Trakia Journal of Sciences, Vol. 10, Suppl. 1, 372-376, 2012

Available online at:
http://www.uni-sz.bg

ISSN 1313-7050 (print)
ISSN 1313-3551 (online)

EFFECTS OF EXHAUSTIVE EXERCISE ON BLOOD GLUCOSE, TOTAL CHOLESTEROL AND TRIGLYCERIDES IN CANINE EXPERIMENTAL MODEL

P. Dzhelebov*, D. Gundasheva, M. Andonova, E. Slavov

Department of General and Clinical Pathology, Faculty of Veterinary Medicine
Thrakia University, Stara Zagora, Bulgaria

ABSTRACT
BACKGROUND: Exercise alters metabolism in different ways depending on exercise duration and intensity.
OBJECTIVES: The aim of this research was to determine the influence of exhaustive exercise on blood glucose, total cholesterol and triglycerides in canine experimental model.
MATERIAL AND METHODS: We used 12 male, mongrel dogs divided into two groups – animals from experimental group were submitted to aerobic exercise until complete exhaustion; animals from control group did no exercise. Serum glucose, total cholesterol (TC) and triglycerides (TG) levels were measured before exercise (BE), right after (0 hour) and on 2nd, 4th, 24th, 48th and 72nd hour, and on day 7th and 14th after exercise.
RESULTS: In experimental group, as compared to BE level, blood glucose decreased insignificantly on 0 hour and 2nd hour. Glucose levels in experimental group were significantly lower compared to controls on 0 hour after exercise ($p<0.05$). TC in experimental group did not change significantly after exercise, but compared to control group TC levels decreased on 4th hour after exercise ($p<0.05$). TG in experimental group increased significantly on 0 hour, both compared to BE level ($p<0.05$) and to controls ($p<0.01$).
CONCLUSION: Single bout of exhaustive exercise has short term influence on metabolism – mobilization of energy sources.

Key words: dog, blood glucose, total cholesterol, triglycerides, exercise

INTRODUCTION

Recently exercise has become a field of intense studies. Various experiments concerning humans and different animal species have been conducted. Results from such studies are sometimes controversial, which depends on the type and amount of exercise, the species involved, climatic conditions, age, nutritional and hydration status, level of adaptation to exercise and many other factors. Some studies have shown that excessive exercise may have some negative effects on organism. Examples include suppression of immunity (1), gastrointestinal bleeding (2), exercise induced haematuria (3), intravascular haemolysis, anemia (4), trauma and electrolyte balance disorders (5). Still these findings have only short term negative effect and do not affect overall health status. It is generally accepted that regular moderate exercise has many long term beneficial effects, while acute exhaustive exercise may have some negative effects. Some of the mechanisms of both negative and positive effects of exercise still remain unrevealed. Nowadays, as obesity is becoming epidemic, beneficial effects of exercise are in the focus of many studies. Exercise and diet may improve overall health status and management of some metabolic disorders such as insulin resistance and dyslipidaemia, which has been proven through various experiments (6-7). Defining the amount of healthy exercise is very important, because changes in cardiovascular function and hematological and biochemical changes are sometimes especially dramatic during exercise. As exercise increases energy expenditure, it may alter metabolism in

***Correspondence to**: *P. V. DZHELEBOV, Department of General and Clinical Pathology, Faculty of Veterinary Medicine, Thrakia University, 6000 Stara Zagora, Bulgaria, e-mail: petkovet@abv.bg*

different ways depending on exercise duration and intensity. Many experiments involve human volunteers, but animal experimental models are also often used. In the field of endurance sports involving humans, horses and dogs, metabolic changes may be used as markers of adaptation to exercise and to monitor results from different training approaches.

The aim of this research was to determine the influence of single bout of exhaustive exercise on blood glucose, total cholesterol and triglycerides in canine experimental model.

