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THE EFFECTS OF PHYSICAL EXERCISE ON SOME PLASMA ENZYMES AND Ca AND P LEVELS IN RACE HORSES*

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Yarış atı olarak yetiştirilen atlarda fiziksel egzersizin bazı plazma enzimleri ile Ca ve P düzeylerine etkileri

Özet: Araştırmada materyal olarak 9 adet 2 yaşlı erkek İngiliz atı kullanıldı. Atlar çevresi 150 m olan kuru kum zemine sahip kapalı manejde 10 dakikada 5400 metreyi tırıs olarak koşturuldu.

Egzersiz öncesi (0 dak), egzersizin 5 dakikası ve egzersiz bitimi (10 dak.) ile egzersiz sonrası 1/2 , 6, 12 ve 24. saatlerde alınan kan örneklerinde plazma Aspartat-aminotransferaz (AST), Alanin-aminotransferaz (ALT), Gama-glutamiltransferaz (GGT), Alkalin-fosfataz (ALP), Kalsiyum (Ca), Fosfor (P) değişimleri incelendi.

Plazma AST, ALP ve GGT düzeylerinde egzersiz bitiminde egzersiz öncesine göre hafif bir artış olmasına rağmen farklılıklar istatistiksel olarak önemli değildi. Keza plazma ALT düzeyindeki değişikler de istatistiksel önemde bulunmadı.

Egzersizle birlikte Ca düzeyinde bir azalma, P düzeyinde ise bir artış saptanmasına karşın egzersiz öncesi döneme oranla meydana gelen bu değişimler istatistiksel olarak önemli bulunmadı.

Anahtar Kelimeler: AST, ALT, GGT, ALP, Ca, P, at, egzersiz.

Summary: In this study nine two-year old, male, English horses which trot 5400 m in 10 minutes on dry sand and closed manage were used.

The changes in plasma Aspartate-aminotransferase (AST), Alanine-aminotransferase (ALT), Gamma-glutamyltransferase (GGT), Alkaline-phosphatase (ALP), Calcium (Ca) and Phosphorus (P) levels were measured in blood samples which were taken before (at 0 min), at the 5th minute, right after (at 10th min) and 1/2, 6, 12 and 24 hours after the exercise.

Although plasma AST, ALP and GGT values were slightly higher in post-exercise period, the differences were not significant statistically in comparison to the pre-exercise levels. And also changes in plasma ALT were not significant statistically.

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Although a slight decrease in plasma Ca level and a slight increase in plasma P level was found with exercise, a statistical difference could not found according to the pre-exercise period.

Key Words: AST, ALT, GGT, ALP, Ca, P, horse, exercise

Introduction

The use of race horses with high performance for a long time is closely related with the training programme applied to the animals (10). It is known that, the application of different type and strength of physical exercise programmes for different periods is necessary to increase the performance of the horse and to have a sufficient physical condition (4). It has been declared that, especially light in degree and prolonged exercise programmes increase the endurance and power of the horse (14), whereas incorrect exercises programmes prevent the use of animal at early ages (31, 36).

It has been suggested that, the changes in haematological parameters, occur during various training programmes, will help to evaluate the response of the horses to the exercise (13, 25). Furthermore it is important to determine the sufficiency of the training programme, and to determine whether this training programme, applied to the animal, force the physiologic limit of the animal or not (30).

It has been declared that, AST which is one of these parameters used for this purpose shows its maximum activity in skeletal muscle (32), it is a sensitive indicator of acute cell destruction, and the activity of AST may increase in skeletal muscle destruction (10, 14). Anderson (1) informed that, a transitory selective change occurs in membrane permeability due to the exertion of skeletal muscle. In horses, great amount of ALT exist in liver, it is less in striated muscle (14). Rose et al. (23) informed that, the level of ALT increase significantly in the cross-country ride which is the hardest part of the 3-day exercise programme that they applied to the animals, and the probable reason of this increase may be the destruction occur in muscle. It has also been declared that, a 18-minute exercise applied to the well-trained horses cause a slight increase in ALT level (13).

The activity changes in muscle enzymes and GGT level can indicate the exertion of animal strength in exercise or the performance of the animal is low. Robertson et al. (21) informed that, a rapid 3-phase training programme that they applied to the animals increased the level of GGT. It is informed that, the reason of this increase may be the excessive stress occurred during training (29).

