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Circulating β-Endorphin, Adrenocorticotropin, and Cortisol Concentrations of Horses Before and After Competitive Show Jumping with Different Fence Heights

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ABSTRACT

Circulating β-endorphin, adrenocorticotropin, and cortisol concentrations were studied before and after competitive show jumping in 18 trained jumper horses aged between 11 and 13 years and having the same level of show experience. Horses were subjected to the same type of management and daily training exercise. Each horse had been ridden by the same rider during both the daily training exercise and show jumping event. All horses, randomly divided into three groups paired by gender, performed in three competition levels with the same circuit design over 10 fences, with 5 upright and 5 cross-pole fences, differing for the fence height: group I (n = 6), 1.10 m; group II (n = 6), 1.20 m; and group III (n = 6), 1.30 m. Repeated measures analysis of variance showed a statistically significant effect of competitive exercise on β-endorphin and cortisol changes in all groups, whereas the effect of exercise on adrenocorticotropin changes was exclusively seen in groups II and III. Two-way repeated measures analysis of variance showed that the effect of fence height was significant ($P = .03$), and time ($P = .0001$) also affected cortisol changes. These results suggest that the hypothalamic-pituitary-adrenal axis response is different with respect to the different fence heights of jumping course and the different time points of the recovery period.

1. Introduction

Measuring hypothalamic-pituitary-adrenal (HPA) axis activity is a good approach to the study of exercise-induced stress in competitive horses by monitoring the secretion of circulating β-endorphin, adrenocorticotropin (ACTH), and cortisol [1-3] levels. In fact, the increased HPA axis activity affects exercise capability [4]. Moreover, the measurement of the HPA axis hormones has also been used to assess performance levels and training status in horses [5], such as the effects of different types of exercise and of show jumping competitions on stress levels in horses [6,7]. This neuroendocrine system is primarily involved in maintaining homeostatic metabolic process, particularly in the regulation of energy fluxes [8]. The major fluxes satisfy the marked increase in energy demands during the exercise. This supply of energy flux is used as a defence mechanism to cope with the exercise-related stressors, preventing the body's stress reaction from becoming overexpressed [9].

HPA axis hormones measurement has also been used in monitoring animal welfare [10,11] and emotional response [12].

Show jumping is quite an intense sport, despite the relatively slow average speed, due to the intense effort required to jump fences every 5 seconds; it is assumed to influence the prevailing anaerobic metabolism [13],

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depending on fence jumping [14]. Power, speed, and technical jumping skill influence how successfully a horse performs [15]. Although numerous studies have been carried out on HPA activity in horses under different exercise conditions, the current state of knowledge concerning the hormonal responses of horses to show jumping is limited [6,13,16-20].

In athlete horses, the secretion of β-endorphin, ACTH, and cortisol is exclusively or partially dependent on type, intensity, and duration of exercise [1,6,21-29] or on their interactions [30], as well as on the state of individual fitness [17,31], level of training [32-35], and age of horses [2,22,36].

The increase in β-endorphin modulates the time to fatigue and is associated with the impairment of performance [37]; in horses too, it is considered as a marker of stress and welfare [25,38,39].

The behavior of β-endorphin during competition has still to be clarified, and there are limited field data regarding the effects of exercise on β-endorphin in horses [1]; nevertheless, such studies could provide a general picture on the effects of exercise during competition with respect to training conditions [19,20].

Novelty stimuli during exercise test were reported to increase plasma ACTH [12], and it has been reported that during competition, increases in plasma cortisol levels in experienced jumpers are smaller than in horses lacking experience, thereby suggesting that horses become conditioned to the mental stress of the show environment [16]. However, cortisol resting levels of sport horses appeared to be affected by stress conditions before a competition [18].

Thus, it seems worthwhile to elucidate further the behavior and the interrelationships of the various hormones of HPA axis after competitive show jumping.

Moreover, during competition, jumping ability has been found to influence circulating cortisol, but not ACTH and β-endorphin, levels [40,41]; the cortisol and ACTH responses have been found to be related to the level of competition experience [19]. After experimental show jumping sessions, no significant effects of fence height and performance result on β-endorphin, ACTH, and cortisol changes have been recorded [20].

On this basis, the aim of this research was to investigate the circulating β-endorphin, ACTH, and cortisol changes in horses before competition and during the recovery period after show jumping, and to evaluate the association of hormonal changes to different levels of difficulty (fence height) and performance success (clear/penalty round).

2. Materials and Methods

2.1. Animals

All methods and procedures used in this experiment were reviewed and approved by the Messina University Institutional Board for the Care and Use of Animals.

Eighteen jumper horses (15 Sella Italiano and 3 Dutch Warmblood; 9 mares and 9 geldings; mean body weight: 510 ± 70 kg), with an age range of 11-13 years (12.3 ± 0.7 years), were studied during an official show jumping event. All horses were housed at the same Equine Research Facility where the event took place and were recruited according to their same level of show experience.

The show experience level of each horse was evaluated with respect to the ratio between the number of victories and the number of shows attended during the past 3 years.

Horses were subjected to the same type of management, including time and length of the daily training exercise and same groom. Horses were all stabled at the same riding school, and each horse was kept in an individual box (4 × 4 m^2) with natural lighting, allowing reciprocal visual contact, and with access to a sand outdoor paddock 2-3 hr/d. Each horse was fed a daily ration of 8 kg of alfalfa and grass hay and 4 kg of a commercially available hay cube ration (split into two feeds). Water and a salt/mineral block were provided in the boxes ad libitum.

The horses were considered to be clinically healthy by the referring veterinarian.

In this study, each horse had been trained during the past few years by the same rider (18 riders for 18 horses), who had subsequently ridden it at the shows. Each horse and each rider usually trained together once a day in the same arena and were familiar with the jumping exercises required. Each horse was exercised once daily for approximately 40 minutes for four consecutive days. All horses, respectively before and after the training session, exercised for 10 minutes of warm-up/warm down, at walk, trot and quiet canter; they also jumped six fences of different heights. All subjects were able to cope with fence height up to 1.30 m, were randomly divided into three groups paired by gender, and performed in three competition levels with the same circuit design over 10 fences, with 5 upright and 5 cross pole fences, differing for fence height: group I (n = 6), 1.10 m; group II (n = 6), 1.20 m; and group III (n = 6), 1.30 m.

The study was conducted in a riding establishment at the Equine Research Facility during a regular show jumping event with spectators, over a 600-m course. The arena was on flat and the surface was covered by grass. Conditions were dry and sunny, and the mean ambient temperature was 24°C (range: 22°C-26°C). The rounds were performed after a warm-up, consisting of 10 minutes of walk, trot, a short spell of quiet cantering, and jumping four fences. Afterward, the horses walked until heart rate decreased to <50 beats/min. Two horses were present simultaneously in the arena during the warm-up period.

Heart rate was monitored with a Polar Sport Tester (Polar Electro Europe BV, Fleurier, Switzerland), which recorded the heart rate at 15-second intervals.

Competition performance was scored according to the time taken and knockdowns on the courses. Faults and refusals of each horse were recorded. The mean speed during the competitions was 5.5 ± 0.3 m/s, and the mean duration was 85.2 ± 1.6 seconds. The competition sessions were cantered at an average speed of approximately 350/min.

To provide a preliminary investigation on the effects of performance on β-endorphin, ACTH, and cortisol changes, regardless of the competition categories, the horses were divided on the basis of the individual results obtained during the competition (clear round: n = 6; penalty round: n = 12).

2.2. Hormone Analysis

Blood samples were collected from the jugular vein using evacuated tubes (Venoject, Terumo; Belgium) in basal