

High-Level Athletic Sprinters: Effects of Tolerance Training on DNA Damage, Acute Phase Proteins and Creatine Kinase

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Abstract

Several studies have suggested that tolerance and speed resistance training are highly beneficial for high-level athletic sprinters in relation to maximal running performance. However ROS generation by high intensity exercise contribute to oxidant accumulation and fatigue depressing the contractile function of myofibers so strength levels decrease, strength and power imbalances $\geq 10\%$ are greater risk of injuries. Thus, how to safely periodize trainings to obtain biopositive adaptations without favoring the prevalence of injuries?

Aim: In the present study, we aimed to evaluate the acute muscle and DNA damage, as well as, kinetics of biomarkers signalling inflammation induced of tolerance training.

Athlete: One male elite sprinter (World Champion with team Brazil 4x100m in 2019 & Brazil's second best performance ever) PB 10"02. Body characteristics: 21 years of age, 80kg body mass, 182.0cm of body height, 6.7 % fat mass.

Methods: Three Blocks with five sprints, distance (10/20/30/40/50m) sum 450m; five minutes of rest between blocks and 30 seconds between sprints. The blood samples were collected from the fingertip for [La⁻] assessment before and 30 seconds after sprints using a portable analyser and after 24h of training, samples were collected from the antecubital vein in EDTA-containing Vacutainer glass tubes. All measurements were obtained via automatic biochemical analyzer. Parameters: C-Reactive protein ultra-sensitive; C-Reactive protein quantitative; CK; DNA damage.

Results: The main results were together with the increase in DNA damage in after sprints compared to resting conditions high levels of CK (approximately 700%) and acute phase proteins (approximately 300/400%) and recovery optimal in approximately 96h.

Conclusion: This study suggests that optimal training or competition for maximum performance (strength, power and speed) should be combined with the best recovery before the next maximum stimulus. Still suggesting that program success may be favored by monitoring the best internal load levels (Biomarkers and comet assay).

Keywords: Biomarkers; signalling inflammation; periodization; injuries

Abbreviations: ROS – Reactive oxygen species

CK – Creatine Kinase

[La⁻] – Blood Lactate Concentrations

(mmol.l⁻¹) – Millimole/liter

Min – Minute

us-CRP - C-Reactive protein ultra-sensitive

Crp - C-Reactive protein quantitative

PB – Personal Best

m – meters

DNA - Deoxyribonucleic acid

Introduction

Several studies confirm the benefits of regular physical exercise, it has also been shown that above certain intensity and duration, acute physical exercise may induce an increase in the production of reactive oxygen species (ROS) [1]. Anaerobic exercise (resistance training and sprinting) concomitant exposure to exercise mediated increased ROS, inflammation, and ischemia [2]. The high formation of ROS in amounts that exceed the capacity of the antioxidant defence system may result in DNA damage [3,4]. Interestingly, high levels of reactive oxygen species promote contractile dysfunction resulting in muscle weakness and fatigue [5]. Strength and power imbalances $\geq 10\%$ are greater risk of injuries. Hamstring injury in elite sprinters was associated with weakness during eccentric action of the hamstrings and

weakness during concentric action of the hip extensors. Studies recent suggest that weakness of the hamstrings and possibly hip extensors is a cause of injury [6-8].

Lactate during trainings is considered to be the best biomarker for the assessment of intensity and performance bioenergetics in elite sprinters, particularly its anaerobic component and is the end product of the anaerobic metabolism, diffusing from the muscle cell into the bloodstream when aerobic and other metabolic pathways are unable to keep up with the removal of pyruvate [9]. However, tolerance and speed resistance training are highly beneficial for high-level athletic sprinters in relation to maximal running performance, obviously very high intensity training to maximizing performance and rank world. Solidly discussed in the scientific literature about that acute exercise causes apoptosis and inflammation [10,11],

muscle metabolism parameters such CK are commonly increased after exercise and Elevated CK is commonly encountered in athletes [12]. CK levels should be monitored during and after exercise to evaluate recovery, that is, to determine whether the levels return to basal, pre-exercise values, or whether high values persist, which can be a signal of trauma, overtraining, or muscular pathology [13]. The purpose of this case report was show data regarding high intensity stimulus running in elite sprinter as well as the impacts and optimal recovery time through acute phase proteins, CK and DNA damage, drawing attention to the need to periodize training and competitions based on reliable biomarkers of the athlete's total recovery, thus avoiding injuries related to imbalances and loss of strength and / or power, induced for ROS and DNA damage (Figures 1 & 2).

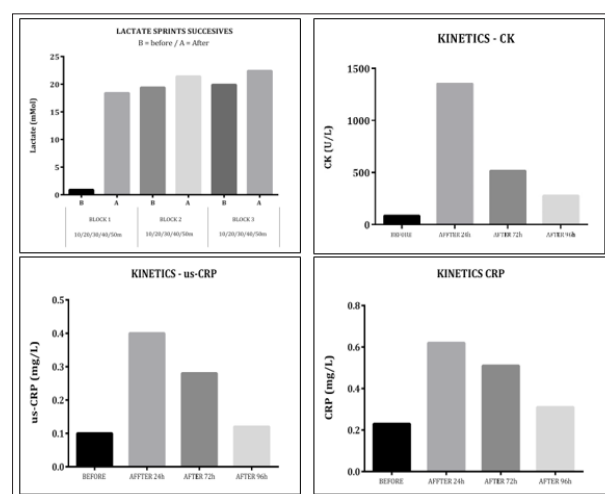


Figure 1: Kinetics of lactate, CK and acute phase proteins.