Alkaline-phosphatase activity is closely related with the bone metabolism, and as the animal gets older this metabolism become slow (14, 16). Therefore, while evaluating the ALP activity, the age must be taken into consideration (3).

It is known that Ca, which has an important role in the contraction of the cells, is stored up in endoplasmic reticulum (17). Various hypothesis including excretion of Ca with perspiration, taken of Ca into the muscle cells during heavy muscular work, and the collection of Ca in intracellular fluid by red blood cells, have been suggested to explain the Ca loss after exercise (9, 27). It has been declared that, the amount of Ca excreted by perspiration is more than the amount of it in plasma (23).

It is implied that, the amount of P increases due to the destruction of ATP during physical exercise (14, 17). Rose et al. (24) informed that, the reason of the increase in P, especially after the endurance ride, can be explained by the dephosphorilation of ATP to provide high energy phosphate for the contraction of muscles.

Generally a regular exercise programme is not applied to the race horses till 1 year of age, and they start to ride at 2-year of age (14, 31). The constructed studies show that the application of an attentive training programme for a long period is necessary in breeding of race horses (7, 13). Although the effects of trot, gallop, and complex exercise programmes on physiological and biochemical parameters in horses at various age have been investigated (10, 11, 20, 22), a little work has done about to increase the efficiency especially in young horses.

In the present study, we aimed to determine the appropriateness of the exercise, which applied as a beginning training to the young horses that are bred as race horses in Gemlik Military Veterinary School and Central Training Commandership, to the animals' physical condition, and to determine the exertion which occurs as a result of the exercise.

Materials and Methods

In the study, nine two-year old male English horses bred as race horses in Gemlik Military Veterinary School and Central Training Commandership were used. All animals were trotted approximately 5400 m in 10 minutes on dry sand, closed manage with a circumference of 150 m. The speed of the horses was approximately 540 m/min. When blood samples were taken, the temperature was 18°C and relative humidity was 78%. Before the present study, this exercise had been applied to the animals 5 days a week for 7 weeks.

Jugular venous blood samples of 10ml were collected from all horses before (at 0 min), at the 5th minute, right after (10 min), and 1/2, 6, 12 and 24 hours after the exercise, and placed into the tubes containing lithium heparin. Blood samples were centrifuged at 3500 rpm for 10 minutes and extracted plasma samples were kept at -20°C until they were analysed.

Plasma AST, ALT, GGT, ALP, Ca and P levels were determined with Ciba Corning Express Plus autoanalyzer by using Bio-Clinica commercial kits.

The importance controls of the differences between groups were determined with variance analysis (28).

Results

The mean values of plasma AST, ALT, GGT, ALP, Ca and P levels before, during and after the exercise, and the standard deviations of the mean values are presented in Table 1.

Table 1. The effects of exercise on some blood parameters in young horses (n=9)

Properties	Pre-exercise O min $\bar{x} \pm S\bar{x}$	During Exercise 5 min $\bar{x} \pm S\bar{x}$	End of the exercise 10 min. $\bar{x} \pm S\bar{x}$	After-exercise			
				1/2hour $\bar{x} \pm S\bar{x}$	6 hour $\bar{x} \pm S\bar{x}$	12 hour $\bar{x} \pm S\bar{x}$	24 hour $\bar{x} \pm S\bar{x}$
AST (U/L)	276.57 17.04	274.00 12.94	279.75 14.53	287.71 14.35	284.12 18.58	283.56 16.19	280.78 16.20
ALT (U/L)	13.02 3.17	13.08 3.24	10.94 1.39	13.80 2.97	14.76 3.17	13.36 2.80	12.79 2.61
GGT(U/L)	15.75 1.94	16.33 1.46	16.12 1.67	16.14 2.92	13.50 1.85	15.56 1.81	15.44 1.90
ALP (U/L)	217.25 8.86	238.67 9.58	231.00 11.22	207.43 10.10	222.37 8.68	232.44 8.76	222.00 11.46
Ca (mg/dl)	11.63 0.22	11.54 0.27	11.20 0.28	11.92 0.29	11.36 0.29	11.76 0.20	10.80 0.24
P (mg/dl)	4.57 0.40	4.82 0.24	4.71 0.24	4.66 0.24	4.14 0.14	5.01 0.21	4.20 0.22

Although slight increases in plasma AST, ALP and GGT levels were noticed at the end of the exercise, the differences were found not to be significant statistically. Undulations determined in plasma ALT level during and after the exercise were also found not to be significant statistically. Although a decrease in plasma Ca level and a slight increase in plasma P level were determined in comparison to the pre-exercise levels, these changes were not significant statistically.