MATERIAL AND METHODS

1. Experimental animals

We used twelve healthy male, mongrel dogs, 1.5 – 3.5 years of age. Adaptation period continued one month. The dogs were treated against parasites with Biheldon (Cheironpharma Europe, each tablet contains - praziquantel 50mg, pyrantel pamoate 150 mg) at a dose of 1 tablet/10 kg. Also they were treated against ectoparasites with antiparasite shampoo, Ectomin and Tapilan (Dorvet, Israel). An antirabies vaccine – Nobivac Rabies (Intervet International B. V.) was also applied. Animals were kept in individual cages (situated indoors, providing constant room temperature) and went for walks twice a day – half an hour in the morning and another walk in the evening. Dogs of experimental group (n=6) weighed 18.67 ± 0.82 kg, and control animals (n=6) – 20.08 ± 3.29 kg. Only experimental animals were submitted to a prolonged strenuous exercise.

2. Exercise protocol

2.1. Adaptation

The aim of the study was to submit experimental dogs to a prolonged strenuous exercise until complete exhaustion. During adaptation period only one person took care of the dogs so that the can get used to him and accept him as “the leader of the pack”. In each day of the last week of adapting period, that person trained them to run on a leash after him riding a bicycle. Dogs were willing to run and easily performed the exercise, which had a very short duration of about 10 minutes and can not be considered as endurance training. Runs were performed off road to avoid trauma. During this week dogs got used to the environment so they were able to run without distracting their attention.

2.2. Exhaustive exercise

In the day of the experiment each dog was submitted to a prolonged strenuous running until complete exhaustion. Dogs ran on a leash following the “leader” riding bicycle at an average speed of about 12 km/h or faster depending on dog` s abilities. Dogs ran galloping and trotting. When fatigue emerged and they were unwilling to run they were encouraged by the leader verbally and by pulling the leash. Exercise was stopped when dogs could no longer run and lay down on the ground refusing to continue.

2.3. Explanatory remarks

Exhaustive exercise began with a 5 min warm up running. To prevent dehydration in every five kilometers of running dogs had access to water. Experiment was conducted under the conditions of moderate climate in spring and autumn - ambient temperature did not exceed 20^0C and humidity was about 55-56 %. We preferred this exercise protocol to running on a treadmill, because treadmill running is less difficult and dogs get easily bored. On the contrary when running off road they are eager to follow their “leader” as long as they can run. Dogs had no endurance training before conducting the experiment so they reached exhaustion easier through this strenuous and prolonged exercise.

Experiment was approved by the Ethics Committee of Veterinary Faculty of Trakia University.

3. Blood samples

Blood samples for measuring TC and TG were collected in sterile glass tubes by punction of *vena cephalica* in the following dynamics – before exercise, right after exercise (0 hour) and on 2nd hour, 4th hour, 24th hour, 48th hour, 72nd hour, 7th day and 14th day after exercise. Blood was collected in tubes and was allowed to cloth and then serum was separated. Blood samples for BE level and on the following days were taken at 8 a.m.

4. Biochemical analysis

4.1. Blood glucose

Blood glucose concentrations were assayed by an express glucose oxidase method using Glucometer Elite (Bayer®).

4.2. Total cholesterol and triglycerides

TC and TG were measured by enzymatic colorimetric test (HUMAN GmbH, Wiesbaden, Germnay) performed on Cobas Mira plus (Roche Diagnostics, Germany).

5. Statistical analysis

Results are presented as means±SD. Data was submitted to Shapiro-Wilk`s test (Statistica 6.0, by StatSoft), standard F-test and t-test (StatMost, version 2.5, provided by DataMost corporation). Differences were considered statistically significant at the $p<0.05$ level.

RESULTS

Two of the dogs completed 24km of running, two of them ran 25km and the other two covered a distance of 30km. All dogs completed the exercise for about 2 hours (1h 58min – 2h 9min). Mean running distance and time were respectively 26.33 ± 2.88 km and 122.83 ± 4.58 min.

In experimental group, as compared to BE level, blood glucose decreased on 0 hour and 2nd hour (with the lowest value on 0 hour), but decrease was insignificant **(table 1)**.

Comparison between experimental and control group in dynamics showed statistically significant lower blood glucose levels in experimental group on 0 hour after exercise ($p<0.05$).

TC in experimental group did not change significantly after exercise.