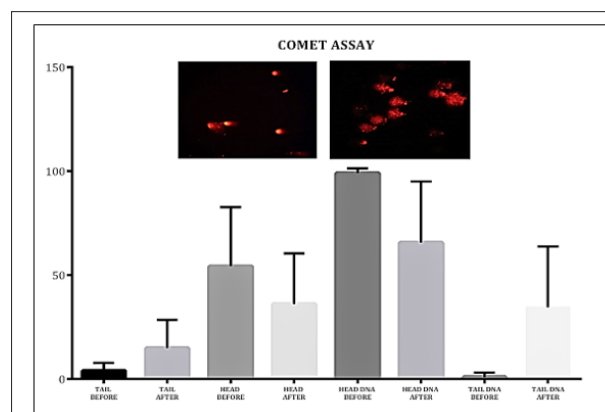


Figure 2: Acute damage DNA (before and after 3 blocks).

Case Presentation

This case report suggests high intensity training focusing on internal loads [La] in high levels all the time, combined with optimal external loads all the time to (maximal running performance). From the successive increase in sprint distance, thus causing considerable improvements in physiological capacity (tolerance), as well as increasing speed and speed resistance. However, we highlight the need for monitoring by biomarkers due

to the significant increase damage to DNA, muscle and signaling of exercise-induced inflammation.

Methods

Athlete

One male elite sprinter athletic (World Champion with time Brazil 4x100m in 2019 & Brazil's second best performance ever) PB 10'02, volunteered to participate in the current study and

signed an informed consent form. Body characteristics were: 21 years of age, 80kg of body mass, 182.0cm of body height, 6.7% of fat mass. The body characteristic's assessment was conducted before the beginning of the experimental protocol, with body mass and fat mass measured using the protocol sum of seven skinfolds [14]. All procedures were performed in accordance with the Declaration of Helsinki and approved by the university Vila Velha ethics committee n° 2.373.739/2017- CAAE 78770017.0.0000.5064.

Protocols

Sprints tests: Three (3) Blocks each with five (5) sprints successive, distance (10/20/30/40/50 m) total 450m; all sprints with maximal speed; five minutes of rest between blocks and 30 seconds between sprints (Tables 1-4).

Table 1: CK, us-CRP and CRP concentrations (basal, 24h, 72h and 96h after training).

Time	CK (U/L)	Us-CRP (mg/L)	CRP (mg/L)
Basal	84	0.1	0.23
24h after	1352	0.4	0.62
72h after	514	0.28	0.51
96h after	276	0.12	0.31

Table 2: Blood lactate (before) and after each block of sprints (10/20/30/40/50m).

Time	[La-] (mmol.l-1)
Rest	-0.6
Warm-up	(0.9) 3.9
Block 1	(4.5) 18.4
Block 2	(19.4) 21.4
Block 3	(19.9) 22.4

Table 3: Comet Assay (tail percentage and head percentage).

Time	Head	Tail	Head DNA	Tail DNA
(Before)	(54,20)	(4,00)	(99,07)	(0,93) 34,38
After	36,08	14,80	65,62	

Table 4: Sprints and time.

Distance (m)	Time - seconds			Mean ± SD
10	1,72	1,88	1,81	1,80±0,08
20	2,88	2,66	3	2,85±0,17
30	3,84	3,81	3,94	3,86±0,06
40	4,66	4,85	5,09	4,87±0,21
50	6,22	6,5	6,2	6,31±0,16

Blood samples

The blood samples were collected from the fingertip for [La-] assessment before and 30 seconds after sprints test using a portable analyzer (Lactate Plus®, Waltham, MA 02454-9141, EUA) and after 24h of training, samples were collected from the antecubital vein in EDTA-containing Vacutainer glass tubes (Becton, Dickinson and Co, Franklin Lakes-NJ), 9-10 a.m. All measurements were obtained via automatic biochemical analyzer (AU680, Olympus/Beckman Coulter, Munich-Germany) or hematological analyzer (Coulter LH750, Beckman Coulter, Brea, CA-USA). The parameters were: C-Reactive protein ultra-sensitive; C-Reactive protein quantitative; CK; DNA damage.

DNA damage

DNA damage were measured using the comet assay, with gel electrophoresis. Comet assay is a simple and sensitive method for quantitatively measuring DNA damages in individual cells [15]. Cells with increased DNA damages display increased DNA migration from the nucleus toward the anode. The migration is observed by fluorescence microscopy after staining with a fluorescent dye (ethidium bromide), and the intensity of the comet tail reflects the number of DNA damage measure with CASP LAB (comet assay software). The Alkaline Comet Assay is a well-validated technique for assessing DNA damages in individual cells [16].

Discussion

The present case study shows the importance of considering the increase inflammatory signaling and muscle damage during maximum sprints to periodize optimal training for elite sprinters, considering that ROS generation by high intensity exercise contribute to oxidant accumulation and fatigue depressing the contractile function of myofibers and results can lower strength levels, strength and power imbalances ≥10% are greater risk of injuries [17,18]. Several studies suggest that CK levels should be monitored during and after exercise to evaluate recovery, that is, to determine whether the levels return to basal, pre-exercise values, or whether high values persist, which can be a signal of trauma, overtraining, or muscular pathology. In summary, results of this case study suggest point to the conclusion that high intensity exercise (sprints and tolerance training) produces DNA damage and in the future research assessing these same variables, in addition to DNA damage and Supplementation on Antioxidant Status and exercises [19]. Finally, it seems to be in the balance between stimuli and recovery to maximize performance. Biomarkers can assist in decision-making to define this optimal periodization.

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Conflict of Interest

There is no conflict of interest. Author have not received a specific grant for this research from any funding agency in the public commercial or not-for-profit sectors.

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