Discussion

In the present study, our results regarding the pre-exercise AST, ALT, ALP and GGT values are within the ranges informed by various authors for AST (10, 18, 23), ALT (20, 22, 23), ALP (10, 18, 23) and GGT (18, 22) in resting horses. It has been suggested that, normal values of these enzymes in race horses are in wide ranges (10,24,31), and the reason of this case can be explained by being different the response of animals to exercise programmes (3, 31).

In this study, statistically no significant differences in AST level was observed after exercise (Table 1), and this make us to think the adaptation of the horses to the exercise programme which had been applied to the animals before the experiment. However, AST activity of the well-trained horses was low (35), and in drought-horses the decrease of AST level in course of time is explained by the adaptation of the animals (19), and these information support our thought. It has been notified that, physiological adaptation decrease the secretion of enzymes due to the decrease of the muscle membrane permeability (5, 12). Our findings regarding the high values observed in the recovery period after exercise (Table 1) are in accordance with the literature (33).

In the presented study, statistically no significant differences were observed in ALT and GGT levels before, during and after exercise (Table 1). Compared to the other studies (13, 14, 23), as the time and strength of the exercise which was applied to the animals in this study were low, it did not cause a destruction in muscle, and this could be the reason of the differences observed among the studies. Gerber (6) informed that, increase in activity can be seen only in liver and muscle diseases.

No change was determined in GGT level with exercise. Although there are some information (2, 20) support our findings about GGT level, there are some studies which declare an increase in GGT level (10, 14). It has been suggested that, GGT level is high in horses which start to ride with a high beginning GGT level or which a good training programme did not applied, whereas the level of GGT does not change significantly in healthy and well-trained horses (26).

In this study, a statistically significant increase was not found in ALP level with exercise, and some undulations was determined in the recovery period (Table 1). Although it has been suggested that the decrease in performance may be related with the increase in ALP (14, 31, 36), no unusual changes occur in bone metabolism with exercise and so ALP is not a parameter related with performance (14). Our findings support the thesis which informed no change in ALP level. Rose et al. (23) applied an exercise which has different physically arduousness phases to the horses, and they found an increase in ALP level in all phases of the exercise. But they could not determine that the reason of this increase is from liver or from muscle.

Our findings about pre-exercise Ca and P levels are in accordance with the literature (16, 18, 24, 34). Although a decrease was observed in Ca level by the end of the exercise, this decrease was found not to be significant statistically (Table 1). Although there are some studies which inform a significant decrease in Ca level after exercise (15, 23), there are some studies which declare no change in Ca level (8, 17, 24). The reason of the differences among the studies can be explained by being different the strength of the exercise. Because the amount of Ca excreted by perspiration changes according to the strength of the exercise. In this study, the exercise programme applied to the animals was light and the season was autumn, and so, these factors might decrease the loss of Ca by perspiration. However, it has been declared that, cold weather decrease perspiration and so the loss of Ca decrease (17). Our findings about the decrease in Ca level can be explained by binding of Ca to troponin molecule in the contraction of muscle during exercise. It has been declared that, during contraction Ca binds actin to myosine by binding troponine molecule (14), and this declaration supports our findings.

In the presented study, the increase determined in plasma P level with exercise and the changes observed in P level after exercise were found not to be significant statistically (Table 1). Furthermore we can suggest that this kind of exercise does not need high energy and the destruction of ATP is not much.

As a result, the changes observed both in enzymes, and Ca and P levels after exercise were found not to be significant statistically. It can be said that, this exercise programme applied to the animals did not force the animals, and the horses adapted to the exercise programme due to the application of the exercise programme before the study. Therefore, we can suggest that, the period or the strength of the exercise or both of them can be increased.

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