Comparison between experimental and control group in dynamics showed statistically significant lower TC levels in experimental group on 4th hour after exercise ($p<0.05$).

TG in experimental group increased significantly on 0 hour, both compared to BE level ($p<0.05$) and compared to controls ($p<0.01$).

In control group, as compared to BE level, measured parameters did not show any significant differences.

DISCUSSION

The study describes the mobilization of different energy sources leading to some biochemical blood changes, during prolonged aerobic exercise with exhaustion as the end point.

For completing such a prolonged running the body muscles use "fuel" that is composed of fatty acids and glucose. Dietary glucose is stored in the muscles and liver as glycogen. Muscle glycogen is used as energy source only by muscles. Liver glycogen breakdown releases glucose, which enters circulation. In the initial phases of prolonged exercise, energy supply of muscles is first met by the breakdown of muscle glycogen and increased glucose uptake from circulation (8). Blood sugar may increase because of hepatic glycogenolysis, but with progression of exercise blood sugar decreases. This activates gluconeogenesis, which can not alone maintain for long time normal blood sugar levels during exercise. This can explain decreased glucose levels in our experiment. Low blood glucose, caused by depletion of glycogen stores in the liver and muscles, leads to a condition of sudden fatigue and loss of energy forcing the animal to stop running.

Dietary fats deposit into adipose tissue and muscles (intramuscular fat). Fats consist of 90% fatty acids and 10% glycerol. During rest and after exercise muscle cells prefer fatty acids as fuel. This energy source can also maintain aerobic muscle work at lower intensity. Triglycerides in muscles are an important energy store that can be used during exercise and may have significant contribution to total energy turnover depending on the type of exercise (9). Adipose depots play the role of energy stores. When muscles need increased energy supply for prolonged period these depots are mobilized. Muscles and heart use fatty acids as fuel and glycerol is used for gluconeogenesis by the liver (10-12). So the increase of triglycerides detected right after exhaustive exercise in our experiment, can be considered to be the result of mobilization of adipose depots.

It is well known total cholesterol levels are lower in humans that practice regular aerobic exercise. Findings about changes in cholesterol levels before and after exercise are not consistent. LDL-C measurements in humans that practice aerobic exercise are also not consistent but most studies report lower LDL-C. Endurance exercise has been definitively proven to increase HDL-C (13). The exact biochemical mechanism leading to these changes in the lipid profile is not known, but increase in the activity of lipoprotein lipase seems to be quite logical explanation. Probably adaptation to endurance exercise increases levels of lipoprotein lipase, which results in higher utilization of triglycerides and involvement of cholesterol in HDL-C. Physical exercise, body weight and diet strongly influence lipid profile (14). Strong positive correlation exists between LDL and body weight. As endurance exercise decreases percentage of body fat it lowers LDL, thus keeping cholesterol lower (15).

CONCLUSION

Exhaustive exercise lowers blood glucose levels, which is due to glycogen depletion, and activates mobilization of adipose depots, which results in transient increase in levels of triglycerides.

Table1. *Glucose, total cholesterol and triglycerides serum concentrations in experimental group (n=6) and control group (n=6). Results are presented as mean±SD.*

Parameter	Group	BE level	0 h	2 h	4 h	24 h	48 h	72 h	7 d	14 d
Glucose (mmol/L)	Experimental	3.18±0.79	2.97±0.62 **b[1]**	2.98±0.58	3.13±0.52	3.13±0.58	3.37±0.61	3.47±0.66	3.37±0.61	3.33±0.34
	Control	3.63±0.45	3.97±0.49	3.52±0.60	3.73±0.56	3.68±0.51	3.82±0.42	3.95±0.41	3.93±0.34	3.8±0.38
Total cholesterol (mmol/L)	Experimental	4.01±0.98	4.15±0.80	4.32±0.73	3.68±0.35 **b[1]**	4.27±0.69	4.22±0.85	4.42±0.98	4.28±0.33	3.63±0.92
	Control	3.99±0.61	4.14±0.27	4.17±0.49	4.25±0.32	3.98±0.47	3.99±0.39	4.10±0.33	3.88±0.47	4.09±0.55
Triglycerides (mmol/L)	Experimental	0.75±0.10	1.23±0.15 **a[1] b[2]**	0.77±0.05	0.78±0.11	0.93±0.25	0.87±0.19	0.89±0.15	0.90±0.19	0.82±0.25
	Control	0.67±0.14	0.79±0.17	0.74±0.24	0.65±0.12	0.70±0.13	0.74±0.08	0.74±0.07	0.65±0.12	0.78±0.24

