et al., 2004), including muscular elements, and participates in the maintenance of blood glucose level during exercise (Brownlee et al., 2006). T/C ratio represents the degree of balance between anabolic and catabolic processes, and has been proposed by numerous authors as an indicator of training workload (Adlercreutz et al., 1986; Vervoorn et al., 1991). It's

worth remarking that T/C is a parameter that needs further investigation and, at present, still generates controversy (Urhausen et al., 2002). This kind of investigations are few and recent in relation to team sports, so the aim of this study is to describe the behavior of T/C ratio, Testosterone, and Cortisol along a whole season, as well as study the variation of these parameters in professional basketball players.

Method

Sample

Male professional basketball team (27.8 \pm 4.8 years; 97 \pm 9.5 kg; 197.2 \pm 7.3 cm; 24.7 \pm 0.9 BMI) from Spanish elite division (ACB). Players suffering from jet-lag were removed from the investigation due to alteration of the first blood test (n=8).

Protocol

Samples were collected just after the transitory period and, during the season, samples were taken each 4-6 weeks, after a 24 h-36 h break since the last game played. Extractions (antecubital vein) were performed at 8:00 AM, in fasting state. Total concentrations of T (nMol/l) and C (μ Mol/l) were determined by chemiluminescence. *Statistical analysis:* Concentration and percentage of variation (Var) of each parameter are expressed through mean and standard deviation (Banfi et al., 2006). RM MANOVA and Student's paired t-test were used.

Results

A total of 64 blood samples from peripheral veins were analyzed (Table 1).

Of the six studied variables, (%) variation of C and T/C Ratio, and concentration of T/C Ratio comply with

	Samples							
	1 ^a	2 ^a	3 ^a	4 ^a	5 ^a	6 ^a	7 ^a	8 ^a
	(Baseline) August	(Preseason) September	(Start season) October	November	January	(Copa CR) February	March	(Finish season) April
T (nMol/L)	21.0 ± 4.8	22.4 ± 4.2	22.9 ± 4.0	21.5 ± 4.5	21.4 ± 3.6	24.9 ± 2.9 ^{a,b}	20.6 ± 2.8 ^b	18.0 ± 3.7 ^b
Var T (%)	0	9.9 ± 0.2	11.7 ± 0.2	3.9 ± 0.2	4.8 ± 0.2	23.8 ± 0.3	1.1 ± 0.2 ^b	-12.2 ± 0.2
C (µMol/L)	0.399 ± 0.155	0.451 ± 0.081	0.439 ± 0.095	0.393 ± 0.131	0.438 ± 0.130	0.441 ± 0.086	0.441 ± 0.088	0.516 ± 0.056
Var C (%)	0	33.3 ± 0.7	33.1 ± 0.9	18.7 ± 0.9	30.1 ± 0.8	35.6 ± 0.9	29.2 ± 0.7	57.4 ± 0.9
Ratio T/C	58.0 ± 17.7	50.8 ± 11.3	54.8 ± 17.1	61.7 ± 26.8	54.8 ± 26.6	58.4 ± 12.1	48.6 ± 13.6	35.4 ± 8.5 ^{a,b}
Var T/C (%)	0	-6.6 ± 0.3	1.4 ± 0.4	15.6 ± 0.6	3.3 ± 0.6	8.1 ± 0.4	-10.9 ± 0.3	-33.7 ± 0.2 ^{a,b}

Table 1. Means, standard deviation and signification of % variation and concentration of Testosterone, Cortisol and T/C Ratio.

Values with letters (a, b) show significant difference: (a): In relation to 1st blood sample -Baseline-, (b) In relation to previous blood sample.

the sphericity assumption: VarC (p=0.000), VarT/C (p=0.004) and T/C (p=0.018). According to the results obtained in MANOVA, C does not show significant changes along the season while the other variables do: T (Quadratic, p=0.001), VarT (Quadratic, p=0.009), Ratio T/C (Linear, p=0.022) and VarT/C (Linear, p=0.006). Table 1 shows significant differences, through Student's paired t-test, between different blood samples along the season. Testosterone (Table 1 and Fig. 1). After a 3.5 day break due to Copa del Rey, a significant increase is observed (6th vs. 1st, p=0.039; 6th vs. 5th, p=0.041). A significant decrease in T is observed in the 7th sample (7th vs. 6th, p=0.010) and, similarly, in varT (7th vs. 6th, p=0.003). At the end of the season a significant decrease in T is also observed (8th vs. 7th,

p=0.003). Cortisol (Table 1), There are no significant variations along the season. T/C Ratio (Table 1 and Fig. 2). A significant decrease is observed at the end of the season (8th vs. 1st, p=0.021; 8th vs. 7th, p=0.017) as well as in VarT/C (8th vs. 1st, p=0.005; 8th vs. 7th, p=0.036).

