The effect of intraocular pressure, serum calcium, magnesium and inorganic phosphorus concentrations on jumping performance of horses

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Abstract: The aim of the study is to evaluate the relation of serum mineral levels (Ca, Mg, Pi) with intraocular pressure (IOP) and jumping performance of horses. Twenty-four jumping horses, actively participated in the competition, were selected from a horse sport center in Bishkek. Intraocular pressures in both eyes of each horse were measured by using a tonometer and blood samples were collected for analyzing serum Ca, Pi and Mg levels. IOP, serum Ca, Mg and Pi values were measured in normal ranges in all jumping horses. Although Ca and P levels were found different in statistic ($p<0,05$) between the groups, IOP and serum mineral levels of Ca, Mg and P had not been found effective on race performance.

Keywords: calcium, intraocular pressure, inorganic phosphorus, jumping horse, magnesium, performance

Serum kalsiyum, magnezyum ve inorganik fosfor konsantrasyonları ile intraokuler basıncın atlarda yarış performansı üzerine etkisi

Özet: Bu çalışma, konkur atlarında göz içi basıncı ile serum Ca, Mg, ve Pi seviyelerinin yarış performansına etkilerini araştırmak amacıyla yapılmıştır. Bu amaçla Bişkek at spor okulunda aktif olarak yarışlara katılan 24 konkur atı seçildi. Çalışmada göz içi basınç (IOP) değerleri, her iki gözden de olacak şekilde tonometre kullanılarak yapıldı. Konkur atlarından kan örnekleri toplanarak serum Ca, Mg ve Pi seviyeleri ölçüldü. Çalışmada spor atlarının IOP, serum Ca, Mg ve Pi değerleri normal değer aralıklarında bulundu. Gruplar arası serum Ca ve P seviyeleri istatistiksel olarak farklı olmasına rağmen ($p<0,05$), IOP, serum Ca, Mg ve Pi seviyelerinin yarış performansını etkilemediği tespit edildi.

Anahtar Kelimeler: göz içi basıncı, inorganik fosfor, kalsiyum, konkur atı, magnezyum, performans

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INTRODUCTION

Horse jumping, based on the jumping over the obstacles in a short time, is one of the most popular equine sports in Kyrgyzstan and around the world. Anatomic and physical conformation, talent and sportive performance of both horses and their riders are very effective on the success of horses in this sport (1-3). Performance of the sport horses is also affected from age, weight and gender, even psychological condition of horses (4-6). The horses are limited near focus capability because of weak accommodative ability of the lens (7). They can only use both eyes until an object approaches within 3–4 ft. Therefore, healthy eyes and good vision is extremely important for jumping performance of the animal (8).

The glaucoma, one of the most important eye problem, are a group of diseases resulting from alterations of aqueous humor dynamics. It cause increase intraocular pressure (IOP). Consequently, normal function of the retinal ganglion cells and optic nerve are negatively affected (8, 9). Calcium (Ca), Phosphorus (P), and Magnesium (Mg) are multivalent cations and role in many biologic and cellular functions. Ca is an important intracellular messenger and influx could have several effects on aqueous humor dynamic such as, ciliary perfusion, osmotic and hydrostatic component (10). Similarly, Mg acts as a cofactor in many enzymatic reactions. In human studies, critical role of Mg is of in the regulating of cellular functions in ocular tissues was revealed. The association of Mg levels with the pathogenesis of glaucoma may be attributed to Mg serve as a cofactor for several enzymes including involving membrane-associated ATPases, modulating of smooth muscle vessel contraction, and regulation of oxidative stress pathways (9).

There is no accessible data about the affect of IOP and relation of serum Ca, Mg and P levels on athletic performance in jumping horses. It was aimed to evaluate the relation of serum mineral levels (Ca, Mg, Pi) with IOP and jumping performance of horses.

MATERIAL and METHODS

Animals

Twenty-four Jumping horses, actively participated in the competition, were selected from a horse sport center in Bishkek and used for this study. All procedures were approved by Ethic Committee of Animal Experiments of Kyrgyz-Turkish Manas University (2016-04/1).

Process of jumping competition

Before the race, horses were treated pre-race training process. In this period, horses were marched, trot out and run gallop for 2, 5, 10 minutes, respectively. After this process sport horses were jumped over the obstacle 5 times. Subsequently, those animals were jumped over 10 obstacles (120-130 cm in height) for 60 seconds during competition. According to the race performance the horses were defined as successful (first 10 animals) and fail (14 animals) (table 1).

Measurement of IOP

Intraocular pressure in both eyes of each horse were measured by using a tonometer (TonoVet R, Kruuse, Denmark) before the competition.

Analyses of serum Ca, Mg and Pi

Blood samples were collected into serum test tubes by the jugular vein to determine Ca, Mg and Pi. Blood samples were centrifuged at 3000 rpm 10 min. to separate the serum. Serum were stored at -20 °C until analysis. Serum Ca, Mg and Pi values were analyzed by chemistry

analyzer (BA-88A Semi-Auto Chemistry Analyzer, Mindray, Chine) in Faculty of Veterinary Medicine, Kyrgyz-Turkish Manas University.

