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Letter to editor

Hormonal responses in heavy training and recovery periods in an elite male weightlifter

Dear Editor-in-chief

The endocrine system has been suggested as a useful indicator for training stress (Kraemer and Ratamess, 2005). An equilibrium between anabolic and catabolic states in athletes is often represented by testosterone-to-cortisol ratio (TCR). Changes in TCR have been positively related to weight training performance (Hakkinen, et al., 1987). The decreased TCR has been used as an indicator for overtraining (Roberts, et al., 1993, Vervoorn, et al., 1991) and insufficient recovery (Passelergue and Lac, 1999). Elite weightlifters undergo year-round training with various overreaching and recovery periods. Previous investigations have not established the detailed time course of the hormonal responses in these periods mostly due to insufficient sampling frequencies.

We investigated the changes in serum levels of total and free testosterone and cortisol, free testosterone-to-free cortisol ratio (FTFCR), insulin-like growth factor-1 (IGF-1), and free triiodothyronine (FT3) and thyroxine (FT4) every 2 weeks for 21 weeks in an elite male weightlifter. This study was performed from August, 2003 to January, 2004, including the preparation, taper, and recovery periods for the World Championship in November, 2003.

The 27-year-old male weightlifter holds the national records of Taiwan (Chinese Taipei) in 56 and 62 kg categories. The subject had ranked top 5 in the world for several years prior to this study and ranked first in the world in 2005 in 56 kg category. His height was 1.58 m and body weight ranged from 55.8 to 59.6 kg during the 21-week study period. The subject has no history of using anabolic steroid or other banned substances.

Venous blood samples were collected after overnight fast every 2 weeks between 7 and 8 am. The first blood sample after the World Championship was collected in week 15. Serum concentrations of total and free testosterone and cortisol were measured with enzyme immunoassay and IGF-1 were measured with enzyme-linked immunosorbent assay kits (Diagnostic Systems Laboratories, Inc., Webster, TX, USA) according to the protocols recommended by the manufacturer. Serum levels of FT3 and FT4 were measured by electro-chemiluminescence using an automatic analyzer (Elecsys 2110, Roche Diagnostics, Basel, Switzerland). Blood samples were frozen and analyzed within 3 days after collection.

Serum hormone concentrations in the end of each 2-week period and the total weight lifted during the 2 weeks prior to the day of blood sampling were shown in Table 1. After reaching the lowest in week 2, total testosterone level showed a general trend of mild increase throughout the tapering period. Free testosterone level decreased by 15.3% in week 2 when the training volume increased significantly. The concentration started to increase after week 2 and reached the highest value in week 12 before the subject left for the competition. Total and free cortisol concentrations continued to rise during the high-volume training period, reaching the highest level in week 8 to remain high in week 12. As the result, FTFCR remained low from week 2 to 12, returning to the basal level in week 15 (Figure 1).

After the high-volume training in week 2, serum IGF-1 concentration was decreased until week 6, and then started to elevate as the training volume decreased (Table 1). Serum FT3 concentration reached the highest level in week 4, and subsequently declined as the training volume decreased. On the other hand, serum FT4 concentrations remained relatively stable throughout the study period (Table 1).

To our knowledge, this is the first study to investigate serum hormonal responses to the variation of training volume with such high sampling frequency in an elite male weightlifter. The results suggested that after high-volume training, free testosterone peaked while free cortisol remained high after 6 weeks of taper. It indicated that the physiological stress induced by such training may last for more than 6 weeks even when the training volume was markedly decreased by more than 50%. As the result, FTFCR was still low when the subject left for the

Table 1. Serum hormone concentrations and training volume in an elite weightlifter during a 21-week training periods.

Period	Preparation				Taper			Recovery			
Week	0	2	4	6	8	10	12	15	17	19	21
Training volume (1000kg)	123	190	148	145	95	100	77	29	112	90	115
Testosterone											
Total (ng/ml)	7.1	7.0	7.4	8.1	8.3	7.8	8.8	7.5	9.0	8.7	9.5
Free (pg/ml)	18.3	15.5	17.6	19.5	23.9	22.3	29.1	18.7	21.9	25.6	26.9
Cortisol											
Total (ng/ml)	84	137	164	142	220	190	202	74	182	165	185
Free (ng/ml)	3.9	8.2	9.1	8.5	18.8	13.9	14.5	4.3	12.1	15.2	14.8
IGF-1 (ng/ml)	216	241	194	176	252	249	274	157	286	201	213
FT3 (pg/ml)	2.67	2.63	3.48	3.01	2.83	2.64	2.73	3.15	3.06	2.40	3.34
FT4 (pg/ml)	13.7	13.6	15.2	13.4	14.1	14.4	12.9	12.1	14.2	12.3	13.1

IGF-1: insulin-like growth factor-1; FT3: free triiodothyronine; FT4: free thyroxine.

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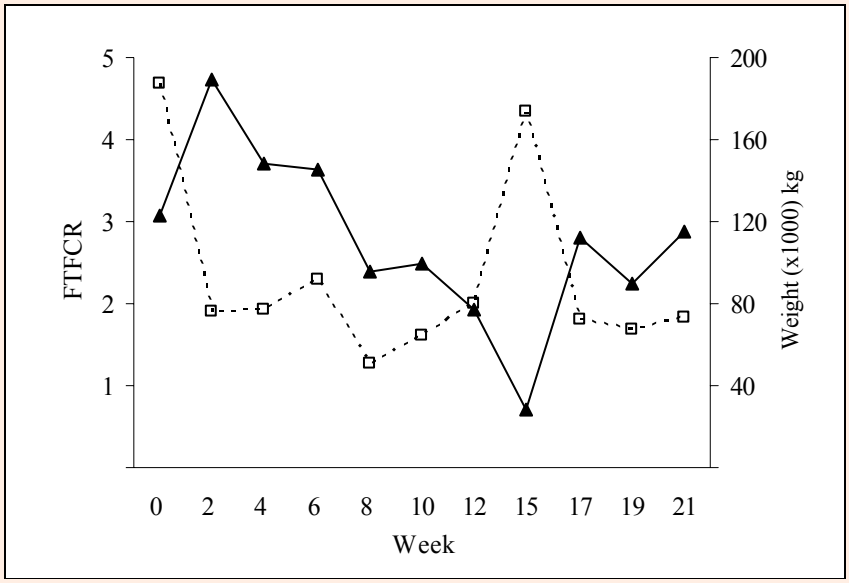

Figure 1. Serum free testosterone-to-free cortisol ratio (□) and bi-weekly training volume (▲) in an elite weightlifter during the 21-week training period.

competition. This may be one of the reasons that the subject only placed 5th in the competition. The longer tapering period and/or further reduction in training volume may be required for the optimal performance.

This study suggested that FTFCR may serve as a useful indicator of the degree of recovery from high-volume training commonly employed by these athletes, showing a marked decrease in high-volume training period and a significant increase after recovery. The routine measurements of these hormones would provide valuable information on physiological responses to the training program in elite athletes.

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