Statistically significant differences are indicated as follows:

a[1] $p<0.05$ within experimental group, as compared to BE level

b[1] $p<0.05$ experimental vs. control group, compared at the same point of dynamics

b[2] $p<0.01$ experimental vs. control group, compared at the same point of dynamics

REFERENCES

1. Robson, P. J., Alston, T. D. and Myburgh, K. H., Prolonged suppression of the innate immune system in the horse following an 80 km endurance race. *Equine Vet J*, 35(2):133-7, 2003.
2. Halvorsen, F., Lyng, J., Glomsaker, T. and Ritland, S., Gastrointestinal disturbances in marathon runners. *Br J Sports Med*, 24(4): 266–268, 1990.
3. Abarbanel, J., Benet, A., Lask, D. and Kimche D., Sports hematuria. *J Urol*, 143(5):887-90, 1990.
4. Telford, R., Sly, G., Hahn, A., Cunningham, R., Bryant, C. and Smith, J., Footstrike is the major cause of hemolysis during running. *J Appl Physiol*, 94: 38–42, 2003.
5. Schott, H., Marlin, D., Geor, R., Holbrook, T., Deaton, C., Vincent, T., Dacre, K., Schroter, R., Jose-Cunilleras, E. and Cornelisse C., Changes in selected physiological and laboratory measurements in elite horses competing in a 160 km endurance ride. *Equine Vet J Suppl*, 36:37–42, 2006.
6. Bradley, R., Jeon, J., Liu, F. and Maratos-Flier, E., Voluntary exercise improves insulin sensitivity and adipose tissue inflammation in diet-induced obese mice. *Am J Physiol Endocrinol Metab*, 295(3):586-94, 2008.
7. Borghouts, L. and Keizer, H., Exercise and insulin sensitivity: a review. *Int J Sports Med*, 21(1):1-12, 2000.
8. Hargreaves, M., Muscle glycogen and metabolic regulation. *Proceedings of the Nutrition Society*, 63:217–220, 2004.
9. Roepstorff, C., Vistisen, B. and Kiens, B., Intramuscular triacylglycerol in energy metabolism during exercise in humans. *Exerc Sport Sci Rev*, 33(4):182–8, 2005.
10. Horowitz, J., Fatty acid mobilization from adipose tissue during exercise. *Trends Endocrinol Metab*, 14:386–392, 2003.
11. Snow, D. and Valberg, S., Muscle anatomy, physiology and adaptations to exercise and training. In Rose, R. and Hodgson, D. (eds), *The Athletic Horse: principles and practice of equine sports medicine*. Philadelphia, PA, W. B. Saunders Co., 1994.
12. Hammel, E., Kronfeld, D., Ganjam, V. and Dunlap, H., Metabolic responses to exhaustive exercise in racing sled dogs fed diets containing medium, low, or zero carbohydrate. *Am J Clin Nutr*, 30:409–418, 1977.
13. Haskell, W., The influence of exercise on the concentrations of triglyceride and cholesterol in human plasma. *Exercise and Sport Sciences Reviews*, 12:205-244, 1984.
14. Akçakoyun, F., Changes in serum lipid profile following moderate exercise. *African Journal of Pharmacy and Pharmacology*, 4(11):829-833, 2010.
15. Yu, H., Ginsburg, G., O'Toole, M., Otvos, J., Douglas, P. and Rifai, N., Acute Changes in Serum Lipids and Lipoprotein Subclasses in Triathletes as Assessed by Proton Nuclear Magnetic Resonance Spectroscopy. *Arterioscler Thromb Vasc Biol*, 19:1945-1949, 1999.