Statistical analyses

Statistical analyses of data were performed using independent simple T- Test in order to compare the means of two independent experimental groups (IBM SPSS Statistics 22.0, ABD).

RESULTS

The measurements of jumping performance, IOP, serum Ca, Mg, Pi and statistical analyses were displayed in table 1 and 2, respectively.

Table 1. The measurements of jumping performance, intraocular pressure, serum Ca, Mg and Pi values

Race ranking	Jumping performance		IOP (mmHg) 15-30	Ca (mg/dl) 10.2-13.4*	Mg (mg/dl) 1.4-2.3*	Pi (mg/dl) 1.5-4.7*
	Second	Number of fouls				
1	54" 81	-	22	12.38	1.55	1.80
2	54" 93	-	25	15.28	1.25	2.46
3	59" 33	-	27	10.76	1.60	1.03
4	64" 33	1	30	13.15	2.66	2.11
5	64" 00	4	37	11.39	0.89	1.51
6	54" 06	≥8	21	24.64	1.42	1.59
7	57" 28	≥8	22	33.87	1.41	1.13
8	60" 56	≥8	20	4.10	1.50	1.17
9	61" 08	≥8	27	8.57	1.54	2.07
10	62" 37	≥8	37	13.71	1.80	2.34
11	Fail	≥8	22	18.77	1.02	0.31
12	Fail	≥8	23	17.99	0.28	3.35
13	Fail	≥8	30	14.19	1.60	1.30
14	Fail	≥8	27	24.35	0.57	2.21
15	Fail	≥8	24	25.95	0.39	3.07
16	Fail	≥8	18	23.47	1.09	2.67
17	Fail	≥8	32	19.95	1.04	1.68
18	Fail	≥8	30	22.04	1.30	2.00
19	Fail	≥8	27	22.95	0.89	1.25
20	Fail	≥8	23	15.74	1.28	3.93
21	Fail	≥8	24	19.61	3.23	1.26
22	Fail	≥8	26	17.18	1.90	1.59
23	Fail	≥8	27	16.25	0.47	1.82
24	Fail	≥8	28	15.34	1.17	3.54

* Normal reference values of serum Ca, Mg, Pi and IOP of horses (MERCK Veterinary Manuel, 2016)

Table 2. The effect of IOP, serum Ca, Mg, Pi levels on jumping performance of horses (Independent simple T- Test)

Parameters	Groups	
	Succesful (n=10)	Fail (n=14)
IOP	24.25±3.53-	25.78±3.72-
Ca(mg/dl)	16.89±8.1b	19.55±3.6a
Mg (mg/dl)	1.56±0.4-	1.33±0.5-
Pi (mg/dl)	1.72±0.5b	2.28±0.9a

In same line, - : $p>0.05$, a,b: $p<0.05$

DISCUSSION and CONCLUSION

Jumping sport is one of the most popular in thoroughbred horse racing. Many factors including horse health and rider condition are effective on the race performance. It has been reported physiologic, hematologic, metabolic, biochemical and also psychological on the training and racing performance of the race horses in previous studies (11, 12). The glaucoma is a group of diseases resulting from alterations of aqueous humor dynamics. It cause increase IOP and normal function of the retinal ganglion cells and optic nerve negatively affected (8, 9). The reference range values of IOP have been reported between 15 and 30 mm/Hg and over 30 mm Hg has been considered as diagnostic for glaucoma (13). Although there are two over-measured horses in the first ten jumping horses (successful group), high IOP value was not found statistically important on race performance. Similarly the horses in fail group (14 animals) were not affected by IOP for race performance in statistic.

Magnesium is the one of the main intracellular cation and acts as a cofactor in more than 300 enzymatic reactions in the body (14). Magnesium has a vital role in the eye functions, therefore, Mg deficiency may have a causative relation with several disorders of the eye. In Mg deficiency conditions (Hypomagnesaemia), some optic disorders including multifocal necrosis in the retinal pigment epithelium (15), myelin disorders in optic nerve and drying on the corneal surface (16). Serum Mg values had not affected on race performance ($p>0,05$) in the presented study.

Over calcium influx causes oxidative stress (10) and it has been reported that Ca influx into retinal ganglion cells were effective on cellular damage on retinal ganglion cells (17). Calcium acts a critical role for many vital functions including neuromuscular transmission and intracellular signaling and in visual transduction via Ca2-binding proteins (18). Besides Ca and iron dietary supplement has been reported as a risk for glaucoma (19, 20). Similarly, high serum Ca level causes keratopathy in corneal band (21). However serum Ca levels were not directly affective on race performance, it was found difference between the groups ($p<0,05$) in presented study.

Serum Pi concentration has been reported as have main role in the maintaining of serum osmolarity. The changes of blood osmolarity due to the phosphorus imbalance may result IOP and may lead to glaucoma (22). Although serum Pi levels were not directly affective on race performance, it was found difference between the groups ($p<0,05$) in presented study.

In conclusion, IOP, serum Ca and Mg levels were not found directly effective on the jumping performance of thoroughbred horses.

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