Discussion

This study is one of the few investigations that contributes to the monitoring of this kind of variables during a whole season, using elite players that play in the ACB as sample. Two of the analyzed hormones, T and T/C ratio, show variations in different phases of the season (Table 1, Fig.1 and 2), inviting to reflect on the possible relations between the results obtained and the planned

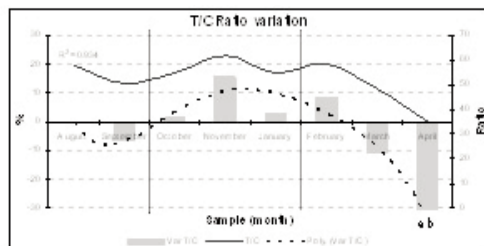
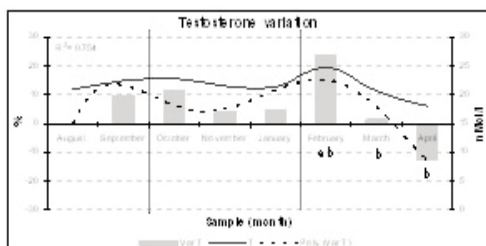


Figure 1 and Figure 2. Variation and concentrations of T and T/C Ratio. Vertical broken lines represent (left to right): Beginning of season and Copa del Rey break. Values with letters (a, b) show significant difference: (a): In relation to 1st blood sample -Baseline-, (b) In relation to previous blood sample.. R2: Correlation of trend line

objectives of the team. Some authors have proposed T as a valid indicator of fatigue (Hoffman et al., 1999; Maso et al., 2004) and, in our present investigation, T has been the variable which has shown most significant variation along the season. The Copa del Rey break (3.5 days) caused significant increases of T (6th vs. 1st, $p=0.039$; 6th vs. 5th, $p=0.041$), suggesting a predominance of anabolic processes (Brownlee et al., 2006). The end of the season entails a less significant decrease in relation to the previous blood sample (8th vs. 7th, $p=0.003$), suggesting accumulated fatigue. These results coincide with previous investigations (Handziski et al., 2006).

Hoffman (1999), on the contrary, observes little variation of this hormone after 28 days of a national team training camp. The author concludes that players could suffer from fatigue. C tends to increase its response to an increase in volume and/or stress (Brownlee et al., 2006). Results obtained agree with this behavior, increasing and maintaining its values, even if showing no significant differences. These results contradict those published by Seco (Seco et al., 2003) — where C decreased along the season— and Hoffman (1999) —where it increased after a reduction in workload—. Both author's results could be explained by overtraining, bearing in mind C's biphasic response to training volume, due to an increase in relation to volume in an early phase and, once exceeded the fatigue level, a decrease provoked by possible alterations in the hypothalamus-hypophysis-adrenal axis (Bonete, 2003).

Seco studied a team which participated in double competition; in Hoffman's case, the national team training camp began one month after the end of the season. T/C

ratio has been proposed by different authors as a potential indicator of training load (Adlercreutz et al., 1986). This variable shows a significant decrease after the last blood sample (8th vs. 1st, $p=0.021$; 8th vs. 7th $p=0.017$), similarly to VarT/C (8th vs. 1st $p=0.005$; 8th vs. 7th, $p=0.036$), agreeing with results obtained by Handziski (2006) and Radoje (2005), and possibly showing accumulated fatigue during the season or incomplete recovery (Vervoorn et al., 1991). Nevertheless, there is no coincidence with Hoffman (1999), where no significant differences between initial and final values were observed during a national team training camp. As it was previously said, Hoffman's results could be influenced by overtraining or accumulated fatigue.

Even though decreases in T/C Ratio reaching 30% are observed in some players, we don't necessarily consider these values as a consequence of overtraining, as we should have more indicators (Hoffman et al., 1999). In summary, the effect of a basketball season is clearly reflected by the studied hormones, with special significance of T and T/C Ratio. C increases at the beginning of the pre-season and keeps a high level along the season, but shows no significant changes. After a break of 3.5 days, anabolic indicators (T and T/C) increase significantly. Consequently, T/C Ratio and/or T, could be possible indicators of the athlete's state which could justify, together with other indicators, necessary action to optimize workload individually. Future investigations should compare these variations with objective workload parameters and/or hormonal modulators.

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